Code of Practice for Pits in Alberta Application – REVISED

Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8
May 15, 2023

Code of Practice for Pits in Alberta Application - Revised

Summit Pit

SLR Project No: 212.06650.00007/8

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for

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May 15, 2023

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1 copy – SLR Consulting (Canada) Ltd.

PREAMBLE

Alberta Environment and Protected Areas (EPA; also previously referred to as Alberta Environment and Parks), submitted three rounds of supplemental information requests (SIRs) for the Mountain Ash Limited Partnership (Mountain Ash), Summit Project. The first round of SIRs was completed by SLR and submitted September 23, 2022, and the second round submitted January 10, 2023.

In the third round of SIRs submitted to Mountain Ash April 28, 2023, EPA requested that all SIR content be provided within an updated Code of Practice for Pits (COP) application.

SLR Consulting (Canada) Ltd. (SLR), on behalf of Mountain Ash, submits this COP, which includes all EPA SIRs , that are directly relevant to the COP content. An addendum is provided to aid in tracking changes within the COP from the SIR process.

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1.0 INTRODUCTION

Mountain Ash Limited Partnership (Mountain Ash) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will be 208 acres (84 ha) in size. This land is currently owned by 1410266 Alberta Ltd. (a general partner of Mountain Ash). The Project received land use and a Master Site Development Plan (MSDP) approval on March 2, 2021, Bylaw C-8051-2020 from RVC.

As part of the ongoing permitting process, Mountain Ash is submitting the following document for the Project under the *Environmental Protection and Enhancement Act* (EPEA) through the Code of Practice (COP) for Pits (AENV 2004a) Registration which considers the overall environmental impacts of the Project on the environment. Mountain Ash has also applied to RVC for a Development Permit (DP) to operate an aggregate operation which received conditional approval on July 13, 2021 (Appendix P). No activity within wetlands will take place until a *Water Act* approval from the Alberta Environment and Protected Areas (EPA) is issued.

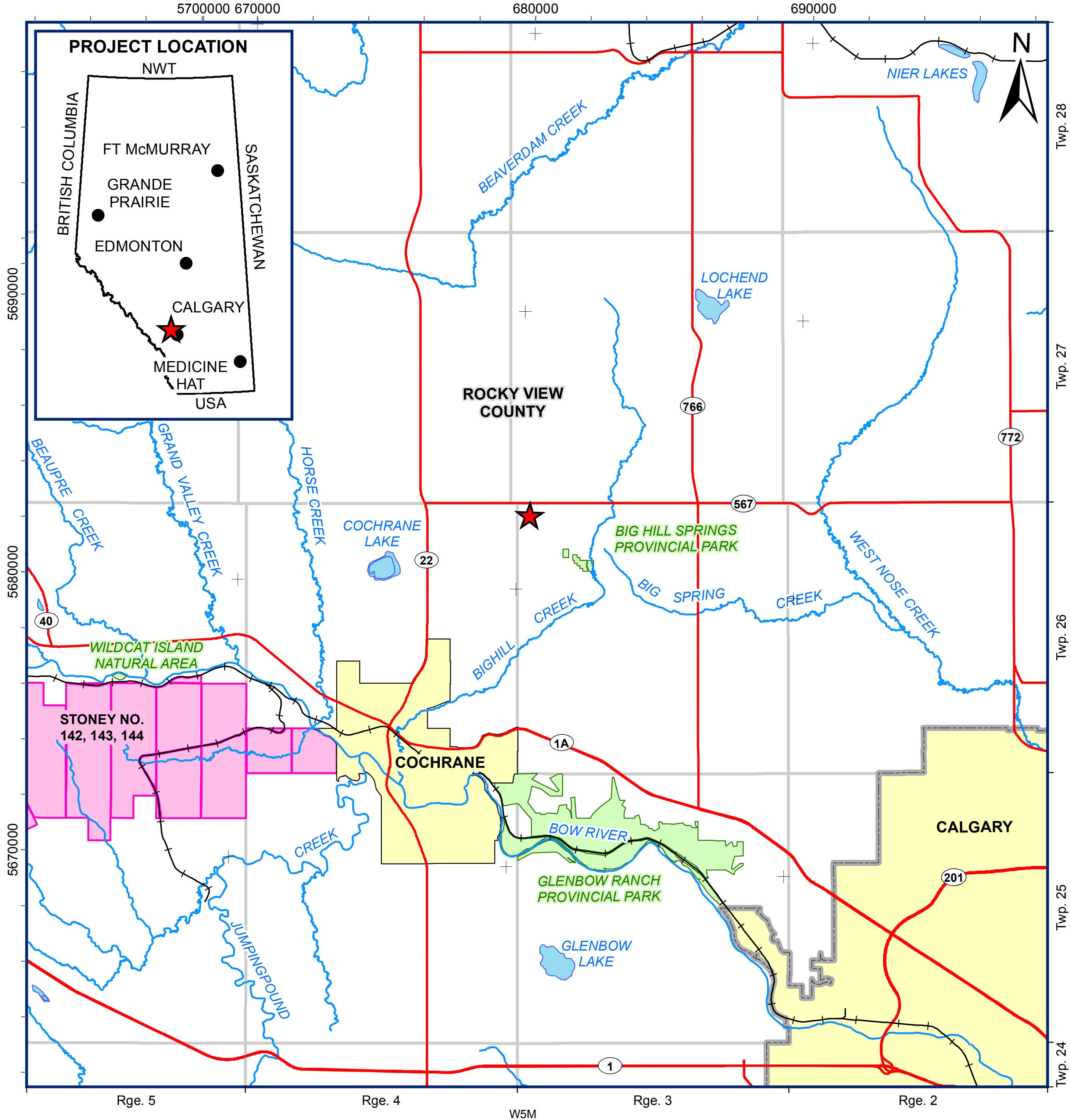
SLR Consulting (Canada) Ltd. (SLR) was appointed by Mountain Ash to compile the COP application. Alberta Environment and Protected Areas (EPA; also previously referred to as Alberta Environment and Parks), submitted three rounds of supplemental information requests (SIRs) for the Project. The first round of SIRs was completed by SLR and submitted September 23, 2022, and the second round submitted January 10, 2023. In the third round of SIRs submitted to Mountain Ash April 28, 2023, EPA requested that all SIR content be provided within an updated Code of Practice for Pits (COP) application. This application has been compiled following *the Guide to the Code of Practice for Pits* published by Alberta Environment dated October 2004 (AENV 2004b). A completed version of the forms/checklists found throughout schedules 1-3 in the Guide to the COP for Pits can be found in Appendix P. Figure 2 has been prepared to show the general attributes of the site.

2.0 SITE OVERVIEW

The following summary provides an overview of existing site conditions:

- Topography: The physiographic region coincides with the Foothills natural region which comprises dissected plateaus and rolling uplands with surficial geology comprising glacial till and abundant buried fluvial deposits. The site is located at an average elevation of approximately 1,280 metres above sea level (masl). The site slopes to the southeast from the topographic high to the north and hosts a low-relief valley feature running northwest to southeast across NW 31-026-03 W5M. In SW 31-026-03 W5M, the topography slopes steeply southwesterly into the valley running west-northwest to east-southeast which leads to Big Hill Springs Provincial Park which is approximately 1,300 m away.
- Climate: The climate in this natural sub-region is typically characterized by cool summers and cold winters but highly influenced by the periodic warm Chinook winds (Downing and Pettapiece 2006). Compared to the rest of the country, Alberta has relatively low precipitation in the lee of the mountains and total average annual rainfall in the area is 450 to 500 mm per year (Alberta Agriculture, Food and Rural Development 2000).
- Zoning and land use: The proposed site is zoned as a Direct Control (DC) district under Bylaw C-8051-2020 signed into law on March 2, 2021. Three dwellings are present in the Project area.

- Flora: Most of the vegetation in the Project area is either tame pasture or hay/treed areas. No rare plants or noxious weeds listed under the *Weed Control Act* were found in the Project area.
- Fauna: Provincially and federally listed species at risk and sensitive species have the potential to be present within the Project area. Three sensitive species, one of which is federally listed, were observed within the Project area including great blue heron, least flycatcher, eastern kingbird, and barn swallow.
- Surface water: The site lies approximately 1,300 m upstream of the Big Hill Springs Provincial Park and is located within the surface water catchment of an unnamed watercourse which forms a tributary to the larger Bighill Creek. Bighill Creek is considered of provincial environmental significance (GoA 2015) based on the presence of the natural springs that feed the perennial creek. No surface water bodies (streams or lakes) have been identified within the site itself; however, there are two large temporary graminoid marsh (M-G-II) wetlands in the northwest corner and a number of other, smaller wetlands mainly classified as Class I ephemeral water bodies that were farmed through wetlands.
- Groundwater: Groundwater in assessment boreholes is between 20 and 24 m below ground surface (mbgs) and above the bedrock. The wetlands are perched on the glacial till and are not groundwater fed. The Project is considered a Dry Pit; therefore, no excavation below or at the groundwater table (GWT) will occur.
- Heritage: A historical resource impact assessment was completed for Phase 1 and 6 of the pit, Phases 2-5 have all been cleared with a statement of justification issued File #: 1408-0192; HRO 14-047. *Historical Resources Act* approval (HRA number 4650-20-0008-002) was conditionally granted for Phases 1 and 6 on July 19, 2021. Mountain Ash is completing additional work, as required, prior to any disturbance.



LEGEND

★ PROJECT LOCATION

HIGHWAY

RAILWAY

WATERCOURSE

▭ COUNTY BOUNDARY

🟪 FIRST NATION RESERVE

🟩 PROVINCIAL PARK

🟨 URBAN

🟦 WATERBODY

NOTES

This map is for conceptual purposes only and should not be used for navigational purposes.

Basedata:AltaLIS Government of Alberta under the Alberta Open Data License.

5 0 5

SCALE: 1:200,000 KILOMETRES

WHEN PLOTTED CORRECTLY AT 8-1/2 x11

NAD 1983 UTM Zone 11N

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

COP APPLICATION

REGIONAL LOCATION

January 7, 2022	Rev 0.0	Figure No.
Project No. 212.06650.00008		**1**

SLR

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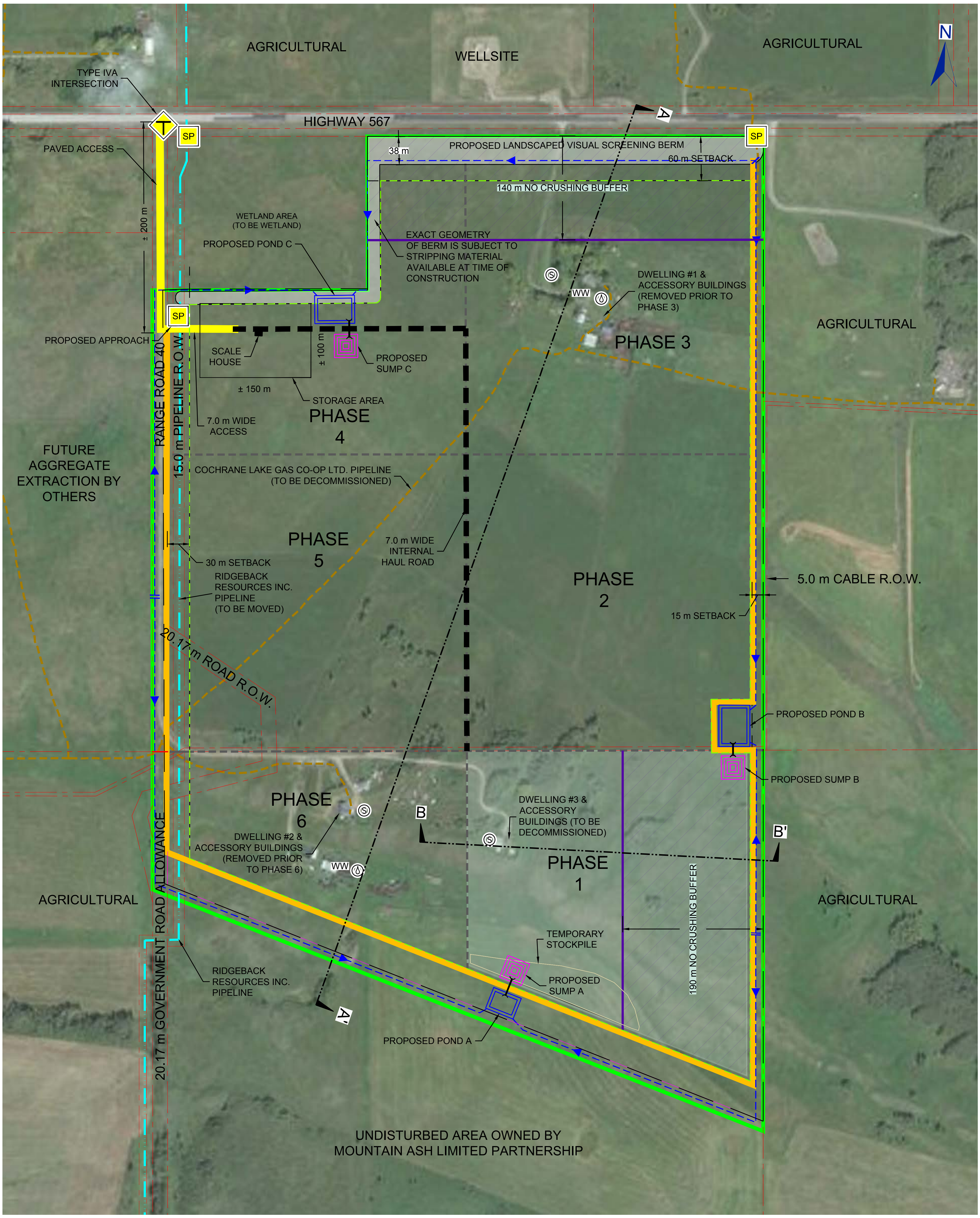
Cadfile name: S_212-06650-00007-A8.dwg



REFERENCES:

- - DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT AND SITE RECONNAISSANCE INFORMATION.
- LEGAL DESCRIPTION:
  W 1/2 SEC 31 TWP 026 RGE 03 W5M
  ROCKY VIEW COUNTY, ALBERTA
- IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY. IMAGERY DATE: SEPTEMBER 9, 2016.

NOTES:

1. PLACEMENT OF ALL DEVELOPMENT SHALL BE IN ACCORDANCE WITH BYLAW C-8051-2020 (DC170).
2. ALL DIMENSIONS ARE APPROXIMATE.
3. SPECIFIC LOCATION AND CONFIGURATION OF HIGHWAY INTERSECTION AND MUNICIPAL ROAD UPGRADES TO BE DETERMINED VIA DEVELOPMENT AGREEMENT PROCESS.
4. SPECIFIC LOCATION AND CONFIGURATION OF THE ON-SITE DEVELOPMENT TO BE DETERMINED AT CONSTRUCTION STAGE.
5. SPECIFIC DETAILS OF LANDSCAPED VISUAL SCREENING BERM TO BE CONFIRMED BY A LANDSCAPING PLAN.

LEGEND:

— — —	PROPERTY BOUNDARY
🟩	PROJECT BOUNDARY
▭	PHASE I EXTRACTION AREA
Ⓞ	EXISTING WATER WELL

LEGEND:

Ⓢ	EXISTING SEPTIC TANK
🟨	MOUNTAIN ASH ACCESS ROAD
- - - -	COCHRANE LAKE GAS CO-OP PIPELINES
— · · —	RIDGEBACK RESOURCES INC. PIPELINE
SP	SUMMIT PIT SIGN
━━━	OVERBURDEN PERIMETER BERM
- - ▶ - -	PROPOSED DRAINAGE DITCH
- - - -	MAXIMUM SIZE OF PIT
—— ——	LIMITS OF DISTURBANCE
A A'	LINE OF CROSS SECTION

0 50 100 200 300 m

SCALE 1:5,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT

SUMMIT PROJECT

SITE PLAN

Date: May 15, 2023
Project No. 212.06650.00006
Figure No. 2

SLR

3.0 PROJECT OVERVIEW

The Project will involve the development of a pit to extract sand and gravel in six phases starting at the southeast corner of the property. The final area will be 208 acres (84 ha), and the pit is expected to commence operations in 2023 with a 30-to-40-year operational life. Phase 1 comprises about 35.5 acres (14.4 ha) and is expected to take 6 to 8 years to deplete. This application is for Phase 1 through Phase 6; however, sand and gravel extraction will only occur in Phase 1 – initially.

The two wetlands in the northwest corner will be retained and Phase 4 will be developed on the lands south and east of them. Each phase, subsequent to Phase 1, is anticipated to take approximately 5 to 7 years to deplete. This is consistent with the development period term as per Bylaw C-8051-2020.

Based on drilling investigations at the site, there is 4 to 6 m of glacial till overburden overlying approximately 16 m to 20 m of sand and gravel. The till soils will be stripped and stockpiled for future use for post development- restoration. The sand and gravel is the target deposit for extraction and lies immediately above the underlying bedrock. The groundwater table lies at the bottom of the sand and gravel deposit, with only subtle seasonal shifts. Groundwater samples were collected in the Winter (Dec) of 2022 and following Spring 2023 (April) and are presented in the Groundwater Monitoring Plan (Appendix H).

The site will be excavated to no less than 1.0 m above the maximum recorded groundwater level (based on progressive monitoring locations as the pit develops) within the gravel deposit and will therefore be worked dry, with no requirement for operational or permanent dewatering. Actual depths will be determined with progressive investigation of water levels as the aggregate resource is developed.

Sand and gravel will be crushed and screened on-site and shipped to markets around Balzac, Calgary International Airport, and north Calgary growth areas.

Figure 3 is a schematic drawing that shows the setting and conceptual model for the site.

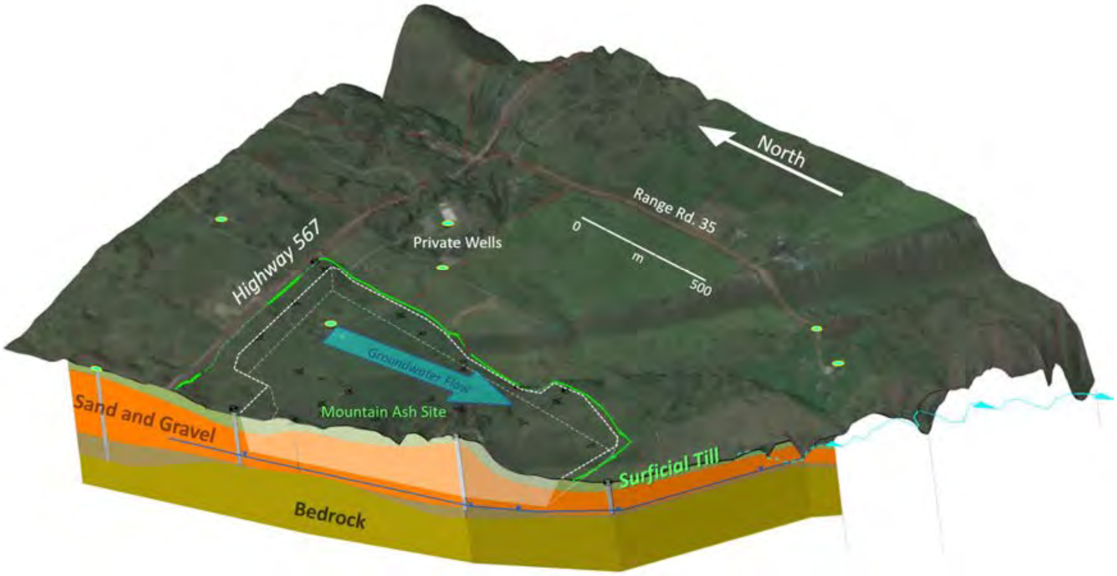


Figure 3: Conceptual Model of Summit Project

Mountain Ash have stated that mining will begin from the southwestern corner of Phase 1 as noted in SIR#2 C11-C12 Tech Memo response (SLR 2023a).

4.0 ACTIVITIES PLAN

4.1 What is Removed – Part 1(a)

Sand and gravel will be extracted and removed from the Summit Pit. Glacial till overburden will be temporarily stockpiled and used for temporary/permanent berm construction and/or stockpiled for progressive rehabilitation.

4.2 Current Pit Size – Part 1(b)

The site is currently unopened, and no historic excavation has taken place on the property. Therefore, there is no current pit size to report.

4.3 Thickness of Topsoil, Subsoil, Overburden and Aggregate – Part 1(c)

4.3.1 Topsoil and Subsoil

The AGRASID *Alberta Soil Information Viewer* was accessed to determine soils expected to be present in the Project area. The *Alberta Soil Names File (Generation 4) User's Handbook* (Alberta Soil Information Centre 2021) was also consulted. This document presents the authoritative suite of acceptable soil series names, with some of their defining attributes, for use in Alberta. The document outlines soil series name, characteristics such as order, great group, subgroup, and parent material type, and texture of soils that occur within a subject area (Alberta Soil Information Centre 2021).

Desktop review determined that underlying parent material in the Project area is moderately to strongly calcareous, mixed Continental and Cordilleran till (Alberta Soil Information Centre 2021). Fertile loam to clay loam Orthic Black Chernozemic soils are extensive, with Gleysolic soils present in poorly drained and lower slope positions expected at the Project (Alberta Agriculture and Forestry 2021). The Dunvargan soil series, a fertile, well-drained Orthic Black Chernozem formed on glacial till parent material, was identified across most of the Project area, with the gleyed variant (Dunvargan-GL) identified in depressional areas.

Soils were classified in the field in accordance with criteria established by the Soil Classification Working Group (1998). Soil inspection locations were completed to verify the desktop review and to help determine the presence or absence of wetlands on the landscape. Soil investigations were conducted on foot with a shovel and hand auger from July 2 to 4, 2020. The soils were investigated to a depth of 30 cm. Soil inspection locations (SILs) were advanced at a rate of approximately one location per 10 hectares (SLR 2022c) . Soil inspection location density was higher in areas where a distinct change was expected and around wetlands for a total of ten soil inspection locations. The depth of each soil horizon encountered at each SIL was recorded to determine best methods for soil handling and replacement. Soil map units have a certain range of properties or variability due to soil being a continuum. Consequently, the soil inspections were extrapolated using the principles of geomorphology and surficial geology in concert with the vegetation patterns to delineate individual soil map units. Soil map units identified in the field were correlated to the general soil series established in each unique ecosite identified within the proposed Project area.

In the field, upland soil inspection locations confirmed that the majority of the Project area consists of Orthic Black Chernozems of the Dunvargan soil series. Textures were loam to sandy clay loam. Wetlands contained gleyed Dunvargan soil series, with mottling in the Bmgj and Ccag and Ckg horizons. Areas of soil disturbance were noted in the vicinity of the several residences in the Project area. Example profiles of Dunvargan and Dunvargan-GL soils are identified in Tables 1 and 2. These soils have low wind erosion risk and moderate water erosion risk.

Table 1: Example Profile for Dunvargan Soil Series

Horizon	Depth (cm)	Colour	Field Texture	Structure	Consistence
Ap	0-19	black	Clay loam	granular	Friable
Bm	19-38	dark yellowish brown	Clay loam	prismatic	Firm
Cca	38-57	pale brown	Sandy clay loam	massive	Very Firm
Ck	57-100	yellowish brown	Sandy clay loam	massive	Very Firm

Table 2: Example Profile for Dunvargan-GL Soil Series

Horizon	Depth (cm)	Colour	Field Texture	Structure	Consistence
Ap	0-33	black	Clay loam	granular	Friable
Bmgj	33-52	brown	Clay loam	prismatic	Firm
Ccag	52-59	grayish brown	Clay loam	massive	Firm
Ckg	59-100	yellowish brown	Sandy clay loam	massive	Firm

Appendix Q provides a second soil profiling survey conducted by AECOM in December 2022. Figure 1:Soil Survey, in Appendix Q, presents locations of additional soil plots, Table 1: Detailed Soil Profile Description presents details of soil profiles collected during the December 2022 soil survey. These were provided to EPA in SIR #2, D5 (SLR 2023b).

4.3.2 Soil Handling and Soil Management

During construction, best practices for erosion and sedimentation control will need to occur to prevent soil erosion once the vegetation is removed. Topsoil and upper subsoil will be salvaged and stockpiled separately for reclamation purposes. These soils are not susceptible to wind erosion; however, water erosion during spring melt or heavy rainfall events is a concern. Soil stockpiles will be vegetated with an appropriate seed mix to prevent water erosion.

Average topsoil depth onsite for upland areas is approximately 25 cm and approximately 30 cm in wetland areas. Approximately 20 cm of suitable subsoil is present. Soil series and subsoil will be further characterized onsite during stripping and grading. Soils will be appropriately managed under the direction of a qualified professional onsite. Unique or problem soils, if present, will be handled separately.

See Appendix A for the Soils Management Plan.

4.3.3 Overburden and Aggregate

Based on drilling investigations at the site, there is 4 to 6 m of glacial till overburden overlying the sand and gravels. These till soils will be stripped and stockpiled around the perimeter of the relevant extraction phases for screening purposes and ultimately for future use in the site restoration.

The sand and gravel is the target deposit for extraction and lies immediately above the underlying bedrock. Groundwater in assessment boreholes were noted between 20 and 24 mbgs and generally lies just above the bedrock. The site will be worked to 1.0 m above the maximum recorded groundwater level within the gravel deposit and will therefore be worked dry, with no requirement for operational or permanent dewatering. Actual depths will be determined with progressive investigation of water levels as the site is developed.

The volumes of material outlined in Table 3 were estimated within the constraints of the mine plan (e.g., side slopes and mine footprint). The external boundaries were sloped in the model assuming a 1 vertical to 0.15 horizontal slope which is based on local experience in this particular deposit (T.Brady, personal communication) as this reflects the cemented nature of this over-consolidated deposit. All buffers have been respected in the calculation and are not included. The internal boundary between each phase was modelled as being vertical if not separated by pit slopes. The volumes calculated are estimated based on the above assumptions, actual quantities may vary subtly.

Table 3: Estimated Volume of Material in Thousands of Cubic Metres, within Pit Extraction Boundary

	Mountain Ash Property
Subsurface Area	Side Slope Angle of 1V:0.15H
Estimated Volume of overburden	3,192
Estimated Volume of Aggregate between Top of Sand and Gravel and 1 m above Water Table	11,844
Estimated Volume of Remaining Aggregate between 1 m above Water Table and Top of Bedrock	1,559

4.4 Erosion and Dust Control Techniques – Part 1(e)

4.4.1 Erosion Control

The techniques to control and minimize the wind erosion of exposed stockpiles include:

- Extraction shall be reduced or suspended if the condition of the active extraction face is dry and dusty, and the wind is directed toward a receptor at a speed sufficient to cause widespread visible erosion of the open face.
- Water shall be applied to stockpile materials that are dry and dusty when the wind is directed toward a receptor at a speed sufficient to cause widespread visible emissions.
- Stockpiles shall be maintained to avoid steep sides or faces.
- Disturbance of storage piles shall be minimized where feasible. For active stockpiles, the disturbed area shall be minimized to the extent possible.

As an added advantage, it is our experience that the overburden, hauling, and remediation areas will be crusted or covered by vegetation or snow after overburden stripping and backfilling is complete. Crusting would occur if the area were not disturbed for a period of time, depending on aggregate soil types and moisture content. Any natural crusting of the surface binds the erodible material, thereby reducing the erosion potential (U.S. EPA 2006). Although not readily quantifiable, it is a mitigating feature.

Extraction shall be suspended if the condition of the extraction face of the overburden is dry and dusty, and the wind is sufficient to cause wide-spread visible erosion of the open face with plumes directed offsite.

Wind forecasts shall be monitored regularly for heavy winds during operations to anticipate the need for these measures and allow for next day planning.

See Appendix B for the Sediment and Erosion Control Plan.

4.4.2 Dust Control

The techniques to control or minimize fugitive dust during aggregate crushing and screening include:

- The crushers will not be within 190 m of the east site boundary and 140 m from the north boundary. Relaxation of crushing buffers are present for the west and south boundaries.
- Where the site foreman deems necessary, the processing plants shall be equipped with a water spray system. The actual water application rate shall vary, being adjusted as needed to reduce visible dust emission. Water will be purchased and trucked in if necessary. No water license is required in this instance.
- Water for the spray system will be provided from third -party water supplier.
- The spray-bars will be triggered whenever the site foreman or scale operator observes visible dust emissions.
- Where possible, the height of lifts and discharge distances to the top of the stockpile will be kept to a minimum, not exceeding a 1.5 m drop height above the known height of the pile.
- Conveyor drop heights shall be minimized to the extent possible to reduce spillage and provide windbreak. Conveyors onsite should be equipped with rubber shrouds to minimize drop height for dust control.
- Conveyor belts shall be cleaned periodically to remove entrained material.
- During extreme windy conditions, the operator will suspend operations until emissions can visibly be controlled.

Truck loading will be suspended if the site foreman or scale operator observes the material to be dry and dusty and the wind is sufficient to cause wide-spread visible emissions with plumes directed toward receptors. The highest point of the material loaded into a truck shall not exceed the vehicles tray walls unless it is covered.

The internal haul routes at the Summit Pit beyond the paved route are unpaved but treated with a Calcium Chloride ($CaCl_2$) or equivalent dust suppression treatment. The following measures shall be used to control and minimize fugitive dust from the internal unpaved roads:

- A truck or trailer-mounted tank will always be located onsite and shall be equipped with a spray bar to deliver dust suppressor evenly over the haul route surface.

- Dust suppressant supply ($CaCl_2$) shall be available to allow the tanker truck to fill and apply the full payload each hour, if necessary, during dry conditions.
- The actual application rate shall vary, depending on surface moisture conditions and traffic conditions, and shall be triggered whenever the site foreman or scale operator observes trucks producing a trailing cloud of dust greater than one third of a trailer length. A sample application manual of $CaCl_2$ is provided in Appendix C.
- Haul routes shall be maintained (i.e., graded) approximately monthly during April to October, to ensure that loose fine material on the haul route surface is minimized.
- Trucks and other mobile equipment shall reduce speed as necessarily to reduce trailing dust clouds. The maximum speed will be 35 km/hr.
- The internal roads shall be clearly delineated to limit traffic to the established haul roads that have been maintained. Limiting the trucks away from unmaintained areas of the site is intended to minimize disturbance of unmaintained areas.
- To prevent spillage and air entrainment during transport of aggregates, the trucks carrying aggregate loads shall be covered during transport on the paved and unpaved roads.
- Disturbed areas of unpaved roads shall be stabilized to the extent possible with rollers or other similar equipment.

The following measures shall be used to control and minimize fugitive dust from the paved Range Road 40:

- The Summit Pit will have one point of entry/exit, which will be paved and well-maintained during operations. The entry/exit point is on Range Road 40, approximately 200 m south of the Highway 567 intersection.
- The Summit Pit shall have the capability to sweep or spray water or other approved dust suppressants as deemed necessary by the site foreman on paved surfaces, as well as roads near the site entrance as needed.
- The actual dust suppressant application rate shall vary, depending on surface moisture conditions and traffic levels, and shall be triggered whenever the scale operator or site foreman observes trailers producing a trailing cloud of dust greater than one third of a trailer length.
- To prevent spillage and air entrainment during transport of aggregates, the aggregate loads shall be covered during transport on the internal unpaved roads.
- Any spillage or material deposited on the paved roads shall be removed promptly.
- Regular sweeping of the paved roads will be conducted as required, at the discretion of the site foreman, to ensure that visible loose fine material of the haul road surface is minimized.
- Trucks and other mobile equipment shall reduce speed as necessarily to reduce trailing dust clouds. The maximum speed will be 35 km/hr.

See Appendix C for the full Dust Control Plan.

4.5 Local and Regional Air Monitoring Initiatives – Part 1(f)

An air quality assessment was undertaken as part of the MSDP application to assess the potential air pollution from the Project operations in relation to sensitive receptors. Project operations will produce anthropogenic emissions and dust into the ambient air. Diesel combustion from engines on heavy trailer and haul trucks and other vehicles emit sulphur dioxide (SO_2), fine particulate matter with aerodynamic diameter below 2.5 micrometres ($PM_{2.5}$), carbon monoxide (CO), and oxides of nitrogen (NO_x). Additionally, fugitive dust emissions from wheel entrainment and pit operations produce suspended particulates (TSP). Since these emissions can pose potential negative effect to human health at high ambient ground-level concentrations, they are regulated and should not exceed their prescribed Alberta Ambient Air Quality Objectives (AAAQOs). As a requirement for the COP for Pits and DP applications, this report details the Ambient Air Quality Monitoring Plan (AQMP) in relation to the operation of the Summit Pit.

Following the *Air Quality Model Guideline* (AQMG), CALPUFF dispersion modelling was done to assess the effects of Project operations on AAAQOs. Modelling was completed for the three key pit operations defined as: overburden removal and backfill, aggregate mining/crushing, and hauling/trucking. Maximum Daily Emission and Annual Average Emission cases were estimated. The results at the Project boundary showed there were no predicted exceedances of AAAQOs for any modelled compounds and any averaging period when the Dust Control Plan is executed appropriately. The predicted maximum concentrations at residence receptors are all less than the AAAQOs for all modelling scenarios and all contaminants.

While Project operations are not expected to exceed ambient air quality objectives beyond the property boundary, Mountain Ash has committed to monitoring for $PM_{2.5}$ and TSP at the property boundary, at two locations, to ensure dust suppression techniques are working. Although several pits have been proposed for the area, no additional pits have been approved with a DP that have the potential to add to the air emissions from Summit Pit operations at adjacent receptors. There is an agreement between future operators to ensure that a cumulative impacts mitigation management agreement is in place to minimize emissions from their respective operations with respect to cumulative effects. Mountain Ash will participate with those operations to address cumulative effects/impacts in the area prior to submitting future DP applications. All relative data captured will be made available to the public www.summitproject.ca Alternatively, interested parties wishing to obtain this information can contact the operator directly.

See Appendix D for the Air Quality Monitoring Plan.

4.6 Inactive Pit Plan – Part 1(g)

It is anticipated that the pit will remain active until the end of pit life. In the event the pit becomes inactive, the operator will ensure all banks are graded to a 3:1 slope.

4.6.1 Progressive Reclamation

As areas are no longer needed for operations, Mountain Ash will reclaim them in accordance with the best industry practices to ensure equivalent land capability can be achieved, in this case, rangeland. Reclamation of mined areas will occur concurrently with mining operations. This will limit the inactive pit area at any given time. Concurrent pit reclamation will also limit any additional soil handling and placement.

Subsoil will be de-compacted before topsoil placement. Subsoil will be recontoured to tie in with the surrounding landscape and create drainage patterns consistent with surrounding land use. Experienced reclamation specialist will supervise machinery to avoid final contours that may cause water ponding or any erosion issues.

Revegetation will occur within the same growing season when topsoil placement is completed to avoid any soil loss via erosion. A seed drill machine or standard farming equipment will be used for maximum germination success. Appropriate species mix, seeding rates, and composition will be based on reclamation criteria/requirements, seed availability, and landowner specifications likely consistent with current land use at the time. Currently, the land is used for tame pasture and hay.

Seed will be sourced from a reputable supplier and a professional agrologist will review seed germination tests, impurities, and presence of weed species in the seed mix. Seed certificates will be reviewed and kept on file.

4.6.2 Monitoring Reclamation Success

Reclamation success will be determined by a landscape that does not require any ongoing treatment or to be worked and provides equivalent land capability as it did prior to disturbance. Continuous monitoring of progressively reclaimed areas will guide further reclamation activities and help identify proper mitigation measures leading to a successful reclamation outcome.

In accordance with the current regulations, Mountain Ash will submit a report on disturbance and reclamation status to EPA, starting five years after registration and then every five years after that until the Final Reclamation Report is submitted and/or a reclamation certificate for the whole pit is received (AENV 2004a and 2004b).

See Appendix E for the Post-Mining Reclamation Plan.

4.7 Scale Drawings of Existing Pit Conditions and Proposed Sequence of Activity – Part 1(h)

There are no existing pit conditions. See Appendix F for Proposed Sequence of Activity and Appendix W for supporting supplemental drawings related to activities plan.

4.7.1 Modelling

Six pit designs were produced using two surface boundaries and three sidewall slope scenarios. To account for the volume of material to bedrock in either outline, the overall pit slope and ramp access needed to be included in the design. The ramp assumes a 20 m width and surface access off Range Road 40 to the northwest.

Figures in Appendix G visually represent the steps taken to produce itemized volumes. Appendix G Figure 1 displays surface boundaries with four working areas labelled accordingly. The areas shown in the figures are the modelled representations of those indicated in the tables.

See Appendix G for in depth methodology, figures, layers used for the modelling, and tables showing gravel estimations and site boundaries.

4.8 Cross-section Drawings of Existing Pit Site Conditions – Part 1(i)

Cross-section drawings of the existing site conditions is provided in Figures 4, 5, and 6. The land is presently used for agricultural purposes and no development has occurred to date. The section in Figure 4 shows existing conditions along a north south- cross--section. The glacial till overburden is shown in green and is slated for removal and temporary stockpiling. The aggregate deposit, shown in yellow will be mined to within 1.0 m of the maximum water table shown as a blue line. The pit will not go into the underlying Paskapoo Formation bedrock, and there will be no mining below the water table.

4.9 Maximum Pit Size – Part 2(a)

The maximum pit size (Phase 1 through 6) will be 208 acres (84 ha), the minable area will be 195 acres (79 ha). Area of each phase are as follows:

- Phase 1 – 36.9 acres (14.4 ha)
- Phase 2 – 39.0 acres (15.19 ha)
- Phase 3 – 39.0 acres (15.20 ha)
- Phase 4 – 30.0 acres (15.20 ha)
- Phase 5 – 41.0 acres (15.96 ha)
- Phase 6 – 21.6 acres (8.41 ha)
- Scale – 0.4 acres (0.16 ha)

4.10 Depth to Groundwater – Part 2(b)

A comprehensive hydrogeological study was conducted on the property in support of the design of the planned aggregate pit. The Groundwater Monitoring Plan (GWMP) is found in Appendix H with the addition of a Hydrogeological Assessment Report (Appendix I) following.

The objective of the hydrogeological investigation was to provide a description of baseline hydrogeological conditions in the vicinity of the proposed Mountain Ash aggregate resource. The potential impacts of the development on groundwater quality and quantity were reviewed. Based on that, mitigation measures were provided to support the development and operation of the aggregate resource being conducted with minimal impact to existing local water users. This includes neighbouring domestic wells, nearby natural heritage features like Bighill Creek, and Big Hill Springs Provincial Park. As the reports in Appendices H and I identify, this will be successfully achieved.

As mentioned previously, the aggregate extraction pit will be worked in six counterclockwise phases starting in the southwest corner of Phase 1 as provided in the second round of SIRs #C11-C12, Drawing 10 (SLR 2023a) . Overburden will be stripped, and the sand and gravel will be extracted under dry conditions. No dewatering of the underlying aquifer is planned. In this manner groundwater resources will be protected.

The hydrogeological report creates a picture of the regional setting of the area based on published sources of information such as published geological maps and water well records. Field investigations were undertaken to find local wells, and to drill and install monitoring wells on the site. The soils were scientifically logged for the geologic profile, and it was found that the site fit in well with the regional setting. From this, an examination of potential impacts was undertaken, and appropriate mitigation was identified. The report demonstrates that no adverse net impact of the operations on the hydrologic/hydrogeologic setting is expected.

The two large wetlands in the northwest corner of the site are to be retained on the landscape.
No streams are located on, or flow from the site, and thus hydrologic impacts are not possible.
The following schematic in Figure 4 illustrates the hydrogeologic profile found at the site. Given the distances involved, it has been vertically stretched to better show the individual layers and thus is not to scale.

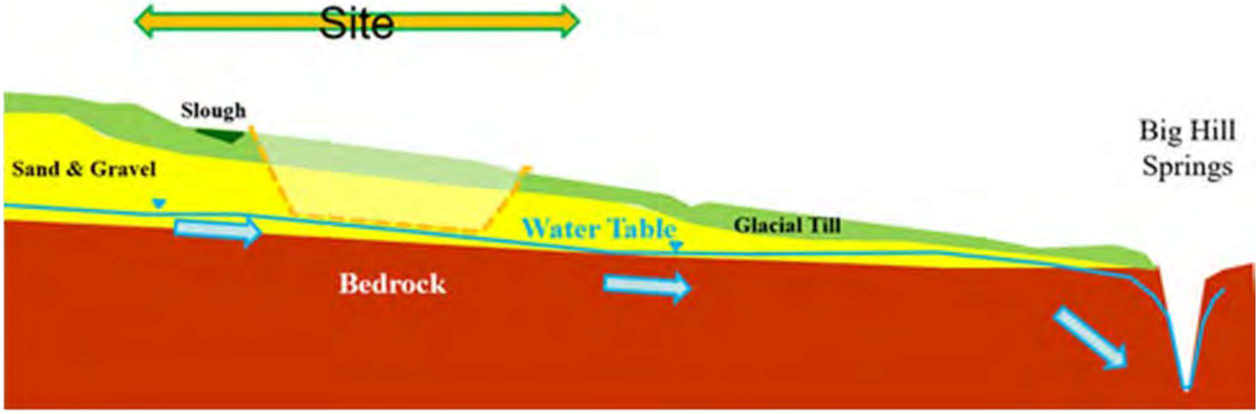


Figure 4: Schematic Cross-section (not to scale)

Hydrogeologically speaking, the northwest wetlands are surface water fed and perched on the 4 to 6 m thick blanket of dense glacial till which limits the leakage of water into the ground. Beneath the till lies the target sand and gravel deposit, which is 14 to 24 m thick and generally dry. The water table is close to the bottom of this deposit and sometimes in the underlying bedrock. This bedrock is the Paskapoo Formation bedrock composed of sandstone, siltstone, mudstone, and shale. Although not a very good aquifer, it is permeable enough to provide local water supply and is tapped by the few wells in the area. Groundwater flows towards the southeast and eventually discharges in Big Hill Springs at the Provincial Park. Appendix I identifies that this function will not be altered; there may be a slight increase in discharge when the pit is operating, due to the capture of rainfall directly into the sand and gravel. It was found that the natural groundwater quality in the sand and gravel and the bedrock is very similar to that in Big Hill Springs as well as that in local water supply wells.

The possibility of impacts from manmade sources such as fuels and solvents during the operational phase of the pit was considered, as well as natural sources such as suspended solids and turbidity from reworking of the material onsite. These potential effects will be mitigated by using best handling practices as outlined in the COP for Pits (AENV 2004a), other codes of best practice, and adhering to regulatory approval conditions. Regular groundwater quality monitoring will continue over the life of the pit with annual reporting to the municipality. In this way the operators will be able to react to unanticipated changes in water quality in the unlikely event they occur.

Under the current excavation scheme, the overall risk of any significant negative impacts on water resources as a result of the development are negligible. This is based on the fact that the aggregate resource will not be mined into the water table, and therefore changes to the groundwater flow system are extremely unlikely.

The following mitigation and design measures are planned to reduce effects on groundwater quality:

- Develop the site on a phased basis to minimize the working area and allow for progressive site restoration;

- Minimize the size of each working area to reduce the potential for generation of suspended sediment in storm water;
- Commission settlement ponds and surface infiltration features early in the scheme development and manage all runoff generated during operations onsite; and
- Implement the operational phase groundwater monitoring program detailed in Appendix H.

Control limits are provided in Section 8.2 of the GWMP. MALP conducted additional baseline sampling in spring of 2023 after thaw (April 2023). Results of the sampling are presented in Technical Memorandum SIR#3-C12 (SLR 2023a). May 2023 GWMP provided in Appendix H, includes all baseline monitoring completed for the Project.

Once operational monitoring and sampling have begun, visual review or trend analysis of the post-baseline data series will be conducted. If the analysis indicates a potential increasing or decreasing trend which may eventually exceed a guideline or control limit, or a guideline or control limit is exceeded, the groundwater response plan outlined in Section 8 and Figure 7 of the GWMP would be implemented as summarized below:

1. A potential rising or falling trend, or parameter exceedance is identified.
2. Resampling confirms the trend or parameter exceedance.
3. AEPA is informed of the potential issue and provided with an investigation plan to identify the source. This may include additional sampling, installation of monitoring wells or other measures as appropriate to identify the source and/or potential extent of the issue.
4. A risk management plan will be developed and submitted for the approval of the Director once an issue and its source have been identified as being related to the operation and if source removal is not feasible. The actions required within the risk management plan would include any and all items appropriate to the risks posed to all groundwater receptors. This could include, but not be limited to risk assessment, additional sampling, installation of monitoring wells, residential well investigation and rehabilitation, changes to operational practices or reporting. If risks cannot be managed or mitigated to the satisfaction of the Director, this may result in the cessation of operations and/or cancellation of the Registration as provided for in *EPEA*.

The effects of the development of this aggregate resource above the water table at this site will be minimal on the surface and groundwater regimes, particularly since the mitigation and design measures discussed above will be implemented. The hydrogeologic assessment report (Appendix I) predicts that there will be no adverse net impact of development at the site on surface water or groundwater users in the vicinity. Ten monitoring wells were installed onsite and were periodically monitored for groundwater depth from October 2014 to April 2023. Water table depths below existing grade range from 21 to 29 m below the high ground and between 12 and 16 m deep in the lower lying areas. The water table is typically in the sand and gravel or upper bedrock. Once approval is granted, the monthly water level monitoring program will begin.

Elevations of the water table at each monitoring location were determined based on topographical survey of the monitoring wells. Sand and gravel wells MW14-101 and MW14-103 and residential wells WW2 and WW4 have been recording continuous groundwater levels using data loggers since October 29, 2014. Groundwater hydrographs are provided in Appendix H and water table elevation data is summarized as follows (SLR 2020b):

- Groundwater elevations ranged from 1,274.87 masl (highest recording) in the sand and gravel in well MW14-101 on November 20, 2014, to 1,259.46 masl (lowest) in the sand and gravel deposits in the dry valley leading to Bighill Springs in well MW19-109 on July 3, 2019;
- Groundwater levels within the sand and gravel layer gradually fell between 2014 and 2019, with a drop of approximately 0.9 to 1.3 m during this period. This is due to a series of dry years with <400 millimetres (mm) of precipitation each year, based on Environment and Climate Change Canada data for the meteorological station at Calgary International Airport. (ECCC, 2022) Even an above average precipitation year (2016) with 520 mm of precipitation did not increase water levels, likely due to a high soil moisture deficit absorbing much of the surplus. Levels rebounded somewhat (0.2 m) in the months between July and September 2019 due to the higher-than-average rainfall totals (526 mm) in the area in spring and summer 2019. This was followed by an average precipitation year (424 mm) in 2020 which allowed soil moisture deficits to be reduced. The levels then gradually declined back to the pre-2019 levels in March 2020 before again rising approximately 0.3 to 0.4 m in the 2020 spring recharge event. Groundwater levels continued to slowly rise through 2020 and into the spring of 2021 due to the high precipitation in 2020 (554 mm) before they started to decline again to the end of the monitoring record; and
- Minimal short-term fluctuation in the groundwater levels within the sand and gravel indicates no influence from pumping within residential wells completed in the bedrock in the area.

Groundwater monitoring will be ongoing to ensure that the base of the pit (and the infiltration areas) will be kept a minimum of 1.0 m above the maximum known or recorded groundwater table based on data obtained from the onsite monitoring wells since 2014.

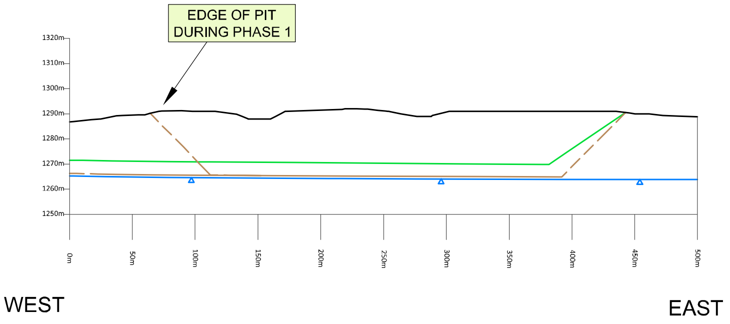
Updates to the Groundwater Monitoring Plan are provided in Appendix H.

4.11 Pit Activities – Part 2(c)

4.11.1 Wet Pit Excavation

There will be no wet pit excavation. As previously mentioned, the site will be worked to 1.0 m above the maximum recorded groundwater level within the gravel deposit and will therefore be worked dry, with no requirement for operational or permanent dewatering. Temporary piezometers will be installed ahead of the extraction to final grade to document groundwater levels.

SECTION A-A'



SCALE:
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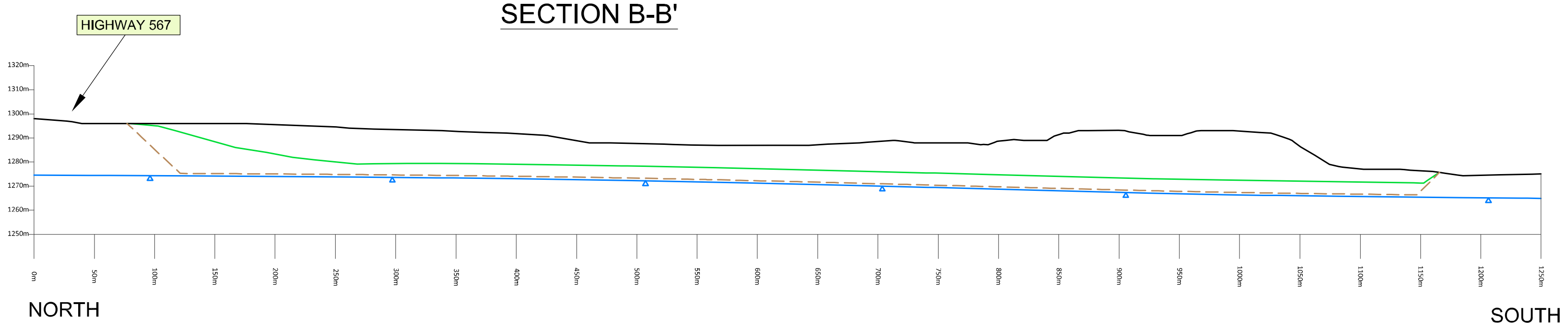
(VERTICAL)
1:4,000 @A3
(HORIZONTAL)
2x VERTICAL
EXAGGERATION

SECTION B-B'



SG03_SECTIONS_v2.dwg

NOTES

LEGEND

- 🟩 RECLAMATION PROFILE
- 🟦 AVERAGE MAXIMUM GROUNDWATER LEVEL
- ▨ PIT PROFILE
- ▨ PRE-MINING TOPOGRAPHY

Please Refer to Schematic Cross-section

MOUNTAIN ASH LIMITED PARTNERSHIP.
SUMMIT AGGREGATES RESOURCE
W 1/2 SEC 31 TWP 026 RGE 03 W5M
COCHRANE
ALBERTA

SLR
global environmental solutions

SLR Consulting (Canada) Ltd.
200 - 708 11th Ave SW
Calgary,
Alberta, T2R 0ER
www.slrconsulting.com

COP APPLICATION

212.06650.00006

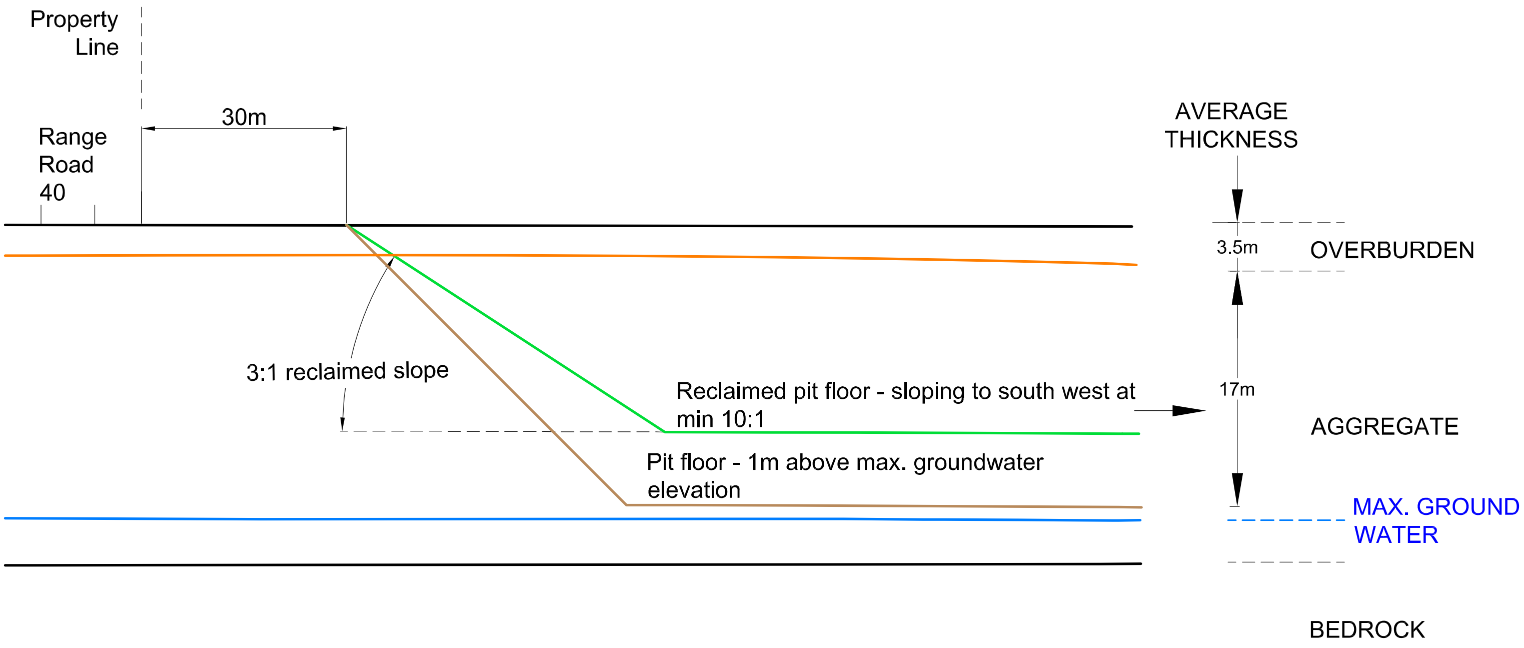
CROSS SECTIONS

Figure 5

Scale
SEE INSET

Date
JULY 2021

SCHEMATIC CROSS SECTION
THROUGH WESTERN
BOUNDARY SHOWING
TYPICAL PIT AND
RECLAMATION PROFILE



NOTES

LEGEND

- ╱ AVERAGE MAXIMUM GROUNDWATER LEVEL
- ╱ PIT PROFILE
- ╱ RECLAMATION PROFILE
- ╱ BASE OF OVERBURDEN
- ╱ PRE-MINING TOPOGRAPHY

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SCHEMATIC CROSS SECTIONS

Figure 6

Scale
NTS

Date
JULY 2021

EM08+9_SECTIONS_v2.dwg

4.11.2 Use of Alternative Reclamation Materials

No alternative reclamation materials are needed nor will be used. Reclamation will be undertaken with native overburden from stockpiles, and/or from current overburden stripping operations. Topsoil will be added from previously stockpiled topsoil on an as needed basis. Where topsoil is brought in from outside sources to aid in reclamation it will be certified clean topsoil and fill only. This will be accomplished by offsite testing of source materials and manifest control of soil delivery and acceptance.

4.12 Mitigation Measures – Part 2(d)

Table 4 describes mitigation measures to be implemented. A set of supporting monitoring plans and more detailed management plans have been developed which are referenced in this table and provided in the appendices.

Table 4: Mitigative Management Measures for Multiple Aspects

Aspect	Management measures	
Soil	Stripping and stockpiling	Limit the area of disturbance as far as practically possible, as outlined in an approved development permit. Implement the Soil/Weed Management Plan provided in Appendix A. Implement the Sediment and Erosion Control Plan provided in Appendix B.
	Contamination	Handle, use, and dispose of all potentially contaminating substances and waste in a manner to prevent soil contamination. Maintain all vehicles and equipment on designated onsite areas. Keep in good working order to prevent spills and leaks; inspect regularly. Contain and clean up spills and leaks immediately. Maintain spill kits (containing absorbent material) on site and train personnel how to use these kits. As necessary, implement spill response and containment measures. Treat contaminated soil in-situ where practical or remove from site and dispose of as hazardous materials.
	Reclamation	Remove surface infrastructure and grade the ground surface as appropriate in accordance with the end land use and requirements at the time. Ameliorate soil if needed to meet end land use requirements. Monitor re-vegetation of the Project site to prevent soil erosion.
Air quality	Dust	Limit the area of disturbance by earthworks as far as practically possible. Monitor and implement reduced vehicle speed limits or other speed control measures on the Project site based on daily conditions. Implement the Dust Control Plan provided in Appendix C. Implement the Air Quality Monitoring Plan provided in Appendix D.
	Air emissions	Implement the Air Quality Monitoring Plan provided in Appendix D.
Surface water	Surface runoff	Design and implement a stormwater management system to contain all surface runoff and allow clean water to be diverted away from the Project site. The Water Management Plan/Stormwater Management Plan is provided in Appendix J.
	Wetlands	Demarcate and implement a buffer zone around all wetlands that will be left in place through construction in accordance with the *Water Act* Approval.

Aspect	Management measures	
	Contamination	Provide proper wash and toilet facilities in site office, and portable toilets for remote parts of the site when the phasing is over 500 m from the site office. In designated areas, maintain all vehicles and equipment to function properly and efficiently to prevent spills and leaks; and inspect regularly. Handle, use, and dispose of all potentially contaminating substances and waste in a manner to prevent contamination of surface water. Implement spill and leak prevention management procedures during construction and normal operation. Contain and clean up spills and leaks immediately. Maintain spill kits on site and train personnel how to use these kits. Identify potential emergency situations that could pollute surface water resources; train personnel on appropriate prevention and response measures.
Groundwater	Contamination	Design and implement a stormwater management system to manage water within the pit and runoff from infrastructure areas. The Water Management Plan/Stormwater Management Plan is provided in Appendix J. Handle, use, and dispose of all potentially contaminating substances and waste in a manner to prevent contamination of groundwater. In designated areas, maintain all vehicles and equipment to function properly and efficiently to prevent spills and leaks, and inspect regularly. Implement spill and leak prevention management procedures during construction and normal operation. Contain and clean up spills and leaks immediately. Maintain spill kits onsite and train personnel how to use these kits. Implement the Groundwater Monitoring Plan provided in Appendix H.
	Water levels	Monitor groundwater levels to ensure that mining remains above the groundwater level as planned. Implement the Groundwater Monitoring Plan provided in Appendix H.
Flora	Vegetation clearing	Limit the area of disturbance as far as practically possible. Clear trees during mid to late winter to avoid the likelihood of encountering nesting birds, in accordance with direction from Alberta Environment and Parks.
	Harvesting	Prohibit the harvesting of any natural vegetation on the Project site by workers.
	Invasive species	Implement weed control measures to prevent the spread of noxious weed species and to comply with the requirements of the Alberta *Weed Control Act*. The Soil/Weed Management Plan is provided in Appendix A.
	Reclamation	Use only certified weed free seed mix where seeding is required. Monitor re-vegetation of the Project site and re-seed where necessary.
Fauna	Vegetation clearing	Limit the area of disturbance as far as practically possible. Clear trees during mid to late winter to avoid the likelihood of encountering nesting birds.
	Site access	Maintain the perimeter fence to deter wildlife accessing the Project site.

Aspect	Management measures	
	Migratory birds	Avoid clearing from March 1 through August 31, in suitable habitat, to avoid disturbing early nesting birds. Avoid clearing from late-April to end of August to avoid potential nesting of migratory birds. Prevent vegetation from becoming established around the edges and perimeter of the stormwater ponds. This will prevent the development of suitable habitat for birds and other wildlife. Comply with federal and provincial legislation relating to migratory birds and designated species at risk (if presence is identified onsite) during Project construction.
	Wildlife occurrence	Train workers to report wildlife incidents such as presence of wildlife on the construction site or during Project operation, or wildlife mortality via collision with a vehicle. Do not harass, hunt, trap, or feed wildlife or livestock on the Project site and surroundings. Manage dust and noise emissions to minimize disturbance to wildlife around the Project site.
Visual impact	Landscape and visual screening	Implement the Landscape and Visual Screening Plan provided in Appendix K.
Noise	Disturbing noise	Schedule operations to occur during daytime hours, whenever practical. Maintain equipment and machinery in good working order, including noise abatement equipment where applicable, to limit noise. Avoiding unnecessary vehicle and equipment idling. Implement the Noise Monitoring Plan provided in Appendix L.
Historical resources	Chance discovery of a historic resource	Train workers on the tell-tale signs of historical or archaeological resources to enable the identification of a chance discovery. In the event that an unknown historic resource is found during the construction or operation of the Project, follow the requirements included in the Approval: Stop all work in the location of the find and contract Alberta Culture and Tourism; Take appropriate action in accordance with regulatory guidance; and Recommence work upon direction of the regulator.

Additional wildlife, traffic, erosion, and sediment control, weed management, surface water and groundwater quality and quantity, wetlands, landscape, air quality/dust control, and noise control mitigative measures are provided in Appendix R (SLR 2022b).

4.13 Proposed Land Uses – Part 2(e)

The proposed land uses will be determined by assessing the surrounding lands during the time of reclamation. Currently, the land is used for tame pasture and hay. As of now, the future land use at the end of the mine lifecycle will be re-established to agricultural and tame pasture/hay.

4.14 Release of Pit Water – Part 2(f)

4.14.1 Stormwater Management Plan

The assessment of stormwater found in Appendix J confirms that the proposals to manage stormwater runoff are feasible, sustainable, and practical and are appropriate for the duration of the development. From the assessment, it can be seen that the following objectives can be met, and that stormwater runoff associated with the development can be managed using Rocky View County/Alberta Provincial stormwater management techniques and best practice guidance:

1. All stormwater runoff generated by incident rainfall on the site (and its immediate surrounds) is managed to prevent flooding downstream in the catchment and maintain "dry" working areas;
2. To provide suitable stormwater quality treatment and prevent potential pollution of the underlying aquifer and surface water bodies within the catchment;
3. To provide a passive or gravity stormwater management system that does not require routine pumping;
4. To achieve separation of "clean" (i.e., stormwater runoff from unworked land) and potentially "dirty" (i.e., runoff from overburden tips) stormwater runoff where practically possible; and
5. To provide stormwater management measures, which can be incorporated into the site development to prevent operational areas being impacted by stormwater runoff.

The site is located approximately 1,300 m upstream of Big Hill Springs and is located within the surface water catchment of an unnamed watercourse which forms a tributary to the larger Bighill Creek. No surface water bodies (streams or lakes) have been identified within the site area itself; however, there are two larger temporary graminoid marsh (M-G-II) wetlands in the northwest corner which are to be retained on the landscape. The other smaller wetlands and ephemeral water bodies scattered across the property where aggregate extraction will take place are not going to be retained.

The pit will be worked in six phases starting in the southeast corner of the property. As previously described, the site will be worked to 1.0 m above the maximum recorded groundwater level within the gravel deposit and will therefore be worked dry. No dewatering of the underlying aquifer or quarried voids is anticipated as groundwater will not be intercepted and incident rainfall on to workings areas will infiltrate into the unsaturated sand and gravels that will form the base of the extraction areas.

The stormwater management strategy is implemented over six Surface Water Management Phases and is presented in detail on Figures 3A to 3F in Appendix J. Generally, the surface water management measures for each stage are similar and include the following:

- Grassed / lightly vegetated Perimeter ditches (swales) will be installed at the outer foot of the screening berms / overburden stockpiles to route "dirty" runoff (initial treatment) from the mounds to appropriately sized settlement/attenuation ponds (secondary treatment). Shallower longitudinal gradients in the swales will encourage longer residence times, lower velocities, and thus improve treatment effectiveness. The perimeter ditches are identified with blue dashed lines and the ponds as blue rectangles on Figure 2 and Figures 3A to 3F in Appendix J.

- A locally created sump excavated into the underlying sands and gravels accepts the "treated" outflow from the pond where the runoff will locally form groundwater recharge (via infiltration through the sands and gravels thus providing a tertiary level of surface water treatment) and reduction in surface water volumes. Sumps are to be connected to the outer settlement ponds by a culvert/pipe beneath the perimeter berm. The infiltration sumps are identified as magenta squares on Figure 2 and Figures 3A to 3F in Appendix J.

- Interception ditches are proposed upslope of the Surface Water Management Phases to prevent stormwater runoff from the up-gradient catchment entering the extraction areas. This water is considered "clean" and therefore does not require treatment; instead, it is routed around the Surface Water Management Phases via diversion ditches and allowed to disperse overland (via a series of shallow excavated diffusion channels). This provides hydrological continuity between the upslope and downslope of the relevant Surface Water Management Phases. The diversion ditches are identified with orange dashed lines on Figure 2 and Figures 3A to 3F in Appendix J.
- Temporary, locally created, sump excavated within the extraction area to collect clean runoff upslope of the Surface Water Management Phases during the development of Phases 2, 3, and 4 (see orange square on Figure 2 and Figures 3B to 3D, Appendix J). Prior to Phase 4 extraction, the temporary sump will also collect water from Pond C during the Phase 3 extraction operation (Figure 3C, Appendix J). The temporary sump is to be located in a low topographic spot within the extraction area and is required due to topographic constraints that impede gravity flow of clean water away from the extraction area (see direction of diversion ditches discharging to the temporary sump). Water collected in the temporary sump will be infiltrated back into the ground.
- Surface water management features (i.e., swales/settlement ponds/sumps) have been designed to accommodate the design 1:100 -year rainfall event (as required by Provincial/County guidance). A conservative approach has been undertaken by providing freeboard allowances and modelling "worst case" scenarios.

Potential maintenance schedules for the stormwater management features have been outlined in Appendix J and their implementation is fundamental to ensure the efficiency of the surface water management measures.

All surface water infrastructure will be located within the Project boundary as explained in the first round of SIRs, and provided in Appendix J.

4.14.2 Release of Pit Water

There will be no release of pit water for the following reasons. Mountain Ash plans to excavate material to 1.0 m above the maximum recorded groundwater level within the gravel deposit. Therefore, no groundwater accumulation is expected within the pit.

A Stormwater Management Plan (SWMP) has been developed which addresses water management within the pit as follows (Appendix J).

- The pit will be divided into quadrants and then into individual cells with a maximum of approximately four cells "open" at any given time.
- Incident rainfall onto the extraction areas within the glacial till horizon will be locally managed and directed to a dedicated sump with proposed minimum dimensions of [5 m (W) × 5 m (L) × 1 m (D)] = 25 m^3.
- Numerical calculations (for the design 1:100-year 24-hour storm event) shows limited accumulation of runoff within the extraction areas when glacial till is exposed. For a maximum of four cells (total area of= 40,000 m^2), the flood depth spread over the extraction base area is equivalent to less than 10 cm of water depth during the design storm event. It should be noted that typical storm events will result in much less runoff than the design storm. The exposure of the till during excavations will be temporary until the underlying sands and gravels are reached.

- Once the excavation enters the sand and gravel, incident rainfall (for the design 1:100-year 24-hour storm event) will readily infiltrate, therefore no management of precipitation within the extraction areas will be required at that stage.

4.15 Soil Replacement Depths – Part 2(g)

Table 5 has been taken from the Stripping and Grading plan found in Appendix M.

Subsoil and totals have been updated based on the 2022 soils field program completed by AECOM, December 29 and 30, 2022, addressed in SIR #2 (SLR 2023b) and found in Appendix Q.

Table 5: Quantities of Materials used to Reclaim Site Post Mining

Phase	Surface Area (m)	Topsoil (m^2)	Subsoil (m^2)	Overburden & Rejects (@15% Gravel) (m^2)	Total (m^3)
1	128,424	32,106	32,106	556,573	620,785
2	151,720	37,930	37,930	749,523	825,383
3	151,989	37,997	37,997	1,093,980	1,169,974
4	116,171	29,043	29,043	675,215	733,301
5	158,236	39,559	39,559	770,145	849,263
6	83,430	20,857	20,857	408,136	449,850
Total	**789,970**	**197,492**	**197,492**	**4,253,571**	**4,609,058**

4.16 Scale Drawing of Site Conditions After Reclamation – Part 2(h)

Scale drawings of the phased approach Mountain Ash is taking with the mining and reclamation plan have been provided in Figures 7 to 13.

5.0 ADDITIONAL ACTIVITIES PLAN INFORMATION

5.1 Inventories

Table 6 includes the estimated tonnage of aggregate based on an anticipated density of 2.0 t/m^3.

Table 6: Estimated Tonnage (‘000 t) of Aggregate within Pit Extraction Boundary

	Mountain Ash Property
Subsurface Area	
Estimated Volume of overburden	5,904
Estimated Volume of Aggregate between Top of Sand and Gravel and 1 m above Water Table ('000 t)	21,913
Estimated Volume of Remaining Aggregate between 1 m above Water Table and Top of Bedrock	2,885

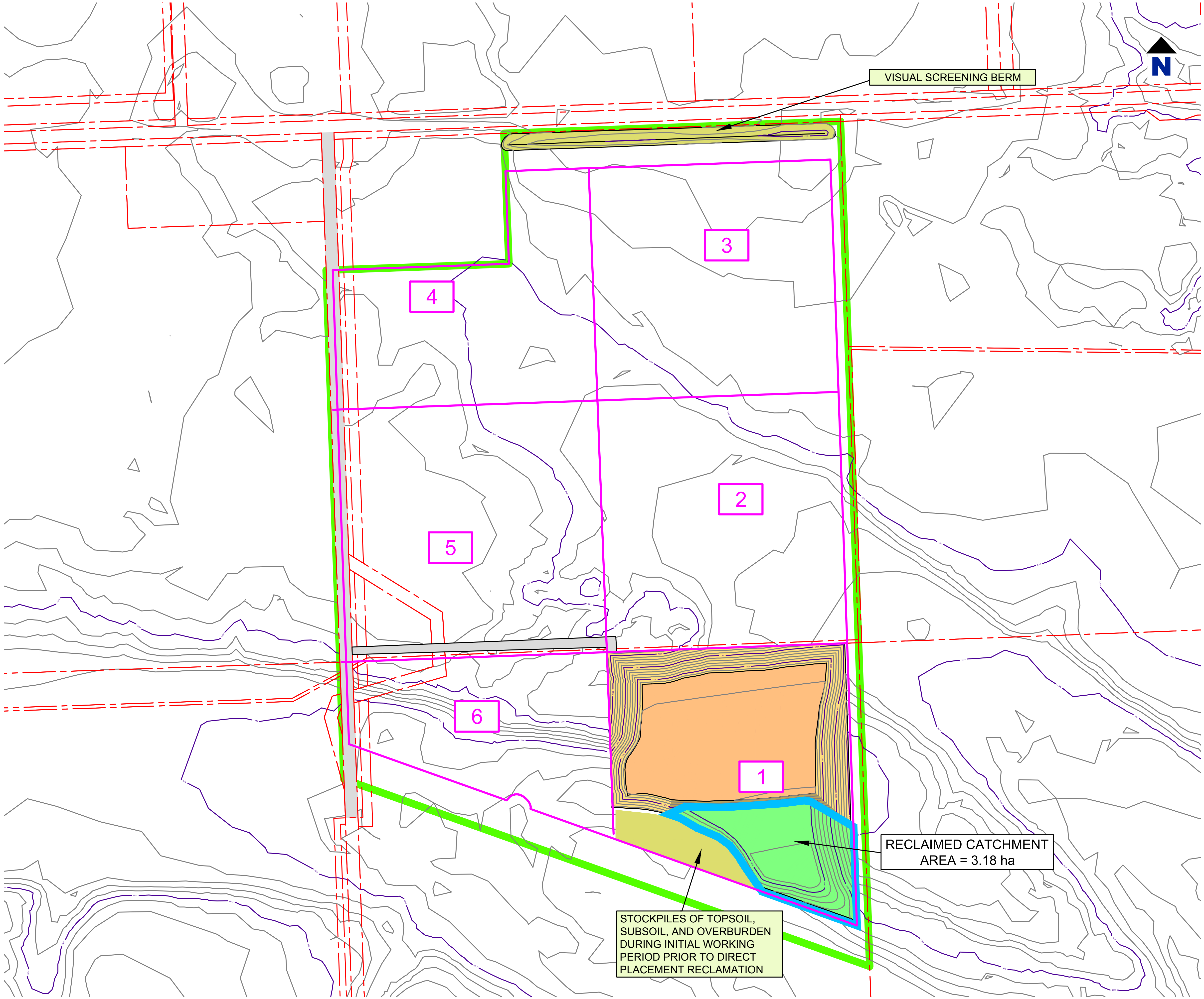
5.2 Undisturbed Buffer Zones

With respect to undisturbed buffer zones, the following will be implemented:

- approximately 140 acres (56.7 ha) along the south boundary owned by Mountain Ash
- 3 m “EPA” undisturbed buffer zone adjacent to all property lines as per the Code of Practice for Pits in Alberta
- 60 m Alberta Transportation (“AT”) setback, containing an approximate 38 m permanent landscaped berm, which parallels Highway 567, up to the avoided wetland area in the northwest corner of the Property
- 30 m municipal setback from the Property Boundary to Range Road 40 (western boundary)
- 15 m municipal setback along the Property Boundary to the Extraction Area (eastern boundary)
- 190 m “no crushing” setback from the east property boundary
- 140 m “no crushing” setback from the north property boundary and

5.3 10 m buffer around undisturbed / avoided wetlands, pursuant to the Alberta Wetland Policy.Depth of Excavation

Depth to excavation, including overburden removal and aggregate extraction, is 14 to 24 m and is detailed for each phase in the mining and excavation plan found in Appendix N.



Cadfile name: 212-06650-00007 EM01_PHASE 1 - COP 09052023.dwg

NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, BING IMAGERY, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

THIS PLAN SHOWS THE GENERAL ORDER OF WORKING, WITH MINING BLOCKS PROGRESSING IN AN ANTICLOCKWISE DIRECTION FROM THE SOUTH EAST.

EACH MINING BLOCK WILL BE NO GREATER THAN 150m X 150m (22,500m³).

LEGEND:

▭	PROJECT BOUNDARY
▭	EXTRACTION (PIT) PHASE BOUNDARIES
▭	LEGAL BOUNDARIES
■	OVERBURDEN / SOIL STORAGE
▭	ACCESS ROAD
◩	ACTIVE MINING AREA
■	PREVIOUS MINING AREA
◩	RECLAIMED AREA
▭	RECLAIMED CATCHMENT AREA

0 50 100 200 300 m

SCALE 1:6,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

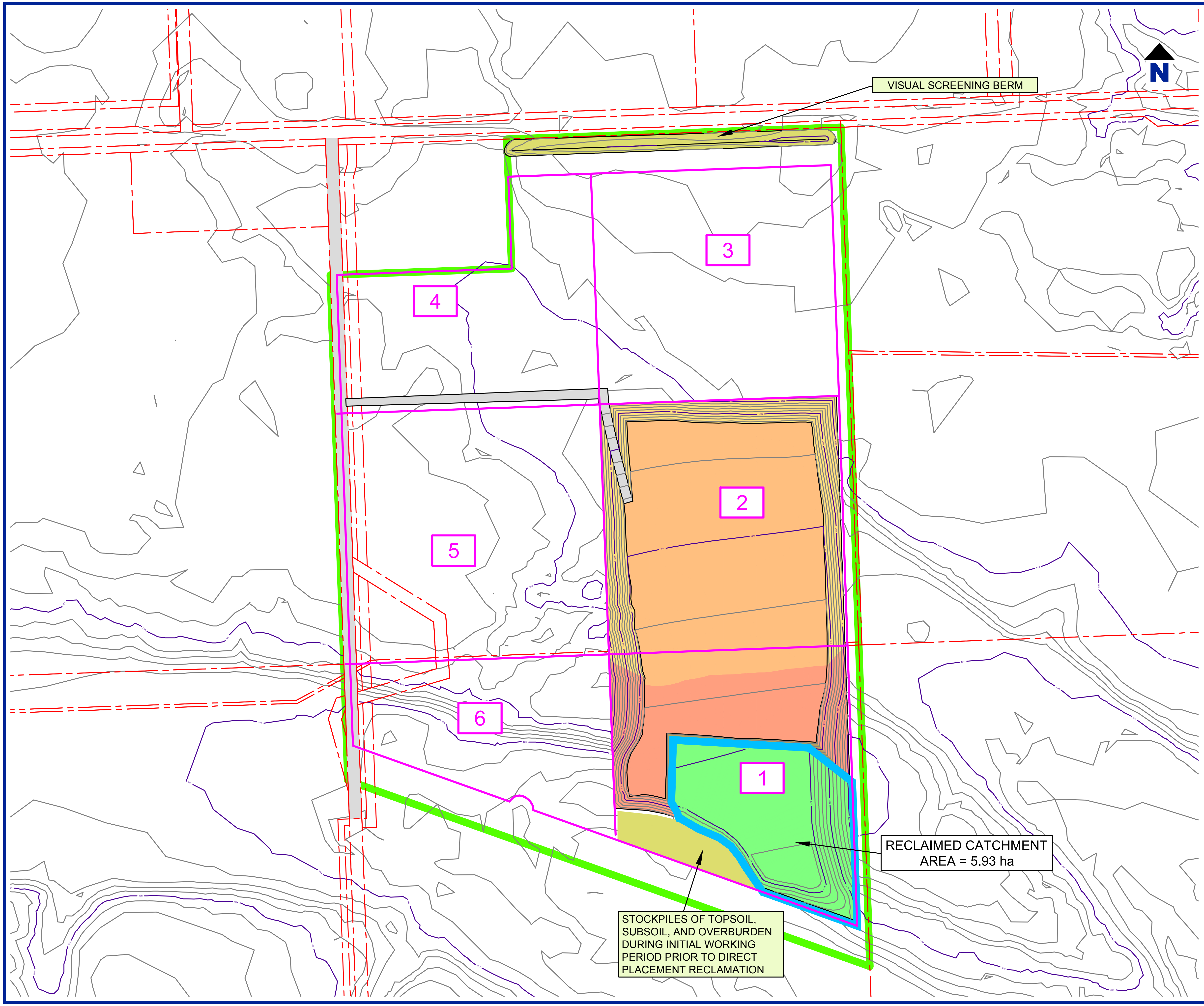
MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 1A

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 7

SLR



NOTES:

DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, BING IMAGERY, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

THIS PLAN SHOWS THE GENERAL ORDER OF WORKING, WITH MINING BLOCKS PROGRESSING IN AN ANTICLOCKWISE DIRECTION FROM THE SOUTH EAST.

EACH MINING BLOCK WILL BE NO GREATER THAN 150m X 150m (22,500m³).

LEGEND:

🟩	PROJECT BOUNDARY
▭	EXTRACTION (PIT) PHASE BOUNDARIES
▭	LEGAL BOUNDARIES
🟨	OVERBURDEN / SOIL STORAGE
▭	ACCESS ROAD
🟧	ACTIVE MINING AREA
🟥	PREVIOUS MINING AREA
🟩	RECLAIMED AREA
▭	RECLAIMED CATCHMENT AREA

0 50 100 200 300 m

SCALE 1:6,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

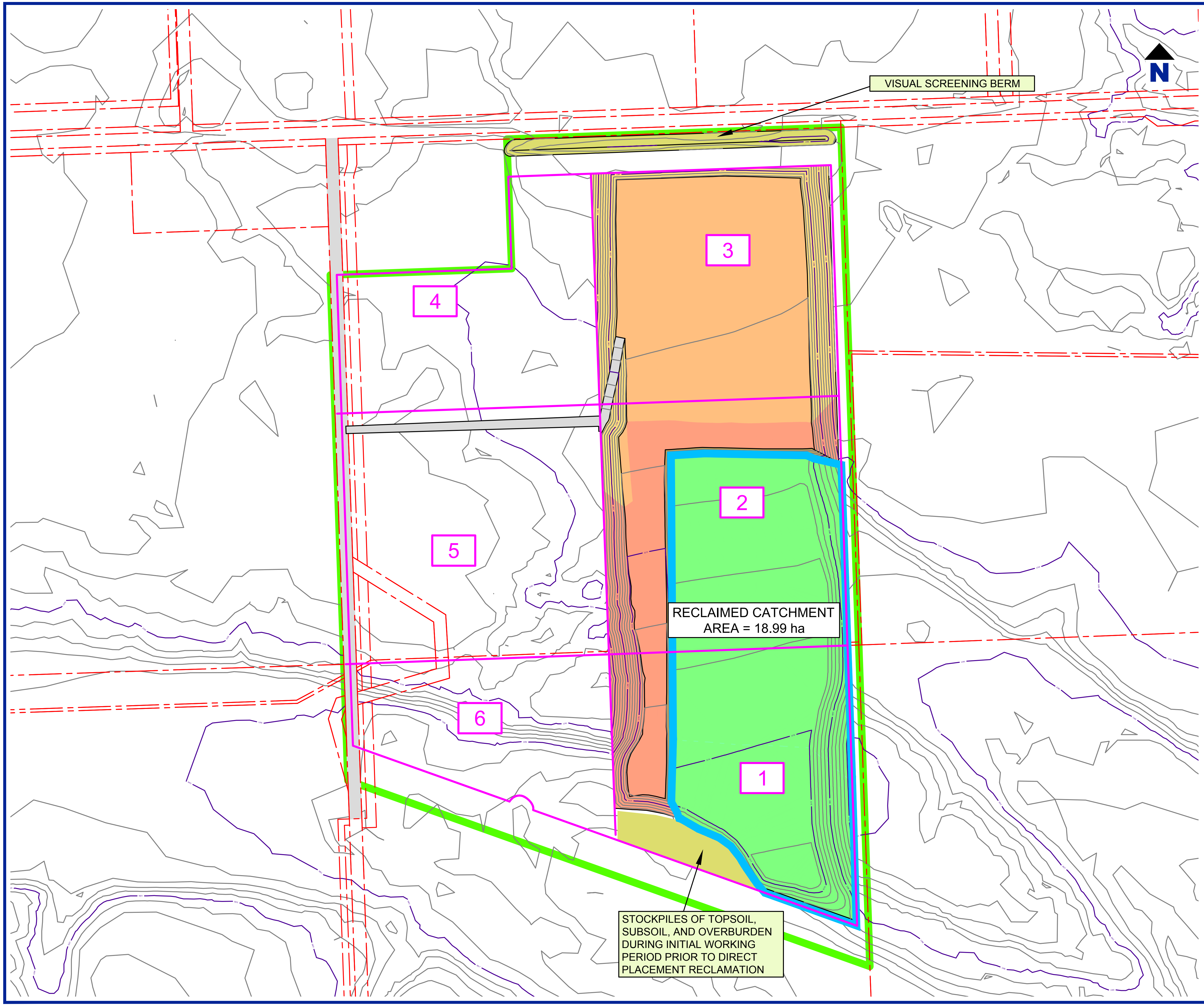
SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 1B

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 8

SLR

Cadfile name: 212-06650-00007 EM01_PHASE 2 - COP 09052023.dwg



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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

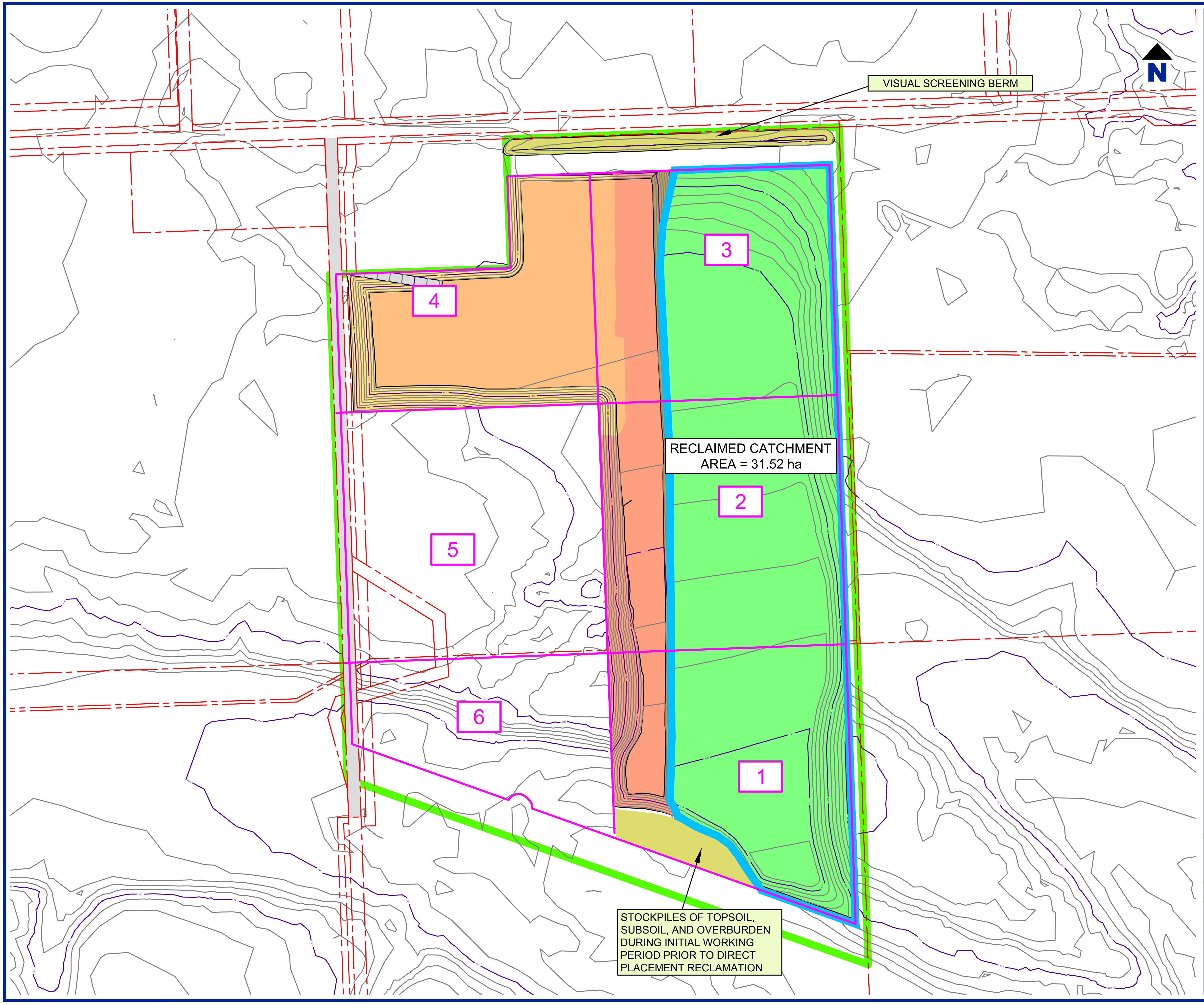
SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION EXTRACTION PHASE 2

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 9

SLR

Cadfile name: 212-06650-00007 EM01_PHASE 3 - COP 09052023.dwg



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SUMMIT PROJECT

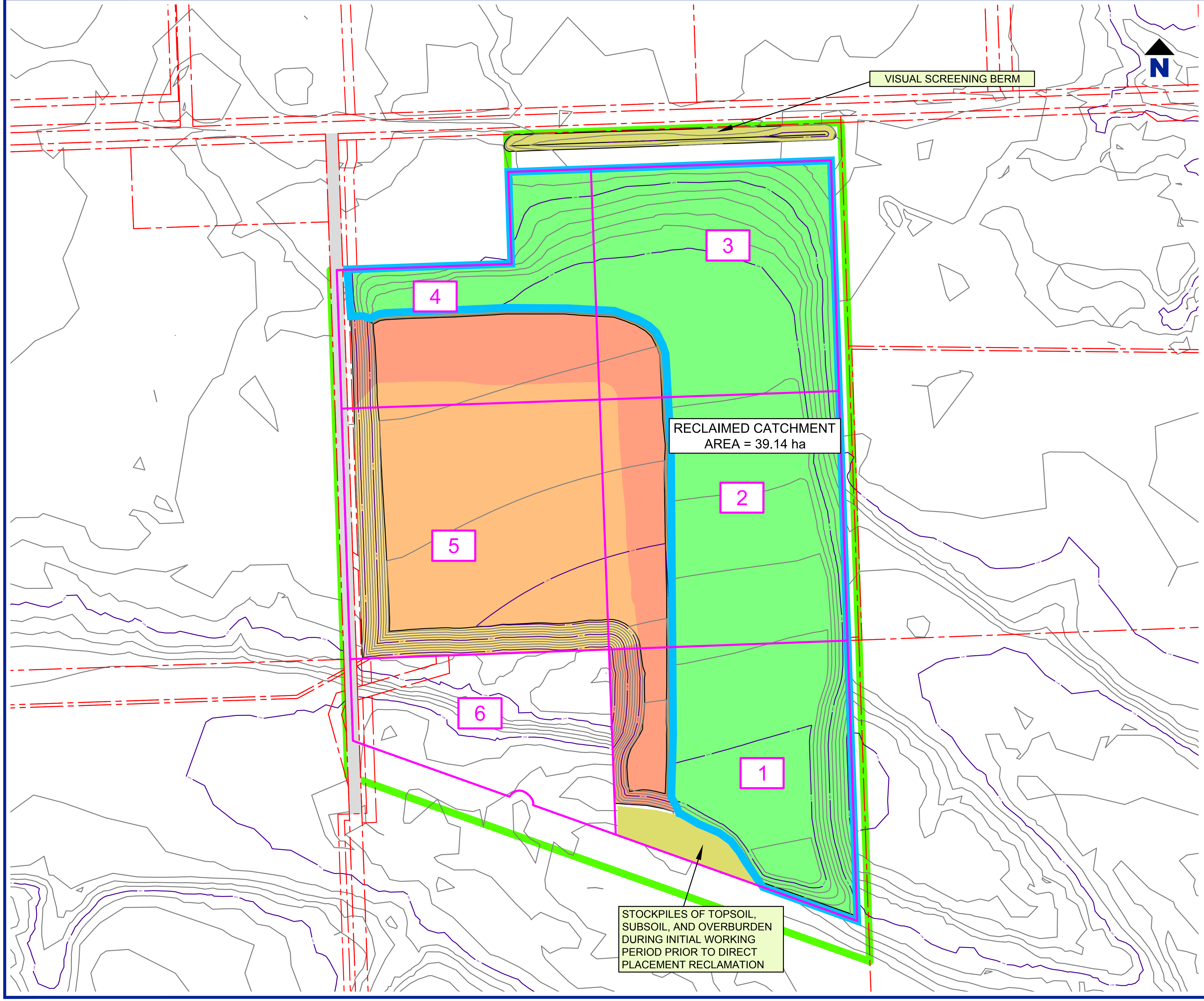
SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 3

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 10

SLR

Cadfile name: 212-06650-00007 EM01_PHASE 4 - COP 09052023.dwg



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■	PREVIOUS MINING AREA
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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

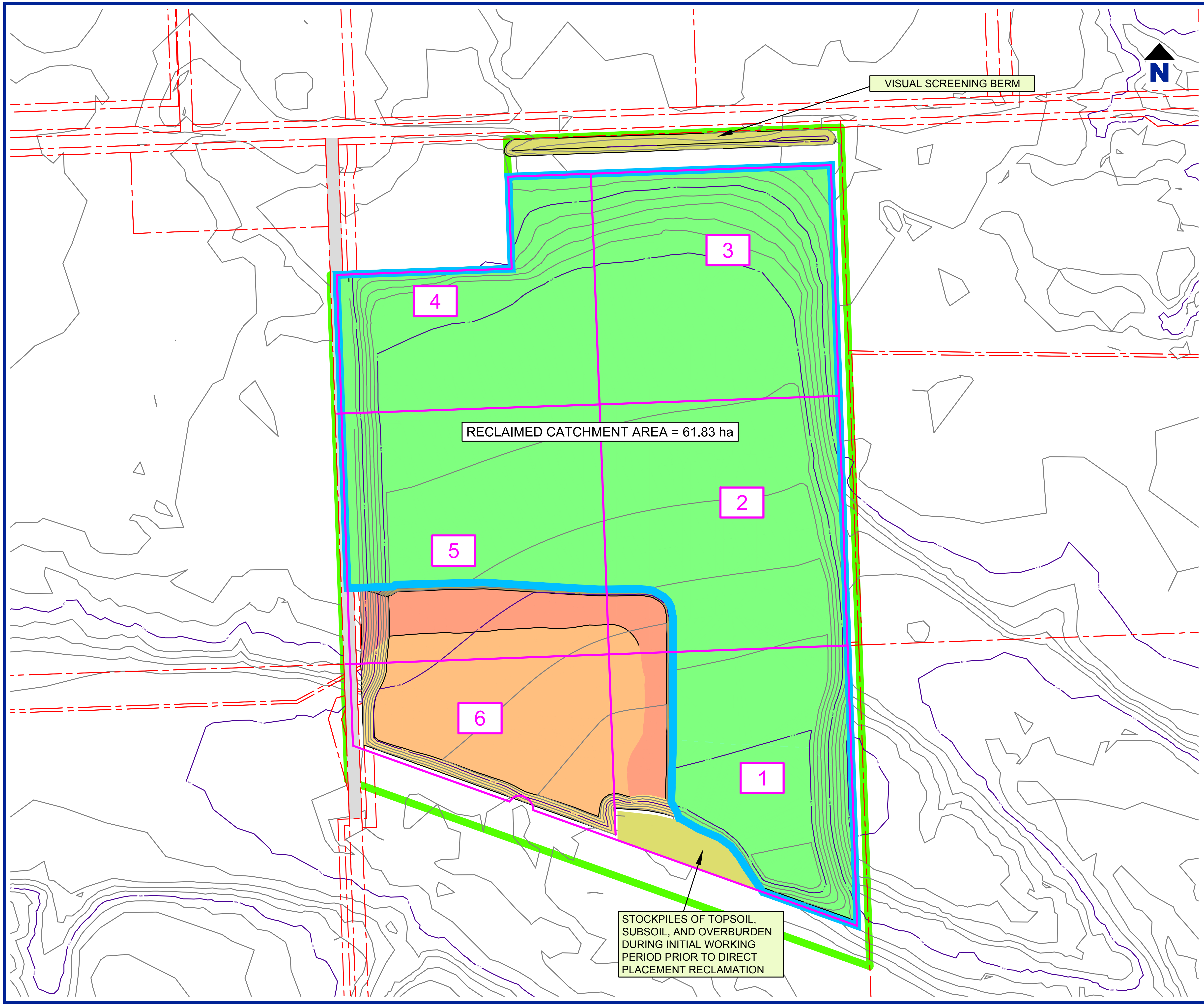
SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 4

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 11

SLR

Cadfile name: 212-06650-00007 EM01_PHASE 5 - COP 09052023.dwg



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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

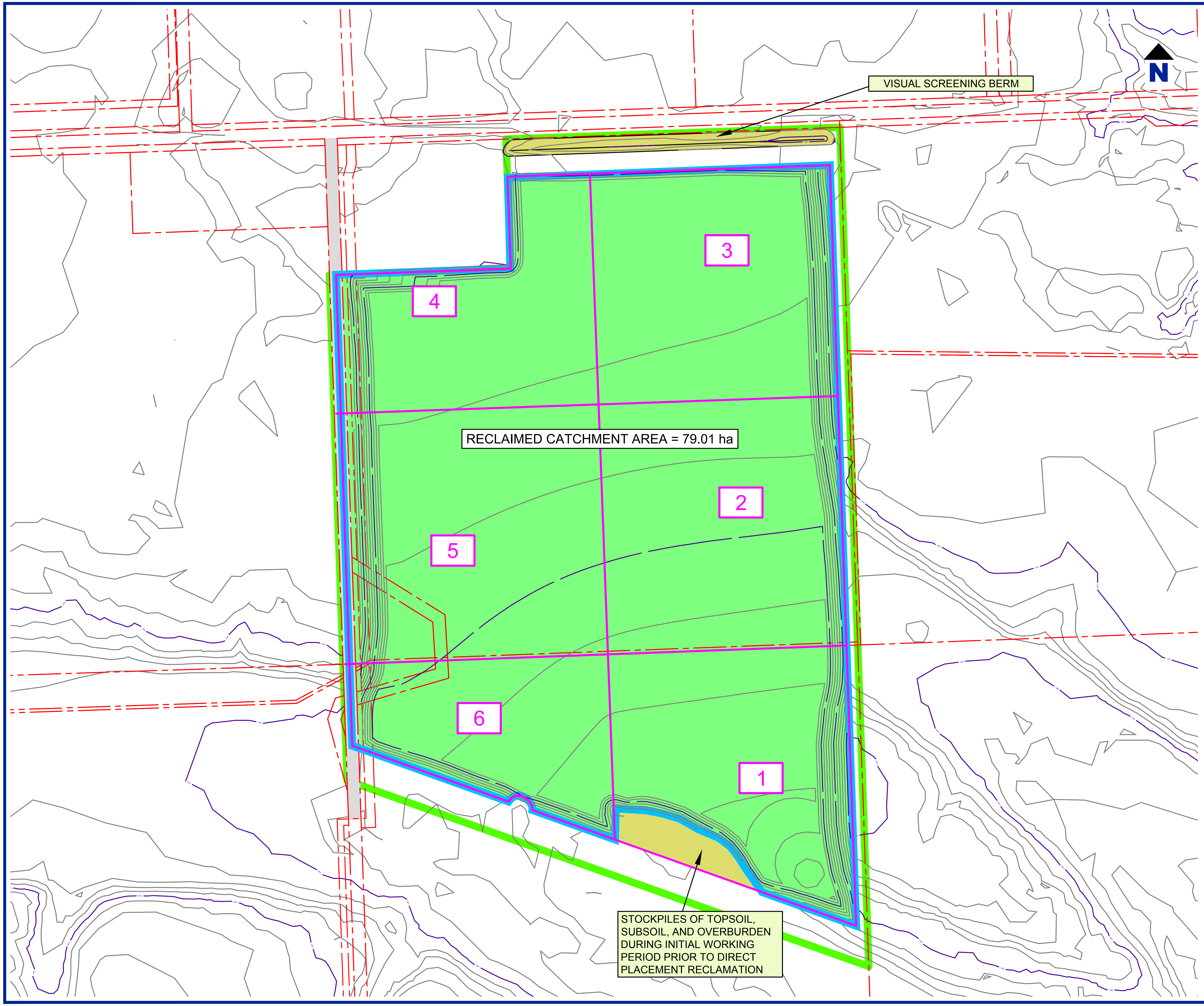
SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 5

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 12

SLR

Cadfile name: 212-06650-00007 EM01_PHASE 6 - COP 09052023.dwg



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▭	EXTRACTION (PIT) PHASE BOUNDARIES
▭	LEGAL LINES
🟨	OVERBURDEN / SOIL STORAGE
▭	ACCESS ROAD
◩	ACTIVE MINING AREA
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0 50 100 200 300 m

SCALE 1:6,000
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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 6

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 13

Cadfile name: 212-06650-00007 EM01_PHASE 7 - COP 09052023.dwg

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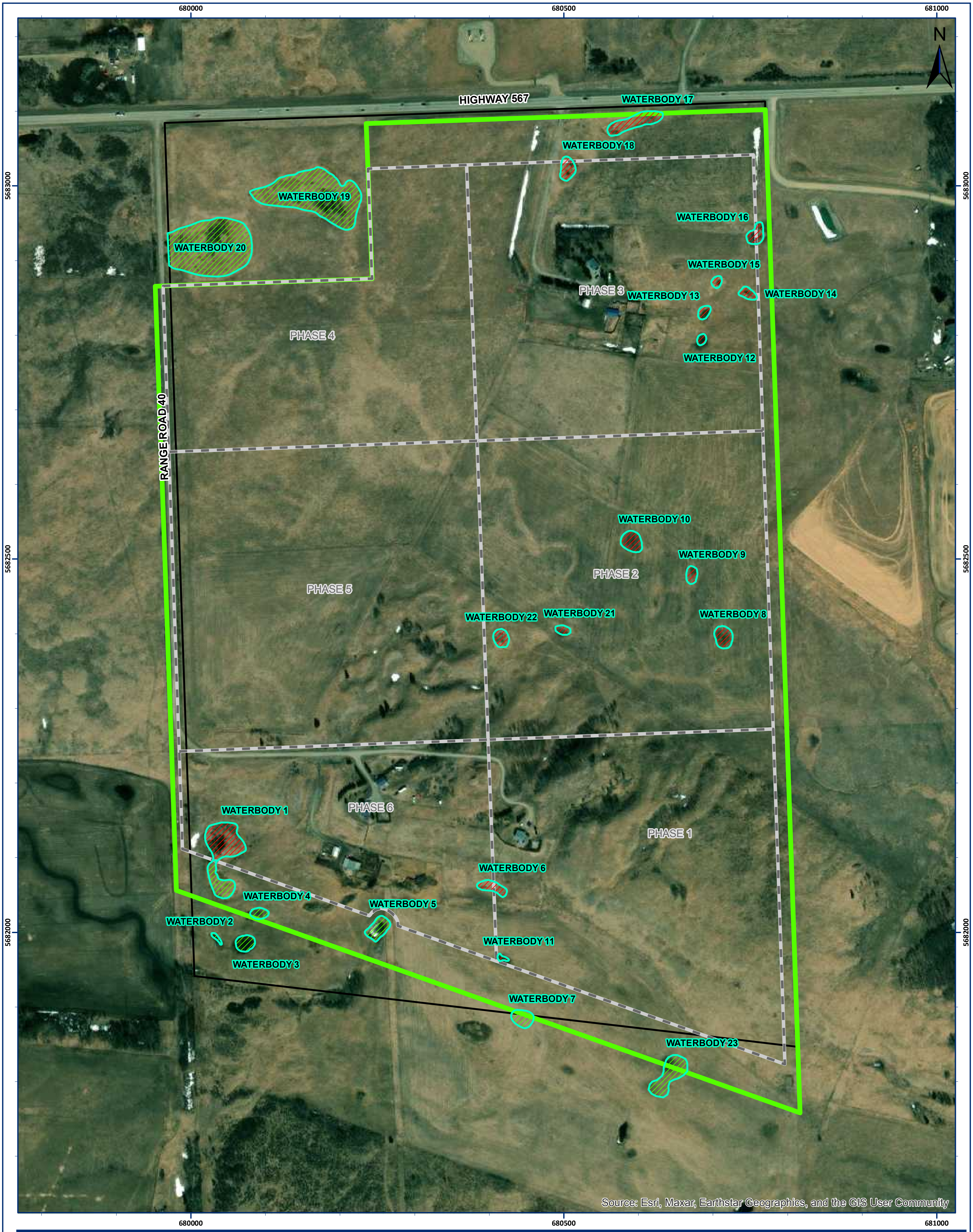

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

LEGEND

▭	AREA ASSESSED	▭	WATERBODY
▭	EXTRACTION PHASE BOUNDARY	▨	INDICATES WATERBODY THAT WILL BE REMOVED
🟩	PROJECT BOUNDARY	▨	INDICATES WATERBODY THAT WILL BE LEFT IN PLACE

NOTES:

0 50 100 200 300 m

SCALE 1:5,000
PAGE SIZE 11 x 17
NAD 1983 UTM Zone 11N
THIS MAP IS FOR CONCEPTUAL PURPOSES ONLY
AND SHOULD NOT BE USED FOR NAVIGATION

MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

IDENTIFIED WATERBODIES

SLR

FIGURE NO:
14

DATE: May 8, 2023

PROJECT NO: 212.06650.00007

5.4 Sensitive Areas

A total of 23 water bodies were assessed as part of this WAIR. Nineteen water bodies were identified as partially or fully within the Project Boundary, including 7 wetlands. Four water bodies fall outside of the Project Boundary but are within the Project Area, including 3 wetlands. Fifteen of the water bodies will be partially or fully removed, including 7 wetlands, and 8 water bodies, including 3 wetlands, will be avoided.

There were no shallow open water wetlands identified other than a man-made dugout excavated at the location of an historical wetland. Wetlands were classified as follows (Appendix S: WAIR, SLR 2023c):

- One permanent graminoid marsh (M-G-III) wetland
- Eight temporary graminoid marsh (M-G-II) wetlands
- Fourteen Class I ephemeral water bodies, including one identified as a man-made dugout.

At the time of the assessment, the ephemeral water bodies and temporary wetlands were farmed through, being identified within cultivated hay fields or tame pasture in the Project area.

Based on a study of groundwater conditions in the Project area, the wetlands are all surface water fed, with no permanent groundwater source (SLR 2020c).Technical Memorandum B8 & B9 from the third round of SIRs (SLR, 2023c), and Appendix T provides the Wetland Monitoring Program for the Project.

5.5 Wildlife Considerations

Five provincially sensitive species listed under the current *General Status of Alberta's Wild Species* (GoA 2017) have been observed within a 1,000 m buffer of and including the Project area. Of the five species identified, the barn swallow is also listed as Threatened under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and under Schedule 1 of *Species at Risk Act* (SARA; GoC 2019). The following species were found within the Alberta Fisheries and Wildlife Management Information System (FWMIS) search area (SLR 2020c):

- Great blue heron
- Sora
- Least flycatcher
- Eastern kingbird
- Barn swallow

Of the five bird species listed above, four species were observed during point counts or incidentally within the Project area. Two active barn swallow nests were observed under the eave troughs of two of the residences present in the Project area. The least flycatcher and eastern kingbird were heard singing in aspen stands at a few locations in the Project area. A single great blue heron was observed flying over the Project and no evidence of nesting was found. Sora, the fifth provincially sensitive species, were not observed during field surveys; and specific habitat for sora was not present.

The potential for grass nesters and tree nesters to use the Project area for nesting habitat is high as both nesting types of birds were observed during the point count surveys and as incidental observations. No active grassland nests were observed; however, a small unoccupied stick nest was observed in the southeast part of the Project area. Nest boxes were observed along the access roads leading to one of the dwellings. One nest box was occupied by a pair of mountain blue birds. Vegetation and tree clearing activities will therefore need to be undertaken during mid to late winter to avoid the likelihood of encountering nesting birds, in accordance with direction from AEP.

No obvious use of wetlands by larger wildlife was observed. Cliff swallows and northern rough-winged swallows were observed around Wetland 5 (dugout).

Cliff swallows were observed collecting mud from the dugout walls and transporting it back to the mud nests under the eavestroughs of one of the dwellings onsite. Wetlands 19 and 20 have been heavily used by cattle and hoof shear was very prominent. No indication of other hoofed mammals was observed, although deer and elk scat and a red fox were observed in the Project area. These mammals may be using water from wetlands when present, although it is unlikely due the temporary water permanence and other less disturbed habitat, such as the Bighill Creek valley to the south.

Mammals observed include elk, mule deer, and red fox (SLR 2020c). Cattle graze within tame pasture lands around the site.

A Wildlife Protection Plan is provided in Appendix U, and were responded to in the first round of SIRs, #D3 (SLR 2022a).

5.6 Equipment Type

The primary operations at the Summit Pit will consist of aggregate extraction, crushing, screening, stockpiling, and offsite shipping.

5.6.1 Aggregate Extraction

Extraction will take place from Phases 1 to 6. Excavation will occur by stripping the deposit with a scraper, dozer, grader, rock trucks, or excavator. There will be no blasting on the site.

5.6.2 Aggregate Processing and Recycling

Aggregate processing can include crushing, screening, and conveyor transferring to drop points. No recycling has been considered in this registration application. Crushing plants can consist of primary and secondary crushers, and screening plants can consist of primary and secondary screeners. Ground dust will be controlled via watering the area around the aggregate processing and loading site. Water is supplied through third-party- vendors and does not require a license.

5.6.3 Conveyor Drop

Conveyors will be included in operation. There will be one or more stack conveyors depending on the phase of operation, which will transfer aggregate from crushers to stockpiles. Typically, the final conveyor is a telescopic stacker to the stockpile. The drop height is set to a maximum of 1.5 m to reduce dust emissions.

5.6.4 Loading and Unloading

Mountain Ash will sell aggregate from the Summit Pit throughout the year; however, most sales will likely be focused over the spring, summer, and early fall period. During this activity, aggregate will be loaded from the stockpiles onto trucks and transported offsite.

5.6.5 Shipping

Trucks are weighed at the scale house before leaving the Summit Pit. There is one entrance to the Summit Pit which is paved and is located off Range Road 40. The internal haul road from the entrance will be unpaved with dust suppression applied on the remainder of the internal routes.

6.0 SECURITY ESTIMATE

Full cost security has been calculated based on the total lands disturbed and the total volume of material being stripped. The total estimated cost of reclamation has been calculated to be $735,116.79. Mountain Ash has included a 10% contingency to capture additional costs above which have been identified in the attached full-cost security calculation. of $73,511.68. The total security proposed to be provided is $808,628.47 which was determined subsequent to the soil survey completed in December 2022 at the request of the department (SLR 2023b). Please refer the attached Soil Survey found in Appendix Q, activities plan drawings found in Appendix W. Costs are detailed as Appendix O. In calculating these amounts, the following was taken into consideration:

- The security proposed reflects the first 5 years of development for phase 1 and is based on 7.6 ha of disturbed area (area's A, B, C and D; see Appendix O)
- Nature of the pit operations – Dry shallow pit
- Reclamation plan – Progressive reclamation is being proposed (see Appendices E and F)
- Reclamation remaining – As this is a new pit no outstanding reclamation
- Potential sources of contamination – No current contamination onsite and none anticipated as this will be a dry pit producing aggregate only with no secondary processing occurring onsite
- Location of pit – Equipment, soil, and hauling costs are based on local standard costs in the Calgary area. Costs were confirmed with contractors in the area.
- Type and amount of equipment – Mountain Ash has provided a detailed list and associated costs that are confirmed with both environmental staff and contractors
- Costs of securing the site for safety – Part of contingency amounts
- Need for updated Plans – Part of contingency amount

Several other considerations were part of the security estimate that are not detailed in the COP for Pits or the Guide to the COP; these are as follows:

- Exclusion of extraction setbacks onsite – Extraction setbacks are not included in the proposed activities plan in order to avoid sterilizing gravel. Minable areas will be high walled and reclaimed slopes rebuilt to 3:1 or flatter.
- Rejects – Upon submission of the 5--year report, Mountain Ash will provide a surveyed quantity of materials that are unsuitable for use or sale in order to secure reject material to be used in future reclamation.
- Staging area and haul road – Topsoil and overburden from the staging area and haul road will be utilized to construct the permanent screening berms along the north property line, as such, material volumes from these areas have been omitted from the security calculation.

As described above, in Section 4.6 and Appendix E, Mountain Ash is proposing to complete progressive reclamation as the pit is developed. This will minimize the total area of open pit operations at any time and reduce the overall environmental impact of the pit.

6.1 Proposal for the Amount of Security

Provided under separate cover, see Appendix O.

6.2 Proposal for the Form of Security

A Letter of Credit (“LOC”) provided by an approved financial institution will be provided to the Government of Alberta as the form of security for the pit.

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8.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR Consulting (Canada) Ltd. (SLR) for Mountain Ash Ltd., hereafter referred to as the “Client”. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. It is intended for the sole and exclusive use of Mountain Ash. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted unless payment for the work has been made in full and express written permission has been obtained from SLR.

This report has been prepared for specific application to this site and site conditions existing at the time work for the report was completed. Any conclusions or recommendations made in this report reflect SLR’s professional opinion.

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Nothing in this report is intended to constitute or provide a legal opinion. SLR makes no representation as to the requirements of compliance with environmental laws, rules, regulations or policies established by federal, provincial or local government bodies. Revisions to the regulatory standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions and recommendations in this report may be necessary.

Appendix A

Soil and Weed Management Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Soil and Weed Management Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006

April 2021

Soil and Weed Management Plan

Mountain Ash Limited Partnership

Rocky View County, Alberta

SLR Project No: 212.06650.00006

Prepared by
SLR Consulting (Canada) Ltd.
200 – 708 11th Ave SW
Calgary, Alberta, T2R 0ER

for

Mountain Ash Ltd. Partnership
1945 Briar Crescent NW
Calgary, AB, T2N 3V6

April 2021

This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

Prepared by:	Reviewed by:
Katrina Sharko, B.Sc., P.Ag. Soil Scientist and Vegetation Ecologist	**Rick Lauzon, P.Biol., R.P.Bio.** Principal Environmental Consultant

Distribution:
1 copy (PDF) – Mountain Ash Limited Partnership
1 copy - SLR Consulting (Canada) Ltd.

Table of Contents

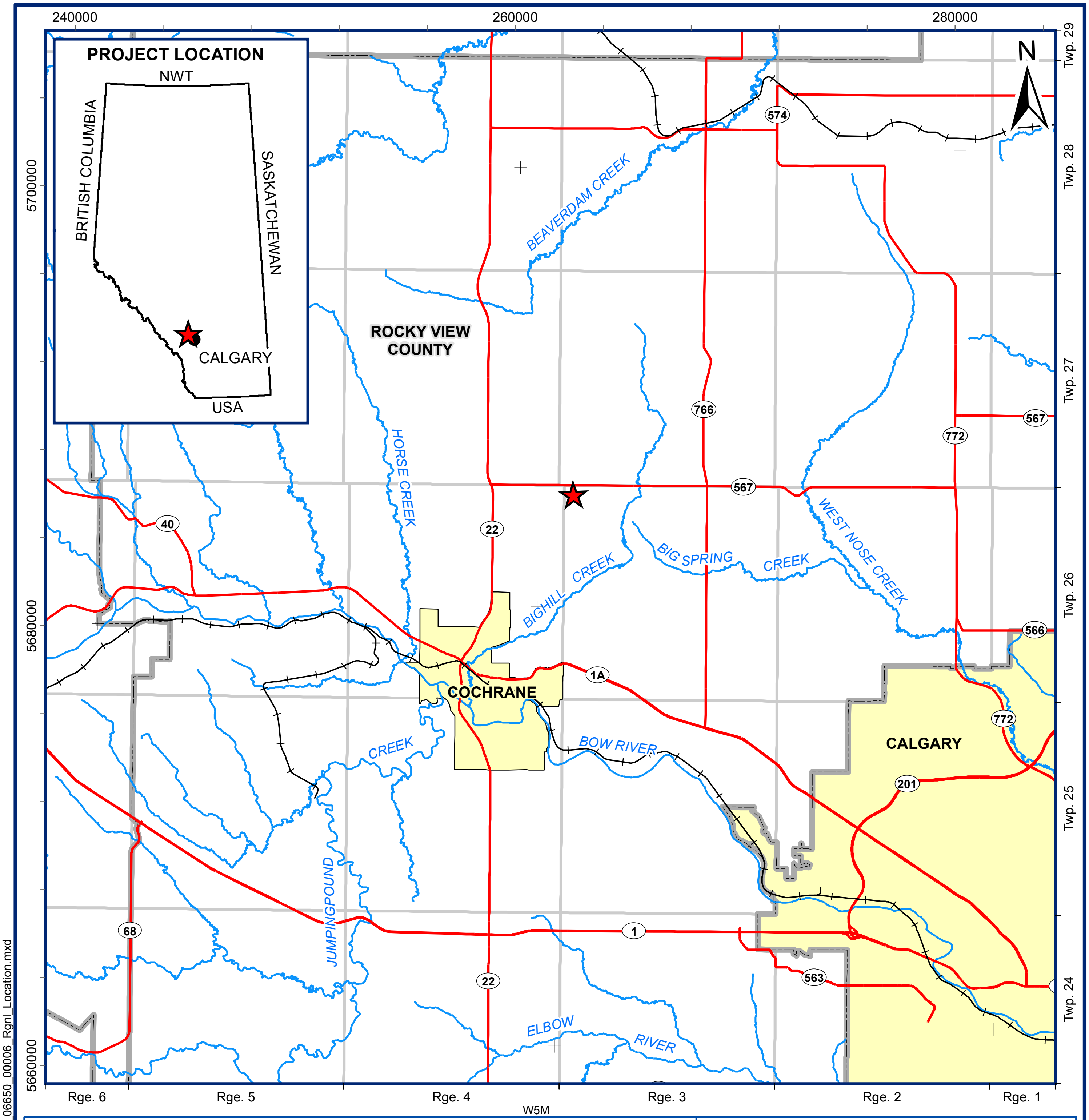
TABLES

FIGURES

1.0 INTRODUCTION

Mountain Ash Limited Partnership (Mountain Ash) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will encompass approximately 208 acres (84 ha) excluding existing road rights-of-way. Mountain Ash is applying for Phase 1 of a six-phase mining plan. This land is currently owned by 1410266 Alberta Ltd. (a general partner of Mountain Ash). Summit Pit received land use and a master site development plan (MSDP) approval on March 2, 2021 (Land Use Bylaw C-8051-2020).

A biophysical impact assessment was undertaken as part of the MSDP application to assess baseline conditions for soils, vegetation and wildlife and to provide an impact and cumulative effects assessment on these resources. As a requirement for the Code of Practice (COP) for Pits and Development Permit (DP) applications, this report details the Soil Management Plan (SMP) and Weed Management Plan (WMP) in relation to the operation of the Summit Pit. This is also consistent with a condition required as part of the land re-designation and MSDP.



LEGEND

★ PROJECT LOCATION

HIGHWAY

RAILWAY

WATERCOURSE

COUNTY BOUNDARY

URBAN

NOTES

This map is for conceptual purposes only and should not be used for navigational purposes.

Basedata:AltaLIS Government of Alberta under the Alberta Open Data License.

5 0 5

SCALE: 1:250,000 KILOMETRES

WHEN PLOTTED CORRECTLY AT 8-1/2 x11

NAD 1983 UTM Zone 12N

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

SOIL AND WEED
MANAGEMENT PLAN

SUMMIT PIT LOCATION

April 8, 2021		Figure No.
Project No.	212.06650.00006	1

[redacted]

D:\Calgary\GIS_Projects_GIS\212_06650_MtnAsh\1.MXDs\fig1_212_06650_00006_Rgnl_Location.mxd

2.0 SOIL ASSESSMENT

The AGRASID Alberta Soil Information Viewer (Alberta Agriculture and Forestry 2021) was accessed to determine soils expected to be present in the proposed Project area. The Alberta Soil Names File (Generation 4) User's Handbook (Alberta Soil Information Centre 2021) was also consulted. This document presents the authoritative suite of acceptable soil series names, with some of their defining attributes, for use in Alberta. The document outlines soil series name, characteristics such as order, great group, subgroup and parent material type and texture of soils that occur within a subject area (Alberta Soil Information Centre 2021).

Desktop review determined that underlying parent material in the Project area is moderately to strongly calcareous, mixed Continental and Cordilleran till (Alberta Soil Information Centre 2016). Fertile loam to clay loam Orthic Black Chernozemic soils are extensive, with Gleysolic soils present in poorly drained and lower slope positions expected at the Project (Alberta Agriculture and Forestry 2016). The Dunvargan soil series, a fertile, well-drained Orthic Black Chernozem formed on glacial till parent material, was identified across the majority of the Project area, with the gleyed variant (Dunvargan-GL) identified in depressional areas.

Soils were classified in the field in accordance with criteria established by the Soil Classification Working Group (1998). Soil inspection locations were completed to verify the desktop review and to help determine the presence or absence of wetlands on the landscape. Soil investigations were conducted on foot with a shovel and hand auger from July 2 to 4, 2020. The soils were investigated to a depth of approximately 1 m at all test hole locations unless auger refusal was encountered. Soil inspection locations (SILs) were advanced at a rate of approximately one to two locations per hectare for a total of 10 soil inspection locations. The depth of each soil horizon encountered at each SIL was recorded to determine best methods for soil handling and replacement. Soil map units have a certain range of properties or variability due to soil being a continuum. Consequently, the soil inspections were extrapolated using the principles of geomorphology and surficial geology in concert with the vegetation patterns to delineate individual soil map units. Soil map units identified in the field were correlated to the general soil series established in each unique ecosite identified within the proposed Project area.

Further soil field work will be completed prior to or in conjunction with site stripping to guide soil storage and stripping practices onsite.

In the field, upland soil inspection locations confirmed that the majority of the Project area consists of Orthic Black Chernozems of the Dunvargan soil series. Textures were loam to sandy clay loam. Wetlands contained gleyed Dunvargan soil series, with mottling in the Bmgj and Ccag and Ckg horizons. Areas of soil disturbance were noted in the vicinity of the several residences in the Project area. Example profiles of Dunvargan and Dunvargan-GL soils are identified in Tables 1 and 2. These soils have low wind erosion risk and moderate water erosion risk.

Table 1: Example Profile for Dunvargan Soil Series

HORIZON	DEPTH (CM)	COLOUR	FIELD TEXTURE	STRUCTURE	CONSISTENCE
Ap	0-19	black	Clay loam	granular	Friable
Bm	19-38	dark yellowish brown	Clay loam	prismatic	Firm
Cca	38-57	pale brown	Sandy clay loam	massive	Very Firm
Ck	57-100	yellowish brown	Sandy clay loam	massive	Very Firm

Table 2: Example Profile for Dunvargan-gl Soil Series

HORIZON	DEPTH (CM)	COLOUR	FIELD TEXTURE	STRUCTURE	CONSISTENCE
Ap	0-33	black	Clay loam	granular	Friable
Bmgj	33-52	brown	Clay loam	prismatic	Firm
Ccag	52-59	grayish brown	Clay loam	massive	Firm
Ckg	59-100	yellowish brown	Sandy clay loam	massive	Firm

2.1 Soil Handling and Soil Management

During construction, best practices for erosion and sedimentation control will need to occur to prevent soil erosion once the vegetation is removed. Topsoil and upper subsoil will be salvaged and stockpiled separately for reclamation purposes. These soils are not susceptible to wind erosion; however, water erosion during spring melt or heavy rainfall events is a concern. Soil stockpiles will be vegetated with an appropriate seed mix to prevent water erosion.

Average topsoil onsite for upland areas is approximately 25 cm and approximately 30 cm in wetland areas. Approximately 20 cm of suitable subsoil is present. Soil series and subsoil will be further characterized onsite during stripping and grading. Soils will be appropriately managed under the direction of a qualified professional onsite. Unique or problem soils, if present, will be handled separately.

3.0 WEED MANAGEMENT PLAN

Weed species and weed control fall under both provincial and municipal legislation. Provincial legislation (i.e., the *Weed Control Act*), is enforced by municipalities, which may have additional bylaws or policies that they also enforce. Under the *Weed Control Act*, exotic or alien plant species are listed as either prohibited noxious or noxious (GoA 2010). According to the *Weed Control Act*, prohibited noxious weeds need to be destroyed, which means “to kill all growing parts or to render reproductive mechanisms non-viable”. Noxious weeds need to be controlled, which means “to inhibit their growth or spread or to destroy”.

3.1 Weed Survey

A weed survey was conducted as part of the biophysical assessment in June 2019 and no weeds were identified. Professionals supporting the site through construction will assess and monitor stockpiles for noxious and invasive weed species. This includes the list of invasive species provided by RVC and species listed under the *Weed Control* Act.

3.2 Weed Control Methods

Since no specific species of weeds have been identified onsite, general weed control methods are presented in this section. Mountain Ash will implement weed control as part of their regular operating practices that will cover construction, operation and reclamation.

Weed control methods may include a combination of or any one of the following:

- Chemical (e.g., herbicides)
- Mechanical (e.g., mowing prior to flowering)
- Manual (e.g., hand pulling prior to seed set)
- Grazing and/or cultivation (may be limited due to landuse)

Herbicide spraying is conducted in early spring, late fall or throughout the growing season depending on weeds treated, for example, late fall application is effective on Canada thistle; whereas, early spring application is effective for downy brome. Mechanical weed control may include mowing scentless chamomile prior to flowering to reduce seed spread. Manual methods would be hand pulling weeds prior to seed set for species such as nodding thistle, scentless chamomile and purple loosestrife. Weed management should optimize control methods with timing of construction.

Onsite staff during the initial stripping and grading phases will identify different types of weeds and develop a map indicating weed species, no spray zones (i.e., water including a buffer area) and different control methods.

4.0 REFERENCES

Alberta Agriculture and Forestry. 2021. AGRASID Alberta Soil Information Viewer. https://soil.agric.gov.ab.ca/agrasidviewer/

Alberta Soil Information Centre. 2021. Alberta Soil Names File (Generation 4) User’s Handbook.

Alberta Weed Control Regulations. 2010. https://www.qp.alberta.ca/documents/Regs/2010_019.pdf

5.0 STATEMENT OF LIMITATIONS

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Appendix B

Sediment and Erosion Control Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Erosion and Sediment Control Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006
April 2021
Revision 1, November 2021

Erosion and Sediment Control Plan for Summit Pit (Revised)

Mountain Ash Limited Partnership

Rocky View County, Alberta

SLR Project No: 212.06650.00006

Prepared by:
Erosion Control Central Ltd.
2333 18 Ave NE #24
Calgary, AB T2E 8T6

for

Mountain Ash Ltd. Partnership
1945 Briar Crescent NW
Calgary, AB, T2N 3V6

November 2021

This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

Prepared by:

CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL
CPESC
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Senior Erosion and Sedimentation Control Professional – Erosion Control Central

Reviewed by:

Jesse Dirom B.Sc., MBA, CESCP
Senior Consultant – SLR Consulting

Distribution: 1 copy (PDF) – Mountain Ash Limited Partnership
1 copy - SLR Consulting (Canada) Ltd.

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APPENDICES

1.0 INTRODUCTION

Mountain Ash Limited Partnership (Mountain Ash) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will encompass approximately 208 acres (84 ha) excluding existing road rights-of-way. Mountain Ash is applying for Phase 1 of a six-phase mining plan. This land is currently owned by 1410266 Alberta Ltd. (a general partner of Mountain Ash). Summit Pit received land use and a master site development plan (MSDP) approval on March 2, 2021 (Land Use Bylaw C-8051-2020).

1.1 Soil Description

Soils across the Project area are loam to clay loam Orthic Black Chernozemics of the Dunvargan soil series, with Gleysolic soils present in poorly drained wetland areas (SLR 2020). These soils have low wind erosion risk and moderate water erosion risk (SLR 2020). No sensitive soils were observed (SLR 2020).

1.2 Surface Conditions

The Project is located within the Foothills Parkland Natural Subregion where hay or feed crops are dominant. Vegetation communities are primarily non-native hay crop, tame pasture and non-native species associated with the residences (SLR 2020). Some native pasture remains, and pockets of aspen trees were found in the south half of the site (SLR 2020).

1.3 Drainage Patterns

The Project area slopes southeast from a topographic high to the north, with a low-relief valley feature running northwest to southeast across the NW ¼ section (SLR 2020). The SW ¼ section slopes steeply south-westerly into a valley running west-northwest to east-southeast, leading to Bighill Creek (SLR 2020).

2.0 EROSION AND SEDIMENT CONTROL

The primary objectives of Erosion and Sediment Control (ESC) are to prevent offsite sedimentation into adjacent vegetated lands and specifically into any adjacent permanent or ephemeral watercourses/wetlands.

2.1 Stormwater Management During Operations

During operations, a series of conveyance ditches will be placed to capture onsite drainage/stormwater and transport it to a series of settlement ponds. The intent is to install these stormwater control measures around the entire site, encompassing all 6 phases. For the purposes of this plan, only controls associated with Phase 1 will be considered and constructed at this time. See Figure 2 for locations of diversion and conveyance ditches and settlement ponds.

See section 2.2.1 for recommended ESC measures for these conveyance ditches.

2.2 Temporary Erosion and Sediment Control Measures

Temporary ESC measures are necessary during construction and will be installed in specified work areas as required. In post-construction, when areas are suitably stabilized, temporary sediment control measures will be removed.

Temporary ESC measures are summarized below and shown on Figure 2.

- temporary sediment control (perimeter silt fence) primarily along south and east boundaries of phase 1
- temporary sediment control (silt fence) along haul route adjacent to wetland preservation area
- temporary sediment control (v-ditch/berm with check dams) to provide some runoff storage in unprotected areas
- temporary erosion control (hydro-mulch/tackifier) to provide temporary cover (e.g., hydro-mulch/tackifier) on bare soil in all disturbed areas
- run-on control (diversion ditch) along west and north boundaries to intercept drainage from upslope areas
- stormwater controls (conveyance ditches and settlement ponds) to convey runoff to ponds to allow sediments to settle
- temporary erosion control (rolled erosion control product) in diversion and conveyance ditches to prevent erosion and reduce potential for downslope sedimentation
- temporary sediment control (check dams) in diversion and conveyance ditches to reduce runoff velocity
- temporary erosion control (hydro-mulch/tackifier) on all overburden areas and other disturbed areas that need to be stabilized beyond the short-term
- good housekeeping (gravel access pad) to reduce dirt/mud tracking onto adjacent paved roadways
- dust control applications, namely Calcium Chloride used on internal haul routes and potentially other gravel surfaces that accommodate common vehicle movements and traffic during operations

2.2.1 Extraction Area and Overburden

Diversion Ditch

- Diversion ditches will be built along north and west boundaries of phase 1 to capture runoff from upslope areas and direct it away from active extraction area.
- To prevent erosion and reduce downstream sedimentation, conveyance ditches will be covered with a Rolled Erosion Control Product (RECP). In most areas, a straw-coconut erosion control blanket will suffice to handle sheer stress velocity and prevent erosion. However, in steeper areas, a more durable RECP such as turf reinforcement matting (TRM) may have to be used to handle a higher runoff velocity. To prevent undermining by runoff, the top or leading edge of RECP is trenched in and covered with soil and an adequate number of staples are used.

Installation will be per manufacturer's specifications and instructions. See construction detail on Figure 3.

- To further reduce runoff velocity in ditches, check dams (e.g., sediment logs, Geo-Ridges) will be installed, especially in steeper areas. In very steep areas, rock check dams will be installed to ensure durability during storm events. See construction detail for rock check dam in Figure 3.

Conveyance Ditch

Conveyance ditch around perimeter of the site is still in conceptual mode. Final design of conveyance ditch may not be exactly as shown in Figure 2. Still, same measures for cover (i.e., RECP) and runoff velocity reduction (i.e., check dams) will apply to conveyance ditch.

Silt Fence

- Before construction, trench in silt fence i) along east and south boundaries of phase 1, ii) along south boundary and around southwest corner of overburden – to the west of phase 1, and iii) along east side of access road at north end, adjacent to wetland preservation area. Locations are shown in Figure 2. See construction detail on Figure 3 for silt fence installation and maintenance instructions. J-hooks will be installed at least every 30 m, and even closer together in steeper areas.
- Silt fence not keyed in properly or otherwise not installed per manufacturer's recommendations must be removed and re-installed.
- Silt fence will be repaired as soon as damaged and sediment build-up removed when it reaches half of fence height
- All silt fencing will be removed once upslope areas have been vegetated or upon project completion.

V-ditch/Berm with Check Dams

- To provide for temporary detainment of runoff, v-ditch/berm with check dams along south boundary between west overburden area and south end of diversion ditch will be installed. Location is shown in Figure 2. ditch will be dug with tilting blade bulldozer, backhoe with articulating bucket or skid steer. Track pack or bucket-pack berms and check dams. Check dams will be installed at minimum intervals of 10 m and below the height of the ditch. See construction detail on Figure 3 for installation instructions.
- Water will be pumped out of ditches when half full to restore storage capacity. Water will be pumped to sediment ponds that do not drain to environmentally sensitive areas.
- Any breaches in ditches or check dams will be repaired. When accumulated sediment reaches one third the depth of the ditch, excess sediment will be removed and spread in an area that will not flow to environmentally sensitive areas.

Slope Track-Packing (Surface Roughening)

- Disturbed (bare) slopes will be track-packed, running machinery up and down slope – not along slope. See construction detail on Figure 3.

2.2.2 Access Road

Access road (Range Road 40), off Highway 567 is paved, and starting in northwest corner of overall site and extending southwards for approximately 200 m and then eastwards to the scale house (Figure 2).

Temporary internal haul road, within site, will be graded and surfaced with a gravel base and treated with Calcium Chloride for dust control. During operations, the north access point will be paved. If temporary stabilization is needed before paving, install gravel pad to help reduce offsite dirt tracking and dust. See construction detail scale area in Figure 3.

2.3 Dust Control

Dust emissions during construction activities will be controlled, as necessary. Water truck will be used on disturbed areas and haul routes, especially during dry, windy conditions.

For comprehensive account of dust control measures, refer to SLR's Dust Control Plan for Summit Pit (April 2021) written for the development permit application.

2.4 Stockpile Stabilization

Stripped materials during the development of Phase 1 will be placed in three stockpiles: topsoil, subsoil and overburden. Overburden removed from the south portion of Phase 1 will be placed along south boundary of Phase 1, and overburden taken from north portion of Phase 1 will be directly placed into the reclamation zone created in the south portion of Phase 1.

Before excavation, silt fence will be installed along the south boundary, downslope of these proposed overburden areas, to address and mitigate the potential for sediment transfer to adjacent areas.

Once overburden areas are in place, hydro-mulch/tackifier will be applied in these areas to provide temporary stabilization until final reclamation occur (See Figure 2). Before stabilization, watering of stockpiles may be necessary to suppress dust. All stockpiles will be vegetated and maintained to prevent soil erosion and stockpile loss.

2.5 Permanent Erosion and Sediment Control Measures

Final reclamation plan for Phase 1 has not yet been completed. The ESC objective is to return all disturbed areas, including overburdens, to a vegetated state.

Ultimately, a 15 m wide berm will be built along the entire east boundary. It will be vegetated, including a row of trees planted along the top of the berm.

2.6 Revised Universal Soil Loss Equation (RUSLE) Evaluation

RUSLE is a tool that provides guidance in choosing appropriate ESC measures to maximize erosion protection and minimize offsite sedimentation. The resulting A-value represents potential sediment delivery from any given slope. Per Section 1200 of Rocky View County's Servicing Standards, all slopes must have an A-value (sediment delivery) of under 2.00 tonnes/hectare/year (Rocky View County 2013).

2.6.1 Annual Rainfall Analysis (R-Value)

R-value is based on average rainfall for the Calgary area, which is represented by City of Calgary default R-value (320) from City of Calgary ESC Guidelines (The City of Calgary 2017).

2.6.2 Site Soil Analysis (K-Value)

Since there is no site-specific soil sieve analysis, The City of Calgary default K-value of 0.079 (The City of Calgary 2017) is used in RUSLE calculations.

2.6.3 Pond Table – During Operations

Per Figure 2, some runoff storage (i.e., v-ditch/berm with check dams) will be placed onsite during operations. Depending on v-ditch/berm storage capacity, corresponding P-value is used for RUSLE calculations. P-value is derived from The City of Calgary Sediment Containment Systems – P-Value Updates (June, 2016 – see Appendix B). Table 1 contains onsite runoff storage information

Table 1: Onsite Runoff Storage During Operations

LS Slope	Pond Identifier	Length of v-ditch	V-ditch Volume* (m^3) = Length of v ditches (m) x 2.5 m^2	Drainage Area (ha)	Storage Capacity (m^3/ha)	P-Value
6	V-ditch/berm with check dams	214	535	0.6	892	0.3

*Formula for v-ditch volume is based on construction detail on ESC3 figure

2.6.4 RUSLE Table – During Operations

The following RUSLE table shows potential sediment delivery totals (A-values) in areas that are either not in an active extraction zone or where overburden material will be stockpiled.

Table 2: RUSLE Calculations During Operations

LS Slope	Slope and Slope Length	R-Value	K-Value	LS-Value	Description of Control Practices	C-Value	P-Value	A-Value (Tonnes/ ha/yr)
1	46 m @ 26.3%	320	0.079	6.70	C - hydro-mulch/tackifier (Flexterra® HP-FGM) P - surface roughening	0.01	0.900	1.52
2	21 m @ 11.4%	320	0.079	1.35	C - hydro-mulch/tackifier (Flexterra® HP-FGM) P - surface roughening	0.01	0.900	0.31
3	26 m @ 7.3%	320	0.079	0.90	C - hydro-mulch/tackifier (Flexterra® HP-FGM) P - surface roughening	0.01	0.900	0.20
4	78 m @ 4.9%	320	0.079	1.14	C - hydro-mulch/tackifier (Flexterra® HP-FGM) P - surface roughening	0.01	0.900	0.26
5	22 m @ 8.6%	320	0.079	0.94	C - hydro-mulch/tackifier (Flexterra® HP-FGM) P - silt fence = 0.6 and surface roughening = 0.9	0.01	0.540	0.13
6	45 m @ 2.4%	320	0.079	0.39	C – none P - silt fence = 0.6 v-ditch berm with check dams = 0.3 and surface roughening = 0.9	1.00	0.162	1.60
7	64 m @ 2.8%	320	0.079	0.54	C - hydro-mulch/tackifier (Flexterra® HP-FGM) P - silt fence = 0.6 and surface roughening = 0.9	0.01	0.540	0.07

2.7 Best Management Practices

2.7.1 Before Construction

- Clearly stake out work area with flagging tape to minimize disturbance of existing vegetation.
- Locate all laydown areas on flat terrain. If necessary, install containment measures (e.g., sediment logs, containment berms) around these areas.
- Install perimeter ESC measures (e.g., silt fence) before earthworks and placement of overburden starts.
- Install stabilized access point into site to reduce potential of dirt/mud tracking onto adjacent roadways.

2.7.2 During Construction

- Install additional ESC measures, as needed, to ensure onsite runoff is dealt with and not leading to offsite sedimentation.
- Provide enough watering or other approved dust control measures (e.g., calcium chloride) to minimize dust on haul roads, stockpiles and any other loose soil onsite, especially during dry windy conditions.
- Complete an erosion and sediment control inspection and report weekly and after a significant or prolonged rainfall event or snowmelt. A significant rainfall event is typically defined as greater than 12 mm of rainfall during a 24-hour period. See Section 2.7.

2.7.3 Post Construction

- Restore/reclaim all disturbed areas as soon as practical and where possible.
- Re-use salvageable subsoil for backfill and remove all other excavated material
- To minimize slope erosion, apply topsoil and regionally approved native grass seed mix.
- Remove and dispose all temporary sediment control measures when no longer needed.
- Remove all unused materials from site and dispose construction debris at an approved waste transfer facility.

2.7.4 General Mitigation Measures

- Ensure all vehicles and equipment brought onsite are free of debris, grease, oil, mud or leaks.
- Conduct cleaning, fueling and servicing of all equipment at a safe distance (preferably 100 m) away from watercourses, wetlands or environmentally sensitive areas. If necessary, conduct these activities in a contained area that is lined and bermed.
- Halt work during heavy rains/snowfall.
- Site-specific spill response plan that includes emergency contact numbers and outlines measures to contain, control, report and clean-up spills and releases of deleterious substances. At a minimum, if a release or spill occurs, immediately notify the Site Construction Supervisor; estimate the volume of fluid released and cease operations to assess the need for and extent of containment measures.
- Report all environmental emergencies and/or releases to:
- Alberta 24 Hour Spill Reporting Line: 1.800.222.6514; and/or
- DFO Emergency Response Line: 1.800.889.8852
- Keep a copy of ESC Plan and all regulatory approvals onsite during construction activity.

2.8 Monitoring

Regular supervision and environmental monitoring during construction process is required, to ensure regulatory compliance, oversee implementation of works in accordance with design plans, minimize site disturbances, limit seepage into work areas and apply preventative control measures.

All erosion and sediment control measures will be continually monitored. A formal inspection and report will be conducted weekly and after a heavy or prolonged rainfall event or snowmelt. A heavy rainfall event is typically defined as greater than 12 mm of rainfall during a 24 hour period.

ESC inspection report will be a written including a photographic record of ESC measures and maintenance requirements. Digital photos will confirm that erosion and sediment control measures were installed and will identify requirements for remedial actions. Each photo will be dated and identified by a photo number.

A copy of each inspection report will be kept onsite. Maintenance must be carried out in timely and diligent manner, ideally within 48 hours of discovering any damaged installation.

Erosion and sediment control inspection reports will be made available to all government regulators on request. In addition, all other regulatory approvals will be kept onsite during construction.

If there is a temporary work stoppage, inspection and maintenance of erosion and sediment control measures must continue.

3.0 REFERENCES

Rocky View County. 2013. *County Servicing Standards.* May 28, 2013.

SLR Consulting (Canada) Ltd. 2020. *Mountain Ash Limited Partnership Aggregate Operation NW and SW 31-26-03 W5M, Rocky View County, Alberta Biophysical Impact Assessment Report.* January, 2020. Calgary, Alberta.

The City of Calgary. 2017. *The City of Calgary Water Resources Erosion and Sediment Control Guidelines*, 2017. Calgary.

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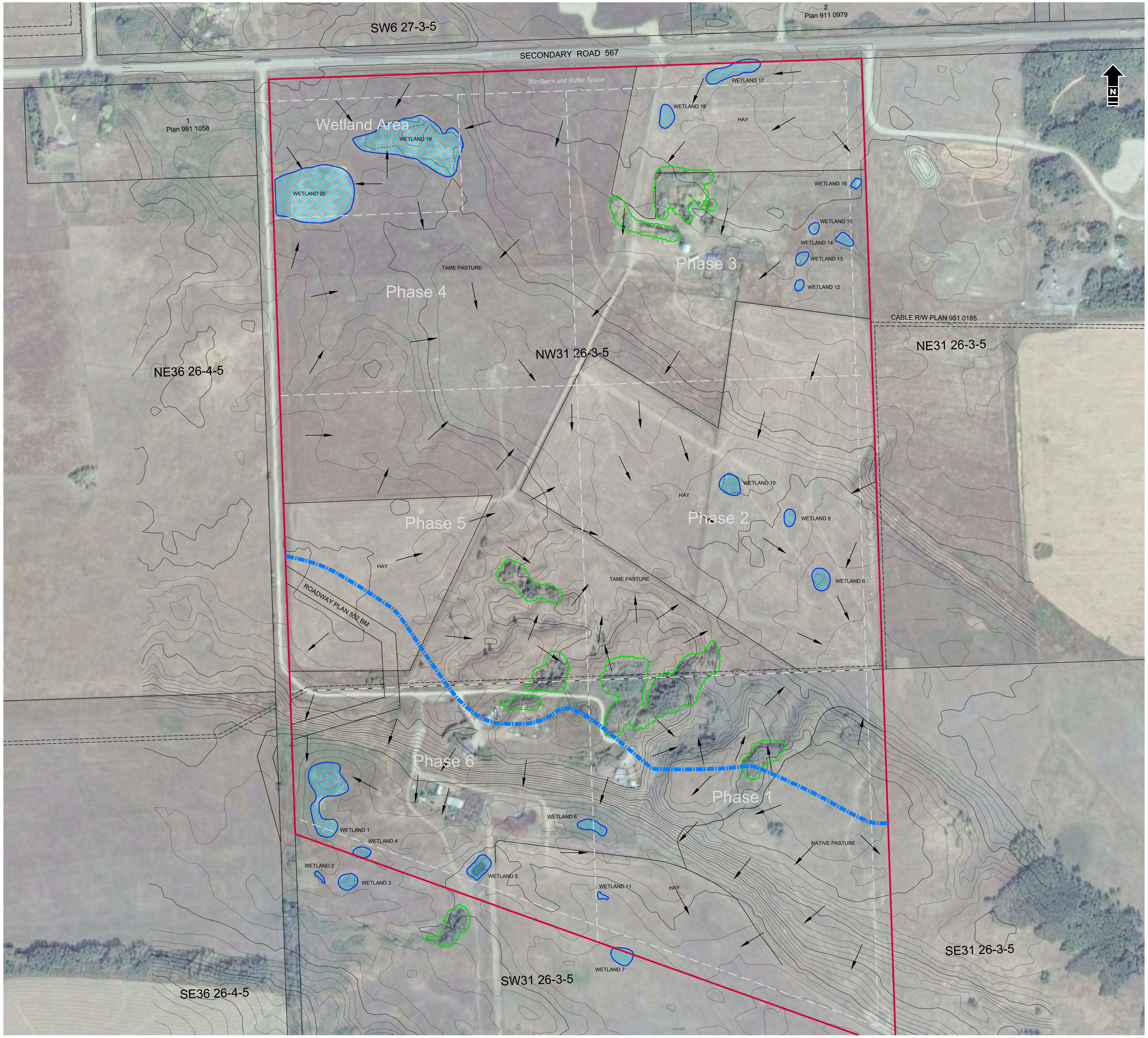
FIGURES

Erosion and Sediment Control Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006



APPROVING AUTHORITY OFFICE USE

FILE No.

Project Information

Legal Description:

Within of N.W. & S.W. Sec.31-26-03-W5

Construction Start

Autumn 2021

Key Plan

ESC Consultant

EROSION
CONTROL CENTRAL

Erosion Control Central (ECC)
#24, 2333 18th Ave NE, Calgary, AB T2E 8T6
David Dinu, CPESC
david@erosioncontrolcentral.com
tel: (403) 909-3700

Legend

▬ ▬ ▬	Development Boundary
~1091~	Contour
⟶	Slope Segment
1081.7	Spot Elevation
③	Slope Number
LS=#.##	RUSLE FAC Slope Factor Value (for freshly prepared construction sites)
→	Flow Direction
▬ ▪ ▬ ▪	Drainage Divide
— — —	Drainage Area Boundary
▨	Wetland
☁	Treed Area
■—●—	Storm Main and Manhole
▬	Catch Basin

0 50 100 150 200

SCALE 1:2500

REVISION					
2	Nov 4-2021	REVISED TO ADDRESS COUNTY COMMENTS	DD		GM
1	Apr 21-2021	ISSUED FOR REGULATORY APPROVAL	DD		GM
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

Engineering Consultant

-

CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL
CPESC®
David Dinu
No.3055

Reference: SLR source material

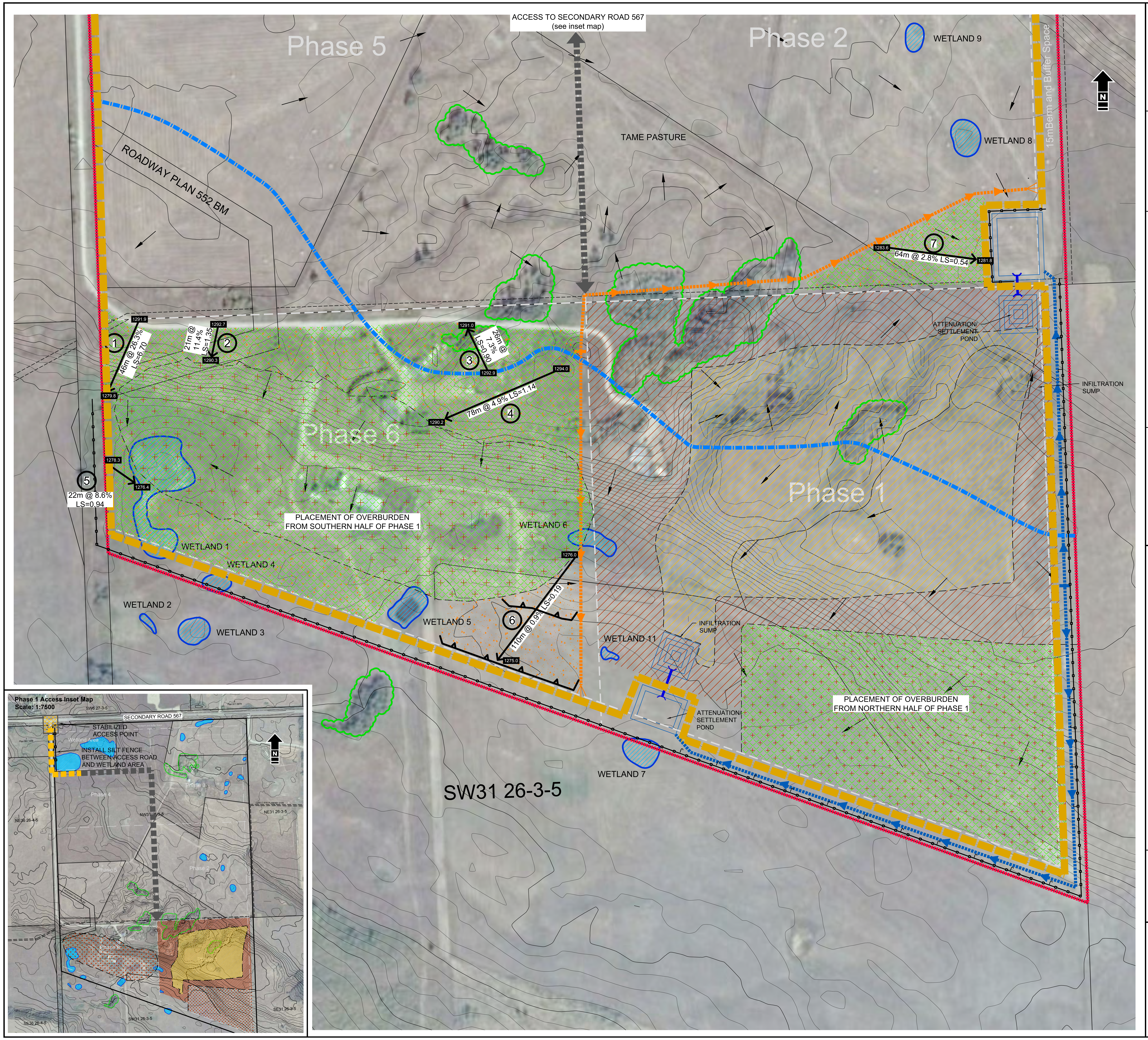
Rocky View County, Alberta
Mountain Ash Limited Partnership Aggregate Operation

ESC Plan
Before Development

Date:	CAD file:	Printed:	Technical:	Drawn:
April 2021	MountainAsh	November 4, 2021	D. Dinu	GM

Disclaimer: This drawing is for the implementation of ESC measures for this site only. All erosion control design information shown on this drawing is intellectual property of ECC and cannot be used or reproduced without authorization from ECC. The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by ECC to ensure the accuracy of the information presented at the time of publication, ECC assumes no liability for any errors, omissions, or inaccuracies in the third party material.

Figure
1



APPROVING AUTHORITY OFFICE USE

FILE No.

Project Information

Legal Description:

Within of N.W. & S.W. Sec.31-26-03-W5

Construction Start

Autumn 2021

Key Plan

ESC Consultant

EROSION CONTROL CENTRAL

Erosion Control Central (ECC)
#24, 2333 18th Ave NE, Calgary, AB T2E 8T6
David Dinu, CPESC
david@erosioncontrolcentral.com
tel: (403) 909-3700

Legend

- Development Boundary
- Contour
- Slope Segment
- Spot Elevation
- Slope Number
- LS=#.## RUSLE FAC Slope Factor Value (for freshly prepared construction sites)
- Flow Direction
- Drainage Divide
- Drainage Area Boundary
- Wetland
- Treed Area
- Culvert
- Attenuation/Settlement Pond
- Drainage Ditch
- Temporary Diversion Ditch with Erosion Control Blanket and Check Dams
- Temporary Perimeter Berm
- Overburden Placement Area
- Active Extraction Area
- Silt Fence with J-Hooks
- V-Ditch/Berm with Check Dams
- Hydro-mulch / tackifier
- Surface Roughening and Hydro-mulch / tackifier
- Surface Roughening
- Internal Haul Road
- Paved Access Road
- Stabilized Access Point

0 20 40 80 120

SCALE 1:1500

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
2	Nov 4-2021	REVISED TO ADDRESS COUNTY COMMENTS	DD		GM
1	Apr 21-2021	ISSUED FOR REGULATORY APPROVAL	DD		GM

Engineering Consultant

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David Dinu
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Reference: SLR source material

Rocky View County, Alberta
Mountain Ash Limited Partnership Aggregate Operation

ESC Plan

Phase 1 - During Operations

Date: April 2021
CAD file: MountainAsh
Printed: November 4, 2021
Technical: D. Dinu
Drawn: GM

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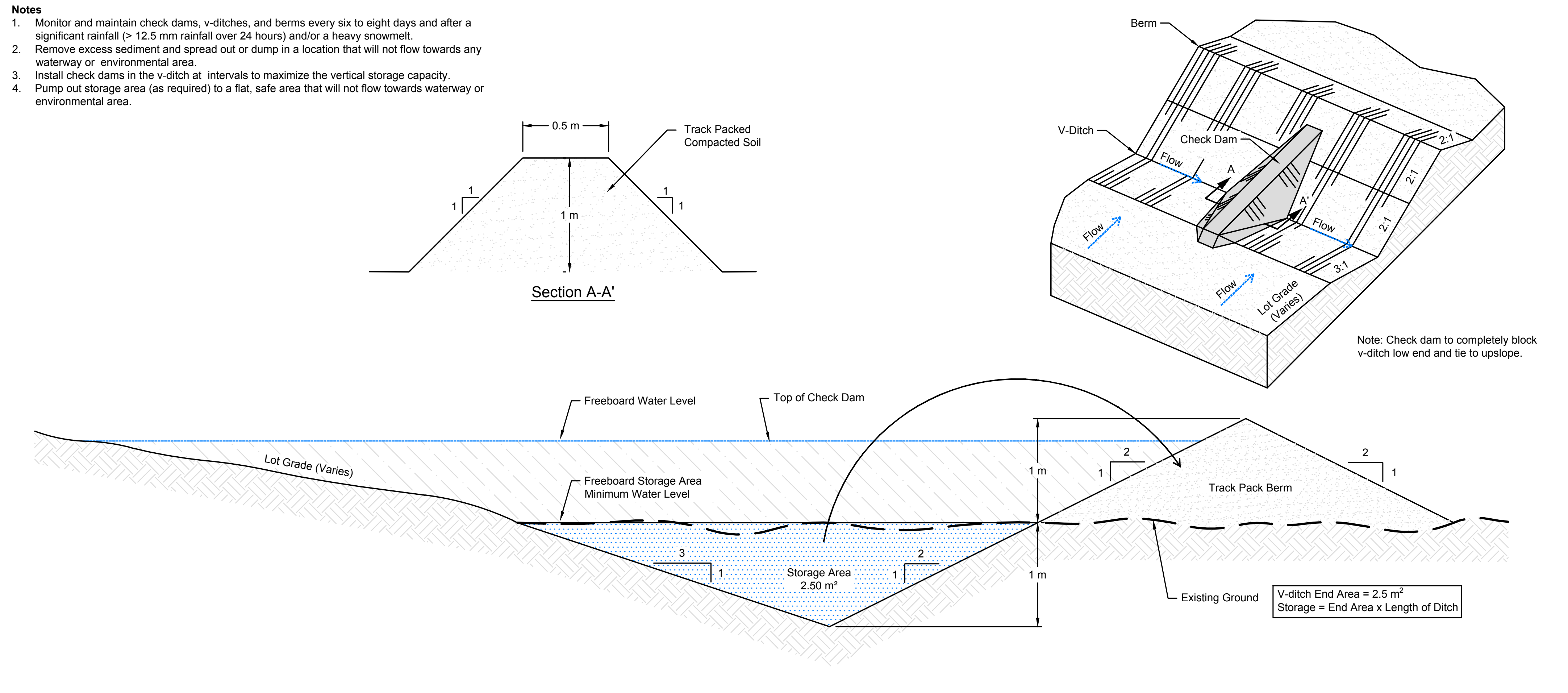
Figure
2

Notes
1. Monitor and maintain check dams, v-ditches, and berms every six to eight days and after a significant rainfall (> 12.5 mm rainfall over 24 hours) and/or a heavy snowmelt.
2. Remove excess sediment and spread out or dump in a location that will not flow towards any waterway or environmental area.
3. Install check dams in the v-ditch at intervals to maximize the vertical storage capacity.
4. Pump out storage area (as required) to a flat, safe area that will not flow towards waterway or environmental area.

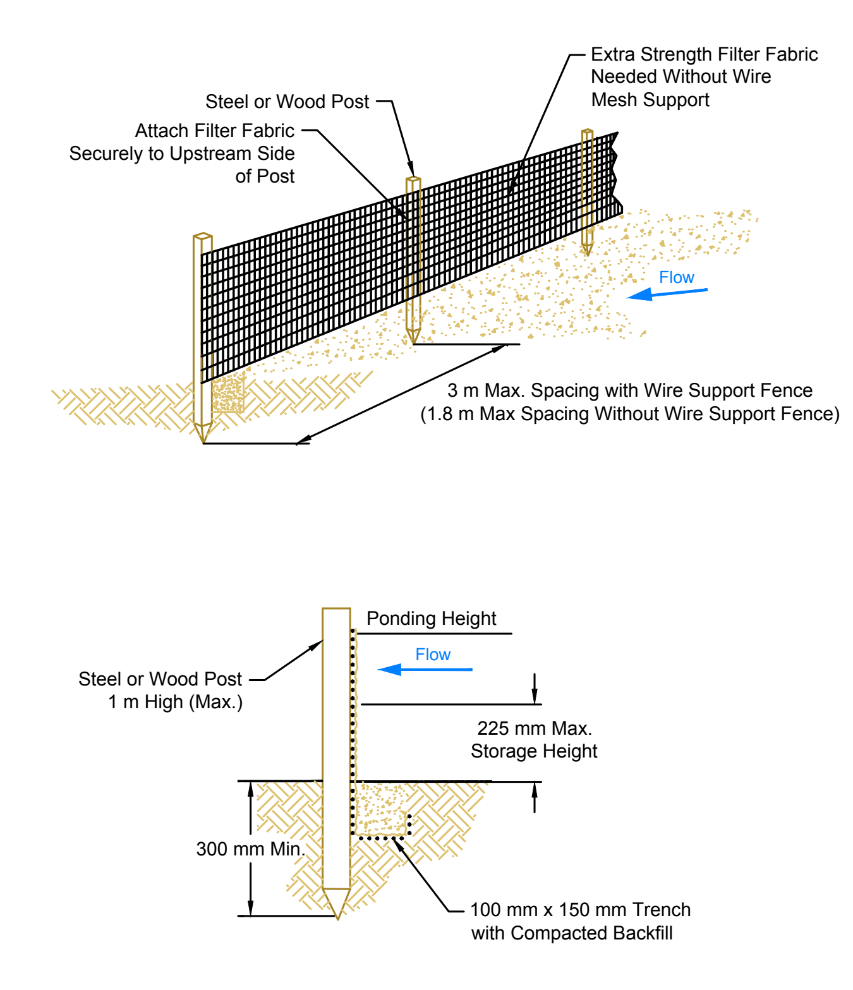


Note: Check dam to completely block v-ditch low end and tie to upslope.

V-ditch End Area = 2.5 m^2
Storage = End Area x Length of Ditch

V-Ditch / Berm with Check Dam

N.T.S.



Notes
1. Place silt fence on slope contours to maximize ponding efficiency.
2. Inspect and repair silt fence every six to eight days and after each storm event (>12.5 mm rainfall over 24 hours) and/or after significant snow melt event.
3. Remove sediment when accumulated silt reaches half of fence height or 225 mm.
4. Place sediment build-up in an area that does not contribute to offsite sedimentation.

Silt Fence

N.T.S.

General Construction ESC Notes:

1) Keep the following information on site and available upon request::
   a. The Erosion and Sediment Control (ESC) Drawing(s), including all amendments; and,
   b. Weekly documentation (including photos and up-to-date written records) detailing implementation, inspection and maintenance of ESC measures.
2) Complete and document inspections of all ESC measures weekly and at critical times when erosion or sediment releases could occur - after heavy and/or prolonged rainfall and rapid snowmelt (defined as >12 mm precipitation within any 24 hour period or snowmelt on wet or thawing soils).
3) Update approved ESC Report and/or Drawing(s) when there are changes to the erosion and sediment control measures or implementation.
4) Promptly address deficiencies documented during inspection of ESC measures and document the maintenance. Immediately report off-site releases of sediment-laden water or other contaminants to the environment. Contact Alberta 24 Hour Spill Reporting Line: 1.800.222.6514
5) Cover or stabilize longer term stockpiles (in place more than 30 days) with mulch and tackifier, vegetation cover or other suitable measures. Place stockpiles on site so material will not be eroded to off-site areas. Where necessary, install sediment control measures (silt fence, sediment logs, etc.) on the down-gradient side of stockpiles.
6) Where necessary, control dirt tracking at all site access points during construction, by means of a stabilized, well-maintained entrance/exit.
7) Should all or part of the site be left in a state where active construction is not occurring for a period greater than six months, the following conditions must be met:
   a. Maintain the inspection frequency listed in #2 unless there is written approval from Rockyview County that states otherwise; and,
   b. Keep pertinent documentation onsite. Documentation may be kept at an alternate specified location via an amendment.
8) Conduct a pre-winter inspection to note any ESC deficiencies that need to be addressed before freeze-up.

Specific Site ESC Notes:

1) Before construction, trench in silt fence i) along east and south boundaries of phase 1, ii) along south boundary and around southwest corner of overburden - to the west of phase 1, and iii) along east side of access road at north end, adjacent to wetland preservation area. Locations are shown in Figure 2. See construction detail on Figure 3 for silt fence installation and maintenance instructions. Ensure j-hooks are installed at least every 30 m, and even closer together in steeper areas.

2) During operations, the north access point will be paved. If temporary stabilization is needed before paving, install gravel pad to help reduce offsite dirt tracking. See construction detail for gravel pad in Figure 3.

3) To provide for temporary detainment of runoff, install v-ditch/berm with check dams along south boundary between west overburden area and south end of diversion ditch. Location is shown in Figure 2. Dig ditch with tilting blade bulldozer, backhoe with articulating bucket or skid steer. Track pack or bucket pack berms and check dams. Install check dams at minimum intervals of 10 m and below the height of the ditch. See construction detail on Figure 3 for installation instructions.

4) To prevent erosion and reduce downstream sedimentation, conveyance ditches will be covered with a Rolled Erosion Control Product (RECP). In most areas, a straw-coconut erosion control blanket will suffice to handle sheer stress velocity and prevent erosion. However in steeper areas, a more durable RECP such as turf reinforcement matting (TRM) may have to be used to handle a higher runoff velocity. To prevent undermining by runoff, ensure that the top or leading edge of RECP is trenched in and covered with soil and that enough staples are used. Always install per manufacturer's specifications and instructions. See construction detail on Figure 3.

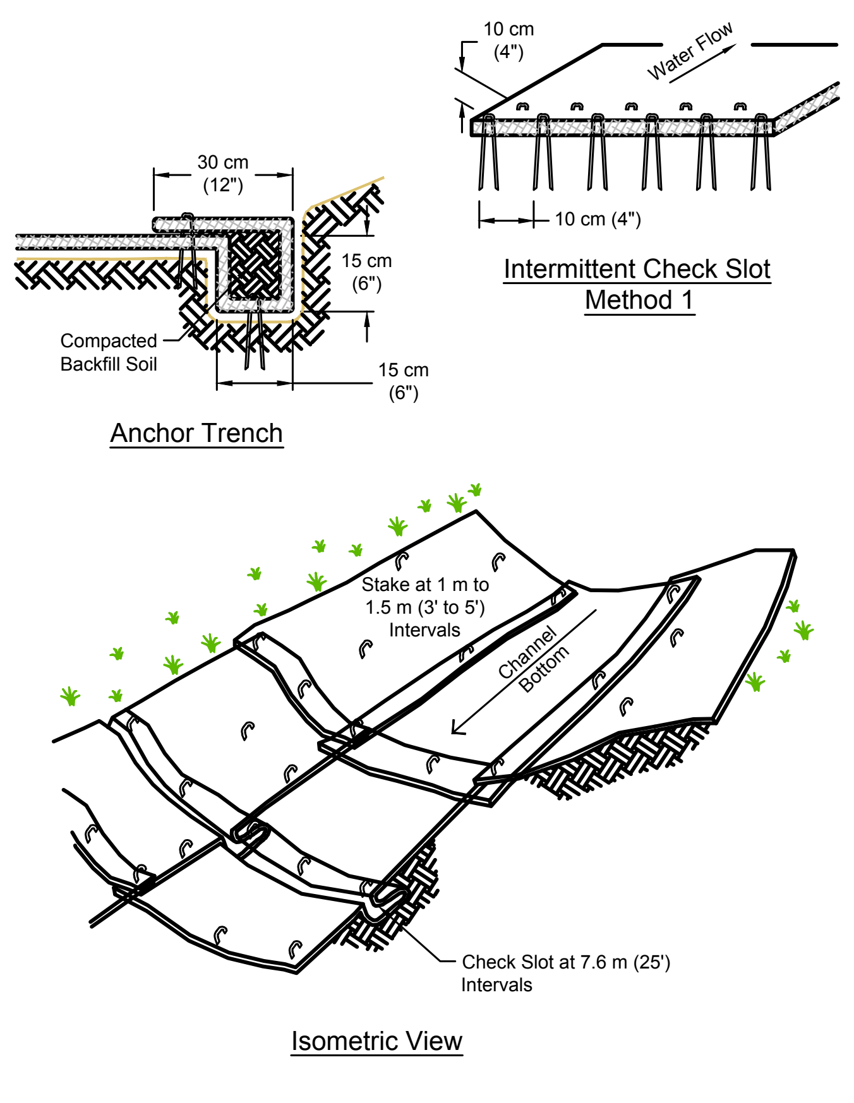
5) To further reduce runoff velocity in ditches, check dams (e.g. sediment logs, Geo-Ridges) should be installed, especially in steeper areas. In very steep areas, rock check dams should be installed to ensure durability during storm events. See construction detail for rock check dams in Figure 3.

6) To prevent erosion at exit points of diversion ditches into surrounding natural environment, install ScourStop™ (or equivalent product) at exit points. Locations are shown in Figure 2. Once ditch is in place install, ScourStop™ per manufacturer's specifications. See Appendix A for ScourStop™ design and installation guide.

7) Dust emissions during construction activities will be controlled as necessary. Water truck should be used on disturbed areas and haul routes, especially during dry, windy conditions. In addition, for haul routes, an approved dust suppressant (e.g. calcium chloride) may be used to keep dust down. Developer is responsible for dust control twenty-four hours a day, seven days a week throughout the duration of the project.

8) Once overburden areas are in place, hydro-mulch/tackifier will be applied in these areas to provide temporary stabilization until final reclamation efforts occur. See Figure 2. Before stabilization, watering of stockpiles may be necessary to suppress dust.

9) Promptly clean any dirt/mud tracked onto adjacent roadways.



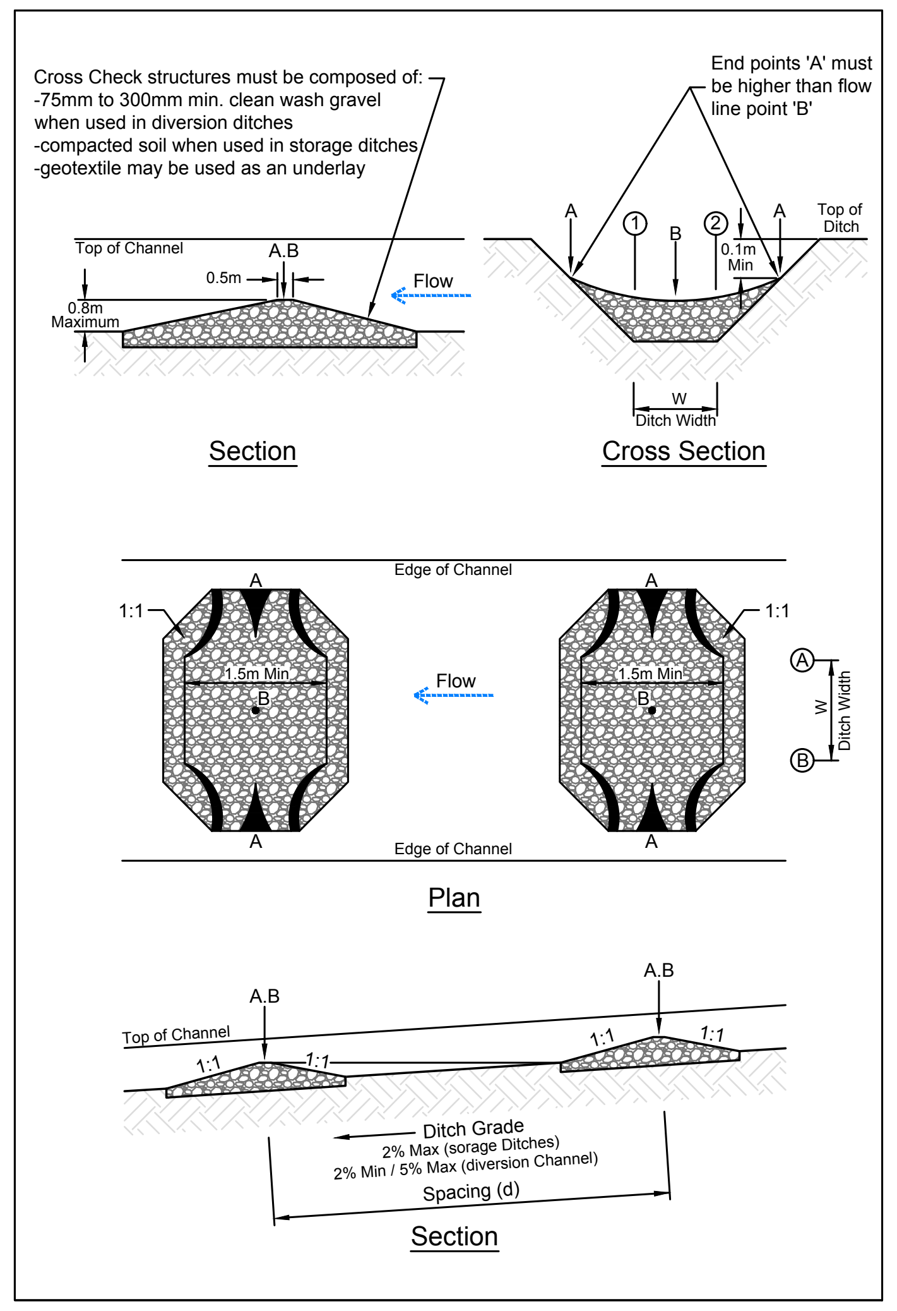
Notes
1. Check slots to be constructed per manufacturer's specifications.
2. Staking or stapling layout per manufacturer's specifications.

Erosion Blanket Channel Installation

N.T.S.

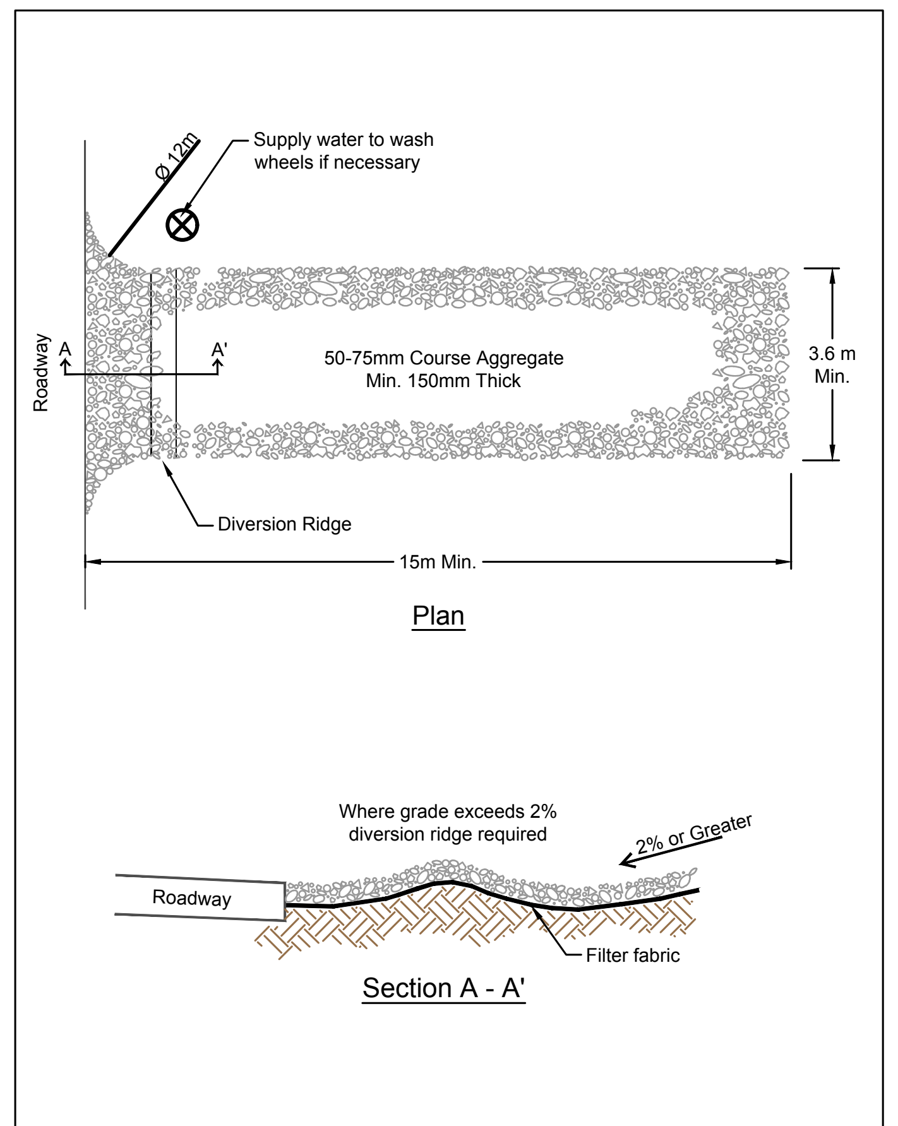
Cross Check structures must be composed of:
-75mm to 300mm min. clean wash gravel when used in diversion ditches
-compacted soil when used in storage ditches
-geotextile may be used as an underlay

End points 'A' must be higher than flow line point 'B'



Rock Check Dams

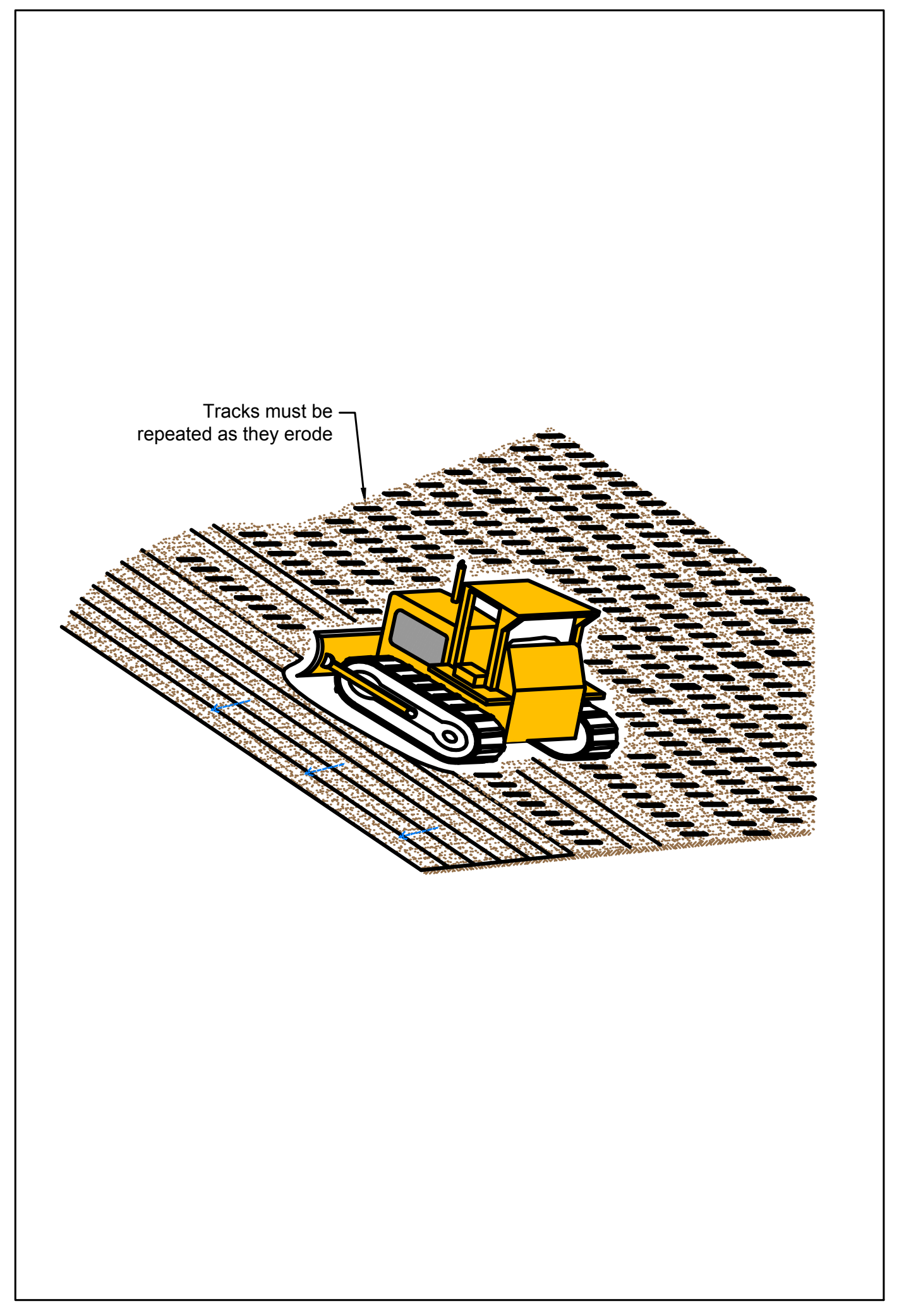
N.T.S.



Notes
1. Maintain the entrance in a condition that will prevent tracking or flowing of sediment onto public right-of-ways. This may require top dressing, repair, and/or clean out of any measures used to trap sediment.
2. When necessary, clean wheels prior to entrance onto public right-of-way.
3. When washing is required, conduct it on an area stabilized with crushed aggregate.

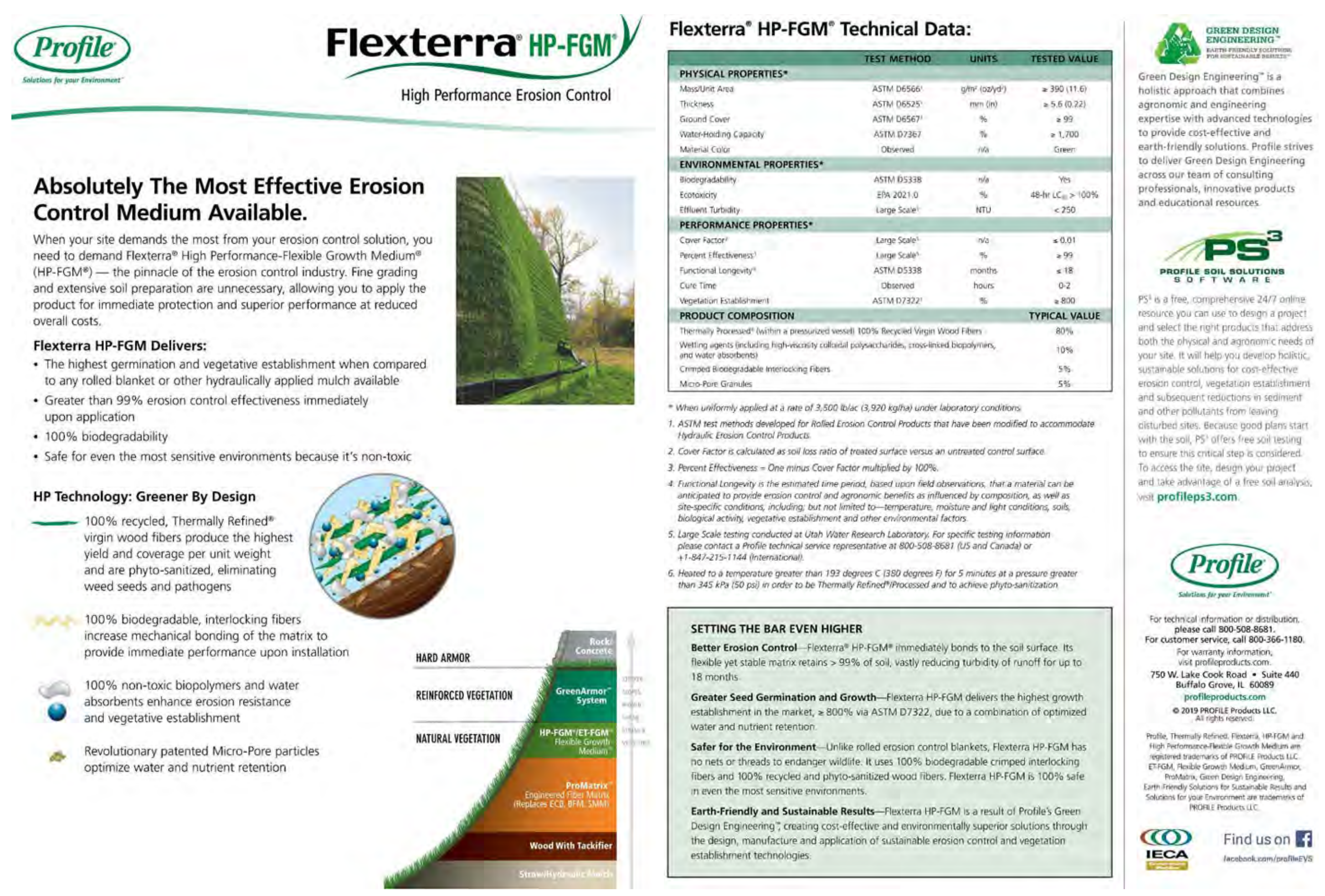
Gravel Access Pad

N.T.S.



Track-packing on slope

N.T.S.



Profile
Solutions for your Environment

Flexterra® HP-FGM®
High Performance Erosion Control

Absolutely The Most Effective Erosion Control Medium Available.

When your site demands the most from your erosion control solution, you need to demand Flexterra® High Performance-Flexible Growth Medium® (HP-FGM®) — the pinnacle of the erosion control industry. Fine grading and extensive soil preparation are unnecessary, allowing you to apply the product for immediate protection and superior performance at reduced overall costs.

Flexterra HP-FGM Delivers:
- The highest germination and vegetative establishment when compared to any rolled blanket or other hydraulically applied mulch available
- Greater than 99% erosion control effectiveness immediately upon application
- 100% biodegradability
- Safe for even the most sensitive environments because it's non-toxic

HP Technology: Greener By Design

100% recycled, Thermally Refined® virgin wood fibers produce the highest yield and coverage per unit weight and are phyto-sanitized, eliminating weed seeds and pathogens

100% biodegradable, interlocking fibers increase mechanical bonding of the matrix to provide immediate performance upon installation

100% non-toxic biopolymers and water absorbents enhance erosion resistance and vegetative establishment

Revolutionary patented Micro-Pore particles optimize water and nutrient retention

Flexterra® HP-FGM® Technical Data:

	TEST METHOD	UNITS	TESTED VALUE
PHYSICAL PROPERTIES*			
Mass/Unit Area	ASTM D6566[1]	g/m² (oz/yd²)	≥ 390 (11.6)
Thickness	ASTM D6525[1]	mm (in)	≥ 5.6 (0.22)
Ground Cover	ASTM D6567[1]	%	≥ 99
Water-Holding Capacity	ASTM D7367	%	≥ 1,700
Material Color	Observed	n/a	Green
ENVIRONMENTAL PROPERTIES*			
Biodegradability	ASTM D5338	n/a	Yes
Ecotoxicity	EPA 2021.0	%	48-hr LC_{50} > 100%
Effluent Turbidity	Large Scale[5]	NTU	< 250
PERFORMANCE PROPERTIES*			
Cover Factor[2]	Large Scale[5]	n/a	≤ 0.01
Percent Effectiveness[3]	Large Scale[5]	%	≥ 99
Functional Longevity[4]	ASTM D5338	months	≤ 18
Cure Time	Observed	hours	0-2
Vegetation Establishment	ASTM D7322[1]	%	≥ 800
PRODUCT COMPOSITION			**TYPICAL VALUE**
Thermally Processed[6] (within a pressurized vessel) 100% Recycled Virgin Wood Fibers			80%
Wetting agents (including high-viscosity colloidal polysaccharides, cross-linked biopolymers, and water absorbents)			10%
Crimped Biodegradable Interlocking Fibers			5%
Micro-Pore Granules			5%

* When uniformly applied at a rate of 3,500 lb/ac (3,920 kg/ha) under laboratory conditions.

1. ASTM test methods developed for Rolled Erosion Control Products that have been modified to accommodate Hydraulic Erosion Control Products.
2. Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface.
3. Percent Effectiveness = One minus Cover Factor multiplied by 100%.
4. Functional Longevity is the estimated time period, based upon field observations, that a material can be anticipated to provide erosion control and agronomic benefits as influenced by composition, as well as site-specific conditions, including; but not limited to—temperature, moisture and light conditions, soils, biological activity, vegetative establishment and other environmental factors.
5. Large Scale testing conducted at Utah Water Research Laboratory. For specific testing information please contact a Profile technical service representative at 800-508-8681 (US and Canada) or +1-847-215-1144 (International).
6. Heated to a temperature greater than 193 degrees C (380 degrees F) for 5 minutes at a pressure greater than 345 kPa (50 psi) in order to be Thermally Refined®/Processed and to achieve phyto-sanitization.

SETTING THE BAR EVEN HIGHER

Better Erosion Control—Flexterra® HP-FGM® immediately bonds to the soil surface. Its flexible yet stable matrix retains > 99% of soil, vastly reducing turbidity of runoff for up to 18 months.

Greater Seed Germination and Growth—Flexterra HP-FGM delivers the highest growth establishment in the market, ≥ 800% via ASTM D7322, due to a combination of optimized water and nutrient retention.

Safer for the Environment—Unlike rolled erosion control blankets, Flexterra HP-FGM has no nets or threads to endanger wildlife. It uses 100% biodegradable crimped interlocking fibers and 100% recycled and phyto-sanitized wood fibers. Flexterra HP-FGM is 100% safe in even the most sensitive environments.

Earth-Friendly and Sustainable Results—Flexterra HP-FGM is a result of Profile's Green Design Engineering™, creating cost-effective and environmentally superior solutions through the design, manufacture and application of sustainable erosion control and vegetation establishment technologies.

GREEN DESIGN ENGINEERING™
EARTH-FRIENDLY SOLUTIONS FOR SUSTAINABLE RESULTS™

Green Design Engineering™ is a holistic approach that combines agronomic and engineering expertise with advanced technologies to provide cost-effective and earth-friendly solutions. Profile strives to deliver Green Design Engineering across our team of consulting professionals, innovative products and educational resources.

PS³
PROFILE SOIL SOLUTIONS SOFTWARE

PS³ is a free, comprehensive 24/7 online resource you can use to design a project and select the right products that address both the physical and agronomic needs of your site. It will help you develop holistic, sustainable solutions for cost-effective erosion control, vegetation establishment and subsequent reductions in sediment and other pollutants from leaving disturbed sites. Because good plans start with the soil, PS³ offers free soil testing to ensure this critical step is considered. To access the site, design your project and take advantage of a free soil analysis, visit **profileps3.com**.

Profile
Solutions for your Environment

For technical information or distribution, please call 800-508-8681.
For customer service, call 800-366-1180.
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IECA

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APPROVING AUTHORITY OFFICE USE

FILE No.

Project Information

Legal Description:
Within of N.W. & S.W. Sec.31-26-03-W5

Construction Start

Autumn 2021

Key Plan

ESC Consultant

EROSION CONTROL CENTRAL

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David Dinu
No.3055

Reference: SLR source material

Rocky View County, Alberta
Mountain Ash Limited Partnership Aggregate Operation

ESC Plan
Construction Notes and Details

Date:	CAD file:	Printed:	Technical:	Drawn:
April 2021	MountainAsh	November 4, 2021	D. Dinu	GM

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Figure
3

APPENDIX A

SCOUR STOP SPECIFICATIONS AND INSTALLATION GUIDE

Erosion and Sediment Control Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006

ScourStop®

DESIGN GUIDE

Circular Culvert Outlet Protection

why use the

SCOURSTOP SYSTEM?

ScourStop transition mats protect against erosion and scour at culvert outlets with a vegetated solution in areas traditionally protected with rock or other hard armor.

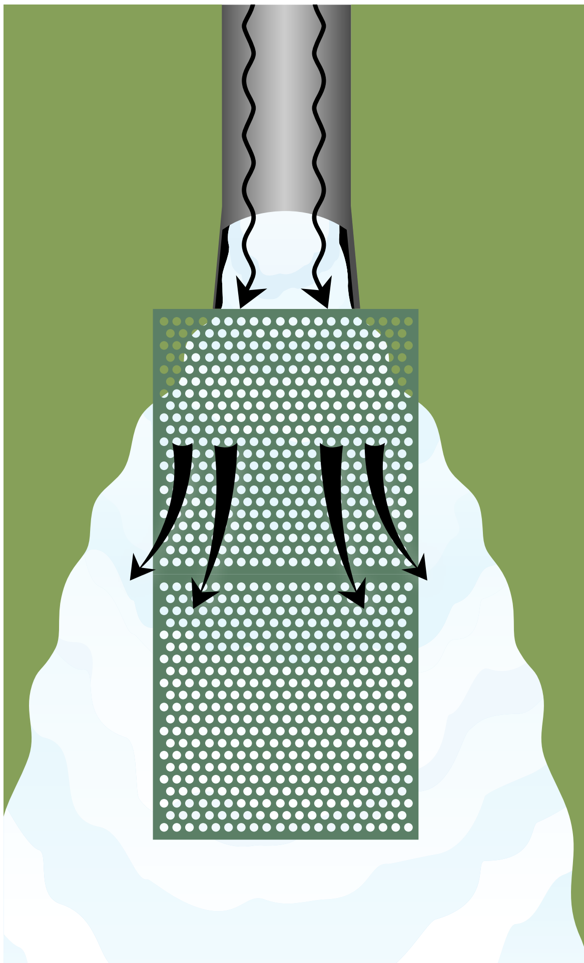
ScourStop is part of a system that includes semi-rigid transition mats installed over sod or turf reinforcement mats. Each 4’ x 4’ x $^{1}/_{2}$” mat is made of high-density polyethylene and secured tightly to the ground with anchors.

Circular Culvert Outlet Protection

PIPE DIAMETER	VELOCITY ≤ 10 FT/SEC		10 < VELOCITY < 16 FT/SEC	
	TRANSITION MAT W x L	QUANTITY OF MATS	TRANSITION MAT W x L	QUANTITY OF MATS
12”	4’ x 4’	1	4’ x 8’	2
24”	8’ x 8’	4	8’ x 12’	6
36”	8’ x 12’	6	12’ x 20’	15
48”	12’ x 16’	12	12’ x 24’	18
60”	12’ x 20’	15	16’ x 32’	32
72”	16’ x 24’	24	20’ x 36’	45

These are minimum recommendations. More ScourStop protection may be needed depending upon site and soil conditions, per project engineer.

- If velocity is greater than 16 fps, contact manufacturer for design assistance.
- ScourStop mats have been shown to at least double the effectiveness of turf reinforcement mats.
- ScourStop fully vegetated channel (2:1 slope): velocity = 31 fps, shear stress = 16 psf.

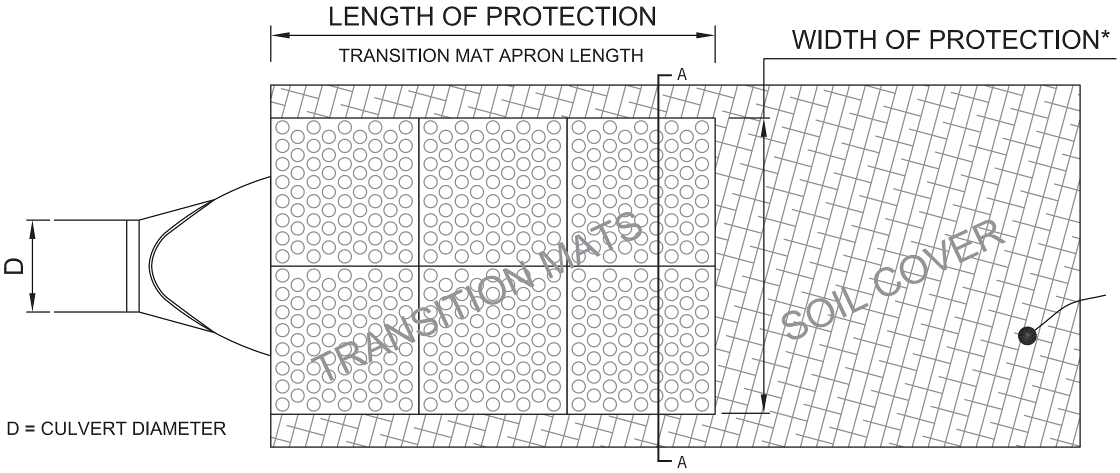


PERFORMANCE ◦ AESTHETICS
NPDES-COMPLIANT ◦ COST-EFFECTIVE

the green solution to riprap
scourstop®
scourstop.com

ScourStop®
Installation Recommendations

1. ScourStop mats must be installed over a soil cover: sod, seeded turf reinforcement mat (TRM), geotextile, or a combination thereof.
2. For steep slopes (>10%) or higher velocities (>10 ft/sec), sod is the recommended soil cover.
3. Follow manufacturer's **ScourStop Installation Guidelines** to ensure proper installation.
4. Install ScourStop mats at maximum 1-2" below flowline of culvert or culvert apron. (No waterfall impacts onto ScourStop mats.)
5. Performance of protected area assumes stable downstream conditions.

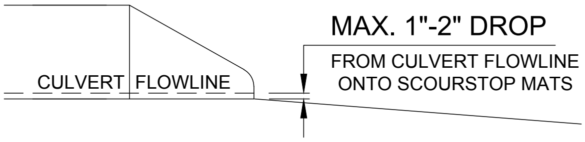


Transition mat apron protects culvert outlet.
*Width of protection:
Bottom width of channel and up both side slopes to a depth at least half the culvert diameter.

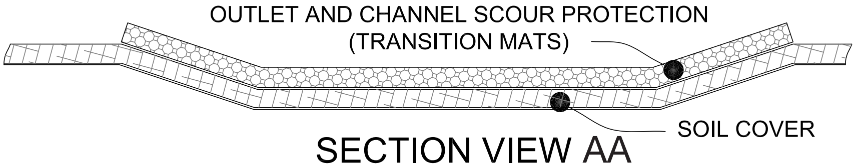
Protect bare/disturbed downstream soils from erosion with appropriate soil cover.

Use normal-depth calculator to compute for downstream protection.

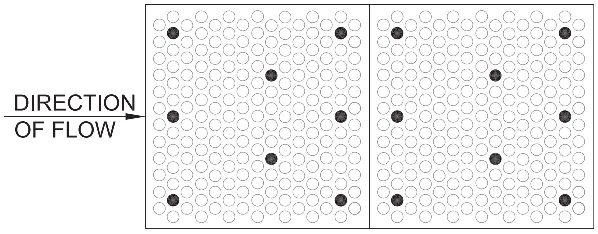
CULVERT OUTLET PROTECTION – PLAN VIEW



PROFILE VIEW

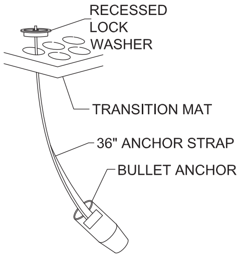


SECTION VIEW AA



ANCHOR PATTERN

Abut transition mats to end of culvert or culvert apron.
Adjacent mats abut together laterally and longitudinally.
Minimum 8 anchors per mat.
Extra anchors as needed for loose or wet soils.
Extra anchors as needed for uneven soil surface.



ANCHOR ILLUSTRATION

Install anchors per **ScourStop Installation Guidelines.**
Minimum depth 24" in compacted, cohesive soil.
Minimum depth 30" in loose, sandy, or wet soil.
Extra anchors as needed to secure mat tightly over soil cover.

HANES® GEO COMPONENTS™
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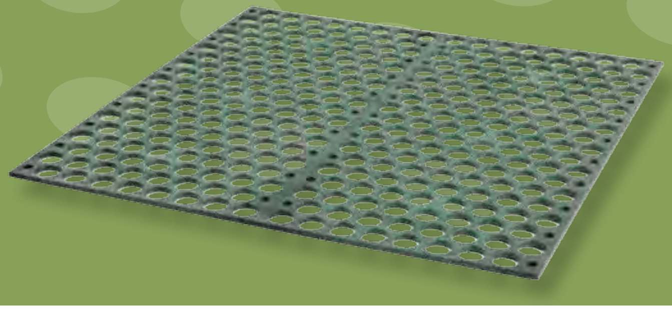
the green solution to riprap
scourstop®



ScourStop®

INSTALLATION GUIDELINES

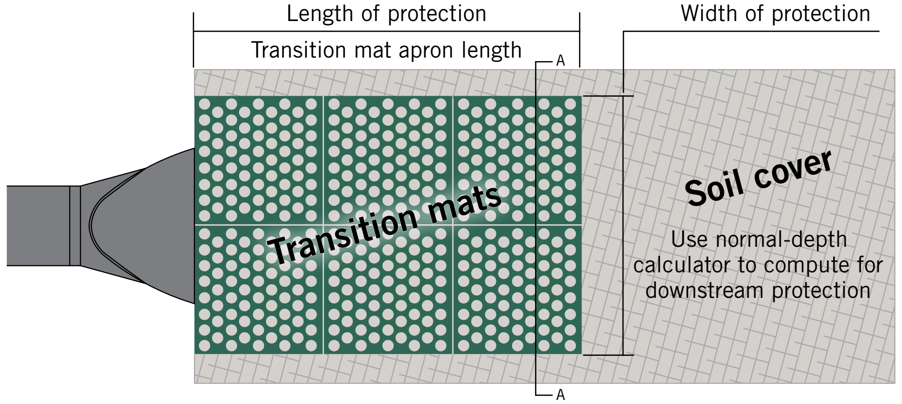
ScourStop may be used in many applications: culvert outlets, curb outfalls, spillways, overflow structures, stream banks, slopes, etc. The details in this example are for typical culvert outlet protection. Project engineer shall determine the limits of soil cover and ScourStop.

Downstream:

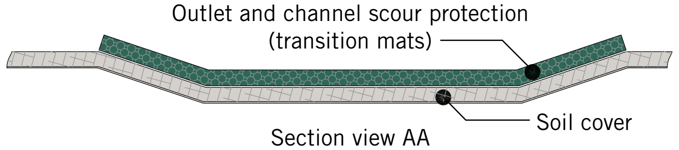
Continue soil cover beyond outlet apron area to properly protect downstream channel and prevent head-cutting.

Width:

Install soil cover wider than proposed ScourStop protection (recommend soil cover full width of channel – across bottom and up both slopes).



Culvert outlet protection – plan view



Section view AA

Electric Hammer:

- **Rotary hammer or demolition hammer** – the greater the impact energy (ft/lbs) and the heavier the hammer, the greater the driving force to install bullet anchors into soil (e.g., Makita HM1214C, Hilti or other).
- Use **hammer-only mode**, no rotation.
- Use 3/4" Ground Rod Driver, which fits onto ScourStop HD Driver.
- Recommend two ScourStop drivers per electric hammer to achieve maximum efficiency.

Maintenance:

- No maintenance is required for a ScourStop solution.
- Mowing over a vegetated ScourStop solution is allowed – minimum height of 4" recommended.
- Mowing is not recommended where soft, saturated soils exist.
- ScourStop surface may be slippery when wet – **use caution**.
- New construction: soil may consolidate, so lock washers may need to be re-tightened after settling.

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NPDES-COMPLIANT ◦ COST-EFFECTIVE

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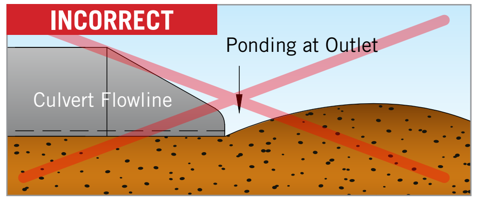
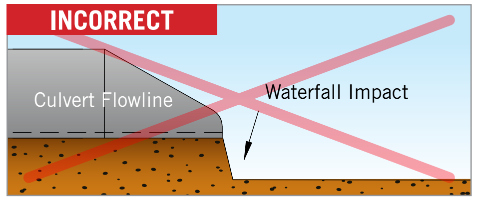
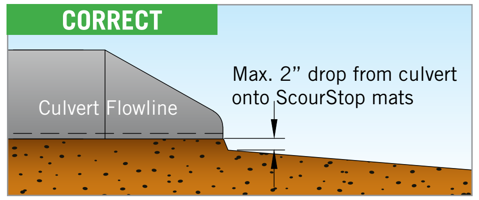
INSTALLATION GUIDELINES

Site Preparation:

1 Finish grading to ensure positive drainage and eliminate ponding.
2 Create defined drainage channel to carry stormwater at outlet and downstream.
3 Compact soil in all areas of fill to create firm seed bed.
4 Install subsurface drainage tile if constant water is expected.
5 Grade a smooth transition from outlet to discharge area (allow for soil cover thickness and ScourStop thickness).
6 Max. 2” drop from culvert outlet/curb opening to top of ScourStop mats (no waterfall impact).

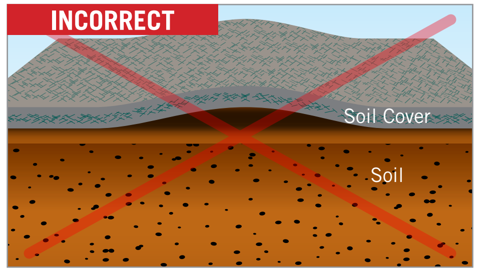


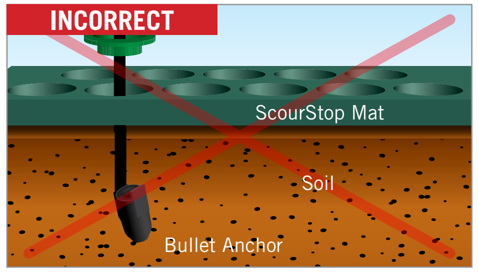


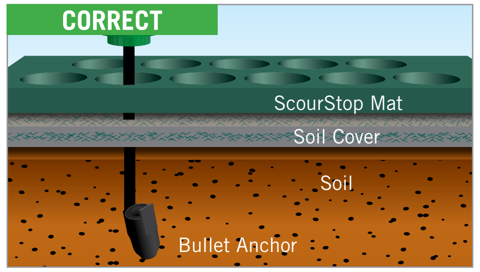


Soil Cover:

1 ScourStop must be placed over soil cover (sod, TRM, or geotextile) – not over bare ground, therefore, install soil cover first.
2 Channel flow data must be evaluated to determine proper soil cover.
3 Install sod; water thoroughly after completing installation.
4 Or install turf reinforcement mat (TRM), after seed and fertilizer, then water thoroughly after completing installation.
5 Non-vegetated: install geotextile (minimum 6 oz. non-woven geotextile fabric).

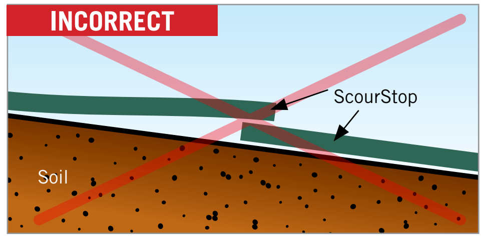


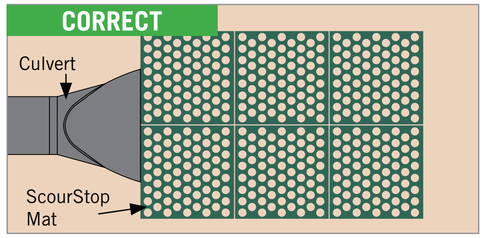




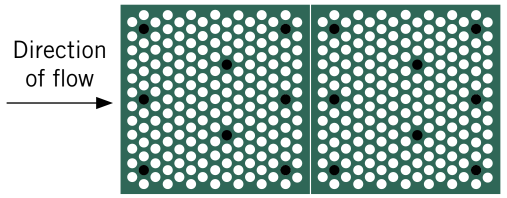
ScourStop Transition Mat Installation:

1 After proper grading and installation of selected soil cover, place ScourStop mats beginning at culvert outlet/curb opening, or at toe of slope, stream bank, or spillway.
2 Place ScourStop mat(s) adjacent to culvert/curb and adjacent to other ScourStop mats to avoid gaps.
3 Do not overlap adjacent mats unless necessary to conform to channel geometry.
4 If desired, ScourStop mats may be cut with circular saw or hand saw.



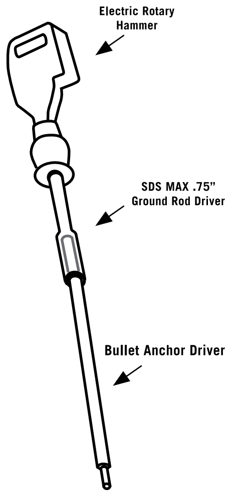


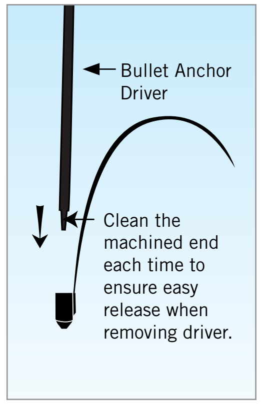
ScourStop Bullet Anchors:



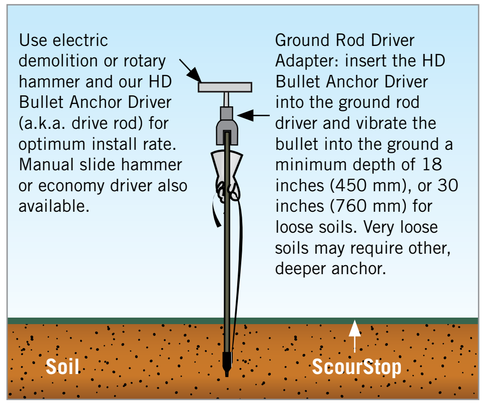
Anchor pattern

1 Use ScourStop bullet anchors (minimum of 8 anchors per mat) to secure mats on top of soil cover and tightly to the soil surface.
2 Insert bullet anchor strap into lock washer (3”-4”).
3 Insert the machined end of the driver into the bullet anchor.
4 Drive anchor through a 2” hole in mat (per recommended anchor pattern), stopping before lock washer is at least 1” above mat.
5 Twist and pull the driver out of the soil. Wipe driver tip with rag or glove to remove soil.
6 Grasp end of strap with one hand and push down on lock washer with the other until lock washer is flush with mat.
7 Place foot on top of lock washer, then give a firm tug on the strap (quick tug, like setting a fish hook) to set the pivoting bullet anchor.
8 Use additional anchors if necessary to secure mats tightly to soil surface.



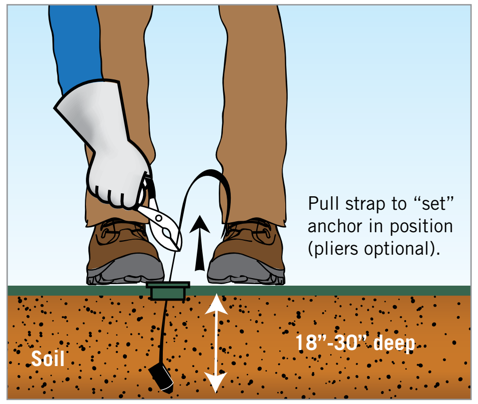


Clean the machined end each time to ensure easy release when removing driver.



Use electric demolition or rotary hammer and our HD Bullet Anchor Driver (a.k.a. drive rod) for optimum install rate. Manual slide hammer or economy driver also available.

Ground Rod Driver Adapter: insert the HD Bullet Anchor Driver into the ground rod driver and vibrate the bullet into the ground a minimum depth of 18 inches (450 mm), or 30 inches (760 mm) for loose soils. Very loose soils may require other, deeper anchor.



Pull strap to “set” anchor in position (pliers optional).

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ScourStop® Transition Mats

ScourStop® Transition Mats are an engineered, proven, bio-technical alternative to traditional hard-armor systems. ScourStop® Transition Mats are manufactured of a semi-rigid HDPE. When combined with soft-armor soil cover and deep-soil earth anchors, the ScourStop® system mechanically protects soil from severe scour and erosion. The ScourStop® system offers greater protection than vegetation alone or rip rap and is lab-tested and field-proven to protect against considerably higher shear stresses and velocities. ScourStop® Transition Mats provide a permanent, low-maintenance solution with immediate, day-one protection and impact resistance over highly erosive areas such as stormwater outfalls, curb outfalls, overflow structures, drainage channels, levees, and shorelines. ScourStop® Transition Mats conform to the property values listed below:

PROPERTY	TEST METHOD	ENGLISH	METRIC
Properties			
Mass/Unit Area	ASTM D6566	**0.942** lbs/ft^2	**4.599** kg/m^2
Thickness	ASTM D6525	**0.463** in	**11.735** mm
Wide Width Tensile Strength	ASTM D4595	**3053** lbs/ft	**4.139** kN/m
Percent Open Area	Calculated	**50** %	**50** %
UV Stability	ASTM D4355	**87** %	**87** %
Manning's n	Calculated	**0.039**	**0.039**
Culvert Outfall Test Exit Velocity Discharge	Prototype	**16** ft/sec	**4.877** m/sec
Velocity Day 1 Performance Fully Vegetated	Flume Testing ASTM D6460	**19** ft/sec	**5.791** m/sec
Shear Day 1 Performance Fully Vegetated	Flume Testing ASTM D6460	**13** lbs/ft^2	**63.472** kg/m^2

11/20/2018

APPENDIX B
RUSLE SUPPORTING DOCUMENTS

Erosion and Sediment Control Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006

TABLE 4-4. C-FACTOR AND P-FACTOR VALUES FOR CONSTRUCTION-SITE RAINFALL BMPS (ISRAELSEN ET AL., 1980; HDI, 1987; SCS, 1978; AND WISCHMEIER AND SMITH, 1978)

TREATMENT		C-FACTOR	P-FACTOR
Bare Soil			
Packed and smooth		1.00	1.00
Freshly disked or rough, irregular surface		1.00	0.90
Sediment Containment Systems (a.k.a. Sediment Trap/Basin)		1.00	0.10-0.90[A]
Bale or Sandbag Barriers		1.00	0.90
Rock (Diameter = 25-50 mm) Barriers at Sump Location		1.00	0.80
Silt-Fence Barrier		1.00	0.60
Asphalt/Concrete Pavement		0.01	1.00
Gravel (Diameter = 60-400 mm) at 300 tonnes/ha		0.05	1.00
Established Vegetation		Figs. 4-3, 4-4	1.00
Sod Grass		0.01	1.00
Temporary Vegetation/Cover Crop		0.45[B]	1.00
Hydraulic Mulch at 4.5 tonnes/ha		0.10[C]	1.00
Soil Sealant		0.10 - 0.60[D]	1.00
Rolled Erosion Control Products		0.10 - 0.30[D]	1.00
Hay or Straw Dry Mulch Applied at 4.5 tonnes/ha and anchored *Assumes planting of grass seed has occurred before application, otherwise C-factor = 1.00.*			
Slope (%)			
1 to 10		0.06	1.00
11 to 15		0.07	1.00
16 to 20		0.11	1.00
21 to 25		0.14	1.00
26 to 33		0.17	1.00
> 33		0.20	1.00
Contour Furrowed Surface *Must be maintained throughout construction activities, otherwise P-factor = 1.00. Maximum length refers to downslope length.*			
Slope (%)	**Max. Length (m)**		
1 to 2	120	1.00	0.60
3 to 5	90	1.00	0.50
6 to 8	60	1.00	0.50
9 to 12	40	1.00	0.60
13 to 16	25	1.00	0.70
17 to 20	20	1.00	0.80
> 20	15	1.00	0.80

[A] Should be constructed as the first step in over-lot grading.

[B] Assumes planting occurs within optimal climatic conditions.

[C] Some limitation on use in arid and semiarid climates.

[D] Value used must be substantiated by documentation.

TABLE 4-4. (CONTINUED)

TREATMENT	C-FACTOR	P-FACTOR
Terracing		
Must contain 2-year runoff volumes without overflowing, otherwise P-factor = 1.00		
Slope (%)		
1 to 2	1.00	0.12
3 to 8	1.00	0.10
9 to 12	1.00	0.12
13 to 16	1.00	0.14
17 to 20	1.00	0.16
> 20	1.00	0.18
Grass Buffer Strips to Filter Sediment-Laden Sheet Flows		
Strips must be at least 15 m (50 ft.) wide and have a ground-cover value of 65% or greater, otherwise P-factor = 1.00.		
Basin Slope		
0% to 10%	1.00	0.60
11% to 24%	1.00	0.80

NOTE: Use of C-factor or P-factor values not in this table must be supported by documentation.

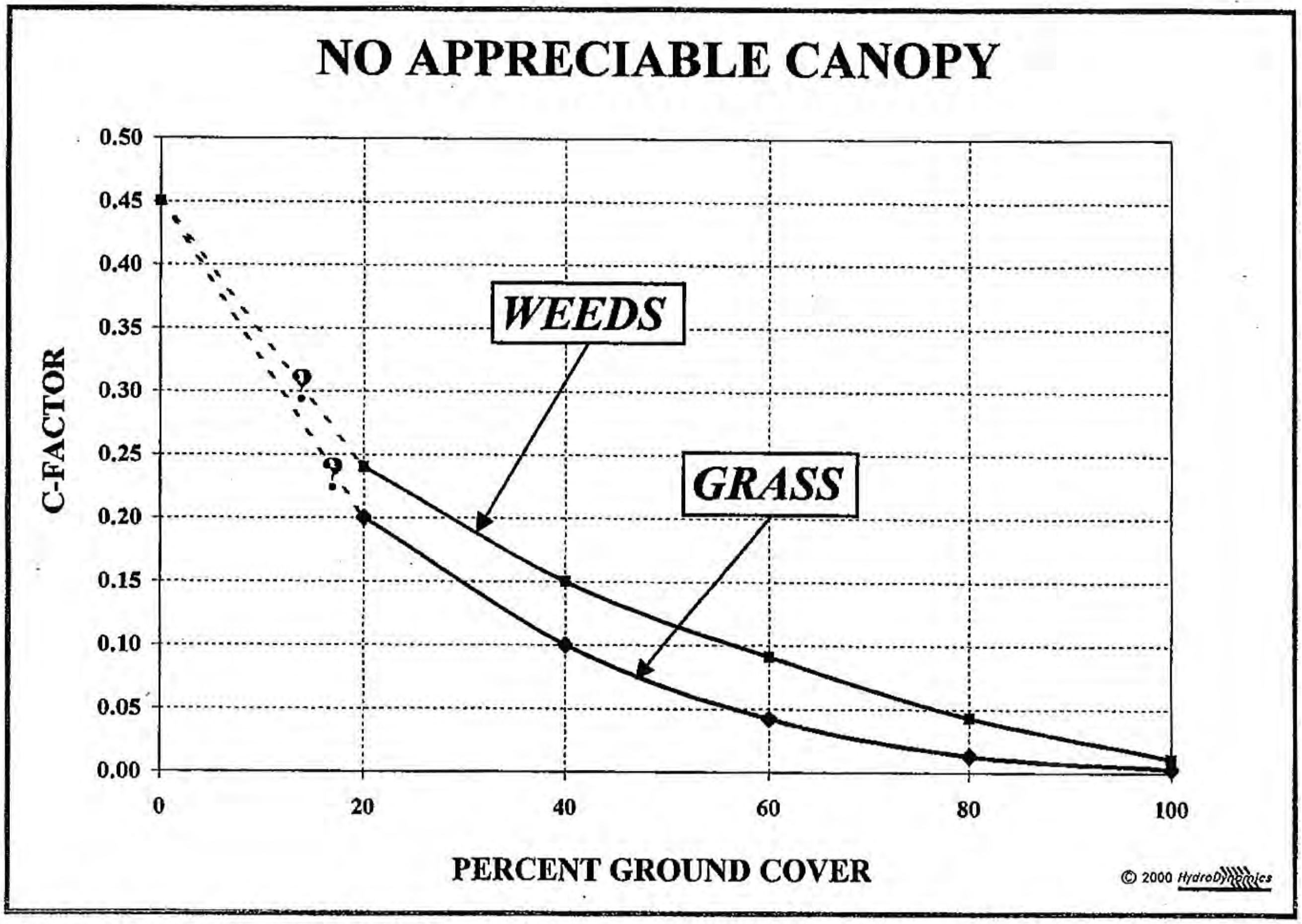

Figure 4-3. C-Factor Values for Established Grass and Weeds (Wischmeier and Smith, 1978)

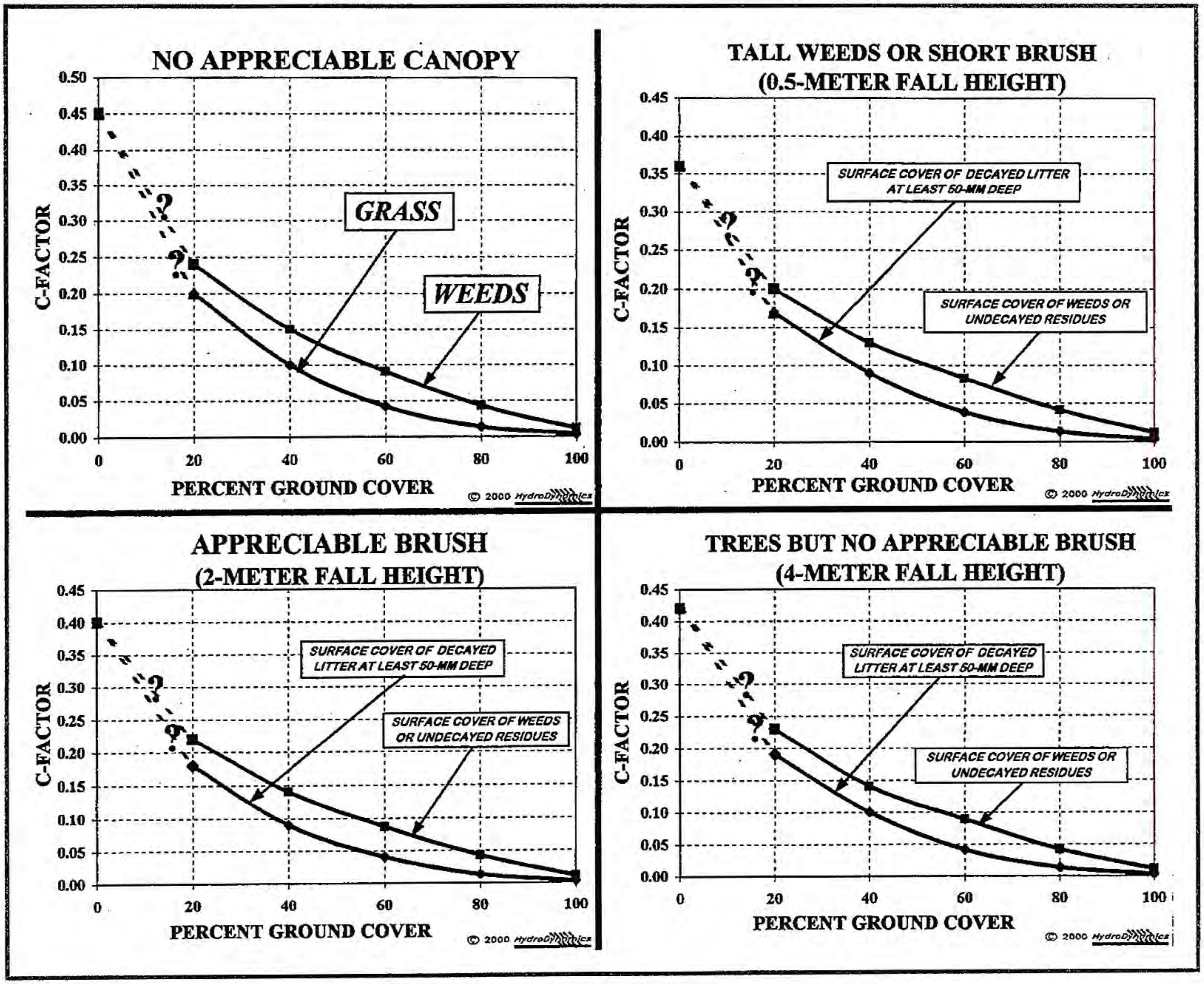

Figure 4-4. C-Factor Values for Various Existing Vegetative Conditions (Wischmeier and Smith, 1978)

Industry Bulletin
June 2016

WATER QUALITY SERVICES – SEDIMENT CONTAINMENT SYSTEMS – P-VALUE UPDATES

This Bulletin is to provide Calgary specific sediment containment system efficiency ratings to improve the accuracy of soil loss calculations and reduce the risk of sediment releases from construction sites. Effective July 1, 2016, the following design volumes and efficiency ratings shall apply:

Design Volume in m3	Percent Efficiency	P-Value
150	34	0.7
200	39	0.6
300	49	0.5
500	61	0.4
750	70	0.3
1200	80	0.2
1750	86	0.1

Sediment containment systems, such as sediment ponds, traps and storage ditches, are a common best management practice used on construction sites to reduce soil loss. These practices are given a P-value, or support practice factor, which is indicative of how effective they are at reducing soil loss from a construction site. The P-value is consequently used in soil loss calculations, where the goal is to propose best management practices that will reduce soil estimated from all slopes on site to below 2 tonnes/ha*yr. Calculations which are below this limit indicate a high probability that soil loss from the site will not have an adverse effect on our rivers , impair the quality of storm drainage or the integrity of the storm drainage system.

Recent modeling, using fifty years of rainfall data for The Calgary area, have resulted in more accurate local efficiency ratings for different sized sediment containment systems. The model was run to include pond volumes ranging from 150m3 to 1750m3. This new range of numbers provides consultants greater flexibility in their designs than the previous single volume of 250m3.

Implementation of these updated targets will increase the accuracy of predicted soil losses from construction sites. There will be a reduction in the number of sediment releases on sites using sediment ponds and this will result in improved compliance with municipal, provincial and federal legislation.

For more information contact:

Nicole Sparks
Team Lead, Stormwater Pollution Prevention
Water Quality Servcies
Nicole.Sparks@calgary.ca.

Appendix C

Dust Control Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Dust Control Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006

April 2021

Dust Control Plan

Mountain Ash Limited Partnership

Rocky View County, Alberta

SLR Project No: 212.06650.00006

Prepared by:
SLR Consulting (Canada) Ltd.
200 – 708 11th Ave SW
Calgary, Alberta, T2R 0ER

for

Mountain Ash Ltd. Partnership
1945 Briar Crescent NW
Calgary, AB, T2N 3V6

April 2021

This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

Prepared by:	Reviewed by:
Xin Qiu, Ph.D., EP, ACM, P.Met Consultant (Air Quality)	**Rick Lauzon, P.Biol., R.P.Bio.** Principal Environmental Consultant

Distribution: 1 copy (PDF) – Mountain Ash Limited Partnership
1 copy - SLR Consulting (Canada) Ltd.

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FIGURES

APPENDICES

1.0 INTRODUCTION

Mountain Ash Limited Partnership (Mountain Ash) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will encompass approximately 208 acres (84 ha) excluding existing road rights-of-way. Mountain Ash is applying for Phase 1 of a six-phase mining plan. This land is currently owned by 1410266 Alberta Ltd. (a general partner of Mountain Ash). Summit Pit received land use and a master site development plan (MSDP) approval on March 2, 2021 (Land Use Bylaw C-8051-2020).

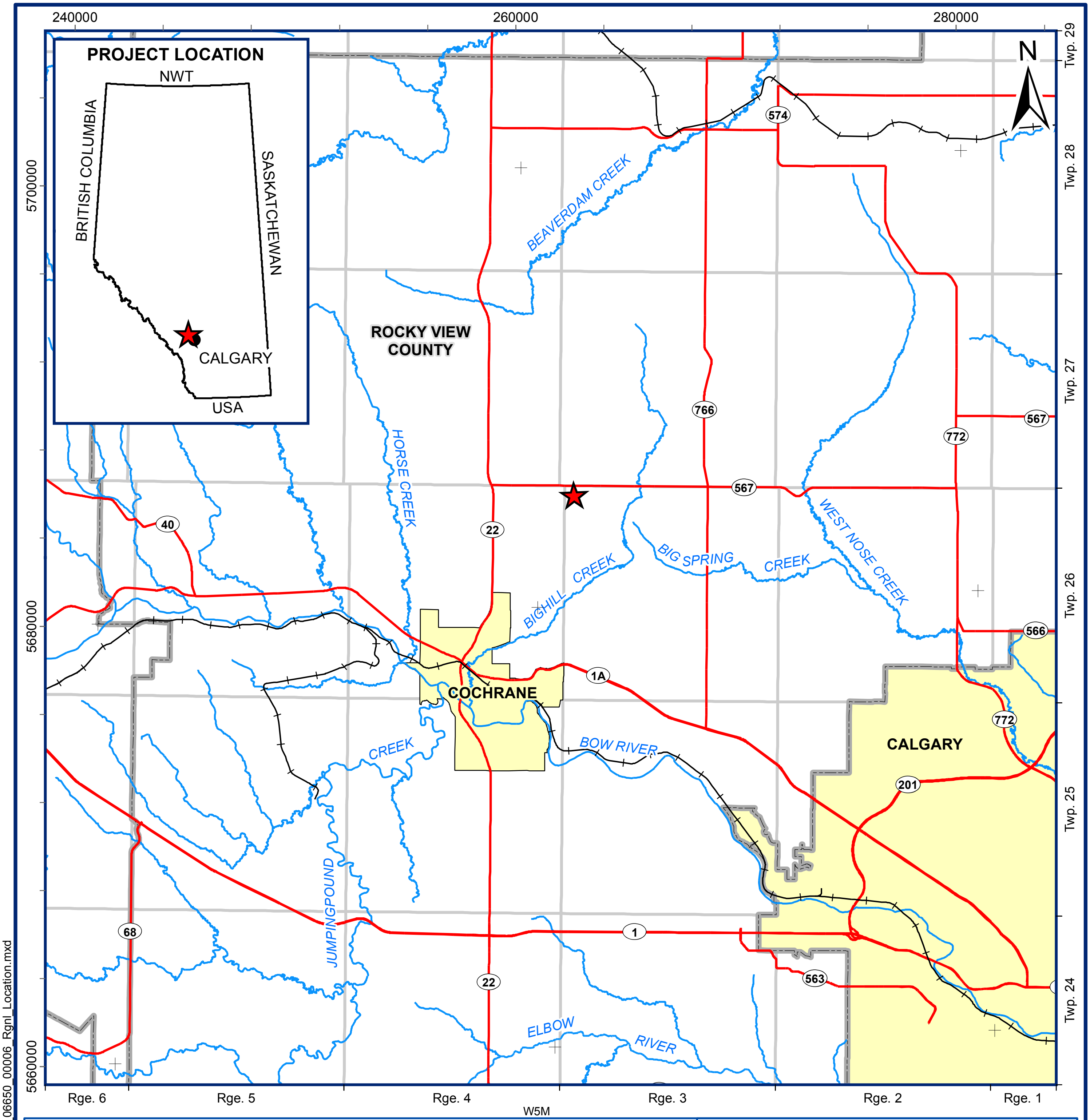
An air quality assessment was undertaken as part of the MSDP application to assess the potential fugitive air emissions generated from the Project operations in relation to adjacent receptors. The primary air emission associated with the Summit Pit operations is anticipated to be particulate matter (e.g., $PM_{2.5}$ and TSP) released in the form of fugitive dust. Sources of fugitive dust can include traffic from on-site haul routes, aggregate processing, recycling, and handling, and natural releases occurring from exposed stockpiles and gravel faces. As a requirement for the Code of Practice (COP) for Pits and Development Permit (DP) applications, this report details the Dust Control Plan (DCP) in relation to the operation of the Summit Pit. The objectives of the DCP are:

- Provide an overview of the operations at the Summit Pit; identify potential sources of fugitive emissions; outline maintenance and inspection procedures.
- Provide a summary of control measures that are or shall be implemented; provide an implementation schedule for the control measures.
- Illustrate how on-going compliance is ensured through the use of a monitoring and record keeping program (i.e., the Ambient Air Quality Monitoring Plan).
- Detail the employee training program for fugitive dust control procedures.

Once implemented, the DCP will serve to minimize dust emissions from the Summit Pit, thereby minimizing or eliminating impacts to nearby receptors and the general local environment.

The Site Manager shall be responsible for ensuring that the control measures identified in this plan are implemented. To limit the transfer of dust to surrounding receptors, an operator must take all reasonable actions to ensure that fugitive dust emissions are minimized using best management practices associated with the industry and any regulatory approvals.

Although several pits have been proposed for the area, no additional pits have been approved with a development permit that have the potential to add to the dust contributions from Summit Pit operations at adjacent receptors. There is an agreement between future operators to ensure that a cumulative impacts mitigation management agreement is in place to minimize the dust from their respective operations with respect to cumulative effects. Mountain Ash will participate with those operations to address cumulative effects/impacts in the area prior to submitting future development permit applications.



LEGEND

★ PROJECT LOCATION

HIGHWAY

RAILWAY

WATERCOURSE

COUNTY BOUNDARY

URBAN

NOTES

This map is for conceptual purposes only and should not be used for navigational purposes.

Basedata:AltaLIS Government of Alberta under the Alberta Open Data License.

5 0 5

SCALE: 1:250,000 KILOMETRES

WHEN PLOTTED CORRECTLY AT 8-1/2 x11

NAD 1983 UTM Zone 12N

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

DUST CONTROL PLAN

SUMMIT PIT LOCATION

April 8, 2021		Figure No.
Project No.	212.06650.00006	**1**

[redacted]

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2.0 SOURCES OF FUGITIVE DUST

Chapter 11 of the US EPA AP-42 document characterizes fugitive dust from stone crushing and aggregate handling as three forms of particulate matter: TSP, PM_{10} and $PM_{2.5}$. TSP is representative of total suspended particulate matter. PM_{10} and $PM_{2.5}$ is the respirable fraction of particulate matter.

2.1 Overview of Pit Operations

The primary operations at the Summit Pit will consist of aggregate extraction, crushing, screening and/or washing, stockpiling and off-site shipping.

2.1.1 Aggregate Extraction

Extraction will take place from Phase 1 to 6. Excavation will occur by stripping the deposit with a scraper, dozer, grader or excavator. There will be no blasting on the site.

2.1.2 Aggregate Processing and Recycling

Aggregate processing and recycling can include crushing, screening and conveyor transferring to drop points. Crushing plants can consist of primary and secondary crushers and screening plants can consist of primary and secondary screeners. Ground dust will be controlled via watering the area around the aggregate processing and loading site. Water is supplied through third party vendors and does not require a license.

2.1.3 Conveyor Drop

A total of four conveyors are considered in operation. Stack Conveyors 1-3, or more depending on the phase of operations, transfer aggregate from crushers to stockpiles, typically the fourth is a telescopic stacker to stockpile. The drop height is set to a minimum of 0.5 m to reduce dust emissions.

2.1.4 Loading and Unloading

Mountain Ash will sell aggregate from the Summit Pit throughout the year; however, most sales will likely be focused over the spring, summer, and early fall period. During this activity, aggregate will be loaded from the stockpiles onto trucks and transported offsite. Aggregate sales may overlap with overburden removal and mining/crushing activities.

2.1.5 Shipping

Trucks are weighed at the scale house before leaving the Summit Pit. There is one entrance to the Summit Pit which is paved and is located off Range Road 40. The internal haul road from the entrance will be unpaved with dust suppression applied on the remainder of the internal routes.

2.2 Inventory of Fugitive Dust Sources

The operations within the Summit Pit, and the associated potential sources of fugitive dust emissions, consist of the following:

- site preparation
    - topsoil stripping and berm construction

  - traffic on unpaved roads
- crushing, screening and washing plants
  - loading/unloading of aggregates
  - traffic on unpaved roads
  - conveyor transfers
- other general site-wide sources of fugitive emissions:
  - traffic on paved and unpaved haul roads from shipping and general site activities
  - wind erosion of active and inactive stockpiles
  - loading/unloading of aggregates from general site activities

Road dust is one of the major emission source groups from the Project. It includes road dust emissions from moving vehicles on paved and unpaved roads, haul-trucks and water trucks on unpaved roads and trucks for calcium chloride applications on unpaved roads, etc. Road dust also includes emissions from off-road equipment and machines performing on-site activities, such as crushing, stripping, bull dozing and grading for remediation, backfilling, stockpiling, etc.

3.0 MEASURES TO CONTROL OR MINIMIZE FUGITIVE DUST

3.1 Aggregate Crushing and Screening

- The crushers will not be within 190 m of the east site boundary and 140 m from all other boundaries.
- Where the site foreman deems necessary, the processing plants shall be equipped with a water spray system. The actual water application rate shall vary, being adjusted as needed to reduce visible dust emission.
- Water for the spray system will be provided from a third-party water supplier.
- The spray-bars will be triggered whenever the site foreman or scale operator observes visible dust emissions.
- Where possible, the height of lifts and discharge distances to the top of the stockpile will be kept to a minimum.
- Conveyor drop heights shall be minimized to the extent possible to reduce spillage and provide windbreak. Conveyors on site should be equipped with rubber shrouds to minimize drop height for dust control.
- Conveyor belts shall be cleaned periodically to remove entrained material.
- During extreme windy conditions, the Operator will suspend operations until emissions can visibly be controlled.

3.2 Truck Loading and Transportation

Truck loading will be suspended if the site foreman or scale operator observes the material to be dry and dusty and the wind is sufficient to cause wide-spread visible emissions with plumes directed towards receptors.

The highest point of the material loaded into a truck shall not exceed the vehicles tray walls unless it is covered.

3.3 Unpaved Roads

The internal haul routes at the Summit Pit beyond the paved route are unpaved. The following measures shall be used to control and minimize fugitive dust from the internal unpaved roads:

- A truck or trailer-mounted tank will be located on site at all times and shall be equipped with a spray bar to deliver dust suppressor evenly over the haul route surface.
- Dust suppressant supply (Calcium Chloride, $CaCl_2$) shall be available to allow the tanker truck to fill and apply the full payload each hour, if necessary, during dry conditions.
- The actual application rate shall vary, depending on surface moisture conditions and traffic conditions, and shall be triggered whenever the site foreman or scale operator observes trucks producing a trailing cloud of dust greater than 1/3 of a trailer length.
- Haul routes shall be maintained (i.e., graded) approximately monthly during April to October, to ensure that loose fine material on the haul route surface is minimized.
- Trucks and other mobile equipment shall reduce speed as necessarily to reduce trailing dust clouds. The maximum speed will be 35 km/hr.
- The internal roads shall be clearly delineated to limit traffic to the established haul roads that have been maintained. Limiting the trucks away from unmaintained areas of the site is intended to minimize disturbance of unmaintained areas.
- To prevent spillage and air entrainment during transport of aggregates, the trucks carrying aggregate loads shall be covered during transport on the paved and unpaved roads.
- Disturbed areas of unpaved roads shall be stabilized to the extent possible with rollers or other similar equipment.

3.4 Paved Roads and Entrance Ways

The following measures shall be used to control and minimize fugitive dust from the paved Range Road 40:

- The Summit Pit will have one point of entry/exit, which will be paved and well-maintained during operations. The entry/exit point is on Range Road 40.
- The Summit Pit shall have the capability to spray water or other approved dust suppressants as deemed necessary by the site foreman on paved surfaces, as well as roads near the site entrance as needed.
- The actual application rate shall vary, depending on surface moisture conditions and traffic levels, and shall be triggered whenever the scale operator or site foreman observes trailers producing a trailing cloud of dust greater than 1/3 of a trailer length.
- To prevent spillage and air entrainment during transport of aggregates, the aggregate loads shall be covered during transport on the internal unpaved roads.
- Any spillage or material deposited on the paved roads shall be removed promptly.
- Regular sweeping of the paved roads will be conducted as required, at the discretion of the site foreman, to ensure that visible loose fine material of the haul road surface is minimized.
- Trucks and other mobile equipment shall reduce speed as necessarily to reduce trailing dust clouds. The maximum speed will be 35 km/hr.

3.5 Wind Erosion of Exposed Stockpiles

- Extraction shall be reduced or suspended if the condition of the active extraction face is dry and dusty, and the wind is directed toward a receptor at a speed sufficient to cause widespread visible erosion of the open face.
- Water shall be applied to stockpile material that are dry and dusty when the wind is directed toward a receptor at a speed sufficient to cause widespread visible emissions.
- Stockpiles shall be maintained to avoid steep sides or faces.
- Disturbance of storage piles shall be minimized where feasible. For active stockpiles, the disturbed area shall be minimized to the extent possible.

3.6 Wind Erosion of Exposed Faces

Mountain Ash expects the overburden hauling and remediation area will be crusted or covered by vegetation or snow after overburden stripping and backfilling is complete. Crusting would occur if the area is not disturbed for a period of time, depending on aggregate soil types and moisture content. Any natural crusting of the surface binds the erodible material, thereby reducing the erosion potential (U.S. EPA 2006).

Extraction shall be suspended if the condition of the extraction face is dry and dusty, and the wind is sufficient to cause wide-spread visible erosion of the open face with plumes directed off-site.

Aggregate stockpiles will be located on the Summit Pit floor in close proximity to the extraction face or in the stockpile area.

Wind forecasts shall be monitored regularly for heavy winds during operations to anticipate theneed for these measures and allow for next day planning.

4.0 IMPLEMENTATION

4.1 Schedule

All control measures are to be in place prior to extraction commencing in the Summit Pit. Control measures shall remain in place so long as the Summit Pit remains in operation.

4.2 Implementation Plan

The following outlines how the DCP shall be implemented, including training of facility personnel:

- The DCP shall be kept on file at the scale house.
- Training on new and existing operating procedures shall be provided to relevant staff; refresher training shall be provided at a minimum of once every 2 years.
- The Summit Pit management shall communicate the DCP to responsible supervisors, who shall ensure staff are following operating procedures defined in the DCP.
- The site foreman shall be responsible for ensuring the DCP is followed; Management shall ensure DCP is reviewed annually.
- The staff shall follow the DCP procedures.

5.0 INSPECTION AND MAINTENANCE

5.1 Maintenance

The following outlines the details regarding the inspection and maintenance procedures that shall be employed at the site:

- The water spray system and the $CaCl_2$ application equipment for the processing plant will be inspected when in use.
- Haul routes shall be maintained on a regular basis as previously indicated in Section 3.3; and, haul routes shall be inspected daily, or more regularly as dictated by wind conditions and truck traffic. The haul routes shall be maintained on a regular basis, as previously indicated, based on the inspection, the wind conditions, and the truck traffic.
- Prior to the operation of the processing plants, the water spray systems and the $CaCl_2$ application equipment should be inspected, and pond water levels shall be inspected to ensure adequate water supply.

5.2 Identification of Problems

The site operator shall be informed of any issues that arise from inspections performed. Operations may be curtailed if dust control equipment is not adequately performing.

6.0 MONITORING AND RECORD KEEPING

Visual inspection for dusty conditions in areas of emission sources identified in the DCP shall occur at a minimum of twice daily during dry weather and once per day otherwise. Records shall be made each time the following events occur:

- dust suppressant is applied to unpaved haul routes and unpaved haul routes are maintained
- water sprays are used at the processing plant and other surfaces
- wet or vacuum-sweeper arrives and cleans paved surfaces; heavy dust plumes are observed
- a complaint is received

All records will be kept onsite in a logbook. A sample Complaint Record Report log form is provided in Appendix A.

In the event of a dust complaint, the complaint will be directed to the site foreman who will follow the protocols outlined in the Complaints Procedures document, which is kept on-site.

The Pit will enact an action plan concerning its operations in response to a complaint, as detailed in the following section.

7.0 RESPONSE TO COMPLAINTS

Complainants should identify the location of the incident as well as the time of day that it was detected and any other relevant information. All dust complaints shall be forwarded to the site foreman and recorded in the logbook as identified in the previous section.

The site foreman shall ensure the following actions:

- conduct a site survey to identify sources of visible dust contributing to the complaint
- create a record of this survey
- determine weather conditions (both current and at the time that the complaint was made)
- report on all on-site activities at the time the complaint was made

If the information collected from the survey procedures indicates the Summit Pit is not the source of the dust, the complainant shall be notified of this finding. Documentation supporting this response mechanism (site survey record and wind station readings at the time of the complaint) shall be provided to the complainant upon request. The site foreman or other Pit staff shall respond to all complaints within 24 hours with a phone call to the complainant.

If it is determined that the complaint is related to Summit Pit activities, the following response procedures shall be followed, in the order provided below.

Level 1 – Inspection and Correction of Operations

The Site Foreman shall ensure that all elements of the DCP are being followed. Control measures such as spraying or watering shall be increased or operations may be curtailed, as required.

Level 2 – Review of the DCP

If the Level 1 response does not adequately resolve the source of the dust complaint, the DCP shall be reviewed for additional control measures.

Level 3 – Operational modifications

If the Level 2 response does not adequately resolve the source of the dust complaint, the Mountain Ash shall commit to making physical changes to the facility to address the source of the dust emissions. Such changes may include, but are not limited to, additional enclosures, relocation of equipment, or additional paving.

8.0 CONCLUSIONS

This document presents a Best Management Practices DCP to control and minimize fugitive dust emissions from the Summit Pit operations. Mountain Ash will implement and abide by these measures contained in the plan. Record keeping, inspections and oversight will ensure an effective dust mitigation program throughout the lifespan of operations at the Summit Pit.

The DCP will serve to minimize all dust emissions from the Summit Pit, so that the risk to human health and the potential for offsite nuisance is minimized.

This DCP will be kept on-site at all times in the scale house for reference.

9.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR for Mountain Ash Limited Partnership., hereafter referred to as the “Client”. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. It is intended for the sole and exclusive use of the Client. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of SLR.

This report has been prepared for specific application to this site and site conditions existing at the time work for the report was completed. Any conclusions or recommendations made in this report reflect SLR's professional opinion.

Information contained within this report may have been provided to SLR from third party sources. This information may not have been verified by a third party and/or updated since the date of issuance of the external report and cannot be warranted by SLR. SLR is entitled to rely on the accuracy and completeness of the information provided from third party sources and no obligation to update such information.

Nothing in this report is intended to constitute or provide a legal opinion. SLR makes no representation as to the requirements of compliance with environmental laws, rules, regulations, or policies established by federal, provincial, or local government bodies. Revisions to the regulatory standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions, and recommendations in this report may be necessary.

Appendix A

Complaint Record Report Log

Dust Control Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006

GENERAL INFORMATION - COMPLAINTANT

Source of Complaint: ☐ Residential or Other: ______________________________
Name: ☐ Mr. ☐ Mrs. ☐ Ms. ____
Telephone No.: (____)______________(home/cell) (____)______________(work)
Email Address: ____
Home/Business Address: ____
City:______________________________________Postal Code: ____________________________

Other Comments: ____
____

COMPLAINT INFORMAION

Date (Month/Day/Year) :__________/_________/____________Time: From:___________________AM / PM
To: ________________AM / PM
Complaint Type: ☐ Dust ☐ Noise ☐ Other : ___________________________________

Address or Nearest Cross Street of Observed Incident: ___________________________________

Description: ____
____
____

WEATHER CONDITIONS DURING TIME OF COMPLAINT

Wind Direction: (Blowing From) _________________________
Wind Speed: ☐ Calm ☐ Moderate ☐ Strong
Cloud Cover: ☐ Clear ☐ Partly Cloudy ☐ Overcast
Condition: ☐ Clear ☐ Fog ☐ Precipitation
Temperature: __________°C or ☐ Humid ☐ Dry

OPERATIONS DURING TIME OF COMPLAINT

Description of Operations (production activity & recorded events during/before complaint period) :
____
____

MITIGATION EFFORTS & COMPLAINT RESPONSE

Date of Response (Month/Day/Year) :__________/_________/ __________
Response Summary : ☐ Attached Copy of Written Response
____
____

Corrective Action Taken : ____
____
____
____

REPORT PREPARATION

Report Prepared by:
Contact: Phone (___) ______________ Email _______________________________
Date (Month/Day/Year): _______ /________/ ___________

Appendix D

Air Quality Monitoring Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Ambient Air Quality Monitoring Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006
June 2021

Ambient Air Quality Monitoring Plan

Mountain Ash Limited Partnership

Rocky View County, Alberta

SLR Project No: 212.06650.00006

Prepared by:
SLR Consulting (Canada) Ltd.
200 – 708 11th Ave SW
Calgary, Alberta, T2R 0ER

for

Mountain Ash Ltd. Partnership
1945 Briar Crescent NW
Calgary, AB, T2N 3V6

June 2021

This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

Prepared by:	Reviewed by:
Ryan Kangas, M.Sc. Senior Air Quality Scientist	**Rick Lauzon, P.Biol., R.P.Bio.** Principal Environmental Consultant

Distribution: 1 copy (PDF) – Mountain Ash Limited Partnership
1 copy - SLR Consulting (Canada) Ltd.

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TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Mountain Ash Limited Partnership (Mountain Ash) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will encompass approximately 208 acres (84 ha) excluding existing road rights-of-way. Mountain Ash is applying for Phase 1 of a six-phase mining plan. This land is currently owned by 1410266 Alberta Ltd. (a general partner of Mountain Ash). Summit Pit received land use and a master site development plan (MSDP) approval on March 2, 2021 (Land Use Bylaw C-8051-2020).

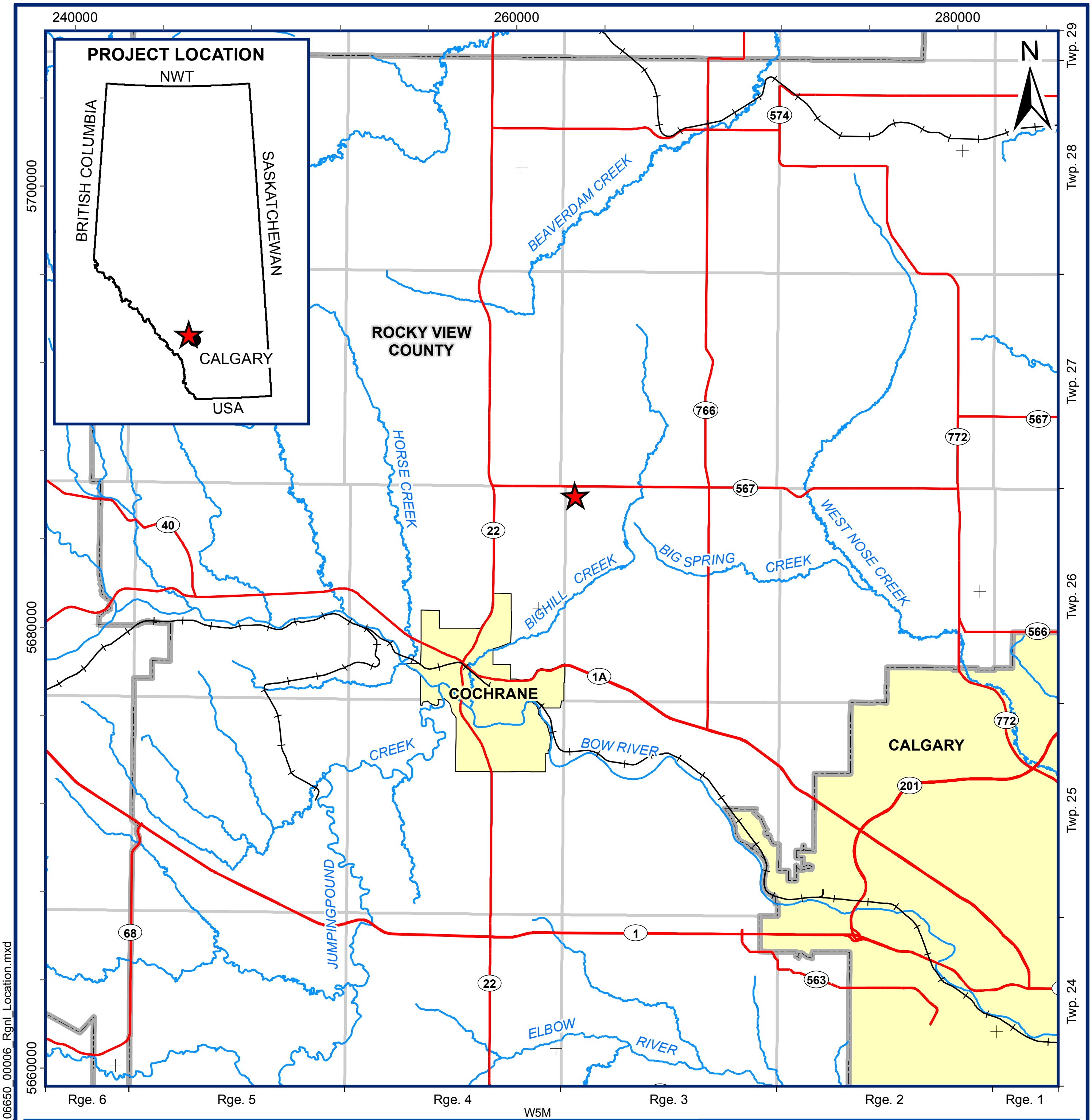
An air quality assessment was undertaken as part of the MSDP application to assess the potential air pollution from the Project operations in relation to sensitive receptors. Project operations will produce anthropogenic emissions and dust into the ambient air. Diesel combustion from engines on heavy trailer and haul trucks and other vehicles emit sulphur dioxide (SO_2), fine particulate matter with aerodynamic diameter below 2.5 micrometer ($PM_{2.5}$), carbon monoxide (CO), and oxides of nitrogen (NO_x). Additionally, fugitive dust emissions from wheel entrainment and pit operations produce suspended particulates (TSP). Since these contaminants can pose potential negative effects to human health at high ambient ground-level concentrations, they are regulated and should not exceed their prescribed Alberta Ambient Air Quality Objectives (AAAQOs) and Canadian Ambient Air Quality Standards (CAAQS). As a requirement for the Code of Practice (COP) for Pits and Development Permit (DP) applications, this report details the Ambient Air Quality Monitoring Plan (AQMP) in relation to the operation of the Summit Pit.

Following the Air Quality Modeling Guideline (AQMG), CALPUFF dispersion modeling was done to assess the effects of Project operations on AAAQOs and CAAQS. Modelling was completed for the three key pit operations defined as: overburden removal and backfill, aggregate mining/crushing, and hauling/trucking. Maximum Daily Emission and Annual Average Emission cases were estimated. The results at the Project boundary showed there were no predicted exceedances of AAAQOs and CAAQS for any modelled compounds and any averaging period when the Dust Control Plan is executed appropriately. The predicted maximum concentrations at residence receptors are all less than the AAAQOs and CAAQS for all modelling scenarios and all contaminants.

While Project operations are not expected to exceed ambient air quality objectives beyond the property boundary, Mountain Ash has committed to monitoring for $PM_{2.5}$ and TSP at the property boundary to ensure dust suppression techniques are working and for the protection of their neighbors. Although several pits have been proposed for the area, no additional pits have been approved with a development permit that have the potential to add to the air emissions from Summit Pit operations at adjacent receptors. There is an agreement between future operators to ensure that a cumulative impacts mitigation management agreement is in place to minimize emissions from their respective operations with respect to cumulative effects. Mountain Ash will participate with those operations to address cumulative effects/impacts in the area prior to submitting future development permit applications.

1.1 Facility Location and Geographical Area

The Project area is northwest of the City of Calgary south of Highway 567 (Figure 1). The closest major community of Cochrane is approximately 9 km SSE, and the nearest neighbor is approximately 250 m to the East, from the property line, excluding self-imposed setbacks as contained herein. Figure 2 provides the site plan. The area is sparsely populated and surrounded by farmland and rolling terrain.



LEGEND

★ PROJECT LOCATION

HIGHWAY

RAILWAY

WATERCOURSE

COUNTY BOUNDARY

URBAN

NOTES

This map is for conceptual purposes only and should not be used for navigational purposes.

Basedata:AltaLIS Government of Alberta under the Alberta Open Data License.

5 0 5

SCALE: 1:250,000 KILOMETRES

WHEN PLOTTED CORRECTLY AT 8-1/2 x11

NAD 1983 UTM Zone 12N

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

AMBIENT AIR QUALITY
MONITORING PLAN

SUMMIT PIT LOCATION

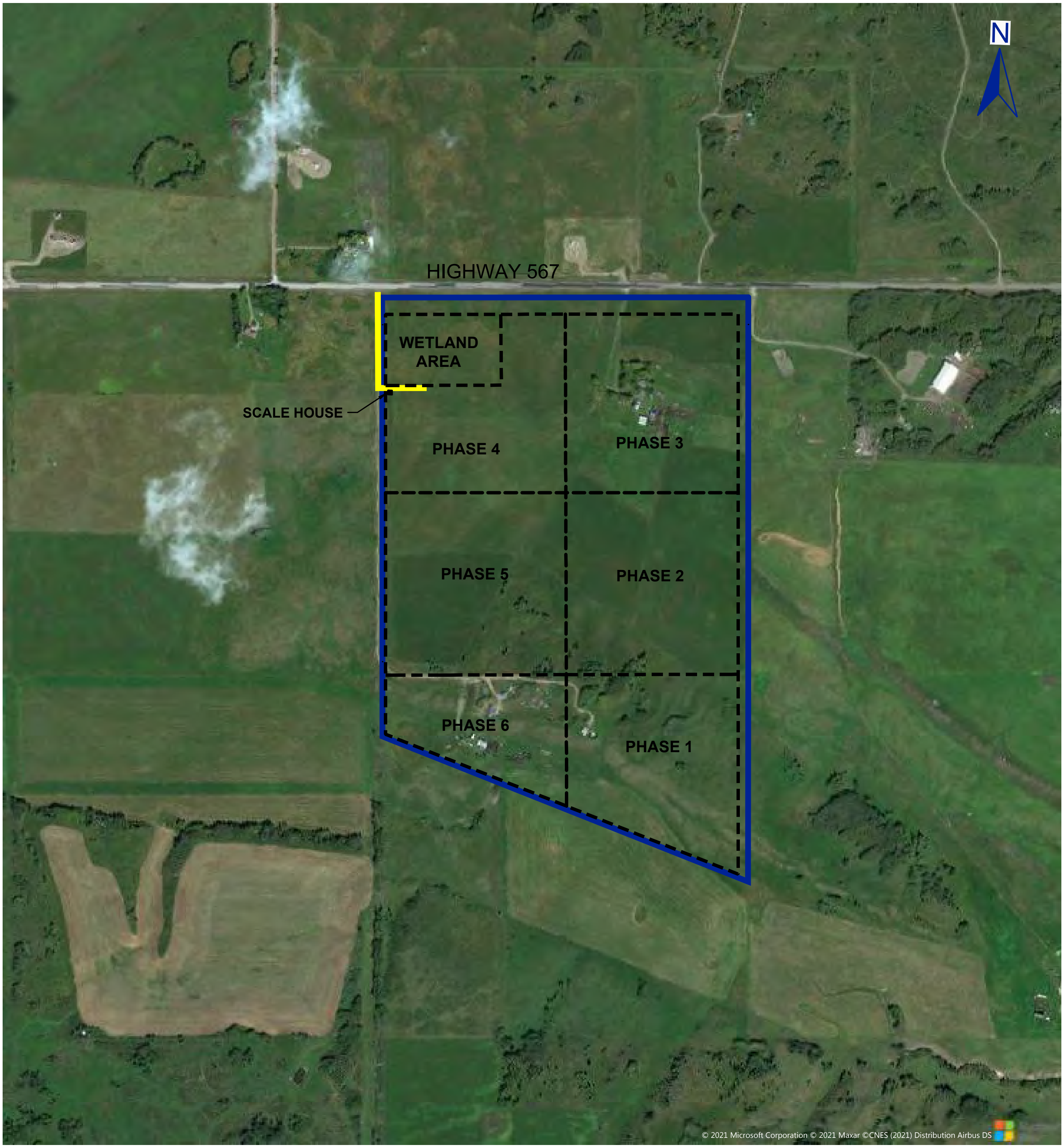
April 9, 2021

Project No. 212.06650.00006

Figure No.
1

SLR

D:\Calgary\GIS_Projects_GIS\212_06650_MtnAsh\1.MXDs\fig1_212_06650_00006_Rgnl_Location.mxd



© 2021 Microsoft Corporation © 2021 Maxar ©CNES (2021) Distribution Airbus DS

NOTES:
DRAWING COMPILED FROM DATA AS PROVIDED BY THE CLIENT.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

🟨 MOUNTAIN ASH PAVED ACCESS ROAD

LEGEND:

▭ SITE LOCATION

⬚ EXTRACTION PHASE BOUNDARIES

0 100 200 400 600 800 m

SCALE 1:12,500
WHEN PLOTTED CORRECTLY ON A 8.5 x 11 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

SLR

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

AMBIENT AIR QUALITY MONITORING PLAN

PLAN OVERVIEW OF SUMMIT PIT SITE

Date: April 12, 2021

Project No. 212.06650.00006

Figure No.
2

Cadfile name: S_212-06650-00006-A4.dwg

1.2 Ambient Air Quality or Issues in the Area

The airborne contaminants of primary concern discharged from the facility are particulate matter, specifically, $PM_{2.5}$ and dust or TSP. $PM_{2.5}$. The major emission source of $PM_{2.5}$ particulates from the Project is machinery and vehicle emissions. TSP sources are gravel roads, mining and crushing operations and wind transport over bare ground. While TSP is often seen as less harmful due to its larger size.

Regional emissions in the area can also come from two active pits and one single point source located within 5 km of the Project. The sources were included in the modelling and are shown in Figure 3. The closest pit is Hillstone Gravel Pit, which is located around 2 km west of the Project while Lafarge Glendale Gravel Pit is around 3.7 km southeast of the Project. The nearby point source emission is Lochend Oil Battery which is about 3.5 km south of the Project.

1.3 Documentation of Monitoring Objective(s)

The objective of the AQMP is to design an ambient $PM_{2.5}$ and TSP monitoring plan to obtain local air quality data that is suitable for comparison with applicable standards.

Alberta's ambient air quality objectives and guidelines are developed under the Alberta *Environmental Protection and Enhancement Act* (EPEA), and its objective is to protect Alberta's air quality. The AAAQOs shown in Table 1 include SO_2, NO_2, CO, $PM_{2.5}$, TSP and the averaging periods for each pollutant varies from 1-hour to annual. The Canadian Council of Ministers of the Environment (CCME) developed CAAQS for $PM_{2.5}$, O_3, SO_2 and NO_2. All CAAQS consist of three interrelated elements: an averaging time period, a numerical value and the statistical form of the numerical standard as shown in Table 2.

Table 1: Alberta Ambient Air Quality Objectives (AAAQOs)

Pollutant	Averaging Period	AAAQOS ($\mu g/m^3$)
SO_2	9th Highest 1-hour	450
	Maximum 24-hour	125
	Maximum 30-day	30
	Annual	20
NO2	9th Highest 1-hour	300
	Annual	45
CO	9th Highest 1-hour	15,000
	Maximum 8-hour	6,000
$PM_{2.5}$	Maximum 24-hour	29
TSP	Maximum 24-hour	100
	Annual	60

Table 2: Canadian Ambient Air Quality Standards (CAAQS)

Pollutant	Averaging Period	Year 2020	Year 2025
SO_2	1-hour[1]	70 ppb	65 ppb
	Annual[2]	5.0 ppb	4.0 ppb
NO_2	1-hour[3]	60 ppb	42 ppb
	Annual[4]	17 ppb	12 ppb
$PM_{2.5}$	24-hour[5]	27 µg/m^3	27 µg/m^3
	Annual[6]	8.8 µg/m^3	8.8 µg/m^3
O_3	8-hour[7]	62 ppb	60 ppb

Notes:

[1] The 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations

[2] The average over a single calendar year of all 1-hour average SO2 concentrations

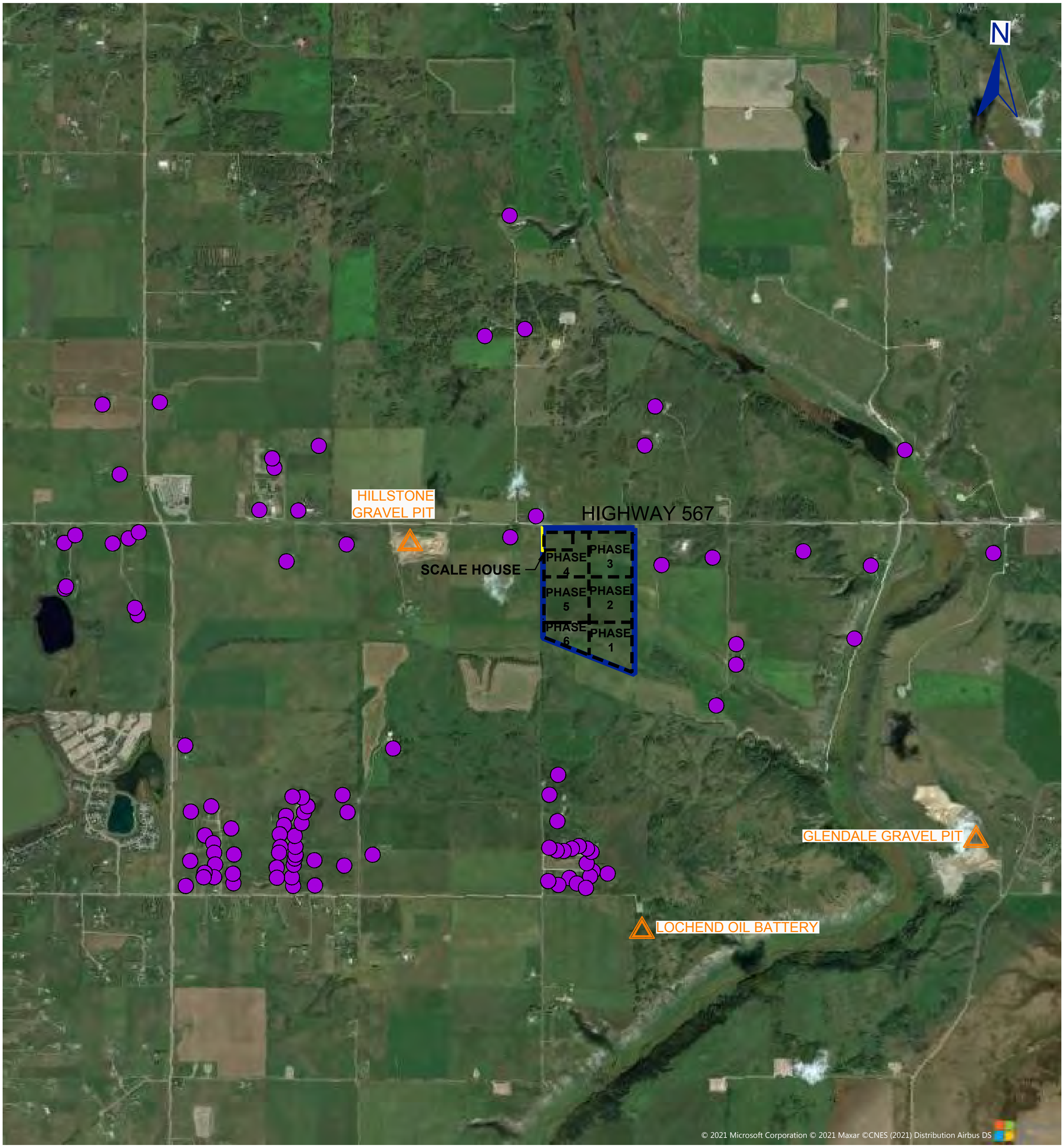
[3] The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations

[4] The average over a single calendar year of all 1-hour average concentrations

[5] The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations

[6] The 3-year average of the annual average of the daily 24-hour average concentrations

[7] The 3-year average of the annual 4th highest of the daily maximum 8-hour average ozone concentrations



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NOTES:
REFER TO FIGURE 2.

LEGEND:

▭	SITE LOCATION	△	AIR QUALITY SOURCE
⬚	EXTRACTION PHASE BOUNDARIES	●	AIR QUALITY RECEPTOR
🟨	MOUNTAIN ASH PAVED ACCESS ROAD		

0 0.5 1 2 3 km

SCALE 1:50,000
WHEN PLOTTED CORRECTLY ON A 8.5 x 11 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

AMBIENT AIR QUALITY MONITORING PLAN

LAYOUT OF MODELLING RECEPTORS

Date: April 12, 2021
Project No. 212.06650.00006
Figure No. 3

Cadfile name: S_212-06650-00006-A4.dwg

1.4 Responsible Authorities

The overall commitment of the AQMP is to ensure that appropriate measures and precautions will be implemented at the facility continuously and effectively, in a manner that is protective of the local airshed and human health. Table 3 lists the various responsibilities that are required by the Project operator in implementing the AQMP.

Table 3: Key Responsibilities

Key Role	Responsibilities
Project Manager	Responsible for overseeing and coordinating all aspects of the Project.
Station Operator	Responsible for operating the monitoring station and conducting routine monitoring activities such as routine site visits, calibrations, and resolving system errors.
	Responsible for regular data downloads and review, data validation, and preparing data reports.
Data Manager	Responsible for reviewing the data analyst's work products.
Quality Assurance Manager	Responsible for ensuring that established QA/QC procedures are followed and will review results of all QA/QC activities.

2.0 MONITORING INFORMATION

2.1 Local Climatology

Climatological data is available from the nearby Springbank Airport located south-southeast of the Project. Wind is predominantly from the west and northwest at the Project location with an average speed of 15 km/h. A wind rose from April 2015 through October 2020 is provided in Figure 4. The wind rose only represents months of expected operations (approximately April-October).

2.2 Substance(s) to be Monitored

As the airborne contaminant of primary concern discharged from the Project is particulate matter, Mountain Ash has committed to establishing an air quality monitoring program. This program is designed to monitor and evaluate ambient $PM_{2.5}$ and TSP concentrations related to potential particulate emissions from the Project. Additionally, wind speed and wind direction will be recorded.

2.3 Method of Monitoring

Mountain Ash will monitor for $PM_{2.5}$ and TSP using the TSI Dusttrak Aerosol Monitor or similar. The Dusttrak uses a light scattering laser photometer to provide real time aerosol readings corresponding to PM_1, $PM_{2.5}$, PM_{10} and PM total. The Dusttrak is suitable for both indoor and outdoor use, has in internal datalogger, alarm capabilities, automatic zeroing for instrument drift, low power usage, and can be equipped with remote communications and additional peripherals. The Dusttrak will also be housed in a temperature and environment-controlled shelter for additional protection from the elements. Additionally, the Dusttrak monitor will be equipped with a wind speed and direction monitor to record the source of particulate readings. A summary of the proposed instrument specifications is provided in Table 4.

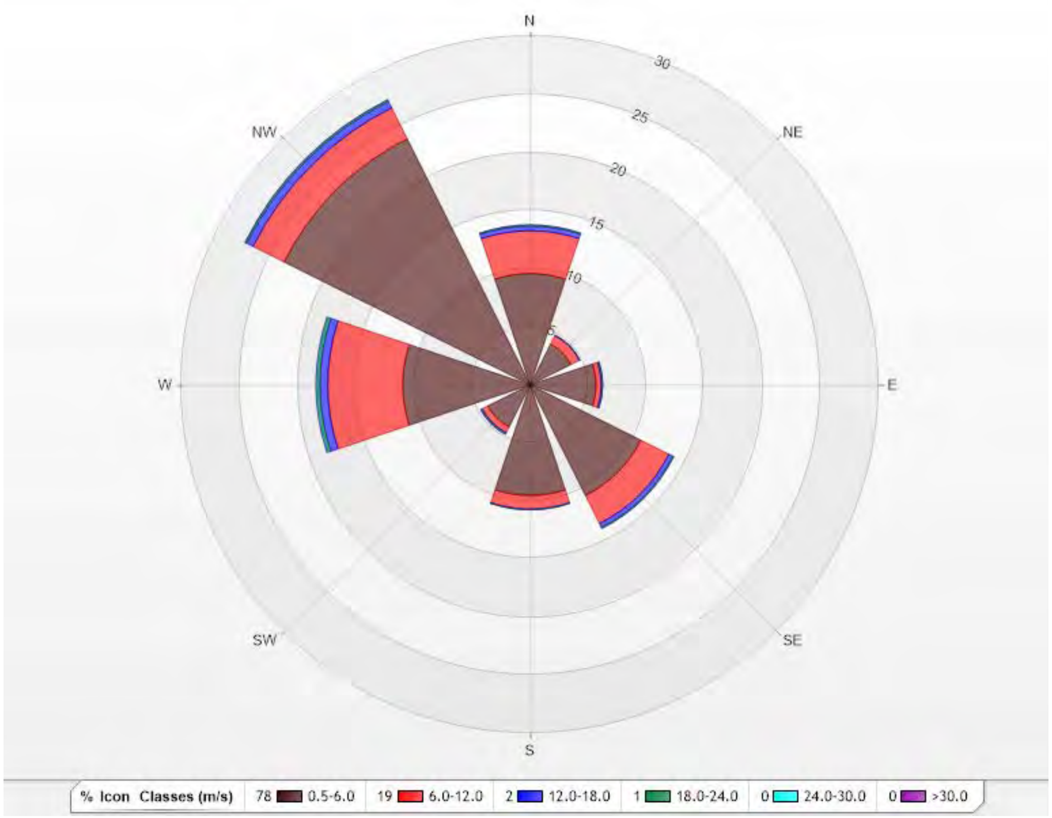

Figure 4 Wind Rose from Springbank Airport

Table 4: Method of Monitoring and Performance Specifications

Monitoring / Instrumentation Method	Resolution	Full Scale	Precision	Accuracy	Data Output Rate
$PM_{2.5}$ and TSP Measurements					
TSI Dusttrak	± .1% or 1 µg/m^3	150,000 µg/m^3	± 1.0 µg/m^3	n/a	1-second
Wind Measurements					
Wind Speed / Luft WS600-UMB	0.1 m/s	75 m/s	n/a	±0.3 m/s or 3%	1-second
Wind Direction / Luft WS600-UMB	n/a	360 degrees	n/a	±3 degrees	1-second

2.4 Instrument Siting Criteria

The location should be based on an objective procedure that will provide the best monitoring results for the needs of the program. The Alberta Air Monitoring Directive provides a list of siting criteria that is applicable to the proposed monitoring objectives and are listed below.

- $PM_{2.5}$ and TSP Sampling Inlet
- sample inlet must be 2 to 15 m above ground
- the inlet must be located greater than 20 m from structures or trees
- no nearby furnace or incinerators
- air flow must be unrestricted in three of the four wind quadrants

The proposed air monitoring location will satisfy the criteria referenced above.

2.5 Monitoring Location

Based on the modelling results, predominant wind direction, and the close proximity of the neighbor east of the Project property line, the location for the $PM_{2.5}$ and TSP monitoring station is determined to be immediately inside the eastern property boundary in line with the Project and nearest neighbor. During the various phases of operations, the location will need to be moved occasionally to remain in line with the nearest neighbor and operations. The eastern boundary resides downwind from the Project during most of the year and will provide a point of maximum for particulate leaving the Project property. The eastern boundary also meets the required clearing from structures and trees and has unrestricted air flow in all four quadrants throughout the entirety of the eastern property boundary. Pictures of the eastern property line are in Appendix A.

2.6 Limitations on Monitoring Site Access

The $PM_{2.5}$ and TSP instrumentation will be located immediately inside the property boundary on the eastern property line between the nearest neighbor and Project operations. There are no roads along the eastern property boundary. Limited vehicle access may be possible depending on ground conditions and fencing but is easily accessible by foot.

2.7 Monitoring Schedule

Continuous monitoring for $PM_{2.5}$, TSP, wind speed and wind direction will be conducted at the monitoring station during mining operations (approximately April through October). Data will be logged in 15-minute increments and will be obtained on an ongoing basis from the instrumentation. Monitoring is proposed to be conducted during the period of mining operations.

3.0 EMISSIONS AND RECEPTORS

3.1 Nearby Industrial Sources

Regional emissions in the area come from two active pits and one single point source located within 5 km of the Project. Hillstone Gravel Pit, which is located around 2 km west of the Project and Lafarge Glendale

Gravel Pit, which is around 3.7 km southeast of the Project. The nearby point source emission is Lochend Oil Battery which is about 3.5 km south from the Project.

3.2 Sensitive Receptors

A number of receptors were included in the modeling. Most of them are human-inhabited areas, ecosystems, or other sites that are more susceptible to emissions. Figure 3 shows the layout of gridded receptors, as black dots, and discrete receptors, marked as black asterisks for more sensitive receptors. The largest residential area in the region is the Town of Cochrane, located approximately 9 km to the Southwest. The nearest residence is located approximately 250 m to the east of the Project property boundary/line.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

4.1 Ambient Monitoring Operations

In general, operations will include regular scheduled station visits, zero and span verifications, calibrations, preventative maintenance and documentation. Instrument specific standard operating procedures (SOPs) will be developed to ensure operators are aware of all detailed information and follow the correct installation, operation and detailed calibration and maintenance procedures for each monitor and sensor.

4.1.1 Monitor Operation

Continuous $PM_{2.5}$, TSP, wind speed and wind direction monitoring are expected to be operational at least 90% of the time on a monthly basis. Operating procedures will be described in the specific monitoring instruments operations manual. Performance specifications are listed in Table 4.

4.1.2 Site Visits

To verify proper operation of the monitoring equipment, scheduled station visits are proposed to be conducted on a quarterly basis. Typical activities to be performed during site visits will include the following and will be documented in a site logbook:

- perform preventative maintenance as recommended by operations and maintenance manuals
- completion of flow rate verifications and leak checks
- cleaning of inlet heads and equipment as required
- removal of tall grass or trees
- instrument calibrations, as required

4.1.3 Instrument Calibration

As many variables can affect the performance of particulate monitoring instruments, instrument calibration at regular intervals is necessary. All calibration checks will be performed by a trained technician or station operator by following the requirements of the maintenance and calibration procedures in the instrument operation manual. Flow checks will need to be performed with a certified calibration device.

Routine calibration checks of the monitoring equipment will be performed quarterly, during operations, for $PM_{2.5}$ and TSP monitoring. Calibration checks for the particulate instruments will include a flow, zero verification and span test. On an annual basis the Dusttrak will need to be returned to the manufacturer for a comprehensive maintenance and calibration verification check. Calibration criteria for each measured parameter are provided in instrument manuals and listed below:

- flows should not deviate by more than 5% of the designated flow rate (3LPM)
- zero checks should be passing
- span (bump check) should be responsive
- verify time is correct

Additional calibration checks are required if any one of the following criteria is met, as appropriate:

- after initial installation
- after major repairs
- if an instrument is physically relocated
- when any maintenance activity that may alter the response of the instrument is conducted
- prior to the removal, repair or replacement of any instrument if it is still operational
- immediately following the installation of a replacement instrument
- immediately prior to project takedown

All test equipment used for calibrations will be maintained and certified on a regular basis. Records that provide traceability to authoritative standards of all equipment used for adjusting monitoring systems will be maintained by operator.

4.2 Data Acquisition and Management

4.2.1 Data Acquisition

Data acquisition will include the collection of electronic data and the generation of hand-written or electronic documentation and records. Data acquisition can be completed either remotely through the modem and instrument or may be downloaded from the instrument directly. Documents and records generated for this project are listed in Table 5.

A data acquisition and data management system will be used. The system will maintain an ongoing real-time log of one-hour data averaging periods for particulate concentrations and wind. This system will store data in an organized manner for reporting purposes and can be used to record maintenance and calibrations within a logbook.

4.2.2 Data Validation

4.2.2.1 Validation Process

Validation of continuous sensor data occurs several times before data is finally archived.

Daily Validation

Daily data validation will be conducted on the one-hour averages using the following steps:

- At a minimum, daily validation should ensure the instruments are running and properly functioning.
- Daily validation should consistently be performed at the same time of day, usually in the morning.
- Daily validation involves the review of the previous 30 hours of data from all monitors. Data is examined for negative baseline, missing data, power failures, rate of change flags or any other data anomalies.
- If the validation process detects an error, investigation should occur.
- A data error may result in the data point being declared invalid.
- A data error may result in instrument repair followed by a recalibration of the monitor/sensor. If the monitor/sensor is replaced, it must be recalibrated immediately following installation.
- The daily check also involves verifying that all communication systems are operational. Corrections or repairs are carried out as required.

Monthly Validation

Monthly data validation will be conducted on one-hour averages using the following steps:

- Monthly data validation involves examination of the daily data.
- The data set is reviewed for the entire month and reasons for missing data is explained, or the data is replaced if available.
- A second review of data from all stations should be performed, preferably by another technician.
- After second review, the dataset is checked for minimums, maximums, averages, data recovery and trends, etc.

Annual Validation

Annual data validation will be conducted on the one-hour averages and will be examined using the following steps:

- As part of the annual data validation, minimums, maximums, averages, data recovery and trends, etc. are calculated and identified. Anomalies are identified and further verification is performed.
- An annual data report is generated and reviewed.
- The dataset is archived.
- The three levels in the verification process coupled with the application of high-quality QA/QC standards provide a defensible dataset.

Data review evaluates incoming data for conformance with predetermined project criteria. Data validation and QA/QC will be performed on a daily, monthly and annual basis with screening criteria that is established to identify data integrity and quality issues early so they can be corrected. The operator will ensure that:

- data observations are within the operating limits of the monitoring equipment
- data continues to be collected and transmitted as designed
- apparent outliers are identified and investigated to determine if they represent a malfunction or some other issue

Data validation evaluates data against a set of criteria to provide assurance that the data are adequate for their intended use. Data validation is intended to confirm the degree of truth in an analytical sense. The data analyst will confirm that:

- the instruments were operated and calibrated in accordance with the manufacturer's specifications
- automated and manual QC procedures meet acceptance criteria
- corrective actions are documented, and their effectiveness is verified
- log books are kept current and accurately record significant station events
- method specific screening and data validation criteria are applied

Data verification evaluates the completeness, correctness, conformance, and compliance of a specific data set against the method, procedural, or contractual specifications. The operator will ensure that:

- data quality and completeness meets or exceeds program requirements
- data is reviewed to identify long term trends
- calibration documentation is reviewed to ensure timeliness of field activities and review the performance of the station sensors
- invalidated data periods are documented and investigated and provide recommendations for improvement as needed.

4.2.2.2 Validation Process Records

As part of the data validation process, data validation codes will be entered for any data value deemed to be invalid, or that need to be qualified.

Whenever any data are invalidated or qualified the monitoring program requires that a data validation log entry be made. The log entries will include the following information:

- who performed the validation action
- when the validation action was completed
- the parameter(s) affected
- the identification of, and justification for, any data adjustments or invalidations
- a brief description of any corrective action performed to address data issues

- the identification of, and justification for, the validity of anomalous data or outliers
- any additional entries for post-validation changes

A 24-hour average will be deemed to be valid if at least 18 hours of sampling occurred from midnight to midnight Local Standard Time.

4.2.3 Documents and Records

Data will be automatically backed up to an online storage folder. Data will be reviewed at regular intervals to check the function of the instruments and to ensure that the data collected is reasonable and valid.

Raw data along with all data reduction and validation procedures will be retained. Raw data will be archived separately and distinct from validated data.

4.3 Non-Compliance, Preventive, and Corrective Action

Documentation of all site visits will be provided through several forms. Station logs and checklists, which detail inspection, calibration, and repair activities, will be maintained by the operator. Records and measurements taken during calibrations will be recorded on forms designed specifically for the instrument. The archive location for these project documents is provided in Table 5.

The monitoring system has been designed to require minimal preventive maintenance. All system components have been selected based on dependability and stability through extensive field application and will be purchased new. The preventive maintenance tasks and schedules recommended by each equipment manufacturer will be followed. Records will be maintained of all preventive maintenance activities.

A collection of spare parts will be maintained for the instrumentation. Inlet filters, O-rings, pumps, and inlet head replacements will be maintained for the particulate samplers. In the event of an instrument failure beyond the repair of the operator, the instrument will be sent to the manufacturer for repair and calibration. In this event, a temporary replacement instrument will be obtained to prevent excessive data loss on the Project.

The station operator will maintain the following support documentation at the monitoring location:

- copies of manufacturer’s operation and service manuals for each piece of monitoring equipment
- copies of applicable SOPs covering tasks to be performed in the operation and servicing of the monitoring system
- station logs, and checklists for recording site visits and maintenance activities
- a copy of the Project AQMP

Any monitoring equipment problems or issues that are identified during calibration or regular site visits, or during the data review process, or that may affect the quality of the data collected, will be documented and reported to the project manager. All monitoring equipment problems that may affect data quality, and the corrective actions taken to resolve them, will be documented using corrective action request forms and will be detailed in the data reports.

Table 5: Summary of Project Documentation and Records

Type of Documentation Generated	Frequency Generated	Preparer	Archive Location
Raw data (digital)	1-hour averages logged hourly and downloaded regularly	Station operator	Data Acquisition System
Validated data	Monthly and annual	Station operator	Data Acquisition System
Station logs	Each station visit	Anyone visiting the site	On site logbook or Data Acquisition System
Equipment checklists	Each station visit	Station operator	On-site or Data Acquisition System
Calibration checks	Quarterly	Station operator	On-site or Data Acquisition System
Maintenance logs	As needed	Station operator	On-site or Data Acquisition System
Spare parts inventory	Quarterly	Station operator	On-site
Monthly data report	As needed	Station operator Project Manager	On-site or Data Acquisition System

4.4 Evaluation and Improvement

The operator will conduct an annual review of the monitoring program following the end of the calendar year to evaluate whether the objectives of the monitoring program have been met. The results of the review will be reported in the relevant data report.

The project manager will reassess the AQMP if:

- the review shows that the objectives of the monitoring project are not being met
- the data are inconsistent or fail to meet the criteria or objectives of the monitoring project
- new monitoring objectives are identified
- there are change(s) in emissions and/or receptors in the area, changes in ambient air quality, changes in monitoring technology, audit results, or public concerns within the area monitored

4.5 Reporting

Quarterly or annual reports will be prepared as needed. The contents of the reports will include the following:

- a station performance summary with data recovery statistics and a discussion of significant events (e.g., audits, calibrations, repairs)
- documentation of the reasons for any missing, invalidated, or adjusted data
- tabular listings of all validated hourly data with daily and monthly summaries
- results of audits and/or calibrations performed
- copies of calibration data forms for all instrument calibrations conducted

5.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR for Mountain Ash Limited Partnership., hereafter referred to as the “Client”. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. It is intended for the sole and exclusive use of the Client. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of SLR.

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Appendix A

Photolog

Ambient Air Quality Monitoring Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006

Pictures look North, East, South, and West (Clockwise from top left) along the eastern property boundary.

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Appendix E

Post Mining Reclamation Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Post-Mining Reclamation Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006
June 2021

Post Mining Reclamation Plan

Mountain Ash Limited Partnership

Rocky View County, Alberta

SLR Project No: 212.06650.00006

Prepared by:
SLR Consulting (Canada) Ltd.
200 – 708 11th Ave SW
Calgary, Alberta, T2R 0ER

for

Mountain Ash Ltd. Partnership
1945 Briar Crescent NW
Calgary, AB, T2N 3V6

June 2021

This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

Prepared by:	Reviewed by:
	ALBERTA INSTITUTE OF AGROLOGISTS MARIA KUDIENKO, P.Ag. 4514 MEMBER
Katrina Sharko, B.Sc., P.Ag. Soil Scientist and Vegetation Ecologist	**Maria Kudienko, B.Sc., P.Ag.** Senior Reclamation Specialist

Distribution:	1 copy (PDF) – Mountain Ash Limited Partnership 1 copy - SLR Consulting (Canada) Ltd.

Table of Contents

FIGURES

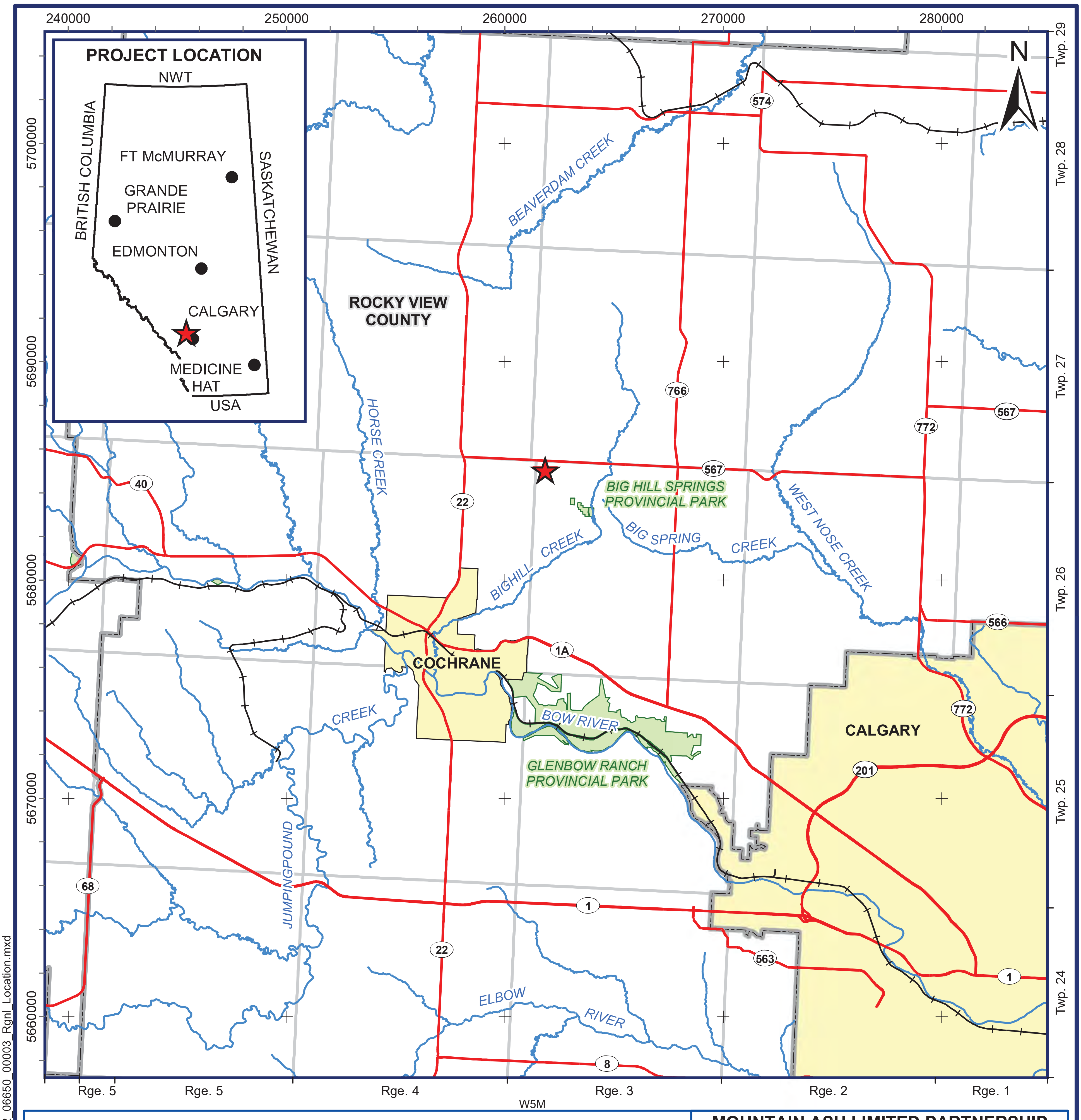
1.0 INTRODUCTION

Mountain Ash Limited Partnership (Mountain Ash) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will encompass approximately 208 acres (84 ha) excluding existing road rights-of-way. Mountain Ash is applying for Phase 1 of a six-phase mining plan. This land is currently owned by 1410266 Alberta Ltd. (a general partner of Mountain Ash). Summit Pit received land use and a master site development plan (MSDP) approval on March 2, 2021 (Land Use Bylaw C-8051-2020).

A biophysical impact assessment was undertaken as part of the MSDP application to assess baseline conditions for soils, vegetation and wildlife and to provide an impact and cumulative effects assessment on these resources (SLR 2020). As a requirement for the Code of Practice (COP) for Pits and Development Permit (DP) applications, this report details the Post-Mining Reclamation Plan (AEP 2004a and 2004b). This is also consistent with requirements of the land re-designation and MSDP.

This Post-Mining Reclamation Plan has been developed based on the information obtained in the biophysical impact assessment, literature review as well as best industry practices and in accordance with recommendations in a User's Guide to Pits and Quarry Reclamation in Alberta (Alberta Land Conservation and Reclamation Council 1992). The objectives of the Post-Mining Reclamation plan are to:

- provide information about the planning process for the phased reclamation and the ultimate closure of the Summit Pit
- provide the endpoints for final reclamation of the Summit Pit and demonstrate how equivalent land capability will be achieved



LEGEND

★	PROJECT LOCATION	—	HIGHWAY	▭	COUNTY BOUNDARY
		┼	RAILWAY	🟩	PROVINCIAL PARK
		—	WATERCOURSE	🟨	URBAN

NOTES

This map is for conceptual purposes only and should not be used for navigational purposes.

Basedata:AltaLIS Government of Alberta under the Alberta Open Data License.

5 0 5

SCALE: 1:250,000 KILOMETRES

WHEN PLOTTED CORRECTLY AT 8-1/2 x11

NAD 1983 UTM Zone 12N

MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

Post-Mining and
Reclamation Plan

REGIONAL LOCATION

January 15, 2020	Rev 0.0	Figure No.
Project No. 212.06650.00003		1

SLR

SLR Consulting (Canada) Ltd.

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2.0 PROJECT SETTING

The Project area settings are summarized from the Biophysical Impact Assessment (SLR 2020) completed as part of the MSDP application and based on literature review.

2.1 Landuse

The Project is located in the Parkland Natural Region and Foothills Parkland Natural Subregion (Natural Regions Committee 2006). The subregion has a relatively short growing season and correspondingly less intensive cultivation due to proximity to the mountains. Rolling to hilly native grasslands, aspen woodlands and willow shrublands are common in areas remaining under native vegetation. Haylands are typical for undulating to rolling terrain in the areas used for agriculture.

All soils in this area are mapped as Class 5 for agriculture, because of adverse climate (subclass C; Land Canada Inventory 2021). Such soils have severe limitations that restrict their capability in producing perennial forage crops. Since the main limitation for agriculture at the site is climate, this subclass cannot be improved (Environment Canada 1972).

Current land use at the site is hayland / tame pasture. In consultation with the landowner, the future landuse at the end of mine life cycle will be tame pasture.

2.2 Terrain and Soil

The site is in low relief – hummocky terrain with slope classes 3 – 4. (AGRASID 2021).

The AGRASID Alberta Soil Information Viewer (Alberta Agriculture and Forestry 2021) and the Alberta Soil Names File (Generation 4) User's Handbook (Alberta Soil Information Centre 2021) were accessed to determine soils expected to be present in the Project area.

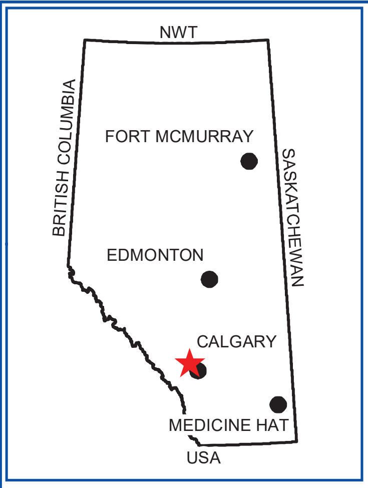
It was determined that underlying parent material in the Project area is moderately to strongly calcareous, mixed Continental and Cordilleran till (Alberta Soil Information Centre 2021. Fertile loam to clay loam Orthic Black Chernozemic soils are extensive, with Gleysolic soils present in poorly drained and lower slope positions expected at the Project (Alberta Agriculture and Forestry 2021). The AGRASID information was consistent with SLR field assessment conducted on June 2019. The Dunvargan soil series, a fertile, well-drained Orthic Black Chernozem formed on glacial till parent material, was identified across the majority of the Project area, with the gleyed variant (Dunvargan-GL) identified in depressional areas. These soils have low wind erosion risk and moderate water erosion risk; no sensitive soils were observed within the Project area during the field investigation.

For Dunvargan soil series, Ap and Ah horizon (topsoil) depths are on average 25 cm and include well drained loam to clay loam soils and average subsoil thickness was 20 cm. SLR recorded average topsoil thickness in the wetland areas as 30 cm and average subsoil thickness as 20 cm.

2.3 Vegetation

Onsite vegetation consisted mostly of hayland / tame pasture species dominated by wheatgrass, brome species, alfalfa, and timothy. Treed areas, marsh areas and native pasture was also present (Figure 2). A detailed vegetation list is provided in Appendix C of the Biophysical Impact Assessment Report.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



LEGEND

▭ AREA ASSESSED
▭ EXTRACTION PHASE BOUNDARY
▭ SITE LOCATION

SOILS

▨ GLEYED DUNVARGAN SOIL[1]

VEGETATION

🟨 HAY
🟫 MARSH
⬜ NATIVE PASTURE
🟩 TAME PASTURE
🟩 TREED

NOTES

1. Soil within the rest of the Project Area is classified as Orthic Black Chernozem of the Dunvargan soil series.

This map is for conceptual purposes only and should not be used for navigational purposes.
Basedata:

100 0 100
SCALE: 1:5,000 METRES
WHEN PLOTTED CORRECTLY AT 11 x 17
NAD 1983 UTM Zone 11N

MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

Post Mining Reclamation Plan

SOILS AND VEGETATION

January 15, 2020	Rev 0.0	Figure No.	2
Project No.	212.06650.00003		

SLR
global environmental solutions

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2.4 Wetlands

Ten wetlands ranging from class 1 to class 3 were identified (Figure 3). Detailed information on wetland assessment, including Classification and Species List is provided in Appendix C and D of the Biophysical Impact Assessment Report.

2.5 Rare Plants

No rare plants or rare ecological communities were documented in ACIMS or identified during the field investigation completed in 2019. Most of the habitat has low rare plant potential as it is tame pasture or hay land.

2.6 Wildlife

Active barn swallow (provincially 'sensitive' and federally 'threatened' species) nests were observed on two residences in the Project area; therefore, the potential exists to interact with or disturb species at risk. However, the Project area is heavily modified by existing land uses, with limited areas of native vegetation that provide limited habitat for wildlife species. The wetlands were dry during the 2019 surveys and therefore were determined to have limited value for wetland wildlife species.

3.0 POST-MINING RECLAMATION PLAN

3.1 Overall Reclamation Objectives

Reclamation objectives will be considered in all stages of mining in order to:

- minimize the footprint of the development
- maximize resource extraction
- prevent double handing of materials
- consider sequencing of pit development in reclamation planning and incorporate direct soil placement and progressive reclamation in all stages of mining, whenever feasible
- optimize the efficiency of soil handling equipment and reduce noise, dust and equipment emissions.

The goal of reclamation is to achieve equivalent land capability and obtain reclamation certificate as required under the *Environmental Protection and Enhancement Act* and *Conservation and Reclamation Regulation* (GoA 2021). The sections below describe how these objectives can be achieved.

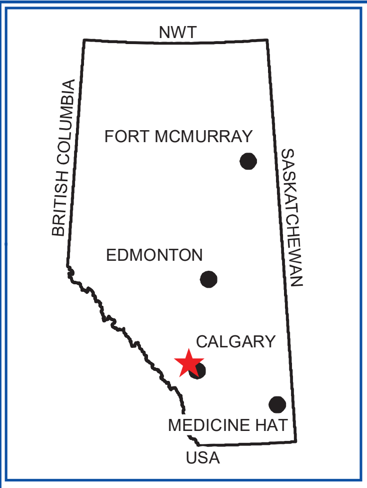
3.2 Vegetation Clearing

Development of the Summit Pit will require onsite vegetation to be stripped. Most of the vegetation onsite is hay, tame pasture or native pasture, where minimal vegetation clearing is required. As such, short vegetation can be salvaged with soil for future reclamation purposes.

3.3 Rare Plant Mitigation

Since no rare plants or rare ecological communities were identified (see Section 2.5.), no rare plant mitigation is required.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



LEGEND

- ▭ AREA ASSESSED
- ⬚ EXTRACTION PHASE BOUNDARY
- 🟩 SITE LOCATION
- ▨ WETLAND (# IDENTIFICATION)

NOTES

This map is for conceptual purposes only and should not be used for navigational purposes.

Basedata:

100 0 100

SCALE: 1:5,000 METRES

WHEN PLOTTED CORRECTLY AT 11 x 17

NAD 1983 UTM Zone 11N

MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

Post Mining Reclamation Plan

IDENTIFIED WETLANDS

January 15, 2020	Rev 0.0	Figure No. 3
Project No. 212.06650.00003		

SLR
global environmental solutions

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3.4 Wildlife Mitigation

Wildlife could be affected by activities including vegetation removal, removal of residences, topsoil stripping and salvage, excavation activities, and by vehicle and equipment traffic. Development will require the removal of habitat (treed areas and wetlands) and dwellings that may affect local wildlife use; although Project area was determined to have low wildlife use (Section 2.6.). As due diligence to avoid contravening the *Migratory Birds Convention Act* and to reduce the potential for impacting active migratory nesting birds which may nest between mid-April and late August, clearing of wetlands and vegetation will occur outside of this period (GoC 2019). Similarly, care will be taken to demolish the residences or remove barn swallow nests from the residences outside the breeding season and prevent their renewed use; thereby avoiding interaction with a species at risk. Best management practices will be implemented (e.g., abiding by restricted activity periods; keeping garbage in wildlife-proof containers; being aware of the potential for wildlife at the Project access and on haul routes) to limit the likelihood of adversely interacting with wildlife.

3.5 Timber Management

There are limited treed areas onsite, consisting of small aspen stands and some planted trees surrounding the house sites. Non-merchantable timber and slash materials will be disposed of at landfill, local campsite(s) or burnt on site.

3.6 Soil Salvage and Soil Conservation

Based on available soil data (Section 2.2.), average topsoil depths onsite were approximately 25 cm in upland areas and 30 cm in wetland areas. Desktop information and field inspection indicates low variability in the topsoil thickness at the Project area.

Suitable upper subsoil was approximately 25 cm thick (Section 2.2); there are no unsuitable subsoil reported for this area. Color change between topsoil and upper subsoil is obvious and can be used to tell soil stripping depth in cases where the anticipated 25 cm or 30 cm does not seem reliable. Wetland and upland topsoil can be salvaged and stockpiled together, and wetland and upland suitable subsoil can be stockpiled together. For soil stripping and overburden volumes, please see the Stripping and Grading Plan (SLR 2021).

Topsoil will be stripped everywhere where soil disturbance occurs at the site, except for the areas under topsoil storage piles. Topsoil will be stripped at least 5 m ahead of the pit face to ensure there is no topsoil loss into the pit. The salvage distance will be increased if pit face is unstable or if it is rapidly advancing. Subsoil will be stripped everywhere where soil disturbance occurs at the site, and at least 3 m ahead of the pit face to reduce loss into the pit.

Topsoil and subsoil piles will not be located over merchantable aggregate, to prevent double handling of soils. Thin, vegetated topsoil piles tend to maintain topsoil quality better than thick piles; therefore, any topsoil piles will not exceed 2 m in depth (AEP 2004b); this will also allow better access for weed management. The surface of the stockpile will be smoothed and properly sloped to make a firm, well-drained base. A drainage channel around stockpiles will be constructed to prevent collection and blockage of surface run-off. Signs indicating topsoil and subsoil piles will be installed on each pile to be used for future reclamation purposes. Progressive reclamation and direct topsoil placement will occur as soon as practically possible to avoid deterioration of topsoil.

Native pasture is found in the south-east section in Phase 1 of the Project. Native prairie will be stripped and salvaged separately and the native prairie area will be reclaimed as soon as practical. This should reduce the future establishment of weeds and invasive species and increase the seed propagule viability upon reclamation of the area. Overall this will encourage the return of native species during final reclamation.

3.7 Erosion and Weed Mitigation

While the onsite soils were determined not to be susceptible to erosion (Section 2.2.) and no sensitive soils were identified during the biophysical assessment, the following mitigation measures for erosion will be implemented:

- Soil will not be salvaged during extremely windy periods, when wind velocity creates a potential for loss of topsoil or subsoil.
- Soils will not be handled when wet conditions are present, such as during spring melt or heavy rain events.
- Salvage or replacement of topsoil and subsoil will only restart when conditions specified above no longer exist.
- Soil stockpiles will be promptly revegetated using suitable seed mix to limit erosion and weed establishment. Proposed species include oats, barley or rye; with the exception of the native pasture topsoil pile that will be allowed to naturally re-vegetate.
- Soil stockpiles will be continuously monitored for weeds and erosion issues and further mitigation measures will be developed based on these observations.
- Reclaimed final slopes will have 3:1 configuration and will be hydroseeded within the first growing season of topsoil placement to avoid any topsoil loss or erosion. Furthermore, slope benching is recommended at this site to prevent erosion. The frequency of benches will be determined based on geotechnical properties of soil.

3.8 Reclamation and revegetation

As areas are no longer needed for operations, Mountain Ash will reclaim them in accordance with the best industry practices to ensure equivalent land capability can be achieved.

Subsoil will be de-compacted before topsoil placement. Subsoil will be recontoured to tie in with the surrounding landscape and create drainage patterns consistent with surrounding landuse. Experienced reclamation specialist will supervise machinery to avoid final contours that may cause water ponding or any erosion issues.

Revegetation will occur within the same growing season when topsoil placement is completed to avoid any soil loss via erosion. Hydro seeders will be used for maximum germination and erosion control success. Species mix, seeding rates and composition will be determined by assessing the surrounding lands during the time of reclamation and will be supported by the approval received in writing from the landowner. Currently, the land is used for native pasture, tame pasture and hay.

Seed will be sourced from the reputable supplier and professional agrologist will review seed germination tests, impurities and presence of weed species in the seed mix. Seed certificates will be reviewed and kept on file.

4.0 MONITORING RECLAMATION SUCCESS

Reclamation success will be determined by a landscape that does not require inputs and provides equivalent land capability as it did prior to disturbance.

Continuous monitoring of progressively reclaimed areas will guide further reclamation activities and help identify proper mitigation measures leading to a successful reclamation outcome.

In accordance with the current regulations, Mountain Ash will submit a report on disturbance and reclamation status to Alberta Environment and Parks, starting five years after registration and then every five years after that until the Final Reclamation Report is submitted and/or a reclamation certificate for the whole pit is received (AEP 2004a and 2004b).

5.0 REFERENCES

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Natural Regions Committee 2006. Natural Regions and Subregions of Alberta; compiled by D.J. Downing and W.W. Pettapiece. Government of Alberta. Pub. No. T/852.

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SLR Consulting (Canada) Ltd. 2021. *Stripping and Grading Plan*, April 2021. Mountain Ash Limited Partnership, Rocky View County, Alberta.

6.0 STATEMENT OF LIMITATIONS

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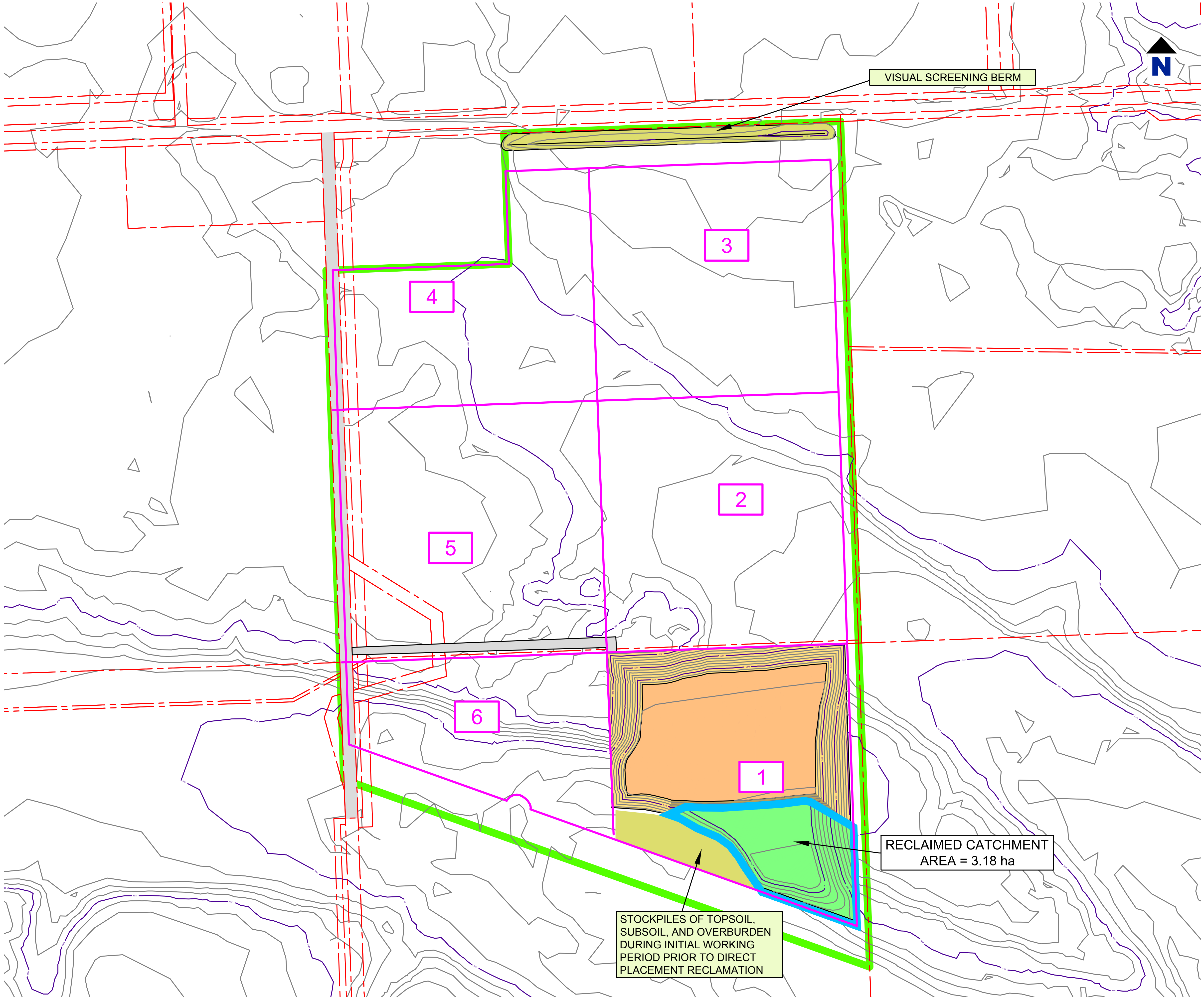
Appendix F

Proposed Sequence of Activity

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Cadfile name: 212-06650-00007 EM01_PHASE 1 - COP 09052023.dwg



NOTES:

DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, BING IMAGERY, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

THIS PLAN SHOWS THE GENERAL ORDER OF WORKING, WITH MINING BLOCKS PROGRESSING IN AN ANTICLOCKWISE DIRECTION FROM THE SOUTH EAST.

EACH MINING BLOCK WILL BE NO GREATER THAN 150m X 150m (22,500m³).

LEGEND:

▭	PROJECT BOUNDARY
▭	EXTRACTION (PIT) PHASE BOUNDARIES
▭	LEGAL BOUNDARIES
■	OVERBURDEN / SOIL STORAGE
▭	ACCESS ROAD
◪	ACTIVE MINING AREA
■	PREVIOUS MINING AREA
◪	RECLAIMED AREA
▭	RECLAIMED CATCHMENT AREA

0 50 100 200 300 m

SCALE 1:6,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

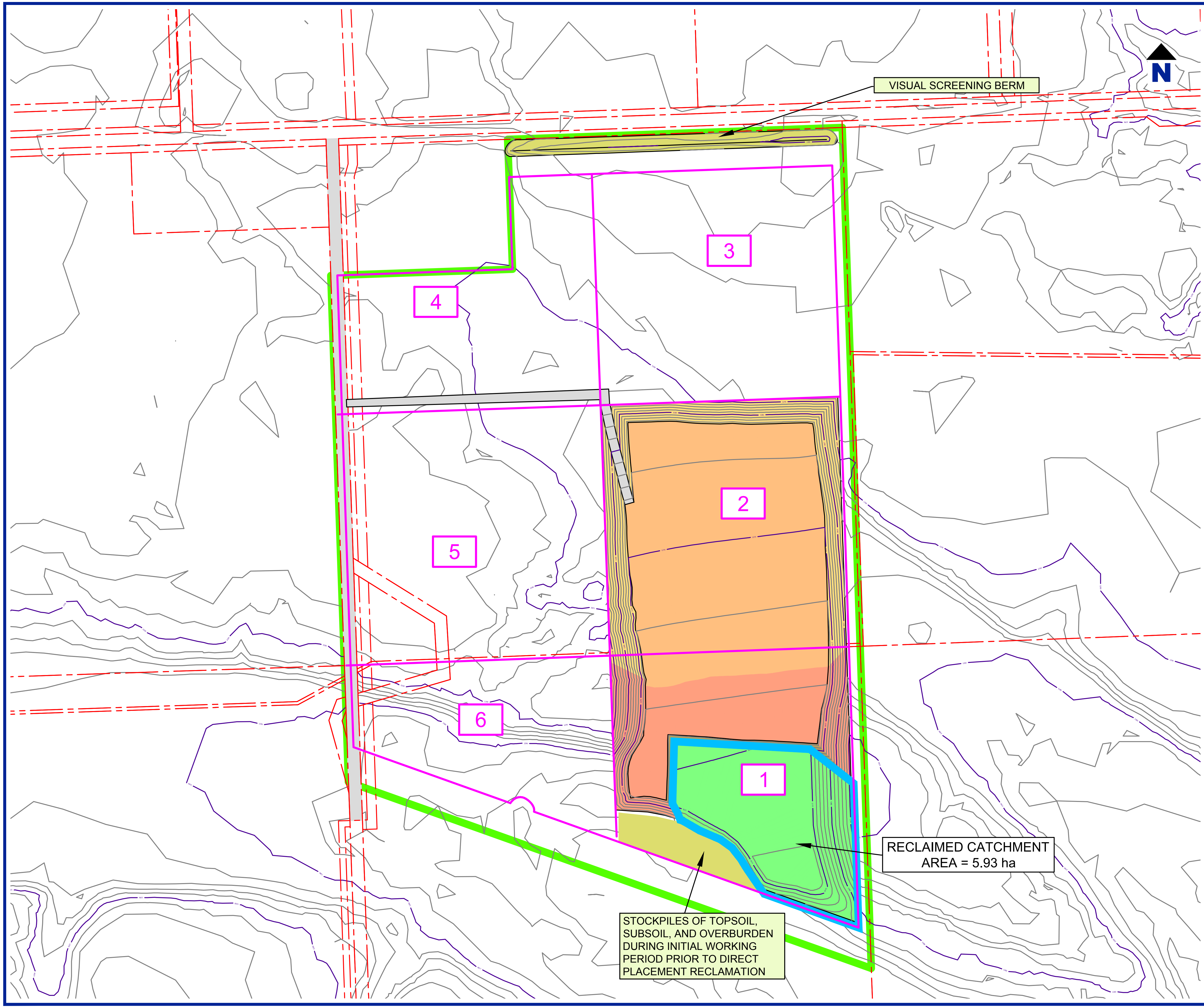
SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 1A

Date: May 10, 2023
Project No. 212.06650.00007

Figure No.
7

SLR



VISUAL SCREENING BERM

RECLAIMED CATCHMENT
AREA = 5.93 ha

STOCKPILES OF TOPSOIL,
SUBSOIL, AND OVERBURDEN
DURING INITIAL WORKING
PERIOD PRIOR TO DIRECT
PLACEMENT RECLAMATION

NOTES:

DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, BING IMAGERY, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
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EACH MINING BLOCK WILL BE NO GREATER THAN 150m X 150m (22,500m³).

LEGEND:

- 🟩 PROJECT BOUNDARY
- ▭ EXTRACTION (PIT) PHASE BOUNDARIES
- ▭ LEGAL BOUNDARIES
- 🟨 OVERBURDEN / SOIL STORAGE
- ▭ ACCESS ROAD
- 🟧 ACTIVE MINING AREA
- 🟥 PREVIOUS MINING AREA
- 🟩 RECLAIMED AREA
- 🟦 RECLAIMED CATCHMENT AREA

0 50 100 200 300 m

SCALE 1:6,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

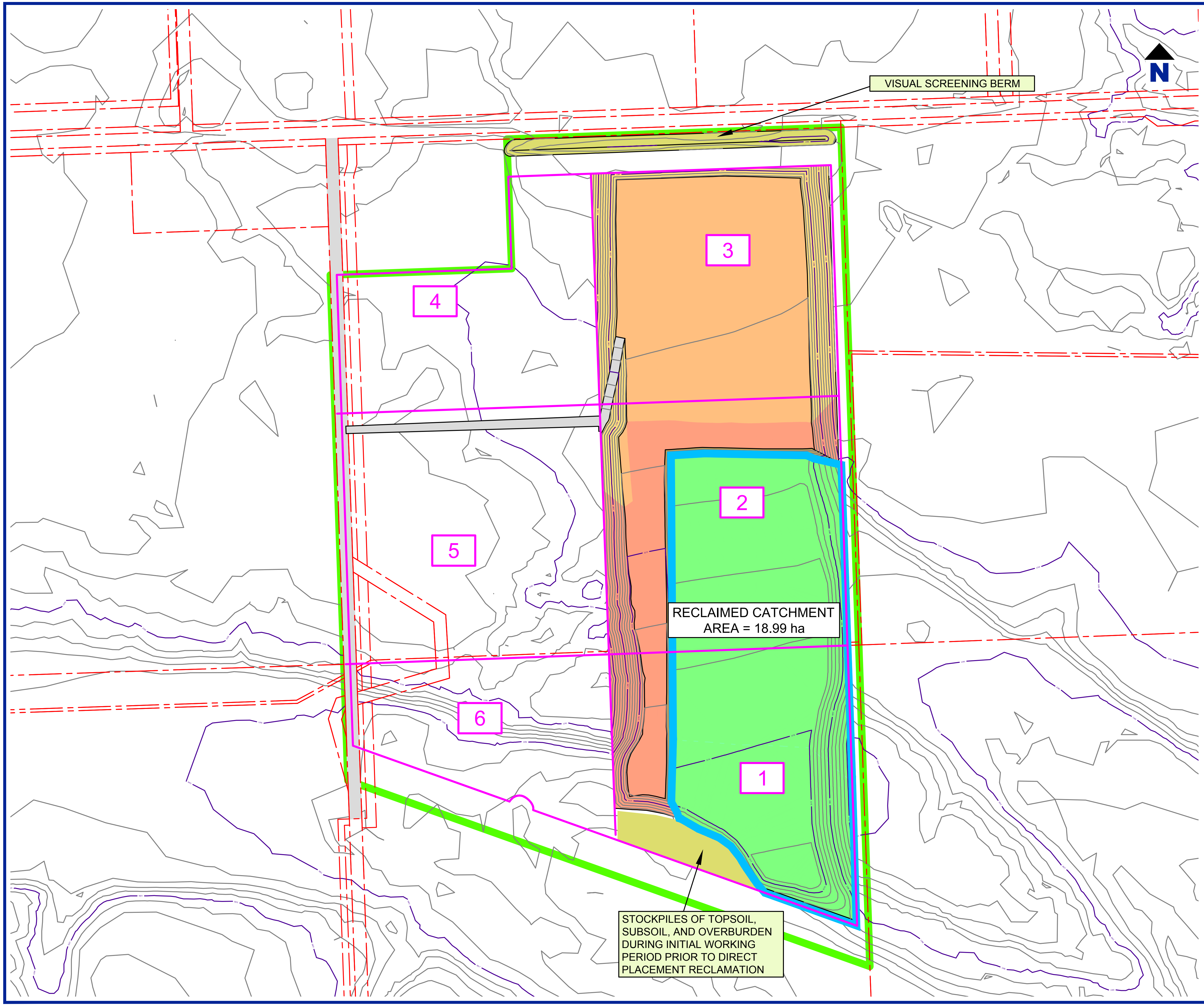
SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 1B

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 8

SLR

Cadfile name: 212-06650-00007 EM01_PHASE 2 - COP 09052023.dwg



NOTES:

DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, BING IMAGERY, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

THIS PLAN SHOWS THE GENERAL ORDER OF WORKING, WITH MINING BLOCKS PROGRESSING IN AN ANTICLOCKWISE DIRECTION FROM THE SOUTH EAST.

EACH MINING BLOCK WILL BE NO GREATER THAN 150m X 150m (22,500m³).

LEGEND:

🟩	PROJECT BOUNDARY
▭	EXTRACTION (PIT) PHASE BOUNDARIES
┄	LEGAL BOUNDARIES
🟨	OVERBURDEN / SOIL STORAGE
⬜	ACCESS ROAD
🟧	ACTIVE MINING AREA
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0 50 100 200 300 m

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SUMMIT PROJECT

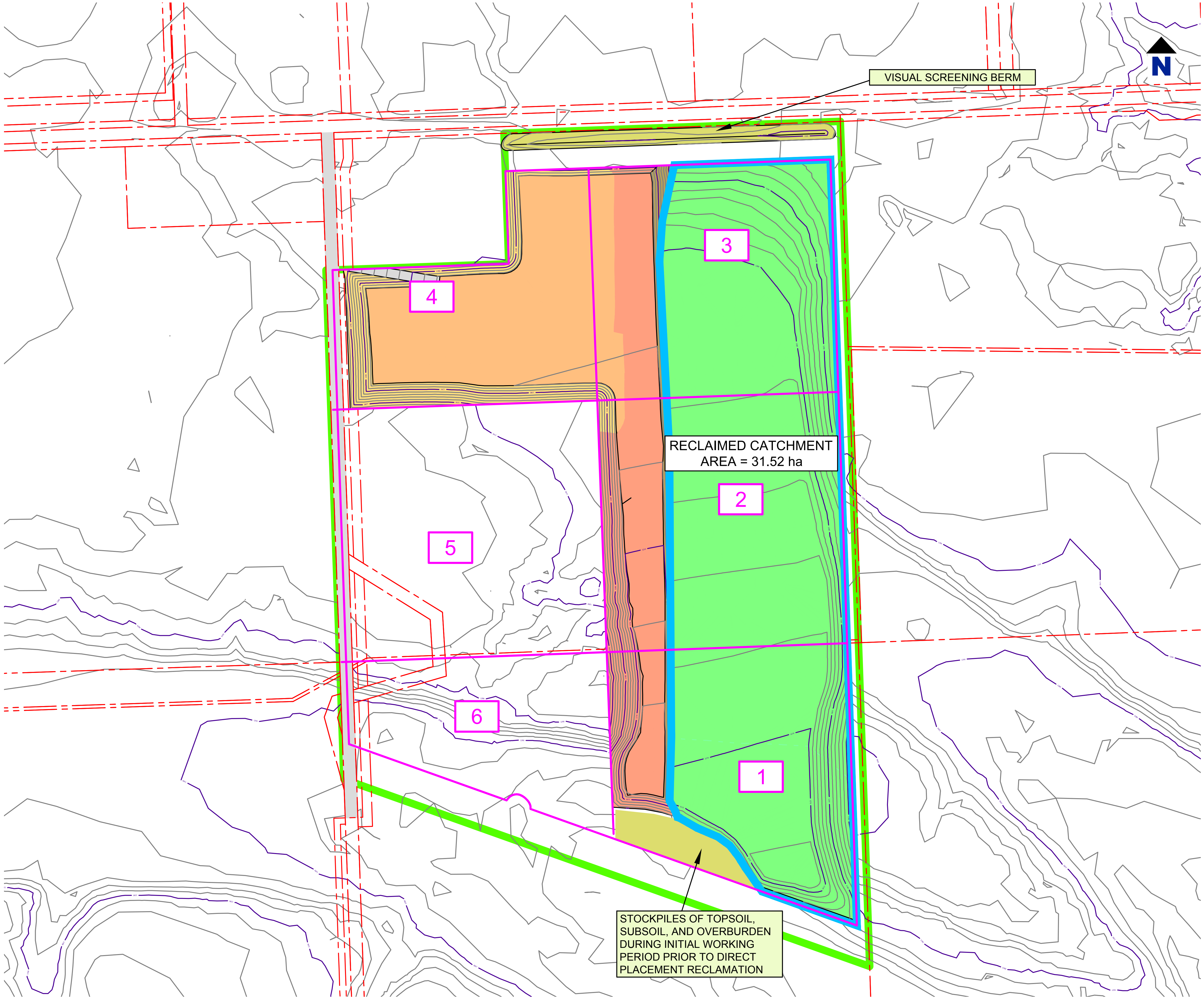
SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 2

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 9

SLR

Cadfile name: 212-06650-000007 EM01_PHASE 3 - COP 09052023.dwg



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SUMMIT PROJECT

SUPPLEMENTAL INFORMATION REQUESTS C8

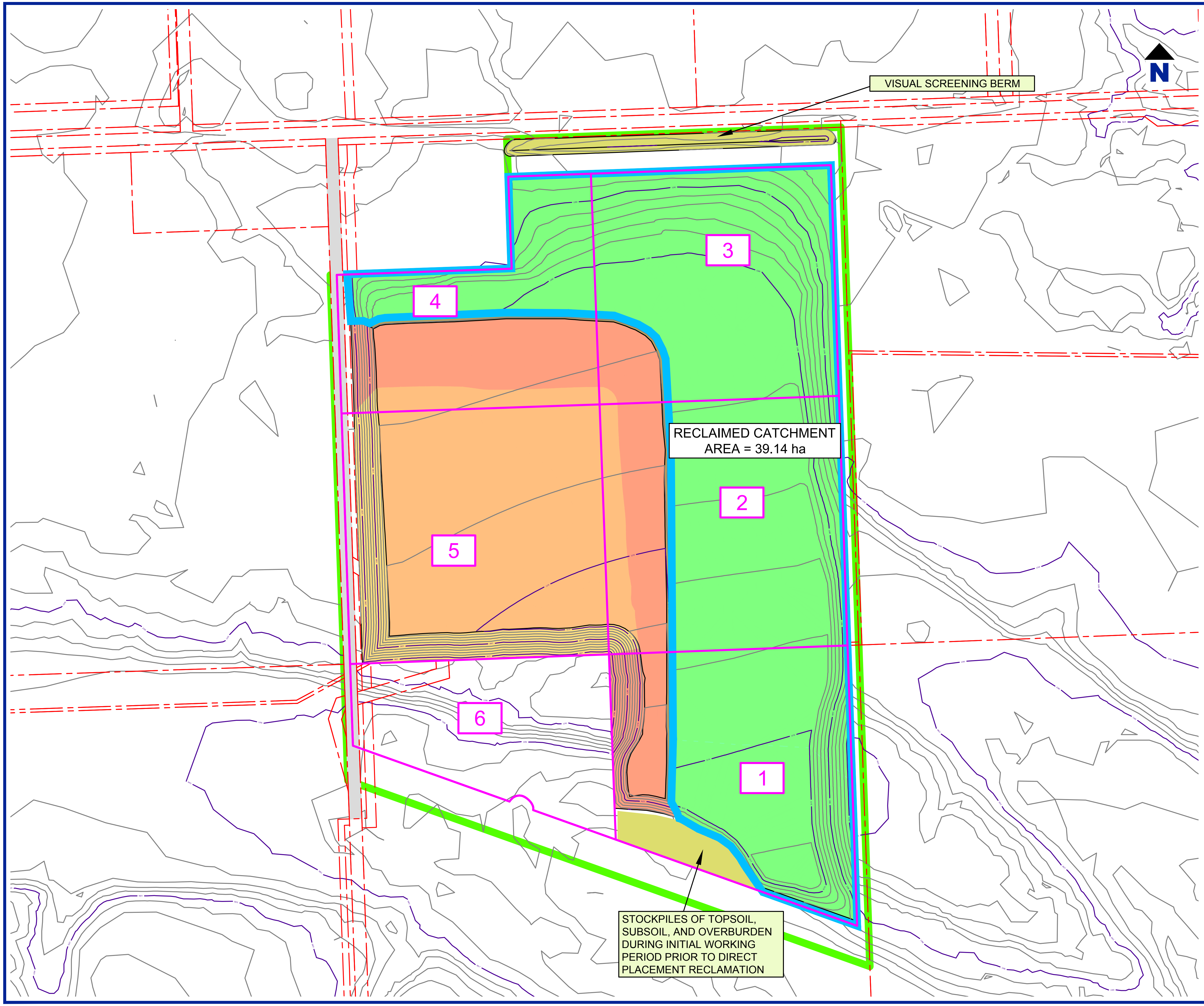
OVERALL WORKING PROGRESSION
EXTRACTION PHASE 3

Date: May 10, 2023
Project No. 212.06650.00007

Figure No.
10

SLR

Cadfile name: 212-06650-00007 EM01_PHASE 4 - COP 09052023.dwg



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NOTES:

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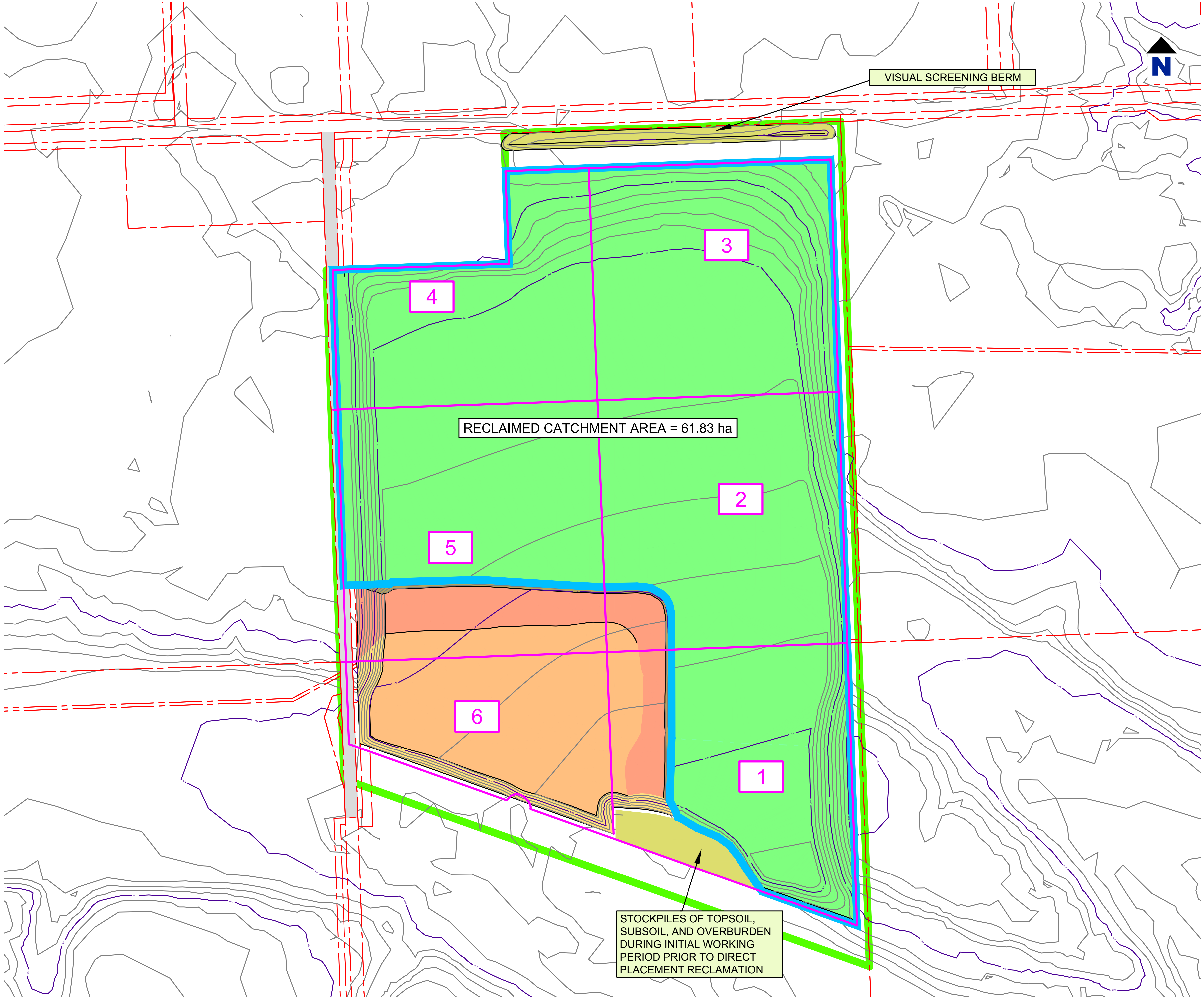
SUMMIT PROJECT

SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 4

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 11

SLR



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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

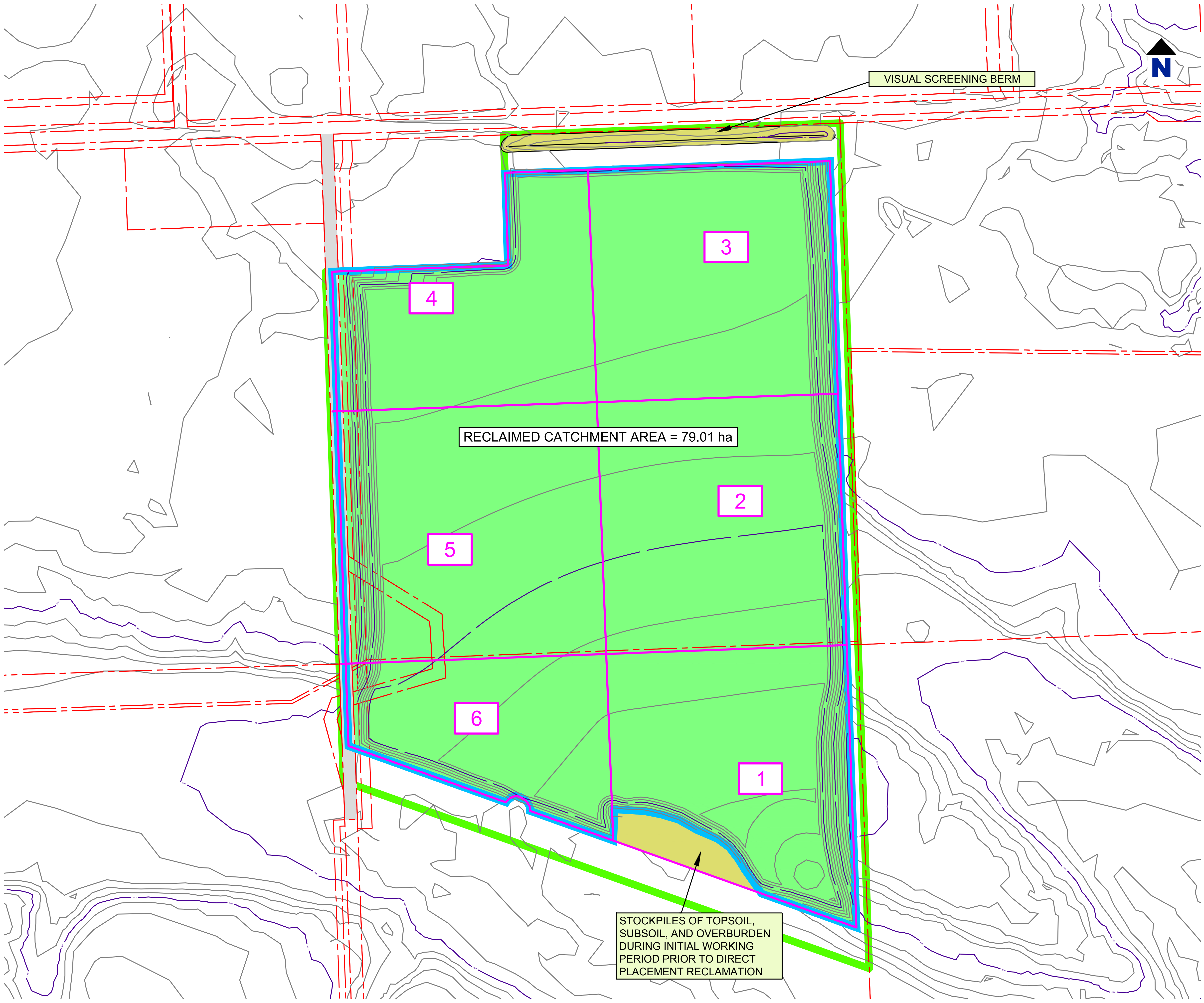
SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 5

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 12

SLR

Cadfile name: 212-06650-00007 EM01_PHASE 6 - COP 09052023.dwg



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▭	LEGAL LINES
▨	OVERBURDEN / SOIL STORAGE
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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PROJECT

SUPPLEMENTAL INFORMATION REQUESTS C8

OVERALL WORKING PROGRESSION
EXTRACTION PHASE 6

Date: May 10, 2023
Project No. 212.06650.00007
Figure No. 13

SLR

Cadfile name: 212-06650-00007 EM01_PHASE 7 - COP 09052023.dwg

Appendix G

Gravel Estimations

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Gravel Estimation

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006

August 2021

global **environmental** and **advisory** solutions

SLR

Gravel Estimation

Mountain Ash Limited Partnership
Rocky View County, Alberta
SLR Project No: 212.06650.00006

Prepared by:
SLR Consulting (Canada) Ltd.
200 – 708 11th Ave SW
Calgary, Alberta, T2R 0ER

for

Mountain Ash Ltd. Partnership
35181 Big Hill Springs Road
Rocky View County, AB T4C 3A2

August 2021

This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

Prepared by:		Reviewed by:
JORDAN COOPER ID: 259114 2021-08-11	ID 189347 ROBERT TILL 10 August 2021	
Jordan Cooper	**Robert Till**	**Jason J. Cox**
Mining Engineer	Senior Hydrogeologist	Technical Director – Canada Mining Advisory

PERMIT TO PRACTICE
SLR CONSULTING (CANADA) LTD.
RM SIGNATURE:
RM APEGA ID #: 189347
DATE: 10 August 2021
PERMIT NUMBER: P005449
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Distribution: 1 copy (PDF) – Mountain Ash Limited Partnership
1 copy - SLR Consulting (Canada) Ltd.

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TABLES

FIGURES

1.0 INTRODUCTION

SLR Consulting (Canada) Ltd. (SLR) is pleased to provide this summary letter to Mountain Ash Limited Partnership (Mountain Ash) for an aggregate and overburden volume estimate for the proposed Summit Pit aggregate resource located at West ½, Section 31, TWP 26, RGE 3 W5M near Cochrane, Alberta (AB), herein after referred to as the "site".

2.0 SCOPE OF WORK

As requested by the client the scope of work involved the volume estimation of material between the surfaces as outlined below:

- The volume of overburden between the ground surface and the top of sand and gravel;
- The volume of aggregate between the top of sand and gravel and a surface 1 metre (m) above the highest established groundwater table over the site; and
- The remaining volume of aggregate between the surface 1 m above highest established groundwater table and top of bedrock over the site.

These volumes are estimated based on the constraints of the mine plan including appropriate setbacks and incorporate volumes estimated for side slope scenarios of 1V:0.15H, 1V:0.25H and 1V:0.5H. The geological surfaces are based on the boreholes enclosed as Appendix A.

3.0 METHODOLOGY

3.1 Modelling

Six pit designs were produced using two surface boundaries and three slope scenarios as noted in Section 2.0. To account for the volume of material to bedrock in either outline, the overall pit slope and ramp access needed to be included in the design. The ramp assumes a 20 m width and surface access off Range Road 40 to the northwest.

A DXF file of the property lines was shared by the client and used as constraints throughout the project.

Below is a list of the layers used:

- _1M_ABOVE_2019_ GW_TABLE_MINOR_CONTOURS – 1m above maximum recorded groundwater level created from available monitoring data, covering the MALP Property North and South areas.
- _1M_ABOVE_2019_GW_TABLE_MAJOR_CONTOURS – 1m above maximum recorded groundwater level created from available monitoring data, covering the MALP Property North and South, Wetland and Range Road 40 areas.
- _AREAS_NUGTER – area of extraction over MALP Property South area provided by client.
- _AREAS_RANGE_ROAD – area of extraction over Range Road 40 provided by client.
- _AREAS_WATERMAN – area of extraction over MALP Property North area provided by client.
- _AREAS_WETLAND – area of extraction over Wetland area provided by client.
- MA_LIDAR_CROPPED_DXF – Surface topography based on LiDAR provided by client.

- MA_BASE_MINERAL_DXF – base of sand and gravel based on site drilling data.
- MA_BASE_OVERBURDEN_DXF – base of overburden based on site drilling data.

Deswik Design and Solids Modelling software was used for this project. It's compatible with AutoCAD files and can carry out all required functions, including volume reporting, pit designs and 3D modelling.

The Figures below visually represent the steps taken to produce itemized volumes. Figure 1 displays surface boundaries with four working areas labelled accordingly. The areas shown in Figure 1 are the modelled representations of those indicated in the tables below. Figure 2 illustrates the results in cross-section. This example is focused on the northern border of each pit design. Figure 1, Figure 3 and Figure 4 include property boundaries with Figure 3 including the Wetlands and Range Road 40 areas (Larger Boundary) and Figure 4 showing only MALP Property North and South (Smaller Boundary). Figure 3 and Figure 4 are final pit designs displayed isometrically.

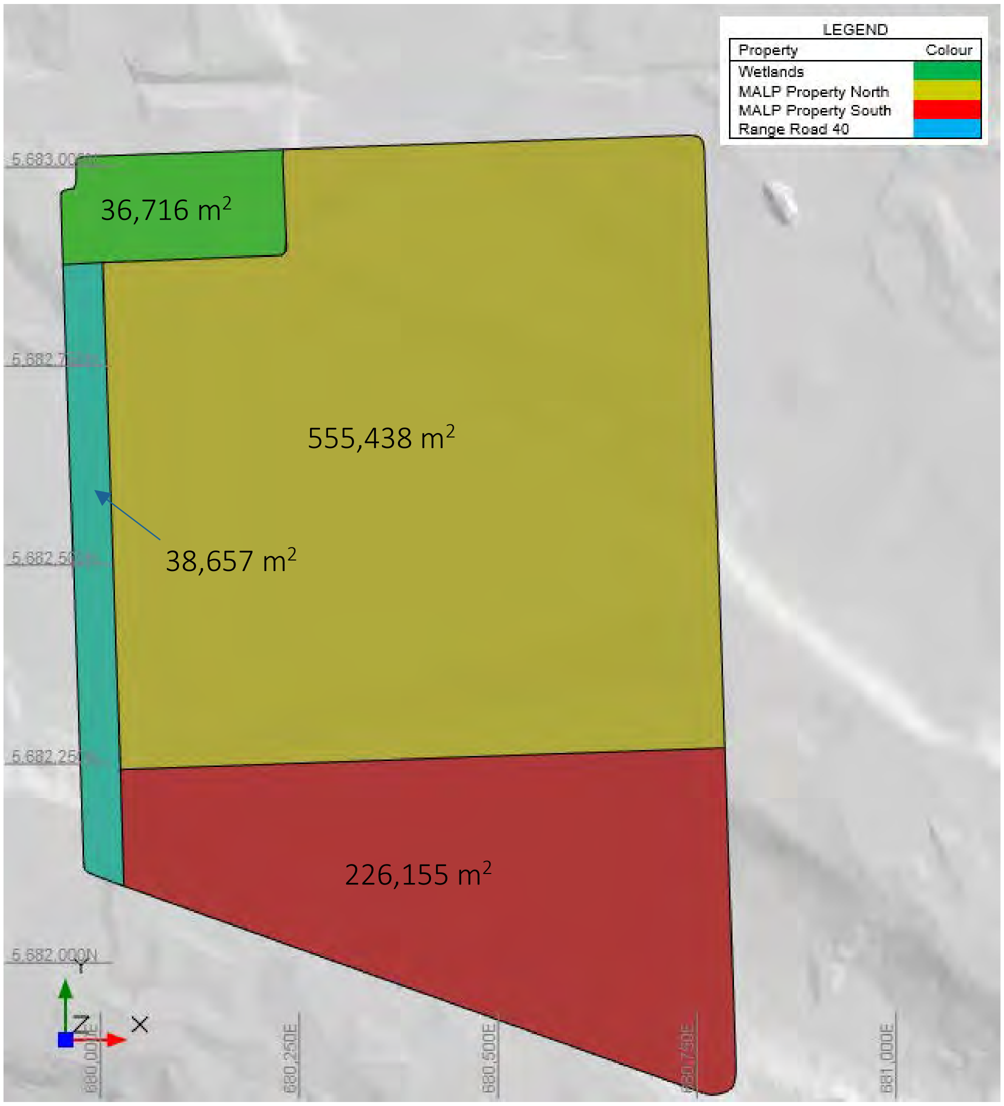

Figure 1 Area Boundaries

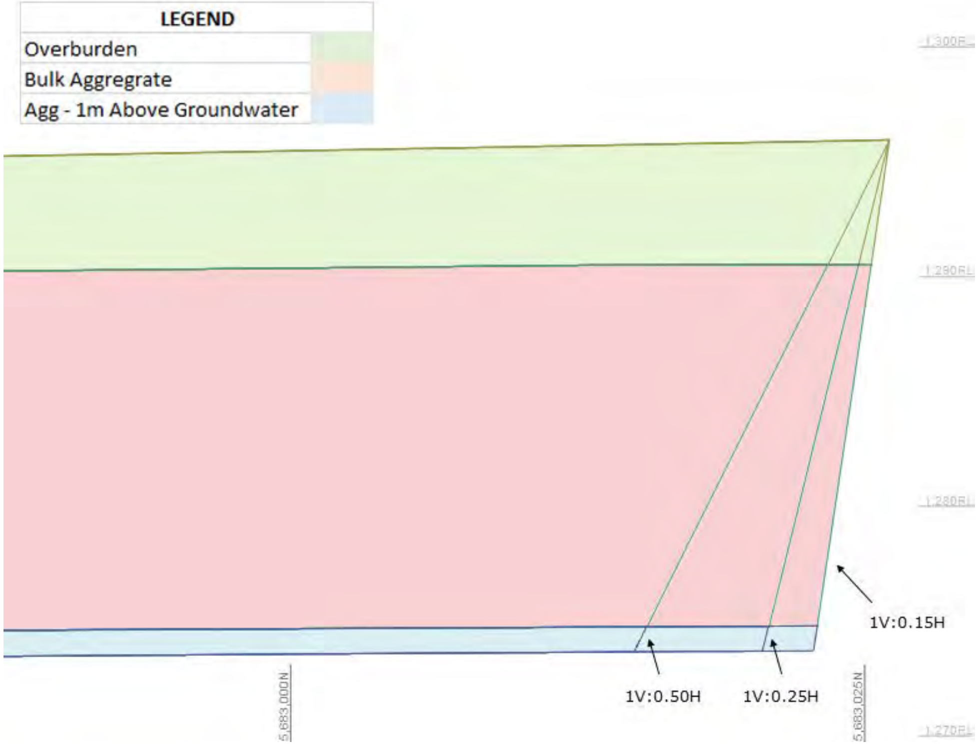

Figure 2 Cross-Section of MALP Property North Area

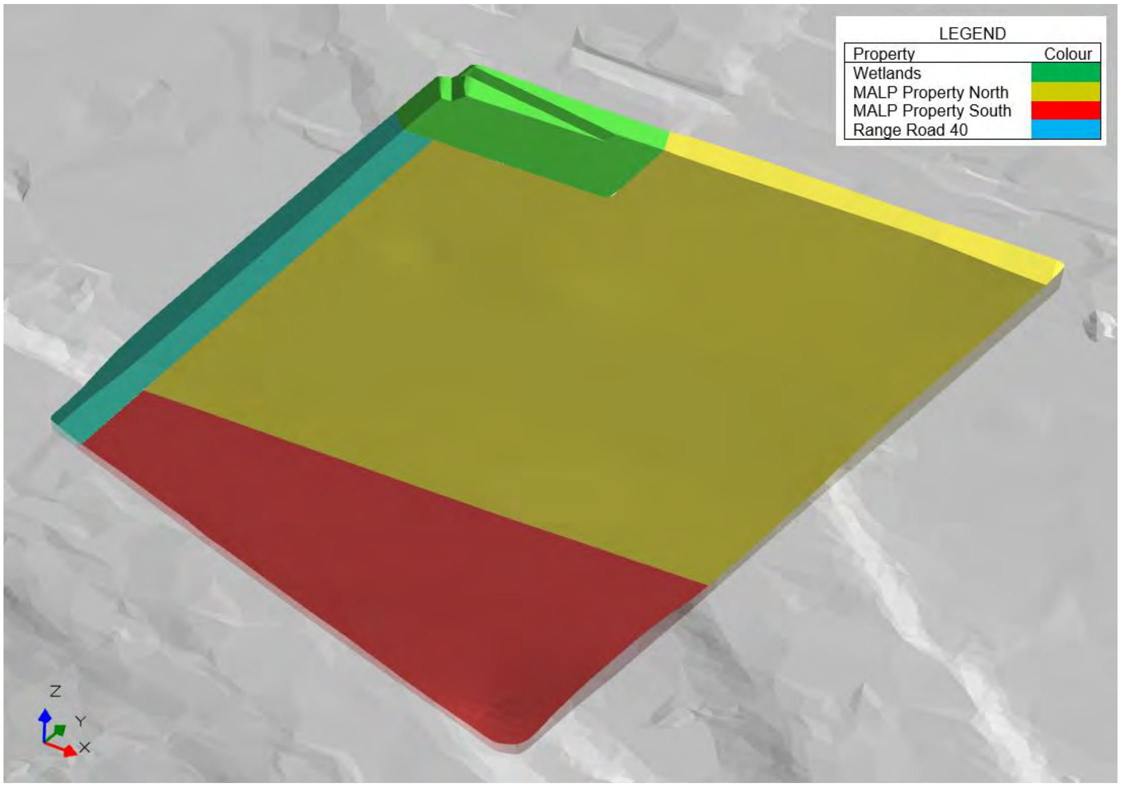

Figure 3 Isometric View of 1V:0.50H Larger Boundary

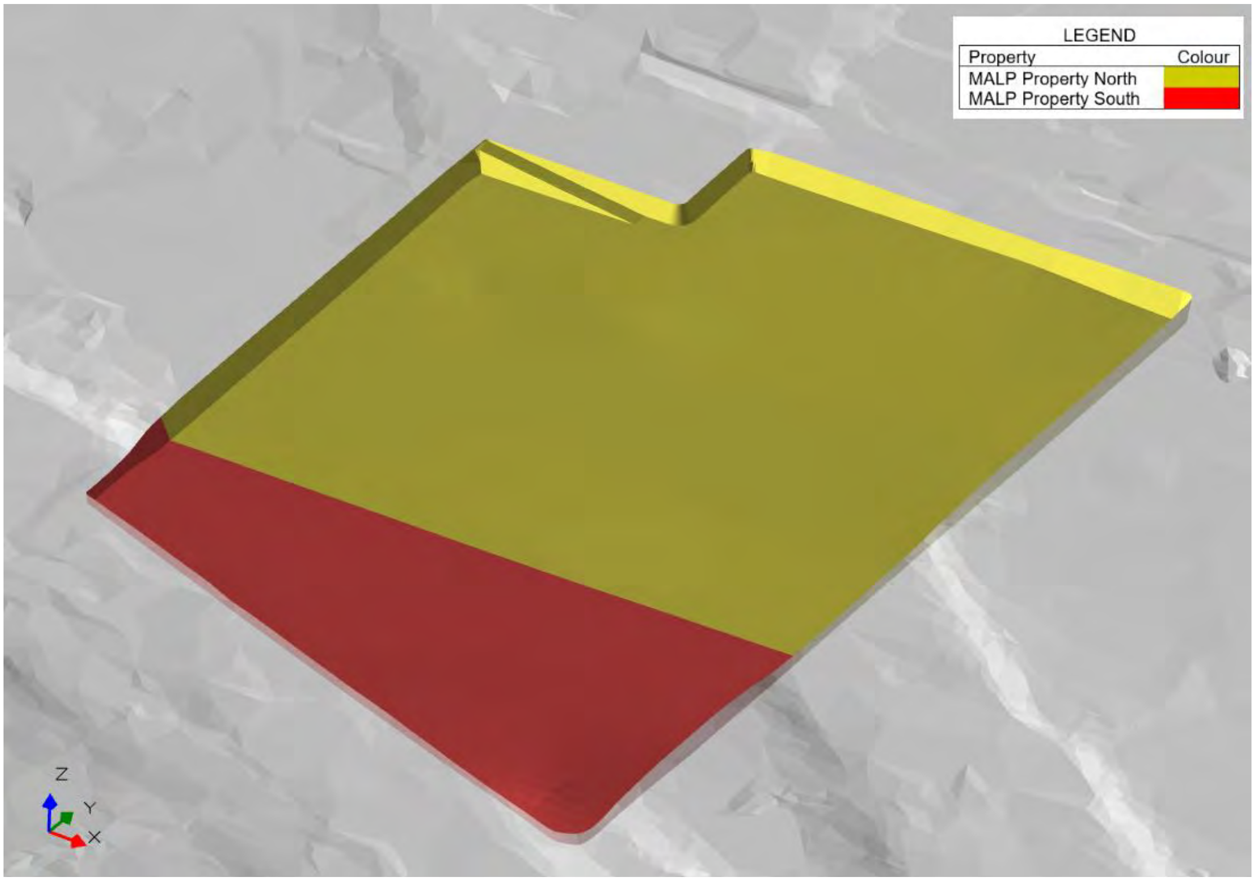

Figure 4 Isometric View of 1V:0.50H Smaller Boundary

Below are cross-section figures outlining the vertical difference in Large versus Small property calculations.

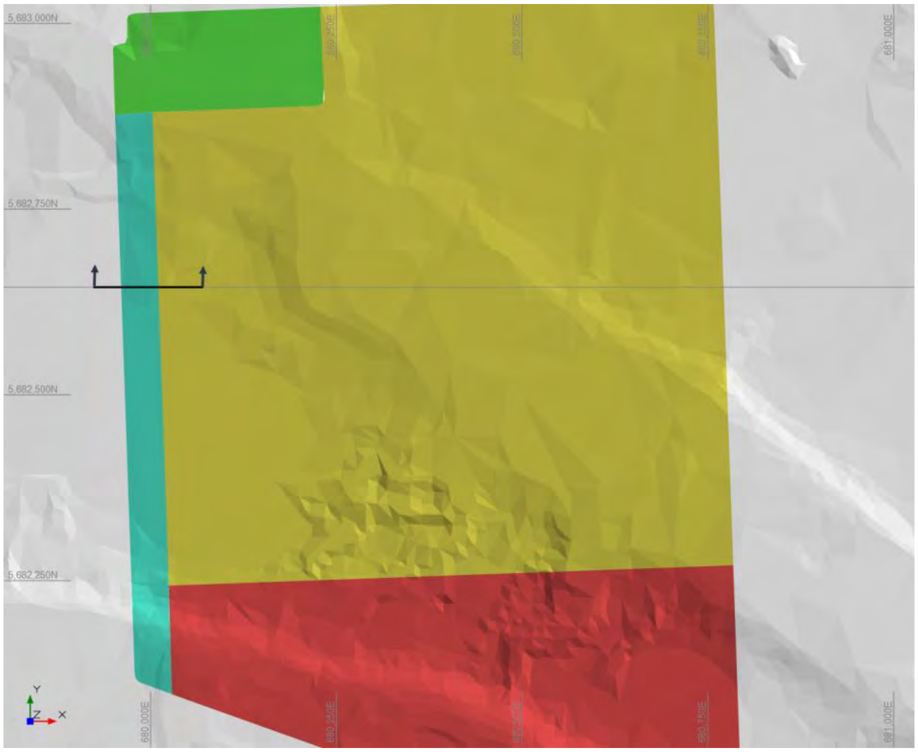

Figure 5 Plan-View of Range Road 40 and MALP Property North Cross-Section Location

The figure below (Figure 6) parses volume estimates out by colour. The grey shading represents only the Large boundary in this particular cross-section and falls within the Range Road 40 property lines, the yellow shading represents only the Large boundary and falls within the MALP Property North property lines and the unshaded (white) sections fall within both the Large and Small boundaries, with pit slopes showing the Small boundary limits within MALP North. Colours selected below are not correlated with colours selected in plan view to separate property lines.

The diagonal lines represent the area difference between the Lafarge property line and the steepest Range Road 40 slope.

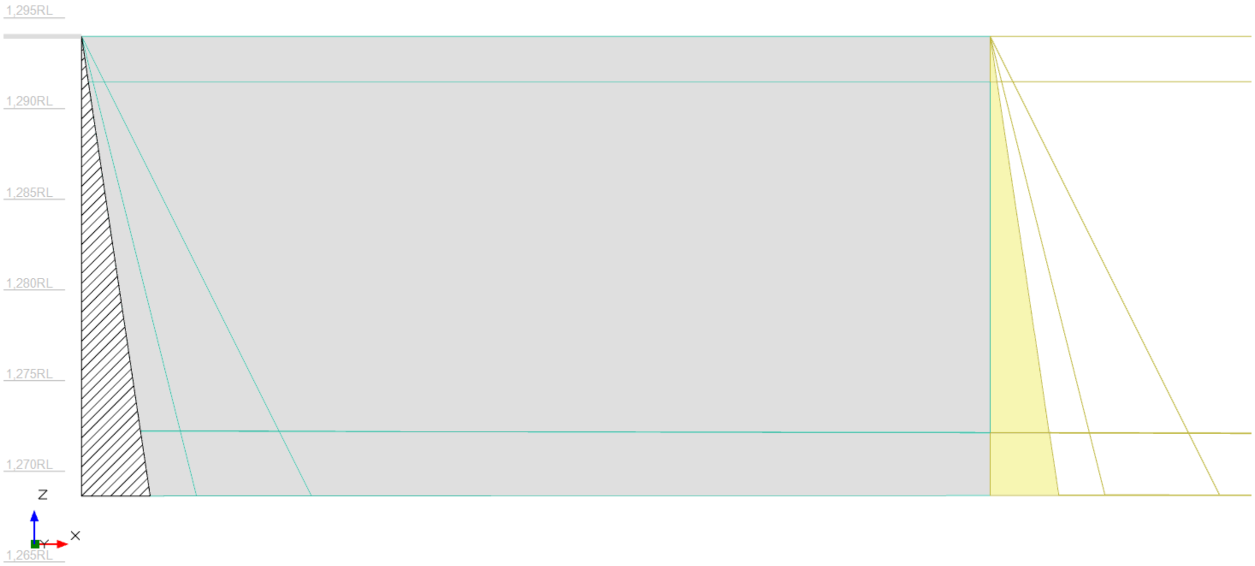

Figure 6 Cross-Section of Range and MALP Property North Showing All Slope Configurations

3.2 Volume Estimation

The volumes of material outlined in Section 1.0 were estimated within the constraints of the mine plan (e.g. side slopes and mine footprint) as provided by the client. The corresponding aggregate tonnage for each slope scenario was produced using a density of 1.85 tonnes per cubic metre (t/m^3) as requested by the client. The external boundaries were sloped in the model as per the indicated side slope scenarios. The boundary between each property was modelled as being vertical if not separated by pit slopes. Estimated volumes for the four areas and estimated tonnages for the corresponding areas are included in the Tables below. The larger boundary includes all areas (MALP Property North, MALP Property South, Wetland and Range Road 40) and the smaller boundary is limited to MALP Property North and MALP Property South. The volumes calculated are estimates based on the assumptions in Section 3, and actual quantities may vary.

The increase in volume per area from the Smaller Boundary to the Larger Boundary is due to the change in boundary design. The western Smaller Boundary perimeter would be sloped, while the internal boundary on the western side of MALP North and MALP South within the Larger Boundary area would be vertical. This is because it no longer represents the perimeter of the pit on the western side of MALP North and MALP South.

Table 1 Estimated Volume of Material within Pit Extraction Boundary

	LARGER BOUNDARY (POTENTIAL VOLUMES)				SMALLER BOUNDARY			
	MALP Property N	**MALP Property S**	**Wetland Area**	**Range Road 40**	**MALP Property N**	**MALP Property S**	**Wetland Area**	**Range Road 40**
Subsurface Area	**Side Slope Angle of 1V:0.15H**				**Side Slope Angle of 1V:0.15H**			
Estimated Volume of overburden ('000 m^3)	2,315	880	138	129	2,312	880	-	-
Estimated Volume of Aggregate between Top of Sand and Gravel and 1 m above Water Table ('000 m^3)	8,336	3,560	419	606	8,285	3,559	-	-
Estimated Volume of Remaining Aggregate between 1 m above Water Table and Top of Bedrock ('000 m^3)	1,237	348	152	119	1,212	347	-	-
Subsurface Area	**Side Slope Angle of 1V:0.25H**				**Side Slope Angle of 1V:0.25H**			
Estimated Volume of overburden ('000 m^3)	2,313	879	138	128	2,309	878	-	-
Estimated Volume of Aggregate between Top of Sand and Gravel and 1 m above Water Table ('000 m^3)	8,312	3,546	414	590	8,243	3,543	-	-
Estimated Volume of Remaining Aggregate between 1 m above Water Table and Top of Bedrock ('000 m^3)	1,230	346	148	113	1,197	345	-	-
Subsurface Area	**Side Slope Angle of 1V:0.5H**				**Side Slope Angle of 1V:0.5H**			
Estimated Volume of overburden ('000 m^3)	2,307	876	137	127	2,302	875	-	-
Estimated Volume of Aggregate between Top of Sand and Gravel and 1 m above Water Table ('000 m^3)	8,249	3,510	402	553	8,136	3,503	-	-
Estimated Volume of Remaining Aggregate between 1 m above Water Table and Top of Bedrock ('000 m^3)	1,213	340	139	99	1,162	338	-	-

Table 2 Estimated Tonnage of Aggregate within Pit Extraction Boundary

	LARGER BOUNDARY (POTENTIAL TONNAGES)				SMALLER BOUNDARY			
	MALP Property N	MALP Property S	Wetland Area	Range Road 40	MALP Property N	MALP Property S	Wetland Area	Range Road 40
Subsurface Area	**Side Slope Angle of 1V:0.15H**				**Side Slope Angle of 1V:0.15H**			
Estimated Volume of overburden ('000 t)	4,283	1,628	256	238	4,277	1,627	-	-
Estimated Volume of Aggregate between Top of Sand and Gravel and 1 m above Water Table ('000 t)	15,421	6,586	775	1,120	15,328	6,585	-	-
Estimated Volume of Remaining Aggregate between 1 m above Water Table and Top of Bedrock ('000 t)	2,288	644	282	220	2,242	643	-	-
Subsurface Area	**Side Slope Angle of 1V:0.25H**				**Side Slope Angle of 1V:0.25H**			
Estimated Volume of overburden ('000 t)	4,279	1,625	255	237	4,272	1,625	-	-
Estimated Volume of Aggregate between Top of Sand and Gravel and 1 m above Water Table ('000 t)	15,377	6,560	766	1,092	15,250	6,555	-	-
Estimated Volume of Remaining Aggregate between 1 m above Water Table and Top of Bedrock ('000 t)	2,275	640	275	210	2,214	638	-	-
Subsurface Area	**Side Slope Angle of 1V:0.5H**				**Side Slope Angle of 1V:0.5H**			
Estimated Volume of overburden ('000 t)	4,269	1,620	254	235	4,258	1,619	-	-
Estimated Volume of Aggregate between Top of Sand and Gravel and 1 m above Water Table ('000 t)	15,261	6,493	745	1,024	15,052	6,480	-	-
Estimated Volume of Remaining Aggregate between 1 m above Water Table and Top of Bedrock ('000 t)	2,243	629	258	183	2,150	625	-	-

4.0 ASSUMPTIONS AND RECOMMENDATIONS

The volume estimates are based on the following assumptions:

- Surface depths provided on borehole logs and the survey data for the borehole locations are accurate as provided by the client and the third parties who were responsible for them. Where the monitoring wells or test holes have not been professionally surveyed, the surface elevations have been estimated from Lidar data covering the site.
- Where drilling or groundwater data was not available, the surface was extrapolated to cover the required area using professional judgement.
- The surface area of the mine and any slope angles were provided by the client based on their mine plan. SLR is not responsible for recommending slope angles for the estimate as they have not provided a geotechnical stability assessment which is outside the scope of works.
- The volume estimate is purely an estimate of the volume of material between the surfaces and within the planned mining area; it does not include any assessment of the quality or economic value of that material. The estimated tonnage is based on an assumed density of 1.85 t/m^3 as provided by the client.
- Volumes calculated are estimates only and the actual quantities of material in the ground may vary depending on physical measurement, model gridding and other potential errors. The volume estimate may change as further geological data becomes available or if the mine plan changes.
- A ramp width of 20 m and a turning radius of 15 m was assumed for all pit designs.
- The pit designs shared within this report reflect only overall slopes. It is not recommended to use these pits as dig limits; the design may have to incorporate catch-benches where necessary and follow geotechnical slope recommendations for SLR to provide pit designs with dig limits.

5.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR Consulting (Canada) Ltd. (SLR) for Mountain Ash Limited Partnership, hereafter referred to as the “Client”. It is intended for the sole and exclusive use of Mountain Ash Limited Partnership. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted unless payment for the work has been made in full and express written permission has been obtained from SLR.

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Opinions and recommendations contained in this report are based on conditions that existed at the time the services were performed and are intended only for the client, purposes, locations, time frames and project parameters as outlined in the Scope or Work and agreement between SLR and the Client. The data reported, findings, observations and conclusions expressed are limited by the Scope of Work. SLR is not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. SLR does not warrant the accuracy of information provided by third party sources.

Appendix H

Groundwater Monitoring Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Groundwater Monitoring Plan

Summit Pit Project

Mountain Ash Limited Partnership

1945 Briar Crescent NW
Calgary, AB T2N 3V6

Prepared by:

SLR Consulting (Canada) Ltd.

200, 708 – 11th Avenue SW
Calgary, AB T2R 0E4

SLR Project No:

212.06650.00007

May 11, 2023

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Appendices

1.0 Introduction

Mountain Ash Limited Partnership (MALP) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will encompass approximately 208 acres (84 ha) excluding existing road rights-of-way. This land is currently owned by 1410266 Alberta Ltd. (a general partner of MALP). The Project received land use and a master site development plan (MSDP) approval on March 2, 2021 (Land Use Bylaw C-8051-2020).

A hydrogeological assessment was undertaken as part of the MSDP application to assess the potential for groundwater impacts from Project operations in relation to nearby groundwater users. The assessment concluded that Project activities are not expected to effect adjacent groundwater well users because aggregate extraction occurs above the water table, and the nearest off-site residential wells are located more than 490 metres (m) away from the closest point of Project operations. As a requirement for the Code of Practice (COP) for Pits and Development Permit (DP) applications, and in response to supplementary information requests (SIRs) from Alberta Environment and Protected Areas (AEPA) dated August and December 2022, and April 2023, this report details the revised and updated Groundwater Monitoring Plan (GWMP) in relation to the operation of the Project. The objective of this GWMP is to monitor potential effects of Project operations on groundwater resources in the vicinity of the site, and to mitigate adverse effects wherever possible. This is also consistent with a condition required as part of the land re-designation and MSDP. Ongoing monitoring and assessment of groundwater levels and quality will be determined for effective monitoring of the lack of effect of operations on groundwater, and to plan and manage mitigation should un-anticipated impact occur.

Several residential water wells and groundwater springs exist near the proposed Project area. The Hydrogeological Assessment (SLR 2020c) concluded these receptors are not expected to be adversely affected by Project activities. This GWMP provides a description of:

- Local geology and hydrogeology
- Potential historical and future sources of contamination
- The proposed groundwater monitoring program including monitoring locations and parameters
- Groundwater response plan

2.0 Site Description

2.1 Land Uses

The site is currently being used for agricultural purposes, previously referred to as Ranch/Farm. There are two large wetlands in the northwest corner which have been classified as Temporary Graminoid Marshes (M-G-II) and a number of other, smaller water bodies which are mainly ephemeral water bodies that have been farmed through. A detailed description of water bodies, including wetlands, on site is provided in the Wetland Assessment and Impact Report (SLR 2022). The site location and surrounding land use is shown on Figure 1.

2.2 Proposed Site Activities

The property will be operated in six phases of similar size excluding Phase 4 and Phase 6 which are smaller than Phases 1 to 3 and Phase 5, with operations commencing initially in the southwest parcel. Phase 1 comprises about 14.4 ha (35.5 acres) and is expected to take 5 to 7 years to deplete, depending on market demand. Each of the subsequent phases is anticipated to take approximately 5 to 7 years to deplete, depending on market demand. The proposed phasing is shown on Figure 2.

Based on drilling investigations at the site, there is 3 m to 6 m of glacial till overburden overlying approximately 20 m of sand and gravel, on average (Appendix A). The till and organic topsoil will be stripped and stockpiled for future use during post-development restoration. It is anticipated that stripping will commence in the southwest corner of Phase 1 and move eastwards. Sand and gravel are the target deposit for extraction/processing and lies immediately above the underlying bedrock. Groundwater in assessment boreholes was noted at between 20 m and 24 m below ground surface (m bgs) and above the bedrock in most wells. the site will be excavated to a depth, not exceeding 1.0 m above the highest recorded groundwater level, within the targeted gravel deposit, and will therefore be a dry excavation. Dry excavations do not require operational or permanent dewatering. Actual depths will be determined with progressive investigation of water levels as the aggregate resource is developed (see Section 7.1.1).

2.3 Potential Sources of Groundwater Contamination

An assessment of potential sources for contamination was undertaken by SLR. Potential sources, which could affect groundwater at the site, are identified and described below, and are shown on Figure 2.

2.3.1 Historical

A search of historical records for potential sources of contamination using the Alberta Environment and Parks (AEP) Environmental Site Assessment Repository (ESAR) indicated that no investigations on the public record had been carried out within the boundaries of the site. This is common for rural settings.

A review of historical air photos from Google Earth dating back as far as May 2002 indicates that the site was undeveloped and consisted of rough grazing land as is the current situation. No evidence of previous contaminating land uses was found.

2.3.2 Current and Future

The following current and future operations at and adjacent to the site have been identified from a review of air photos, site visits, recent development applications and the MSDP which have the potential to impact soil and groundwater quality onsite:

- Oil and gas infrastructure is currently located in close proximity to the site and is likely the biggest contamination risk to groundwater in the area. This infrastructure includes several operational oil wells with associated pump jacks located along Highway 567 north of the site, and a pipeline which runs north/south along the western boundary of the site.
- Septic systems are present at the three residences on site and could be a potential hazard to groundwater quality if not functioning correctly.
- Volker Stevin Highways Maintenance Facility (10 acre) is located adjacent to SW31-26-3-W5M, to the west.

- Diesel fuel, equipment refueling, equipment and lubricants will be stored on-site adjacent to the scale building. Fuels and lubricants will be stored in accordance with current regulations and, as per the recommendations in the Hydrogeological Assessment (SLR 2020c), be located in an area where thick clay overburden is still present. The location of the proposed storage, refueling and maintenance area is shown on Figure 2.

There are no significant quantities of chemicals stored or used at the site. Future operations will ship incidental hazardous and non-hazardous wastes off site for disposal at an approved waste facility. This is common with other rural land uses.

3.0 Geology

The geology and hydrogeology in the vicinity of the site has been compiled from site specific drilling data, available published documents, and the AEP water well database. Figure 3 shows the line of a vertical cross-section (Figure 4) that runs northwest to southeast along the direction of groundwater flow towards the springs (A-A’). It has been prepared to illustrate the relationship between the various geological units at the site and is referred to in the following subsections.

3.1 Surficial Geology

Surficial geology in the vicinity of the Project has been determined from published geology maps (Shetsen 1987). Two primary layers are found, as can be seen in the cross-section in Figure 4. The upper strata are predominantly comprised of Pleistocene-age moraine draped over underlying sand and gravel. This moraine consists of an unsorted mixture of clay, silt, sand, and gravel with local water-sorted material; this is called a glacial till. The till in the vicinity of the site, is of a relatively consistent thickness with a flat to undulating topography. The till topography reflects the topography of underlying deposits, which in turn reflect the shape of the bedrock surface below. Underlying the draped moraine at the site is sand and gravel of glaciofluvial origin, which formed on the slopes and base of meltwater channels draining melting ice sheets (Shetsen 1981).

Borehole logs for 31 test holes from the site indicate that surficial deposits over the majority of the site include approximately 3 m to 6 m of silty, sandy or gravelly clay till and approximately 0.5 m of organic topsoil (this overburden and topsoil will have to be removed to expose the underlying aggregate deposit). Beneath the clay till is the sand and gravel deposit of interest, which is generally a well graded mixture of sand and gravel containing occasional beds of pure sand or pure gravel up to 2 m thick. The sand and gravel unit varies in thickness, with an average thickness of approximately 20 m.

3.2 Bedrock Geology

Consolidated bedrock underlies the unconsolidated sand and gravel layer as indicated on Figure 4. The bedrock represents the basement to site operations where the sand and gravel is not saturated. Structurally, the site is located several kilometres (km) east of the furthest extent of the main Cordilleran Deformation. As such, the bedrock is relatively flat lying with little folding or faulting compared to older bedrock further west in the Disturbed Belt. The bedrock beneath the sand and gravel at the site consists of Tertiary, Paleocene age (55 to 65 million years old) sedimentary rocks of the Upper Paskapoo Formation. The Paskapoo Formation comprises grey to greenish grey, thickly bedded, calcareous sandstone interbedded with siltstone or mudstone and minor conglomerate or thin limestone beds (Alberta Geological Survey 1999). Drilling at this site has found grey sandstones and siltstones directly underlying the sand and gravel. The bedrock was derived from sediments eroded from the Rocky

Mountains during a period of uplift and erosion and carried east by river systems which drained melting ice from the mountains west of the site. The sandstones within the Paskapoo are a complex series of stacked river channel deposits separated by floodplain siltstone and mudstone deposits (Hamblin 2004).

Outcrops of the Paskapoo Formation sandstone can be seen in the steep slopes at the Big Hill Springs Provincial Park southeast of the site. A number of domestic well records from the immediate vicinity identify sandstone and shale[1] beneath and surrounding the site.

4.0 Hydrogeology

The hydrogeological regime at the application site and the surrounding area is described in the following sub sections:

- Aquifer properties
- Groundwater levels and flow
- Baseline water quality assessment
- Regional and local water users

The hydrogeological data is drawn from the Hydrogeological Assessment (SLR 2020c). This data has been used to develop a conceptual site model that has in turn been used to develop the monitoring system installed to assess potential impacts associated with the proposed development.

4.1 Aquifer Properties

A number of different geological units with different hydraulic properties are present in the study area. The distinct units are discussed here progressively with depth from surface (and increasing geological age). The testing of two monitoring wells and two residential wells was undertaken and a summary of the work is provided below. Hydraulic conductivity testing methodology and analysis are provided in the Hydrogeological Assessment (SLR 2020c) and are not reproduced here.

4.1.1 Surficial Unconsolidated Deposits

Surficial deposits of unconsolidated soils consist of till overlying sand and gravel deposits as described in Section 3.1 above. Groundwater flows in the intergranular pores in these soils, and the rate of flow is proportional to the hydraulic conductivity of the soil. For example, the hydraulic conductivity is low where clay rich material infills these pores but is significantly higher where clean sand and gravel is present.

Since the upper glacial till that caps the site is not saturated, no groundwater monitoring wells were installed and therefore no field testing for hydraulic conductivity was undertaken. These soils are not typically aquifers, as their hydraulic conductivity is in the range of 10^{-8} to 10^{-7} m/s (Freeze and Cherry 1979), but they do act as a protective layer for underlying deposits.

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[1] It is common for drillers to use the term “shale” to describe mudstones and siltstones, as the differences are subtle, and they all share a common fine-grained appearance to the untrained eye.

As detailed in the Hydrogeological Assessment (SLR 2020c) a number of slug and pumping/recovery tests were undertaken on monitoring wells MW14-101 and MW14-103 which are screened in the sand and gravel. The testing determined hydraulic conductivities of approximately 1 x 10^{-4} m/s to 3 x 10^{-4} m/s. These values fall in a narrow range and are typical of sand and gravel aquifers.

4.1.2 Paskapoo Formation Bedrock

The Paskapoo Formation is the most significant aquifer formation in western Alberta and potentially the Prairie region, and although of regional importance as a whole, the isolated nature of the main sandstone units can provide variable success for residential wells. Only the sandstone facies of the Paskapoo Formation demonstrate any significant intergranular porosity; however, the pore spaces may be filled with calcareous cement in some areas. Bedding planes, joints and structural fractures contribute to a secondary permeability of the bedrock as well. Based on water well records in the area and the drilling at this site, much of the formation in this area is primarily comprised of fine-grained bedrock such as siltstone, mudstone and shale which demonstrate low intergranular porosity. Secondary fracture porosity is likely to be responsible for the yields obtained from residential wells in the vicinity of the site. Lower yields are recorded from wells completed within mudstone and siltstone than from the sandstone (Geological Survey of Canada, 2007; Ozaray and Barnes 1977). The majority of residential wells in the area are drilled into the Paskapoo Formation indicating that the aquifer is locally important for groundwater supplies.

A short-term pumping and recovery test was undertaken on WW2 as described in the Hydrogeological Assessment (SLR 2020c). The test results showed that the Paskapoo Formation sandstone and shale penetrated by WW2 has an approximate hydraulic conductivity of 2 x 10^{-7} m/s. The hydraulic conductivity value obtained reflects this fractured bedrock. When purging the wells, WW2 had drawdown of >7 m at a flow rate of approximately 12 Litres per minute (L/min) and WW4 had drawdown of just 0.09 m at a flow rate of approximately 39 L/min. The contrast between the performances of the two wells demonstrates the variability of the hydraulic properties of the bedrock in the Paskapoo Formation.

4.2 Groundwater Levels and Flow

A total of ten groundwater monitoring wells have been installed at various times in the sand and gravel at the site since 2014. The wells are variably screened from the bedrock up into the base of the sand and gravel.

The locations of these monitoring wells and their groundwater elevations (on July 3, 2019) are presented on Figure 5. The well construction details are found in Appendix A. The information from these wells have historically been supplemented with groundwater level information from residential wells WW2 and WW4 also presented in Figure 5.

The groundwater monitoring points completed at the site have been subject to periodic groundwater elevation monitoring between October 2014 and April 2023. Sand and gravel monitoring wells MW14-101 and MW14-103 and bedrock residential wells WW2 and WW4 have been equipped with dataloggers recording continuous groundwater levels on a daily basis since October 2014. Groundwater hydrographs of monitoring data to April 2023 are presented in Appendix B, a review of which shows:

- A downward vertical gradient between the sand and gravel deposits and the underlying Paskapoo Formation was demonstrated in SLR 2020c. Therefore, there is a component of downward vertical groundwater flow from the sand and gravel to the bedrock. The amount of downward groundwater flow is probably limited due to the relatively lower hydraulic conductivity of the underlying bedrock, inhibiting drainage to depth; however, the recharge is enough to locally sustain single wells drilled into the bedrock.
- Minimal short-term (daily/weekly) fluctuation in the groundwater levels within the sand and gravel (Appendices B1 and B2). This indicates negligible or no influence from pumping within residential wells in the area.
- Groundwater levels within the sand and gravel gradually fell over the initial years of monitoring between 2014 and 2019, with a drop of approximately 0.9 to 1.3 m during the period (Appendices B1 and B2). This is due to a series of dry years with <400 millimetres (mm) of precipitation each year, based on Environment and Climate Change Canada data for the meteorological station at Calgary International Airport. Even an above average precipitation year (2016) with 520 mm of precipitation did not increase water levels, likely due to a high soil moisture deficit absorbing much of the surplus. Levels rebounded somewhat (0.2 m) in the months between July and September 2019 due to the higher-than-average rainfall totals (526 mm) in the area in spring and summer 2019. This had followed an average precipitation year (424 mm) in 2020 which allowed soil moisture deficits to be reduced. The levels then gradually declined back to the pre-2019 recharge levels in March 2020 before again rising approximately 0.3 to 0.4 m in the 2020 spring recharge event (see Appendices B1 and B2). Groundwater levels continued to slowly rise through 2020 and into the spring of 2021 due to the high precipitation in 2020 (554 mm) before they started to decline again to the end of the monitoring record. Comparison of the groundwater elevations to rainfall therefore indicates that it takes a minimum of two consecutive years of above average precipitation to create a sustained rise of groundwater levels in the sand and gravel under natural conditions.
- A variable response to the pumping from normal use in residential bedrock wells, with the wells recovering within a few hours of extended pumping (Appendices B3 to B5). The degree of response between wells is indicative of the differing performance of the wells due to variability of the hydraulic conductivity within the Paskapoo Formation.

Using site groundwater observation data, Figure 5 shows the inferred potentiometric groundwater surface (drawn in blue) in the sand and gravel at site as recorded on 3 July 2019. Figure 5 shows that the horizontal flow direction in the sand and gravel is towards the south-southeast and the Big Hill Springs valley.

The potentiometric surface within the Paskapoo Formation cannot be drawn based on just two far apart data points (WW2 and WW4). Examination of historical water levels at other wells based on the water well records show that the elevation of the potentiometric surface is between about 1,266 and 1,268 metres above sea level (masl) in the area of the site, which is near the bedrock surface. If one assumes the bedrock potentiometric surface is near ground level at the Big Hill Springs, which is about 1,240 masl, then there is strong lateral gradient southeast towards the springs at which point groundwater is observed discharging to the surface.

4.2.1 Groundwater/Surface Water Interactions

Two large wetlands (Water bodies 19 and 20) located in the northwestern corner of the site have a surface elevation of approximately 1,290 masl and are perched on 6 m of low permeability fine grained till. The presence of freestanding water is temporary based on observations made at the site, with water being present for only a temporary period of about four weeks after snow melt. Monitoring well MW14-101 located close to one of the wetlands (Water body 20) has a groundwater elevation in the sand and gravel of approximately 1,274 masl, which is well below the base of the till (at about 1,284 masl). This demonstrates that the wetlands are not fed by groundwater from the sand and gravel. Thus, it is inferred that the wetlands are fed by rainfall and snowmelt from the local catchment and from the catchment across Highway 567 transported by the culvert located beneath the highway. These wetlands will be retained on the landscape.

Since groundwater from beneath this site flows southeasterly towards the Big Hill Springs, it represents an offsite interaction of groundwater with surface water in the area. Bedrock outcrops can be seen on the valley walls surrounding the stream and springs and thus it is inferred that the host valley is incised into the bedrock. Stream flow downstream of Big Hill Springs has been manually measured in several studies at the Provincial Park over the years, the results of which are presented in Table 1. The collected data indicates that this flow ranges from 40 litres per second (L/s) to 400 L/s, with an average flow in the vicinity of 70 to 100 L/s. Flows from October to February (fall/winter) are generally in the range of 50 to 100 L/s, while flows from March to September (spring/summer) are more variable. The variability in flow rates speaks to the seasonality of inputs to the discharge. There is lower stream flow in late summer and over winter when groundwater flow is the primary input. The highest and more variable flows are found during spring and summer when spring freshet and snowmelt periods occur, and during summer storms when high runoff occurs.

Table 1: Summary of Big Hill Spring Flow Data

Source	Measurement Point	Date	Number of Measurements	Lowest Flow (L/s)	Highest Flow (L/s)	Average Flow (L/s)
Ozaray and Barnes (1977)	Unknown	Unknown	Unknown	--	40.0*	--
Borneuf (1983)	Unknown	Unknown	Unknown	--	11.3**	--
Caron (2004)	Source	2003 - 2004	9	45.3	89.4	73.0
	Culvert downstream of Park	2003 - 2004	9	54.6	76.7	70.0
Poschmann (2007)	Source	2003 - 2006	20	50.0	240.0	100.0
Fouli (2018)	Main Spring	June 2017	1	--	184.0*	--
Fouli (2020)	Main Spring	July 2019	1	--	227.0*	--
Fennell (2021)	Unknown	Unknown	Unknown	100.0	400.0	--

*Where only one figure for the spring has been quoted in the published source it has been added in the Highest Flow column. Those results posted for Fouli (2018, 2020) are the highest flows measured in the reports, other results for the main springs were only presented in charts with no specific values attached.

**This figure is considered an outlier when compared with the other flows measured at the Project area and so is not included in the summary statistics.

4.3 Baseline Water Quality Assessment

Groundwater samples have been collected from the accessible residential wells in the Paskapoo Formation bedrock, the onsite sand and gravel monitoring wells and the furthest publicly accessible upstream discharge point at Big Hill Springs as part of the baseline water quality assessment. A detailed comparison of the water quality in the Hydrogeological Assessment (SLR 2020c) concluded that this is the same water type for the sand and gravel, the Paskapoo bedrock, and the discharge from Big Hill Springs. The groundwater and spring water chemistry supports the conclusion that groundwater within the saturated sand and gravel recharges the Paskapoo Formation bedrock and provides baseflow to Big Hill Springs. A summary of historical water quality is provided in Table 2 with details provided in appended Tables A1, A2 and A3. In general, more recent results reflect historically measured ranges, as would be expected, since operations have not yet begun.

4.3.1 Surficial Deposits

Table A1 (appended) indicates that groundwater in the sand and gravel deposit is of marginally poor quality for drinking. The Alberta Tier 1 Groundwater Remediation Guidelines (2023) set guidelines protective of all water users which have been applied for agricultural land use in coarse-grained soils.

Generally, natural groundwater has a moderately alkaline pH (7.2 to 8.2), low sodium (5 to 10 milligrams per litre {mg/L}), low chloride (7 to 29 mg/L) and high hardness (280 to 350 mg/L). A number of total metals exceeded Tier 1 guidelines. These included trace metals such as arsenic, barium, cadmium, chromium, lead, manganese, and mercury. In addition, microbiological parameters (total coliforms and E.Coli) were exceeded. Total metals exceeded guidelines likely due to high turbidity during sampling in the monitoring wells. Turbidity is an artifact of some sampling methodologies, like the one used for this Project. The method inadvertently stirs up sediment within the monitoring well during sampling. A comparison of dissolved (filtered) metals versus total metals was completed for the onsite sand and gravel groundwater samples collected on July 4, 2019, with concentrations of both presented in Table A1. Table A1 shows that in almost all cases where an exceedance of the total metal guideline concentration occurs, the dissolved concentration for the same sample is significantly reduced and falls below the relevant guideline. This is due to the total metal sample being preserved using acid, which dissolves sediments stirred up during sampling. This leads to higher metals concentrations than the filtered dissolved metal sample. The dissolved metal concentrations in groundwater are, therefore, more representative of natural conditions and indicate that groundwater is generally of good quality with low dissolved metals.

It is recommended that a program of well development occurs in the existing monitoring wells in an attempt to remove sediment remaining from drilling within the wells and reduce the turbidity sampling issues as much as possible.

4.3.2 Paskapoo Formation Bedrock

Table A2 (appended) indicates that groundwater in the Paskapoo Formation is of relatively good quality for drinking, with all parameters meeting the Canadian Drinking Water Quality (CDWQ) guidelines except a single exceedance of total coliforms in WW4 and a single turbidity exceedance in WW2. E.Coli was not detected in WW4 which indicates that the coliforms were not related to fecal contamination; however, they do indicate that the well could be vulnerable to bacterial contamination. pH values were moderately high (7.6 to 8.1) in all samples, indicating slightly more alkaline conditions within the bedrock as compared to the sand and gravel.

Table 2: Groundwater Quality Summary, Expressed as Historic Ranges

Parameter	Units	Groundwater					
		Guideline (Alberta Tier 1)[1]	Sand and Gravel[2]		Guideline (CDWQ)	Paskapoo Formation[3]	
			min	max		min	max
Aluminum	mg/L	0.05[4]	<0.0030	0.44	0.1 (OG)	0.0041	0.011
Antimony	mg/L	0.006	<0.00060	0.0013	0.006 (MAC)	<0.00050	0.00088
Arsenic	mg/L	0.005	<0.00020	0.00061	0.01 (MAC)	0.000121	0.00032
Barium	mg/L	2	0.22	0.48	1 (MAC)	0.11	0.41
Bicarbonate (as HCO3)	mg/L	NV	310	400	NV	340	391.6
Boron	mg/L	1	<0.020	0.032	5 (MAC)	<0.020	0.039
Cadmium	mg/L	0.00037[4]	<0.000020	0.000063	0.005 (MAC)	<0.000005	0.00004
Dissolved Calcium	mg/L	NV	61	79	NV	55	80
Chloride	mg/L	100	7.83	29	<250 (AO)	1.38	17
Chromium	mg/L	0.001	<0.0010	0.0013	0.05 (MAC)	<0.0010	0.0012
Copper	mg/L	0.007	<0.0002	0.0074	2 (MAC) / 1 (AO)	0.0016	0.125
Hardness	mg/L	NV	280	350	NV	-	-
Iron	mg/L	0.3	<0.060	1.2	<0.3 (AO)	<0.010	0.3
Lead	mg/L	0.005[4]	<0.00020	0.0023	0.005 (MAC)	<0.00020	0.011
Mercury	mg/L	0.000005	<0.0000019	0.0000048	0.001 (MAC)	<0.0000020	<0.00020
Dissolved Magnesium	mg/L	NV	30	37	NV	30	39.9
Manganese	mg/L	0.02	<0.0040	0.11	0.12 (MAC) / 0.02 (AO)	<0.0010	0.015
Molybdenum	mg/L	NV	0.00051	0.012	NV	0.00063	0.00222
Nickel	mg/L	0.12[4]	<0.00050	0.0035	NV	<0.00050	0.00174
Nitrate-N	mg/L	3	0.97	5.22	10 (MAC)	0.37	3.4
Nitrite-N	mg/L	0.1[4]	<0.010	0.098	1 (MAC)	<0.005	0.012
Dissolved Potassium	mg/L	NV	2.4	6.3	NV	2	3.3

Parameter	Units	Groundwater					
		Guideline (Alberta Tier 1)[1]	Sand and Gravel[2]		Guideline (CDWQ)	Paskapoo Formation[3]	
			min	max		min	max
pH		6.5 - 8.5	7.2	8.2	7.0 -10.5	7.6	8.1
Selenium	mg/L	0.002	0.00037	0.0022	0.05 (MAC)	0.00037	0.0018
Silver	mg/L	NV	<0.0001	<0.0001	NV	<0.00007	0.00012
Dissolved Sodium	mg/L	200	5.2	18	<200 (AO)	6.4	22
Sulphate	mg/L	500[4]	4.8	77	<500 (AO)	5.9	21
Thallium	mg/L	NV	<0.00020	<0.00020	NV	<0.00020	<0.00020
Total Dissolved Solids (calculated)	mg/L	500	280	380	<500 (AO)	300	349
Turbidity	NTU	NV	0.54	>4000	1 (OG)	0.2	1.23
Uranium	mg/L	0.01	0.0014	0.0027	0.02 (MAC)	0.00064	0.0021
Zinc	mg/L	0.03	<0.003	0.01	<5 (AO)	0.0046	0.99
Total Coliforms	MPN/100 mL	<1 (MAC)	<1	120000	<1 (MAC)	<1	11
E.Coli	MPN/100 mL	<1 (MAC)	<1	100	<1 (MAC)	<1	<1

Notes:

1. Table 2, Alberta Tier 1 Groundwater Remediation Guidelines (2023) applied for Agricultural land use in coarse grained soils
2. Metal concentrations are dissolved unless stated otherwise.
3. Metal concentrations are total unless stated otherwise.
4. Tier 1 guideline is the lowest of the aquatic life guideline and all other guidelines. Lead is based on the potable water pathway, as is sulphate in the absence of an assessment for the very high natural groundwater hardness. Cadmium and nickel guidelines are hardness dependent and nitrite as N guideline is chloride dependent for the aquatic life pathway. Guidelines quoted are based on the lowest chronic guideline applied for the range of hardness or chloride observed.

4.3.3 Big Hill Springs

Table A3 (appended) summarizes water quality results of water samples taken from the creek downstream from the springs (BHS1) at Big Hill Springs Provincial Park on October 30, 2014, August 4, 2015, July 10, 2019, December 15, 2022, and April 19, 2023, by SLR. Data collected by SLR for general water quality parameters was combined with a number of published sources to provide the baseline water quality summary included in Table 3 below.

Table 3: Historical Summary of Bighill Spring Water Quality

Parameter	Units	Number of Measurements	Lowest Value	Mean Value	Highest Value	Standard Deviation
Temp	C°	36	3	5	7.9	0.9
Electrical Conductivity (EC) (field)	uS/cm	19	260	365	580	78.0
Electrical Conductivity (EC) (lab)	uS/cm	26	403	536	610	56.6
pH	---	10	7.94	8.20	8.37	0.1
Dissolved Oxygen	mg/L	1	10.92	N/A	10.92	N/A
Turbidity	NTU	5	0.8	2	5.1	N/A
Calcium	mg/L	37	43	70	77.1	6.8
Magnesium	mg/L	37	18	34	39	4.2
Sodium	mg/L	37	5	7	13.4	1.3
Potassium	mg/L	37	1.9	3	6.7	0.8
Chloride	mg/L	36	1.8	7	16.8	3.2
Nitrate-N	mg/L	36	1	3	7.2	1.4
Sulphate	mg/L	37	4.7	9	13.5	1.8
Bicarbonate	mg/L	37	200	364	390	36.6
Total Dissolved Solids (TDS)	mg/L	36	190	457	526	95.6
Summary includes data from: Caron, 2004; Poschmann, 2007; Fouli, 2020; Koning, 2022 and this report.						

Groundwater emerging at Bighill Springs is generally cold (approximately 3 to 8°C), with an alkaline pH (>8), low sodium, low chloride, and saturated with respect to calcium (Turner and Jones, 2005). Of some interest, both calcium (Ca) and bicarbonate (HCO_3) have the highest concentrations in the spring water. Tufa is primarily composed of $CaCO_3$, which is consistent with these groundwater concentrations and the formation of tufa within the Provincial Park. It should be noted that data from July 10, 2019, showed uncharacteristically low bicarbonate, calcium, and TDS concentrations (200 mg/L, 43 mg/L and 190 mg/L respectively) and which, on first review, appears could be anomalously low. Further review reveals that two studies; SLR (2020) and Fouli (2020), sampled the springs on the same day (July 10, 2019), and while the concentrations were not identical, they were of the same order of magnitude. Flow measured on the sampling date by Fouli (2020) and listed in Table 1 indicates a high flow condition (227 L/s) on that day. This would indicate that a high proportion of the flow sampled may have been comprised of stormwater runoff (Environment Canada reported thundershowers in the area during previous days) which would have had a much lower dissolved mineral content and diluted the spring flow, thus lowering key parameter concentrations, therefore accounting for the uncharacteristically low values mentioned above.

Since this groundwater discharge is the source for a surface water stream, and the point of sampling is within that stream, it is compared to the Environmental Quality Guidelines (EQG) for Alberta Surface Waters (March 2018). The EQG has guidelines for 22 parameters of the sampling suite. The samples met 18 of the guidelines for these parameters indicating that water discharging from the spring is generally of good quality. It is noted that total coliforms and E.Coli concentrations exceed the CDWQ drinking water guidelines; however, there is no CWQG bacteria guideline for the protection of aquatic life.
High concentrations of E.Coli are consistent with the presence of livestock in the stream catchment and of which evidence was abundant adjacent to the property line at the sampling location. Only aluminum, selenium and nitrate as nitrogen exceeded the EQG guideline in these natural waters. Of minor note, the laboratory detection limit for mercury (0.001 mg/L) in 2014 and 2015 exceeded the guideline (0.000005 mg/L) and thus the “non-detect” reported in Table A3 may or may not meet the lower guideline. Mercury sources in this geologic setting are not common, nor will the proposed aggregate operation be a source of mercury. Mercury concentrations measured in 2019 fell below the guideline. Since this water is the source for the stream, the downstream biota will be acclimatized to this form of the natural water quality.

4.4 Regional and Local Water Users

As part of the original hydrogeologic study (SLR 2020c), a field verified water well survey was conducted to establish residential well use, baseline water quality conditions and to provide an assessment of the hydraulic parameters within the aquifers used by local residences adjacent to the site. Initially, a water well record search was undertaken by obtaining records from the Alberta Water Wells database which are presented in Appendix C (updated in 2019). This was followed by a door-to-door survey (October to December 2014) of residences within a 500 m radius of the site with visits on a number of occasions to those houses where no resident was at home. Where possible, the formal well records were correlated with the actual wells in the field. It was considered that the 1,600 m radius required for a *Water Act* application is not appropriate as no groundwater body is to be disturbed by the Project which will be worked dry, and much of that greater area is not in the same groundwater flow field. A number of properties were surveyed and sampled and/or yield tested in order to further assess the relevant aquifer units. At each residential well, a questionnaire was completed to determine the type of well, well completion details, water levels and whether the well user has any issues with water quality or quantity. The questionnaires completed at the residential wells are provided in Appendix D.

The majority of local wells (for which there are records) are used for domestic or commercial purposes. The Alberta records indicated a total of 17 wells within 500 m of the Project with two of those decommissioned (391599 and 391600) and one with very little available detail (395793). Figure 3 presents the locations of the wells identified from the records search and the door-to-door survey for which Table 4 summarizes the information collected. The majority of drilled wells are drilled to between 30 m and 75 m bgs and are screened within the Paskapoo Formation.

Two drilled wells (WW1 and WW4) are on the site at the residences of the current tenants; however, all of the other drilled wells recorded are greater than 100 m from the site boundary. With respect to the WW1 property, there is a well listed in the records for this property (494800); however, the geology recorded in this record is completely different than the rest of the area. It had been concluded that the available log is for a different well and has been misfiled in the digital records kept by AEPA. Therefore, the log has not been used in the analysis.

Dug wells identified at location WW5 (four wells in total) are between 6.1 m and 7.6 m deep according to details provided by the householder. This location is in the bottom of the valley at the southeast end of Section 31. No lithological logs are available for the dug wells; however, based on their estimated depth and the lithological details provided in nearby drilled wells to the east, it is inferred that they are completed in the sand and gravel deposits. The well owners reported that the static water level is 3 m bgs. Although this was unconfirmed by direct measurement, it is a reasonable estimate, given the shallow nature of the wells.

Table 4: Water Wells within 800 Metres

Water Well Number	Alberta Water Well Record Number	No. of Wells	Well Owner	Easting (UTM)	Northing (UTM)	Well Depth (m)	Drilled / Dug	Distance (m) and Direction from Site
WW1	Unknown	1	Waterman	680559[1]	5682875	Unknown	Drilled	On Site
WW2	1475699	1	Rawn	680988[1]	5682770	50.9	Drilled	200 E
WW3	1475698	1	Rawn	681173[1]	5682907	36.0	Drilled	400 E
WW4	350194	1	Nugter	680257[1]	5682091	35.1	Drilled	On Site
WW5	N/A	4	Burnco	681547[1]	5681568	6.1 – 7.6	Dug	800 SE
WW6	Unknown	1	Unknown	See Note[2]	SW Quarter, S32-T26-R3	Unknown	Drilled	900 E
WW7	Unknown	1	Unknown	See Note[2]	SW Quarter, S32-T26-R3	Unknown	Drilled	900 E
WW8	395786	1	Hodgson	See Note[2]	NE Quarter, S31-T26-R3	62.5	Drilled	690 E
WW9	360164	1	Carroll	680744[1]	5683480	67.1	Drilled	350 N
WW10	Unknown	1	Unknown	See Note[2]	SE Quarter, S6-T27-R3	Unknown	Unknown	800 N
WW11	391000	1	Unknown	679932[3]	5683339	39.6	Drilled	350 N
WW12	Unknown	1	Unknown	See Note[2]	NE Quarter, S36-T26-R4	Unknown	Unknown	270 W
WW13	Unknown	1	Big Hill Estates	See Note[2]	SW Quarter, S30-T26-R3	Unknown	Drilled	1,800 S
N/A	1022436	1	Lafarge Canada Inc.	679682[3]	5682526	30.5	Drilled	
N/A	387449	1	Lafarge Canada Inc.	See Note[4]	NE Quarter, S36-T26-R4	33.8	Drilled	
N/A	494773	1	Lafarge Canada Inc.	See Note[4]	NE Quarter, S36-T26-R4	30.5	Drilled	

Water Well Number	Alberta Water Well Record Number	No. of Wells	Well Owner	Easting (UTM)	Northing (UTM)	Well Depth (m)	Drilled / Dug	Distance (m) and Direction from Site
N/A	2095665	1	Unknown	See Note[4]	SW Quarter, S6-T27-R3	25.6	Drilled	
N/A	390998	1	Unknown	See Note[4]	SE Quarter, S6-T27-R3	65.5	Drilled	
N/A	390999	1	Unknown	See Note[4]	SE Quarter, S6-T27-R3	73.2	Drilled	
N/A	391598	1	Unknown	See Note[4]	NW Quarter, S3-T26-R3	39.6	Drilled	
N/A	395786	1	Unknown	See Note[4]	NE Quarter, S31-T26-R3	62.5	Drilled	

1. Location based on GPS measurement in the field.
2. Plotted by AEP at quarter centre centroid, adjusted to likely location, subject to field confirmation.
3. Location based on Abacus Datagraphics database.
4. Wells plotted at quarter-section centroid in Abacus Datagraphics database. Not likely actual location.

5.0 Regulatory Framework

The site will operate under a Development Permit issued by RVC and an Approval under the COP for Pits. A requirement of the Development Permit is to prepare a groundwater monitoring program for assessing whether site operations are impacting groundwater quality and levels. This document is intended to meet this latter requirement.

It is proposed that for the first year, groundwater quality at the onsite monitoring wells be assessed initially by comparing groundwater monitoring results with the Alberta Tier 1 and/or 2 Soil and Groundwater Remediation Guidelines (updated August 2022) and herein referred to as the Tier 1 or Tier 2 Guidelines. The Tier 1 Guidelines contain guidelines which are protective of all receptors and potential exposure pathways, whereas the Tier 2 Guidelines can be modified to exclude those pathways or receptors which don't apply. Monitoring results will be compared to guidelines for Agricultural land use based on the current site and surrounding land uses. The site is coarse-grained with respect to contaminant migration in the surficial deposits.

Water quality results obtained from residential wells which opted to join the monitoring program, will be assessed against the Guidelines for CDWQ and equivalent Alberta potable groundwater guidelines.

Water quality results obtained from the Bighill Springs (BHS1) will be compared against the Environmental Quality Guidelines (EQG) for Alberta Surface Waters as updated. Additional water quality guidelines were developed by SLR from baseline sampling by SLR and others for the protection of tufa formation (section 8.2).

Background groundwater chemistry will be established using historical groundwater monitoring data and additional data collected during April 2023 after spring freshet and prior to development of the site. Control limits setting upper and lower acceptable bounds for parameters have been derived for each sampling point using the pre-operational data, and subsequent data will be compared to these control limits.

6.0 Proposed Groundwater Monitoring Well Network

6.1 Groundwater Monitoring Objectives

The objectives of the groundwater monitoring program are twofold:

- To enable understanding of the groundwater flow regime at the site and adapt the basal elevation of the pit in response to observed groundwater levels.
- To confirm the site is having only the effects predicted, but also to enable the gathering of sufficient information to identify and provide solutions to any unanticipated groundwater problems should they arise through the life of the site.

6.2 Groundwater Monitoring Approach

The site monitoring program is designed to provide data to enable the assessment of potential impacts to groundwater quality in the vicinity of the site. By extrapolation it can be inferred what the likely effects of any observed changes will be at potential receptors such as private residential wells. In addition, potential receptors will also be monitored directly as a precaution to assess potential changes. All monitoring wells installed within the boundaries of the site will receive the earliest warning possible of any changes in the groundwater system.

Background monitoring provides a key benchmark for the assessment of change within the groundwater system, both temporally, before development commences, and spatially, in up-gradient locations. Down-gradient wells provide information on what changes, if any, may be occurring as the groundwater passes beneath the site. By this method, early warning is attained on site, long before any problem could manifest itself in the more distant private wells.

6.3 Groundwater Monitoring Network Description

The groundwater monitoring network for the site will comprise three main elements:

- Existing onsite sentinel monitoring wells to monitor groundwater flowing directly beneath the site in upgradient, downgradient and cross-gradient locations from the actively working areas.
- Monitoring of adjacent residential wells as part of a precautionary water well protection program which protects both the operator and the local residents.
- Sampling of water quality within Big Hill Springs to confirm no negative effects are being seen.

The locations of the proposed groundwater monitoring points for the baseline monitoring are presented in Figure 3 and the monitoring wells for Phase 1 monitoring are presented in Figure 6.

Ten monitoring wells have been installed onsite. The monitoring wells are screened either at the base of the sand and gravel unit or across the upper bedrock / sand and gravel interface to ensure the water table could be measured. The wells are constructed of 50 mm diameter polyvinyl chloride (PVC) pipe with a hydrated bentonite chip seal placed around the annulus of the solid section of standpipe above the screened section. An above ground steel protective cover with a lockable lid was concreted in place above the top of the wells. Borehole geological information and monitoring well construction details are provided in the SLR well logs in Appendix A.

As indicated in Section 4.4 and Table 4, several residential wells are located within or close to an 800 m radius of the site (WW1 to WW12), and MALP has offered to include them in the monitoring program as a precautionary measure to confirm the quality and quantity of water available in these wells is unimpacted by the Project. WW13 (Big Hill Creek Estates Water Coop) is approximately 1.8 km to the south of the site, and unlikely to be affected by the Project because it falls on the other side of a groundwater divide; however, a commitment was made during the Public Hearing to review data from this well as part of the monitoring program. It is our understanding that this well is monitored by others and Mountain Ash proposed to enter into a data sharing agreement, however the Co-Op has not yet agreed.

Confirmatory sampling from the furthest publicly accessible upstream point of the stream flowing from Big Hill Springs will be sampled within the Big Hill Springs Provincial Park (BHS1).

7.0 Groundwater Monitoring Program

7.1 Methodology

7.1.1 Groundwater Monitoring

Each onsite groundwater monitoring well will be measured for depth to groundwater using an electronic water level tape on a monthly basis during operating months (April to November). Prior to the day's monitoring, the water level probe will be inspected and tested for proper operation. The depth to the nearest millimetre from the highest point of the well pipe (which has been surveyed for geodetic elevation) will be observed and recorded. The depth to the bottom of each well will also be measured and noted if any soil particles are present. The water level probe will be cleaned with an Alconox and water solution, rinsed with clean tap water, neutralized with isopropyl alcohol, and then rinsed with distilled water between each well to minimize the potential for cross contamination between wells.

Additional simple piezometers will be installed within the pit once the base of extraction reaches within approximately 3 m of the proposed extraction depth to confirm that no extraction takes place within 1 m of the groundwater table. These will be installed approximately every 200 m as the excavation moves laterally and will be removed as the area is worked out and prepared for restoration.

Groundwater levels will only be measured within residential wells where safe access to the wellhead can be provided. Water levels will be measured using the same methodology outlined above for the onsite monitoring wells. Pressure transducers with built in data loggers will also be installed in available residential wells to establish the normal range of water level fluctuation due to daily use. Twelve private wells have been identified (WW1 to WW12) within or near the 800 m limit as described above.
Each owner has been approached to see if they wish to be included. Some decline as they do not wish to be disturbed by monitoring staff or due to their great distance from the operation. Participation will be based on owner's willingness. All owners within 800 m have been approached, and the monitoring details will be provided to them upon issuance and approval of the development permit. Owners initially were given an overview of the program's intentions, process, procedures, and pending approval by the development authority. Monitoring of wells within an 800 m radius of the active area of the pit will commence once DP approval has been obtained and will continue for a period of 5 years or until the Phase 1 DP expires.

7.1.2 Monitoring Wells

Prior to groundwater sampling, each monitoring well will be purged using the parameter stabilization method. While purging, the following geochemical parameters will be monitored and recorded periodically with a minimum of three minutes between readings: temperature, pH, electrical conductivity (EC). The time, flow rate and cumulative volume purged will also be recorded with qualitative observations such as colour, odour and sheen, if any.

Stabilization will be considered achieved after all parameters have stabilized for three successive readings. The following stabilization criteria will be used:

- pH: +/- 0.2 units
- Temperature: +/- 0.2°C
- EC: +/- 5%

Each well will be purged until field parameters have stabilized.

7.1.3 Residential Wells

Residential well samples will be collected from a point within the household system before any water quality treatment. The sample will be taken after a purge of 15 minutes or until field parameters are deemed to have stabilized. Attention will be paid to ensure that static water from the pressure tank is not inadvertently sampled.

7.1.4 Groundwater and Surface Water Sampling

Samples will be collected from the dedicated sampling equipment (for monitoring wells and surface water) or the sampling tap (for residential wells) and transferred directly to clean, laboratory prepared sample containers that will be labelled prior to sample collection. A clean pair of disposable nitrile gloves will be worn during sample collection and a new pair of gloves used at each sample location.
Upon collection, the sample containers will be placed immediately into sealed coolers with ice packs and delivered directly under Chain-of-Custody (COC) to the laboratory the same day.

7.1.5 Groundwater and Surface Water Analytical Program

The proposed Phase 1 monitoring and sampling schedule is provided in Table 5 and the monitoring point locations presented in Drawing 6. The parameters included in the suites in Table 5 are defined as follows:

- **Field Parameters**: Temperature, pH, specific conductance, turbidity
- **Routine Potability**: alkalinity, bicarbonate (HCO3), electrical conductivity (EC), ion balance, dissolved calcium (Ca), iron (Fe), potassium (K), manganese (Mn), magnesium (Mg), sodium (Na), chloride (Cl), sulphate (SO4), nitrite (NO2), nitrate (NO3), pH, hardness, total dissolved solids
- **Tier 1 metals**: Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Se, Si, Sn, Sr, Ti, Tl, U, V, Zn
- **Petroleum Hydrocarbons**: Benzene, toluene, ethylbenzene, xylenes, petroleum hydrocarbon fractions F1 & F2 Turbidity.

These parameters take into account all those likely indicator parameters which would indicate unanticipated impacts to the groundwater from the operations. Full details of the parameters to be tested are provided in Table 5, below.

7.2 Quality Assurance and Quality Control (QA/QC)

Field procedures will be implemented to minimize the potential of cross contamination between sampling locations. Sample handling protocols will be established to track and maintain the integrity of the samples. Disposable Nitrile gloves will be used at all times and will be changed between sampling locations. Sampling will progress from up-gradient locations to down-gradient locations, reducing the potential for cross contamination from potentially impacted areas to un-impacted or background locations.

Field duplicates will be submitted at a rate of 1 per every 10 samples collected or a minimum of one per sampling event. A field or equipment blank will be run through the sampling equipment and then submitted to the laboratory for analysis to assist in assessing the effect of field sampling and sample shipping methodologies on the accuracy and precision of the analytical results. For volatile parameters, a travel or trip blank prepared by the laboratory will accompany the sample bottles and be submitted for analysis.

For each duplicate, a relative percent difference (RPD) is calculated for each parameter analysed for comparison to SLR's standard QA/QC acceptance limits. RPD will be calculated as follows:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100$$

Where: C1 is the concentration in the original sample; and

C2 is the concentration in the duplicate.

Analytical error increases near the reported detection limit (RDL); therefore, the RPD is not normally calculated unless the concentrations of both the original and duplicate samples are greater than five times the RDL. If the RPD for a sample and its duplicate do not meet SLR's RPD standards (60% for organic parameters or 40% for inorganic parameters) for the parameters analysed, an explanation is required to qualify the difference in values.

Chain-of-custody forms will be completed for all samples submitted to the laboratory and will accompany each sample shipment. Sample temperatures will be maintained between 0°C and 10°C at all times by being kept in sealed coolers on ice. Samples will be shipped for analyses within the recommended time requirements.

All samples will be submitted to a Canadian Association for Laboratory Accreditation Inc. (CALA) accredited laboratory that uses AEP recognized methods to conduct laboratory analyses. Laboratories accredited by CALA are required to be ISO17025 compliant. Method blanks, control standards samples, certified reference material standards, method spikes, replicates, duplicates and instrument blanks are routinely analysed as part of the analytical laboratory's QA/QC programs.

7.3 Proposed Monitoring Schedule

Historical water quality from the residential wells shows that the water is of consistent quality between the residential wells collected at different times and at various depths within the bedrock. Water quality within the sand and gravel is likewise consistent between the monitoring wells and at different times of year (excluding the outliers due to high turbidity within the samples). This historical data (excluding outliers) is used to form the baseline groundwater quality with the completion of baseline sampling during the spring 2023 freshet and prior to the commencement of stripping and excavation. Results of the baseline sampling to date is provided in Tables A1 to A3, with the monitoring point locations presented in Figure 3.

Now baseline water quality has been established for all sampling points, the program will be reduced to sampling of only those monitoring wells surrounding the working areas (i.e., those stripped areas. those extracting sand and gravel, or those being actively restored) and for wells which will act as baseline for later phases, plus those residential wells within 800 m of the working areas. Monthly water level monitoring will continue at onsite monitoring wells during operating months. The Phase 1 monitoring and sampling schedule is provided in Table 5 and the monitoring point locations presented in Figure 6.

Table 5: Proposed Phase 1 Monitoring Schedule

Parameter / Parameter Suite	**Monitoring Point**	**Frequency**
Water Level	**Onsite Monitoring Wells** MW14-101, MW14-102*, MW14-103, MW18-104, MW18-105, MW18-106, MW18-107, MW19-108, MW19-109, MW19-110, PIZ21-001	Monthly during Operating Months (April -November)
	Residential Wells WW1, WW2, WW3, WW4, WW5**, WW6**, WW7**, WW8**, WW9**, WW10**, WW11**, WW12**, WW13**	Manual readings twice annually (April and November). Data loggers installed and recording daily fluctuations.
Field Parameters **Routine Potability** **Tier 1 dissolved metals**	**Onsite Monitoring Wells** MW14-102*, MW19-108, MW19-109, MW19-110	Biannually (twice per year)
	MW18-106, MW18-107	Every 2 years
Petroleum Hydrocarbons	**Onsite Monitoring Wells** MW14-102*, MW19-108, MW19-109, MW19-110	Annually
Field Parameters **Routine Potability** **Tier 1 dissolved and total metals**	**Residential Wells** WW1, WW2, WW3, WW4, WW5**, WW6**, WW7**, WW8**, WW13**	Annually until Phase 1 DP expires
	Surface Water BHS1	Annually
Turbidity: Field measurement	**Surface Water** BHS1	Quarterly
Stream Flow Rate		Monthly

* - MW14-102 has been dry since it was drilled, it will be monitored as per the schedule and only sampled should groundwater levels rise into the monitoring well.

** - Pending well owner agreement for inclusion in the monitoring program

8.0 Groundwater Response Plan

The groundwater response plan is presented schematically in Figure 7. The following sections describe the components of the plan.

8.1 Baseline Groundwater Sampling

Groundwater sampling has been conducted previously at the site to establish existing conditions and perform an impact assessment. To establish the baseline, historical data has been aggregated for the onsite monitoring wells and residential wells to define the baseline groundwater quality in the sand and gravel and the bedrock, respectively. This allows the natural seasonal and annual variability of the groundwater quality to be established. Routine sampling frequencies will be undertaken on the proposed schedule in Table 5 going forwards. All water quality taken from private wells will be shared with homeowners.

8.2 Establish Control Limits

The initial baseline groundwater monitoring has been used to develop "control limits" (described in Section 5) that can be used to identify groundwater quality issues at the site. Control limits are provided in Table 6 below for those parameters not included in the Alberta Tier 1 or EQG guidelines using all available data to April 2023. These control limits are applied to ensure all groundwater quality parameters remain stable to protect water dependent features not covered by the guidelines, and which includes the tufa formations in the Provincial Park. The control limits are dependent on the parameter considered for each aquifer and incorporate statistically significant deviation from background groundwater quality if natural concentrations are above applicable guideline values. Consideration of natural seasonal variability in measured concentrations will be made so that it can be determined if observed results reflect naturally occurring concentrations or if results are potentially being driven by impacts from operations.

Table 6: Control Limits for Parameters Not Covered by Provincial Guidelines

Parameter	Units	Groundwater Quality in Monitoring Wells at the Project Site		Spring Water Quality at BHS1 (Downstream of the Spring)	
		Lower Control Limit	Upper Control Limit	Lower Control Limit	Upper Control Limit
Temp	C°	3.0	7.9	3.0	7.9
pH	---	7.2	8.4	7.9	8.4
HCO_3	mg/L	310	400	200	390
Ca	mg/L	61	79	43	77
TDS	mg/L	280	380	190	526
Turbidity	NTU	0	100*	0	7.1**

* While turbidity can be measured reasonably accurately in surface water, representative groundwater values are difficult to obtain from monitoring wells, as they are highly method dependent and subject to large fluctuations depending on how much disturbance occurs within the well. Efforts will be made to use best practice in obtaining representative turbidity samples, however historical results in some of the monitoring wells indicate turbidities much higher than the proposed upper control limit can be obtained on occasion.

** From Environmental Quality Guidelines for Alberta Surface Waters - Maximum average increase of 2 NTU from background for longer term exposures used. Maximum increase of 8 NTU from background can be used for short term exceedances (i.e., high runoff events).

In addition to the control limits developed above, annual monitoring data will be reviewed to determine the presence of increasing or decreasing trends in groundwater quality and elevations using Mann-Kendall analysis or equivalent statistical method once a sufficient data set has been established. Increasing trends in parameters of concern will initiate source identification and flag a given well for follow up during subsequent monitoring events.

8.3 Annual Groundwater Monitoring

Annual groundwater monitoring and sampling for Excavation Phase 1 will occur as described in Table 5 after the baseline sampling period. Groundwater monitoring data will be entered and stored in a format suitable for identifying control limit exceedances and trends. Please be aware that this program will be extended in breadth for each successive Phase; however, those steps are subject to renewed approvals at that time.

8.4 Annual Groundwater Monitoring Report

An annual groundwater monitoring report will be prepared and submitted to RVC by April 30 of the year following the year in which the information on which the report is based was collected. It will include data summaries and an interpretation of the results with respect to the environmental performance of the site.

The report will also highlight any recommended changes to the monitoring program to make it more effective or recommendations for any risk management measures to be undertaken in the subsequent year. This is a key component of any adaptive monitoring plan, whereby groundwater is managed based on progressive results, and risk management is undertaken based on real risk.

Individual well owners will receive a summary of the data for their well privately each year.

8.5 Identification of a Problem

If an exceedance of a control limit or increasing trend is detected at a given well, the well will be re-sampled for the full suite of parameters. If the re-sampling confirms the initial result, AEPA will be notified of the result. If the source can be easily identified and managed, details will be provided to APEA with the notification. If not, a Source Investigation Plan will be provided.

8.6 Source Investigation

Once a control limit exceedance or increasing trend is confirmed by re-sampling, attempts will be made to identify potential sources and remove or manage them if feasible. Source removal might include such activities as removal of surficial soil impact, repair of leaks, etc., however, the operator will be doing daily inspections of equipment, routine maintenance and monitoring at the site which will likely flag issues before impacts show up at the sentinel wells. Depending upon the situation, a detailed investigation of the source zone may be necessary and will be included as part of the Risk Management Plan (Section 8.7).

8.7 Risk Management Plan

As indicated on the flow chart in Figure 7, a risk management plan will only be developed if an issue and its source are identified as being related to the operation. This plan will be developed if exceedances or increasing trends are confirmed and source removal is not feasible.

The first step in any risk management plan will be a preliminary risk assessment to identify any potential receptors and applicable pathways. The preliminary risk assessment will determine if there are any immediate risks to receptors.

After the preliminary risk assessment is completed, a specific risk management and mitigation process will be developed and implemented to reduce the potential risk to any receptors to levels acceptable to AEPA. Such activities will be commensurate with the problem at hand. For example, a spill of hydrocarbons would entail containment with soaker pads and the subsequent removal of impacted soils as appropriate depending on the nature of the impact. The actions required could include but not be limited to additional sampling, installation of monitoring wells, residential well investigation and rehabilitation, changes to operational practices or reporting. If risks cannot be managed or mitigated to the satisfaction of the Director, this may result in the cessation of operations and/or cancellation of the Registration.

9.0 Summary

The foregoing groundwater monitoring plan has been developed using both industry standard techniques and enhancements based on the unique setting of this site. Monitoring of both groundwater levels (as they might conceptually affect private well performance) and groundwater quality (given the local use of the underlying aquifer by others as a potable water source) will be undertaken. It is expected that the monitoring program will confirm and refine the interpretation of the site found in the supporting hydrogeological report (SLR 2020c). It will also serve to identify unanticipated problems, first and foremost at the site by way of the sentry monitoring well network. Private wells are a much greater distance from the excavation and given that the pit development is above the water table, there is little likelihood of impacts there. The monitoring program is intended to periodically confirm this and provide that data to the pit operator and private well owners alike. A groundwater response plan has been presented that outlines the steps that will be taken should unanticipated conditions develop.

10.0 Statement of Limitations

This report has been prepared and the work referred to in this report has been undertaken by SLR Consulting (Canada) Ltd. (SLR) for Mountain Ash Limited Partnership, hereafter referred to as the “Client”. It is intended for the sole and exclusive use of Mountain Ash Limited Partnership. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted unless payment for the work has been made in full and express written permission has been obtained from SLR.

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Sincerely,

SLR Consulting (Canada) Ltd.

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Tables

Groundwater Monitoring Plan

Summit Pit Project

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00007

May 11, 2023

Table A1
Sand and Gravel Monitoring Well Groundwater Quality Results

Parameter	Guideline (Alberta Tier 1)*	Units	MW14-101				MW14-103					MW18-104				
			20-Nov-14	16-Aug-22	15-Dec-22	19-Apr-23	20-Nov-14	4-Aug-15	16-Aug-22	14-Dec-22	19-Apr-23	4-Jul-19		16-Aug-22	14-Dec-22	19-Apr-23
Aluminum	0.05^1	mg/L	***0.164***	0.0072	<0.0030	0.034	***5.57***	***0.109***	<0.0030	<0.0030	**0.23**	***3.7***	0.0051	<0.0030	<0.0030	<0.003
Antimony	0.006	mg/L	*<0.00050*	<0.00060	<0.00060	<0.00060	*<0.00050*	*<0.00050*	<0.00060	<0.00060	<0.00060	*0.0049*	0.0013	<0.00060	<0.00060	<0.00060
Arsenic	0.005	mg/L	*0.00035*	<0.00020	<0.00020	<0.00020	***0.007858***	*0.000336*	<0.00020	<0.00020	0.0003	*0.0044*	0.00080	0.00025	0.00027	0.00023
Barium	2	mg/L	*0.424*	0.43	0.4	0.39	*0.7*	*0.332*	0.38	0.37	0.39	*0.61*		0.48	0.43	0.41
Bicarbonate (as HCO3)	NV	mg/L	382	340	330	370	380	375	380	360	400	310		330	360	370
Boron	1	mg/L	*<0.020*	<0.020	<0.020	<0.020	*<0.020*	*<0.020*	<0.020	<0.020	0.031	*0.025*	0.031	<0.020	<0.020	<0.020
Cadmium	0.00037^1	mg/L	*0.000016*	<0.000020	<0.000020	<0.000020	*0.00029*	*<0.000005*	<0.000020	<0.000020	0.000031	*0.00036*	0.000039	<0.020	<0.000020	<0.000020
Calcium	NV	mg/L	76	73	73	70	75	73	76	78	79	63		69	70	63
Chloride	100	mg/L	10.5	13.0	13	12	7.8	8.8	17.0	20	22	29.0		17	18	15
Chromium	0.001^2	mg/L	*<0.0010*	<0.0010	<0.0010	<0.0010	***0.0076***	***0.0016***	<0.0010	<0.0010	<0.0010	***0.018***	<0.001	<0.0010	<0.0010	<0.0010
Copper	0.007	mg/L	*<0.0010*	<0.0010	0.002	0.0032	***0.0093***	*0.0013*	0.001	<0.0010	0.0035	***0.064***	0.0025	0.0063	0.0027	0.0026
Hardness	NV	mg/L	329	310	320	300	324	317	340	350	340	280		320	330	290
Iron	0.3	mg/L	*0.28*	<0.060	<0.060	<0.060	***12***	*0.22*	<0.060	<0.060	0.21	***7.6***	0.18	<0.060	<0.060	<0.060
Lead	0.005^1	mg/L	*0.00031*	<0.00020	<0.00020	<0.00020	*0.00464*	*<0.00030*	<0.00020	<0.00020	0.00032	*0.0049*	<0.0002	<0.00020	<0.00020	<0.00020
Mercury	0.000005	mg/L	***<0.00010***	-	<0.0000019	0.0000028	***<0.00010***	***<0.00020***	-	<0.0000019	0.0000041	***0.00003***		-	<0.0000019	<0.0000019
Magnesium	NV	mg/L	33.7	31	33	31	33.4	32.6	36	37	35	30		36	37	33
Manganese	0.02	mg/L	*0.02*	<0.0040	<0.0040	0.012	***0.93***	*0.01*	<0.0040	<0.0040	**0.048**	***0.62***		0.017	<0.0040	<0.0040
Molybdenum	NV	mg/L	*0.0008*	0.00063	0.00061	0.001	*0.00184*	*0.00086*	0.00064	0.00069	0.00051	*0.015*	0.012	0.0034	0.0035	0.0023
Nickel	0.12^1	mg/L	*<0.00050*	0.0027	<0.00050	<0.00050	*0.01196*	*0.00051*	<0.00050	<0.00050	<0.00050	*0.02*	0.0024	0.00089	<0.00050	<0.00050
Nitrate-N	3	mg/L	1.19	1.5	1.5	1.7	**5.22**	1.801	1.7	1.5	1.6	0.97		1.6	1.7	1.6
Nitrite-N	0.1^1	mg/L	<0.05	<0.010	<0.010	<0.010	<0.05	<0.005	<0.010	<0.010	<0.010	0.098		<0.010	<0.010	<0.010
Potassium	NV	mg/L	4.8	4.4	4	3.8	4.3	3.9	3.5	3.6	3.6	4.1		3.3	3.3	2.9
pH	6.5 - 8.5		7.9	7.58	7.87	7.87	7.8	8	7.63	7.86	7.75	7.91		7.24	8.19	7.57
Selenium	0.002	mg/L	*<0.00060*	0.00038	0.00052	0.00048	*0.00112*	*0.00087*	0.00098	0.0012	0.00089	*0.00049*	0.00024	0.00079	0.00064	0.0005
Silver	NV	mg/L	*<0.000070*	<0.00010	<0.00010	<0.00010	*<0.000070*	*<0.000070*	<0.00010	<0.00010	<0.00010	*0.00044*	<0.0001	<0.00010	<0.00010	<0.00010
Sodium	200	mg/L	6	5.5	5.8	5.9	8.8	7.9	9.6	9.6	9.4	13		7.8	8.2	7.1
Sulphate	500^1	mg/L	8.88	7.3	7.8	7.1	11.9	10.56	13	13	11	9.2		77	7.3	6.8
Thallium	NV	mg/L	*<0.00020*	<0.00020	<0.00020	<0.00020	*<0.00020*	*<0.00020*	<0.00020	<0.00020	<0.00020	*<0.00020*	<0.00020	<0.00020	<0.00020	<0.00020
Total Dissolved Solids (calculated)	500	mg/L	337	310	300	320	354	333	350	350	370	310		380	330	320
Turbidity	NV	NTU	9.6	-	0.54	580	680	8	-	29	81	130		-	1.2	36
Uranium	0.01	mg/L	*0.001697*	0.0016	0.0014	0.0015	*0.002014*	*0.001563*	0.0017	0.0016	0.0017	*0.0019*	0.0015	0.0019	0.0018	0.0018
Zinc	0.03	mg/L	*<0.020*	<0.0030	<0.0030	<0.0030	***0.033***	*<0.020*	<0.0030	<0.0030	<0.0030	***0.072***	<0.003	<0.0030	<0.0030	<0.0030
Total Coliforms	<1 (MAC)^3	MPN/100 mL	-	-	-	-	-	<1	-	-	-	**>24000**		-	-	-
E.Coli	<1 (MAC)^3	MPN/100 mL	-	-	-	-	-	<1	-	-	-	**10**		-	-	-

Notes:

* - Table 2, Alberta Tier 1 Groundwater Remediation Guidelines (2023) applied for Agricultural land use in coarse grained soils

NV = no value

1. Tier 1 guideline is the lowest of the aquatic life guideline and all other guidelines. Lead is based on the potable water pathway, as is sulphate in the absence of an assessment for the very high natural groundwater hardness. Cadmium and nickel guidelines are hardness dependent, aluminum is pH dependent and nitrite as N guideline is chloride dependent for the aquatic life pathway. Guidelines quoted are based on the lowest chronic guideline applied for the range of hardness, pH or chloride observed.

2. Guideline is for chromium (hexavalent) and used for screening purposes when not analyzed

3. No guideline value is provided in Alberta Tier 1 guidelines, so Canadian Drinking Water Guideline value has been included for comparison purposes. (MAC = Maximum Allowable Concentration)

Metal concentrations in groundwater are provided as dissolved metals unless otherwise indicated or by total metal concentrations being indicated in *italics.* A comparison between total and dissolved metals was undertaken on 4 July 2019 and therefore two columns of metal concentrations are shown.

BOLD RED – Exceeds guideline

Table A1
Sand and Gravel Monitoring Well Groundwater Quality Results

Parameter	Guideline (Alberta Tier 1)*	Units	MW18-105					MW18-106					MW18-107				
			4-Jul-19		16-Aug-22	14-Dec-22	19-Apr-23	4-Jul-19		16-Aug-22	15-Dec-22	19-Apr-23	4-Jul-19		16-Aug-22	15-Dec-22	19-Apr-23
Aluminum	0.05[1]	mg/L	***5.4***	<0.003	0.0051	<0.0030	0.017	***13***	0.0034	<0.0030	<0.0030	0.0059	***7***	0.0033	<0.0030	<0.0030	0.02
Antimony	0.006	mg/L	*0.006*	<0.00060	<0.00060	<0.00060	<0.00060	*0.0048*	<0.00060	<0.00060	<0.00060	<0.00060	*0.00079*	<0.00060	<0.00060	<0.00060	<0.00060
Arsenic	0.005	mg/L	***0.0056***	<0.0002	<0.00020	<0.00020	<0.00020	***0.017***	<0.0002	<0.00020	<0.00020	<0.00020	***0.0076***	0.00023	<0.00020	<0.00020	<0.00020
Barium	2	mg/L	***2.8***		0.36	0.34	0.34	*1.1*		0.35	0.31	0.31	*0.79*		0.35	0.32	0.32
Bicarbonate (as HCO3)	NV	mg/L	320		340	320	320	360		350	330	360	370		360	330	360
Boron	1	mg/L	*0.021*	<0.02	<0.020	<0.020	<0.020	*<0.020*	<0.02	<0.020	0.032	<0.020	*<0.020*	0.029	<0.020	<0.020	<0.020
Cadmium	0.00037[1]	mg/L	***0.0055***	<0.00002	<0.000020	<0.000020	<0.000020	***0.00095***	<0.00002	<0.000020	<0.000020	<0.000020	*0.00033*	<0.00002	<0.000020	<0.000020	0.000033
Calcium	NV	mg/L	69		64	65	61	73		70	72	67	71		71	70	68
Chloride	100	mg/L	13.0		10	10	9.5	9.3		11	11	9.7	10.0		15	16	15
Chromium	0.001[2]	mg/L	***0.0046***	<0.0010	<0.0010	<0.0010	<0.0010	***0.081***	<0.001	<0.0010	<0.0010	<0.0010	***0.025***	<0.001	<0.0010	<0.0010	<0.0010
Copper	0.007	mg/L	***0.11***	0.0003	0.0054	0.0013	<0.0010	***0.11***	0.00072	0.0015	<0.0010	0.0033	***0.018***	<0.0002	**0.0074**	0.001	0.0038
Hardness	NV	mg/L	300		290	300	280	310		310	320	300	310		320	320	300
Iron	0.3	mg/L	***49***	0.16	<0.060	<0.060	<0.060	***37***	0.16	<0.060	<0.060	<0.060	***17***	0.15	<0.060	<0.060	<0.060
Lead	0.005[1]	mg/L	***0.025***	<0.0002	0.0015	<0.00020	<0.00020	***0.019***	<0.0002	<0.00020	<0.00020	<0.00020	***0.0075***	<0.0002	<0.00020	<0.00020	<0.00020
Total Mercury	0.000005	mg/L	***0.0013***		-	<0.0000019	<0.0000019	***0.00032***		-	<0.0000019	<0.0000019	***0.000048***		-	<0.0000019	<0.0000019
Magnesium	NV	mg/L	32		31	33	30	31		33	34	32	32		34	34	32
Manganese	0.02	mg/L	***2.90***		<0.0040	<0.0040	<0.0040	***1.90***		<0.0040	0.0058	<0.0040	***0.60***		<0.0040	<0.0040	<0.0040
Molybdenum	NV	mg/L	*0.0014*	0.00096	0.00062	0.00071	0.00061	*0.005*	0.0012	0.0006	0.00088	0.00073	*0.0021*	0.00095	0.00069	0.0007	0.00074
Nickel	0.12[1]	mg/L	*0.015*	<0.0005	<0.00050	<0.00050	<0.00050	*0.036*	<0.0005	<0.00050	<0.00050	<0.00050	*0.014*	<0.0005	<0.00050	<0.00050	<0.00050
Nitrate-N	3	mg/L	2.6		2.3	2.1	2.3	2.3		2.6	2.4	2.7	2		2.6	2.3	2.6
Nitrite-N	0.1[1]	mg/L	<0.010		<0.010	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010	0.034		<0.010	<0.010	<0.010
Potassium	NV	mg/L	2.9		2.4	2.4	2.4	3.3		3.3	3.2	3.2	3		3.2	3.1	3
pH	6.5 - 8.5		8.05		7.56	8.01	8.08	7.87		7.71	7.95	7.86	7.8		7.53	7.79	7.64
Selenium	0.002	mg/L	*0.00093*	0.00043	0.00037	0.00052	0.0004	*0.0011*	0.00067	0.00048	0.00085	0.00058	*0.00094*	0.00081	0.00055	0.00088	0.00065
Silver	NV	mg/L	*<0.00010*	<0.0001	<0.00010	<0.00010	<0.00010	*0.0017*	<0.0001	<0.00010	<0.00010	<0.00010	*0.0001*	<0.0001	<0.00010	<0.00010	<0.00010
Sodium	200	mg/L	5.7		5.2	5.3	5	9		6.2	7.1	6.3	6.6		6.2	6.7	7.1
Sulphate	500[1]	mg/L	5.8		4.8	5.6	5.2	7.6		6.3	7.2	7	6.6		6	6.7	5.8
Thallium	NV	mg/L	*0.00023*	<0.00020	<0.00020	<0.00020	<0.00020	*0.0002*	<0.00020	<0.00020	<0.00020	<0.00020	*<0.00020*	<0.00020	<0.00020	<0.00020	<0.00020
Total Dissolved Solids (calculated)	500	mg/L	300		290	290	280	320		310	310	320	320		320	310	320
Turbidity	NV	NTU	>4000		-	86	>4000	3100		-	6.7	>4000	53		-	19	160
Uranium	0.01	mg/L	***0.012***	0.0018	0.0016	0.0014	0.0016	*0.003*	0.002	0.0015	0.0016	0.0016	*0.0027*	0.0017	0.0015	0.0014	0.0016
Zinc	0.03	mg/L	***0.19***	<0.003	0.0048	<0.0030	<0.0030	***0.13***	<0.003	0.0031	<0.0030	<0.0030	***0.037***	<0.003	<0.0030	<0.0030	<0.0030
Total Coliforms	<1 (MAC)[3]	MPN/100mL	**<100**		-	-	-	**1100**		-	-	-	**>2400**		-	-	-
E.Coli	<1 (MAC)[3]	MPN/100mL	**<100**		-	-	-	**<10**		-	-	-	<1		-	-	-

Notes:

* - Table 2, Alberta Tier 1 Groundwater Remediation Guidelines (2023) applied for Agricultural land use in coarse grained soils

NV = no value

1. Tier 1 guideline is the lowest of the aquatic life guideline and all other guidelines. Lead is based on the potable water pathway, as is sulphate in the absence of an assessment for the very high natural groundwater hardness. Cadmium and nickel guidelines are hardness dependent, aluminum is pH dependent and nitrite as N guideline is chloride dependent for the aquatic life pathway. Guidelines quoted are based on the lowest chronic guideline applied for the range of hardness, pH or chloride observed.

2. Guideline is for chromium (hexavalent) and used for screening purposes when not analyzed

3. No guideline value is provided in Alberta Tier 1 guidelines, so Canadian Drinking Water Guideline value has been included for comparison purposes. (MAC = Maximum Allowable Concentration)

Metal concentrations in groundwater are provided as dissolved metals unless otherwise indicated or by total metal concentrations being indicated in *italics*. A comparison between total and dissolved metals was undertaken on 4 July 2019 and therefore two columns of metal concentrations are shown.

BOLD RED – Exceeds guideline

Table A1
Sand and Gravel Monitoring Well Groundwater Quality Results

Parameter	**Guideline (Alberta Tier 1)***	**Units**	**MW19-108**					**MW19-109**				**MW19-110**		
			4-Jul-19		**16-Aug-22**	**14-Dec-22**	**19-Apr-23**	**5-Jul-19**	**16-Aug-22**	**14-Dec-22**	**19-Apr-23**	**10-Jul-19**	**14-Dec-22**	**19-Apr-23**
Aluminum	0.05[1]	mg/L	***15***	0.0051	**0.39**	<0.0030	**0.44**	***95***	0.029	0.0035	**0.32**	***10***	<0.0030	<0.003
Antimony	0.006	mg/L	*0.0022*	<0.00060	<0.00060	<0.00060	<0.00060	*0.0034*	<0.00060	<0.00060	<0.00060	*<0.00060*	<0.00060	<0.00060
Arsenic	0.005	mg/L	***0.0086***	0.00022	0.00061	<0.00020	0.00039	***0.071***	0.00023	<0.00020	0.0003	***0.0084***	<0.00020	<0.00020
Barium	2	mg/L	*1.1*		0.39	0.33	0.37	***7.2***	0.24	0.22	0.25	***2.2***	0.33	0.32
Bicarbonate (as HCO3)	NV	mg/L	390		340	350	370	350	370	370	370	330	320	360
Boron	1	mg/L	*0.029*	<0.02	<0.020	<0.020	<0.020	*0.087*	<0.020	<0.020	0.031	*<0.020*	<0.020	<0.020
Cadmium	0.00037[1]	mg/L	***0.00095***	<0.00002	0.000063	<0.000020	0.00005	***0.01***	<0.000020	0.000024	0.000054	***0.0042***	<0.000020	<0.000020
Calcium	NV	mg/L	74		79	68	70	77	73	77	72	62	68	62
Chloride	100	mg/L	14.0		10	12	12	18	17	17	16	8.4	9.1	8
Chromium	0.001[2]	mg/L	***0.038***	<0.001	**0.0011**	<0.0010	**0.0013**	***0.19***	<0.0010	<0.0010	<0.0010	***0.019***	<0.0010	<0.0010
Copper	0.007	mg/L	***0.038***	<0.0002	0.005	<0.0010	0.0036	***0.29***	0.0013	<0.0010	0.003	***0.032***	<0.0010	0.0015
Hardness	NV	mg/L	320		340	310	310	350	320	340	310	280	310	280
Iron	0.3	mg/L	***29***	0.16	**1.2**	<0.060	0.59	***190***	<0.060	<0.060	0.32	***10***	<0.060	<0.060
Lead	0.005[1]	mg/L	***0.024***	<0.0002	0.0023	<0.00020	0.00089	***0.15***	<0.00020	<0.00020	0.0006	***0.019***	<0.00020	<0.00020
Total Mercury	0.000005	mg/L	***0.000067***		-	<0.0000019	0.0000046	***0.00208***	-	<0.0000019	0.0000048	***0.000002***	<0.0000019	<0.0000019
Magnesium	NV	mg/L	32		34	34	33	37	33	36	31	30	33	31
Manganese	0.02	mg/L	***0.74***		**0.11**	0.0055	**0.054**	***8.9***	0.0054	0.0068	**0.030**	***7.3***	<0.0040	<0.0040
Molybdenum	NV	mg/L	*0.0065*	0.0029	0.0012	0.0012	0.0034	*0.023*	0.0022	0.0019	0.0017	*0.0015*	0.00075	0.00084
Nickel	0.12[1]	mg/L	*0.047*	0.0023	0.0035	0.00071	0.0021	***0.41***	0.00084	0.00065	0.0015	*0.065*	<0.00050	<0.00050
Nitrate-N	3	mg/L	2.4		2	2	2.1	1.7	**3.2**	2.9	**3.1**	1.9	1.6	1.7
Nitrite-N	0.1[1]	mg/L	0.048		<0.010	<0.010	<0.010	0.065	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Potassium	NV	mg/L	3.4		3.3	3.1	3.1	6.3	2.9	3	2.8	2.7	2.9	2.9
pH	6.5 - 8.5		7.91		8	8.01	7.88	8.19	7.48	8.07	7.97	7.82	7.96	7.98
Selenium	0.002	mg/L	*0.0013*	0.00074	0.00079	0.00076	0.00061	*0.00059*	**0.0022**	0.002	0.0019	*0.00096*	0.0006	0.00052
Silver	NV	mg/L	*0.0003*	<0.0001	<0.00010	<0.00010	<0.00010	*0.0025*	<0.00010	<0.00010	<0.00010	*<0.00010*	<0.00010	<0.00010
Sodium	200	mg/L	12		8.8	7.4	6.7	18	7.2	7.7	6.8	6	6.2	5.7
Sulphate	500[1]	mg/L	17		8.7	8.3	6.9	26	10	10	10	8.1	6.7	6.1
Thallium	NV	mg/L	*0.00028*	<0.00020	<0.00020	<0.00020	<0.00020	*0.0026*	<0.00020	<0.00020	<0.00020	*0.00024*	<0.00020	<0.00020
Total Dissolved Solids (calculated)	500	mg/L	350		320	310	320	360	340	340	340	290	290	300
Turbidity	NV	NTU	670		-	48	30	>4000	-	1.5	330	<0.10	3	46
Uranium	0.01	mg/L	*0.0047*	0.0027	0.0023	0.0018	0.0017	***0.016***	0.0025	0.0022	0.0025	*0.006*	0.0015	0.0016
Zinc	0.03	mg/L	***0.15***	<0.003	0.01	<0.0030	0.0039	***1.2***	<0.0030	*<0.0030*	<0.0030	***0.14***	<0.0030	<0.0030
Total Coliforms	<1 (MAC)[3]	MPN/100mL	**<10**		-	-	-	**120000**	-	-	-	**180**	-	-
E.Coli	<1 (MAC)[3]	MPN/100mL	**<10**		-	-	-	**100**	-	-	-	**63**	-	-

Notes:

* - Table 2, Alberta Tier 1 Groundwater Remediation Guidelines (2023) applied for Agricultural land use in coarse grained soils

NV = no value

1. Tier 1 guideline is the lowest of the aquatic life guideline and all other guidelines. Lead is based on the potable water pathway, as is sulphate in the absence of an assessment for the very high natural groundwater hardness. Cadmium and nickel guidelines are hardness dependent, aluminum is pH dependent and nitrite as N guideline is chloride dependent for the aquatic life pathway. Guidelines quoted are based on the lowest chronic guideline applied for the range of hardness, pH or chloride observed.

2. Guideline is for chromium (hexavalent) and used for screening purposes when not analyzed

3. No guideline value is provided in Alberta Tier 1 guidelines, so Canadian Drinking Water Guideline value has been included for comparison purposes. (MAC = Maximum Allowable Concentration)

Metal concentrations in groundwater are provided as dissolved metals unless otherwise indicated or by total metal concentrations being indicated in *italics.* A comparison between total and dissolved metals was undertaken on 4 July 2019 and therefore two columns of metal concentrations are shown.

BOLD RED – Exceeds guideline

Table A2

Paskapoo Formation Residential Well Groundwater Quality Results

Parameter	Guideline (CDWQ)	Units	WW1		WW2				WW3			WW4			
			29-Oct-14	4-Aug-15	29-Oct-14	4-Aug-15	10-Jul-19	16-Aug-22	29-Oct-14	4-Aug-15	16-Aug-22	30-Oct-14	4-Aug-15	5-Jul-19	16-Aug-22
Total Aluminum	2.9 (MAC) / 0.1 (OG)	mg/L	0.0068	0.011	<0.0050	<0.0050	0.006	*<0.0030*	0.0061	<0.0050	*<0.0030*	<0.0050	<0.0050	0.0041	*<0.0030*
Total Antimony	0.006 (MAC)	mg/L	0.00088	<0.00050	0.00059	<0.00050	<0.00060	*<0.00060*	<0.00050	<0.00050	*<0.00060*	<0.00050	<0.00050	<0.00060	*<0.00060*
Total Arsenic	0.01 (MAC)	mg/L	0.000126	0.000132	0.000165	0.000205	<0.00020	*<0.00020*	0.000143	0.000121	*<0.00020*	0.000192	0.000194	0.00032	*<0.00020*
Total Barium	2 (MAC)	mg/L	0.282	0.284	0.128	0.142	0.11	*0.12*	0.221	0.225	*0.24*	0.385	0.391	0.36	*0.41*
Bicarbonate (as HCO3)	NV	mg/L	366.6	359.6	380.6	375.1	350	370	391.6	377.7	380	371.8	365.2	340	360
Total Boron	5 (MAC)	mg/L	0.022	<0.020	0.032	<0.020	0.023	*0.039*	<0.020	<0.020	*<0.020*	<0.020	<0.020	<0.020	*<0.020*
Total Cadmium	0.007 (MAC)	mg/L	0.000013	<0.000005	0.000016	0.000024	0.000029	*<0.000020*	0.00004	0.000024	*<0.000020*	0.000008	<0.000005	<0.000020	*<0.000020*
Dissolved Calcium	NV	mg/L	70.3	68.2	63.6	63.4	55	59	73.2	69.7	72	75.3	72	80	75
Chloride	<250 (AO)	mg/L	4.29	4.49	1.38	1.93	2	1.7	10.31	5.88	15	10.86	10.95	12	17
Total Chromium	0.05 (MAC)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	*<0.0010*	<0.0010	<0.0010	*<0.0010*	<0.0010	<0.0010	0.0012	*<0.0010*
Total Copper	2 (MAC) / 1 (AO)	mg/L	0.0317	0.013	0.0022	0.0016	0.0045	*0.012*	0.125	0.0057	*0.0035*	0.0017	0.0018	0.034	*0.0035*
Total Iron	<0.3 (AO)	mg/L	0.015	0.014	0.018	0.04	<0.060	*<0.060*	<0.010	<0.010	*<0.060*	0.017	0.044	0.3	*<0.060*
Total Lead	0.005 (MAC)	mg/L	0.00127	0.00048	<0.00030	<0.00030	0.00054	*0.0012*	0.00302	<0.00030	*<0.00020*	<0.00030	<0.00030	0.011	*0.00025*
Total Mercury	0.001 (MAC)	mg/L	<0.00010	<0.00020	<0.00010	<0.00020	<0.0000020	-	<0.00010	<0.00020	-	<0.00010	<0.00020	<0.0000020	-
Dissolved Magnesium	NV	mg/L	35.1	31.8	37.3	35	30	32	39.9	35.5	37	35.2	31.5	35	33
Total Manganese	0.12 (MAC) / 0.02 (AO)	mg/L	<0.0010	<0.0010	0.004	0.0042	0.012	*0.015*	0.0014	<0.0010	*<0.0040*	<0.0010	<0.0010	<0.0040	*<0.0040*
Total Molybdenum	NV	mg/L	0.00148	0.00147	0.00222	0.00193	0.0014	*0.0015*	0.00113	0.00104	*0.00081*	0.00076	0.00066	0.00065	*0.00063*
Total Nickel	NV	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	0.0006	*<0.00050*	0.00174	<0.00050	*<0.00050*	<0.00050	<0.00050	<0.00050	*<0.00050*
Nitrate-N	10 (MAC)	mg/L	1.67	1.658	0.78	1.054	0.37	0.54	1.87	1.889	1.9	3.02	3.314	3.2	3.4
Nitrite-N	1 (MAC)	mg/L	<0.05	<0.005	<0.05	<0.005	<0.010	0.012	<0.05	<0.005	<0.010	<0.05	<0.005	<0.010	<0.010
Dissolved Potassium	NV	mg/L	3.3	3.2	2.8	2.6	2	2.3	3.1	3	2.9	3.1	2.9	3	2.8
pH^2	7.0 -10.5		8.1	8	8	8.1	7.95	7.58	7.9	8	7.64	8	8	8.13	7.62
Total Selenium	0.05 (MAC)	mg/L	0.00084	<0.00060	0.00112	0.00105	0.00052	*0.00037*	0.0007	0.00085	*0.00068*	0.0018	0.00096	0.00093	*0.00086*
Total Silver	NV	mg/L	<0.000070	<0.00007	<0.00007	<0.00007	<0.00010	*<0.00010*	<0.00007	<0.00007	*<0.00010*	<0.00007	<0.00007	0.00012	*<0.00010*
Dissolved Sodium	<200 (AO)	mg/L	7.2	7	13.8	9.3	17	22	7.8	7.6	7	7.1	6.5	7.7	6.4
Sulphate	<500 (AO)	mg/L	6.95	7.51	15.82	12.85	20	21	10.33	11.09	9.7	7.66	6.77	5.9	5.9
Total Thallium	NV	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	*<0.00020*	<0.00020	<0.00020	*<0.00020*	<0.00020	<0.00020	<0.00020	*<0.00020*
Total Dissolved Solids (calculated)^3	<500 (AO)	mg/L	318	310	328	317	300	320	349	330	340	339	328	330	330
Turbidity	1 (OG)	NTU	0.2	0.31	0.2	**1.23**	0.31	-	0.2	0.25	-	0.6	0.23	0.66	-
Total Uranium	0.02 (MAC)	mg/L	0.001299	0.001241	0.001023	0.001214	0.00091	*0.00064*	0.001744	0.001688	*0.0016*	0.001785	0.001672	0.0021	*0.0017*
Total Zinc	<5 (AO)	mg/L	<0.020	<0.020	0.024	<0.020	0.046	*0.013*	0.205	<0.020	*0.0046*	0.029	0.031	0.99	*0.028*
Total Coliforms	<1 (MAC)	MPN/100 mL	-	<1	-	<1	1	-	-	<1	-	-	<1	**11**	-
E.Coli	<1 (MAC)	MPN/100 mL	-	<1	-	<1	<1	-	-	<1	-	-	<1	<1	-

Notes:

NV = no value

OG = Operational Guidance

AO = Aesthetic Objective

MAC = Maximum Allowable Concentration

Canadian Drinking Water Quality CDWQ Guidelines: September 2019

2. pH Objective (CDWQ): 7.0 - 10.5

3. Calculated result only includes measured parameters. Actual TDS may be higher.

BOLD RED – Exceeds guideline

Table A3
Big Hill Springs Water Quality Results

Parameter	Guideline (Alberta EQG for Surface Water)	Units	BHS1				
			30-Oct-14	4-Aug-15	10-Jul-19	15-Dec-22	19-Apr-23
Hardness (as CaCO3)	NV	mg/L	336	317	200	330	310
Total Aluminum[1]	0.05	mg/L	0.0182	0.0144	**0.3**	-	-
Total Antimony	NV	mg/L	<0.00050	<0.00050	<0.00060	-	-
Total Arsenic	0.005	mg/L	0.000153	0.000146	0.00061	-	-
Total Barium	NV	mg/L	0.304	0.313	0.21	-	-
Bicarbonate (as HCO3)	NV	mg/L	376.1	371	240	360	390
Total Boron[2]	1.5	mg/L	0.024	<0.020	<0.020	-	-
Total Cadmium[3]	0.00037	mg/L	0.000032	0.000008	0.000034	-	-
Dissolved Calcium	NV	mg/L	74.1	72	48	75	70
Chloride[4]	120	mg/L	9.6	10.12	8.2	16	13
Total Chromium[5]	0.001	mg/L	<0.0010	<0.0010	0.001	-	-
Total Copper[6]	0.007	mg/L	<0.0010	0.001	0.0013	-	-
Total Iron	0.3	mg/L	0.027	0.019	0.25	-	-
Total Lead[7]	0.007	mg/L	<0.00030	<0.00030	<0.00020	-	-
Total Mercury	0.000005	mg/L	**<0.00010**	**<0.00020**	0.0000025	-	-
Dissolved Magnesium	NV	mg/L	36.7	33.3	20	36	33
Total Manganese	NV	mg/L	0.0019	0.0012	<0.0040	-	-
Total Molybdenum	0.073	mg/L	0.00141	0.00089	0.00038	-	-
Total Nickel[8]	0.13	mg/L	<0.00050	<0.00050	0.00088	-	-
Nitrate-N[9]	3	mg/L	2.83	**3.037**	1.4	2.7	2.9
Nitrite-N[10]	0.1	mg/L	<0.05	<0.005	<0.010	<0.010	<0.010
Dissolved Potassium	NV	mg/L	3.4	3.3	4.8	3.0	2.8
pH	6.5-9		8.2	8.2	8.07	8.37	8.21
Total Selenium[11]	0.001	mg/L	**0.00218**	**0.0013**	0.00068	-	-
Total Silver	0.00025	mg/L	<0.000070	<0.000070	<0.00010	-	-
Dissolved Sodium	NV	mg/L	7.8	7.5	5	7.6	7.4
Sulphate[12]	500	mg/L	9.36	8.36	4.7	8.8	7.2
Total Thallium	0.0008	mg/L	<0.00020	<0.00020	<0.00020	-	-
Total Dissolved Solids (calculated)[13]	NV	mg/L	342	334	210	340	340
Turbidity[14]	7.1	NTU	0.8	1.07	5.1	1.7	0.19
Total Uranium[15]	0.015	mg/L	0.001953	0.001875	0.0013	-	-
Total Zinc	0.03	mg/L	<0.020	<0.020	<0.0030	-	-
Total Coliforms	NV	MPN	-	2420	>2400	-	-
E.Coli	NV	MPN	-	1733	1600	-	-

Notes:

NV = no value

Environmental Quality Guidelines for Alberta Surface Waters, March 2018

1. Aluminum Guideline value is for long term exposure. (Protection of Freshwater Aquatic Life): if pH >= 6.5 then 0.05 mg/L, else if pH < 6.5 then use equation
2. Boron Guideline value is for long term exposure. Short term exposure value is 29 mg/L
3. Cadmium Guideline value varies with hardness. Based on a typical hardness of 300 to 340 mg/L
4. Chloride Guideline value is for long term exposure. Short term exposure value is 640 mg/L
5. Chromium Guideline value is for hexavalent chromium as conservative value. Trivalent chromium guideline is 0.0089 mg/L.
6. Copper Guideline is for long term exposure and only applies to waters of hardness >= 50mg/L as $CaCO_3$
7. Lead Guideline varies with hardness. Based on a typical hardness of 300 to 340 mg/L
8. Nickel Guideline varies with hardness. Based on a typical hardness of 300 to 340 mg/L
9. Nitrate Guideline value is for long term exposure.. Short Term exposure value is 124 for Freshwater
10. Nitrite as N guideline varies with chloride. Based on a typical chloride concentration of 8 to 10 mg/L
11. Alert concentration for sensitive environments = 0.001 mg/L. Guideline value = 0.002 mg/L
12. Sulphate Guideline value varies with hardness. Based on a typical hardness of 300 to 340 mg/L
13. Calculated result only includes measured parameters. Actual TDS may be higher.
14. Maximum increase of 8 NTU from background for short term. Maximum average increase of 2 NTU from background for longer term exposures.
15. Uranium Guideline value is for long term exposure. Short term exposure value is 0.033 mg/L

BOLD RED – Indicates Exceeds guideline

Figures

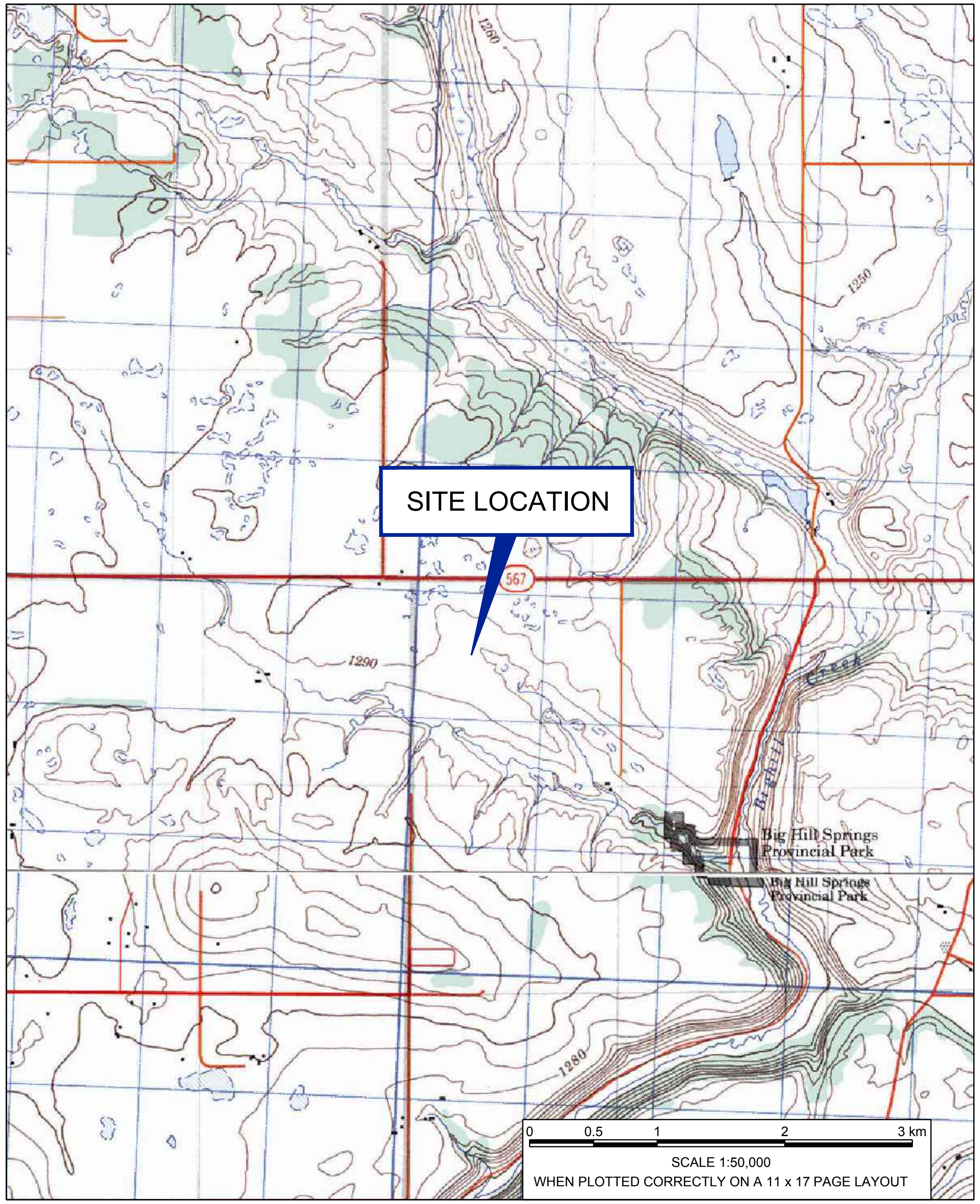
Groundwater Monitoring Plan

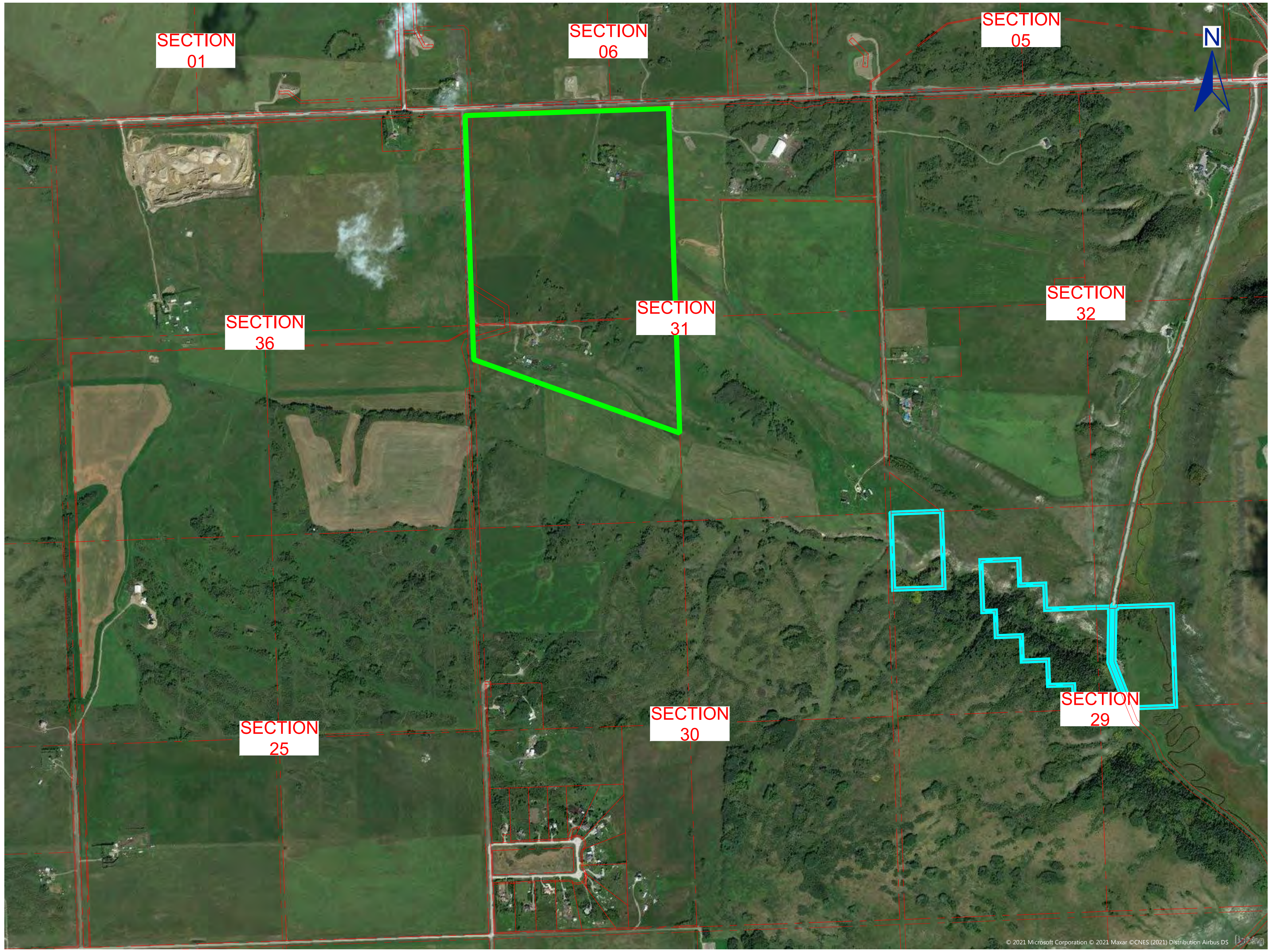
Summit Pit Project

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00007

May 11, 2023





NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY. IMAGERY DATE: SEPTEMBER 9, 2016.

LEGEND:

— — —	PROPERTY BOUNDARY
🟩	SUBJECT BOUNDARY
🟦	BIG HILL SPRINGS PROVINCIAL PARK

0 0.2 0.4 0.8 1.2 km

SCALE 1:20,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

GROUNDWATER MONITORING PLAN

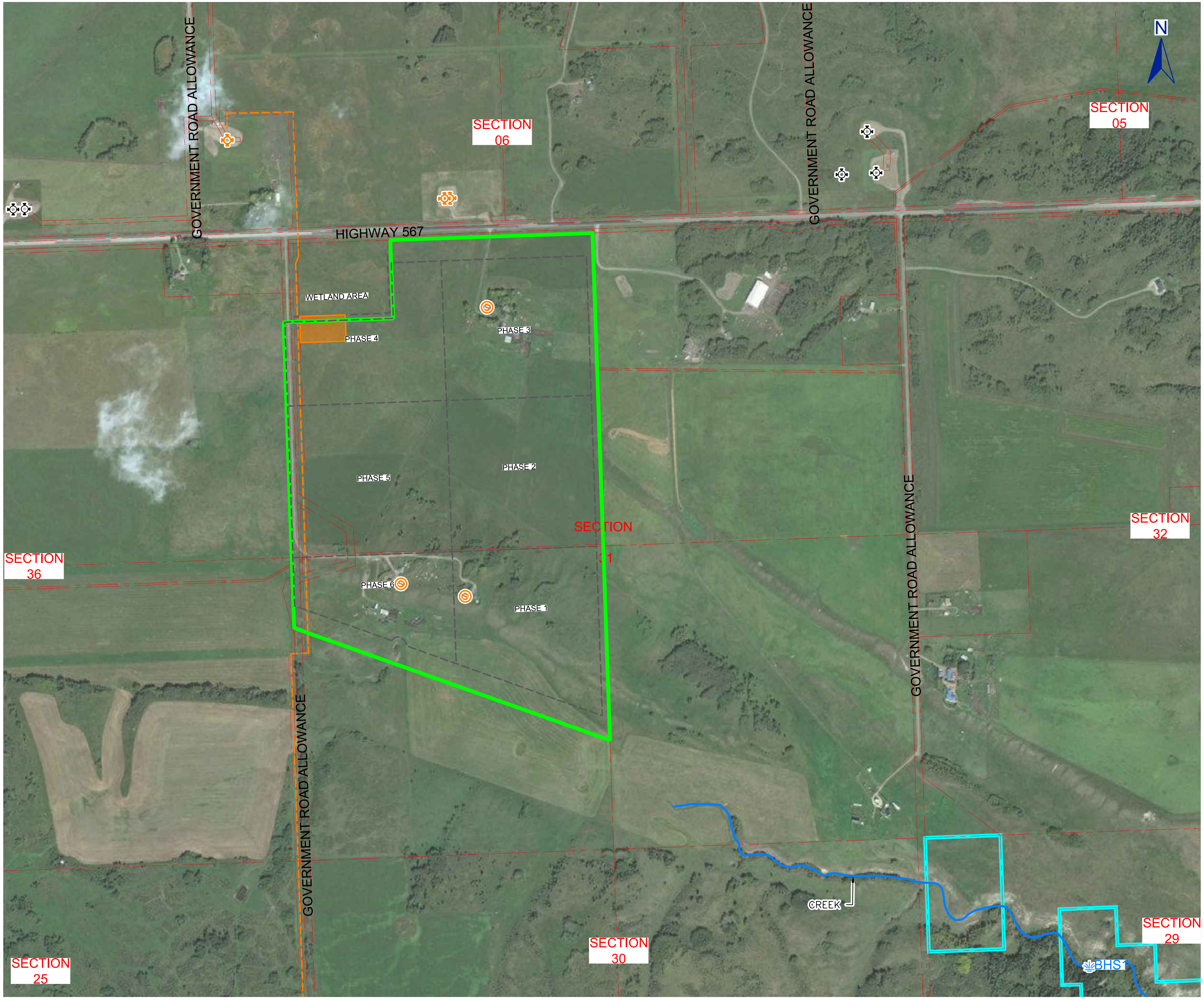
SITE LOCATION &
STUDY AREA

Date: January 10, 2023
Project No. 212.06650.00007

Drawing No.
1

SLR

Cadfile name: S_212-06650-00007-A5.dwg



NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY. IMAGERY DATE: SEPTEMBER 9, 2016.

LEGEND:

— – —	PROPERTY BOUNDARY
🟩	SITE LOCATION
▭	BIG HILL SPRINGS PROVINCIAL PARK BOUNDARY
⬚	EXTRACTION PHASE BOUNDARIES
⛲	SURFACE WATER MONITORING POINT
⌖	WELL CENTRE
	POTENTIAL SOURCES OF GROUNDWATER CONTAMINATION
Ⓢ	EXISTING SEPTIC TANK
– – – –	OIL PIPELINE
⌖	WELL CENTRE
🟧	PROPOSED REFUELLING, EQUIPMENT MAINTENANCE AND STORAGE LOCATION

0 100 200 400 600 m

SCALE 1:10,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

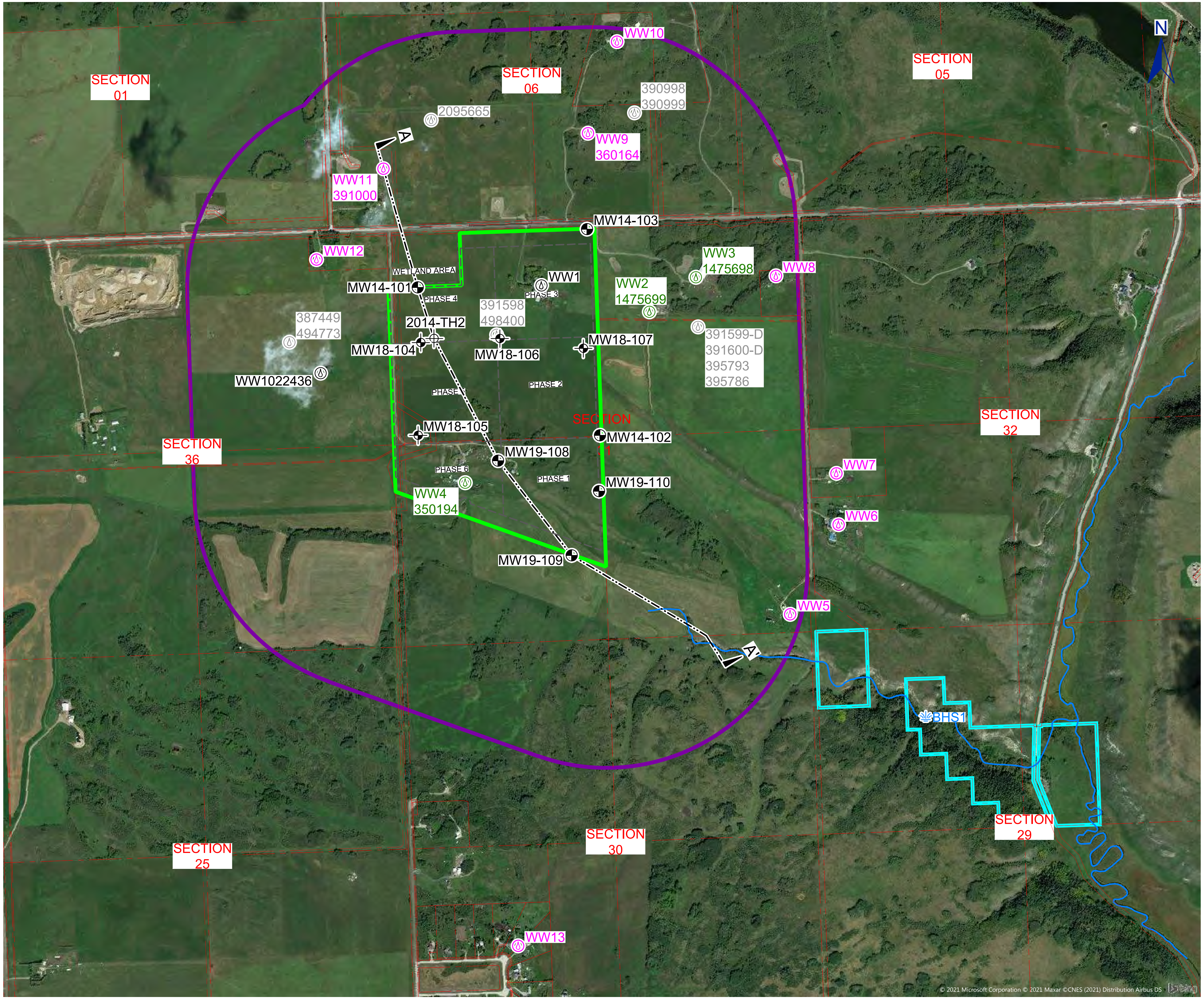
GROUNDWATER MONITORING PLAN

CURRENT AND HISTORICAL POTENTIAL SOURCES OF GROUNDWATER CONTAMINATION

Date: January 10, 2023
Project No. 212.06650.00007
Drawing No. 2

SLR

Cadfile name: S_212-06650-00007-A5.dwg



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NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY. IMAGERY DATE: SEPTEMBER 9, 2016.

LEGEND:

PROPERTY BOUNDARY
PROJECT BOUNDARY
BIG HILL SPRINGS PROVINCIAL PARK BOUNDARY
EXTRACTION (PIT) PHASE BOUNDARIES
800 m RADIUS FROM SITE
ID BOREHOLE (OTHERS)
ID BOREHOLE COMPLETED AS A MONITORING WELL
ID BOREHOLE COMPLETED AS A MONITORING WELL (OTHERS)
ID WATER WELL
ID WATER WELL (WELL PLOTTED AT QUATER SECTION CENTROID BASED ON DATABASE. EXACT LOCATION WITHIN QUARTER SECTION IS UNKNOWN)
ID-D WATER WELL (DECOMMISSIONED)
ID PREVIOUSLY SAMPLED WATER WELL TO BE INCLUDED IN MONITORING PROGRAM
ID WATER WELL TO BE ADDED TO MONITORING PROGRAM
SURFACE WATER MONITORING POINT
A A' STRATIGRAPHIC CROSS SECTION LINE

STATION ID	NORTHING	EASTING
MW14-101	5682867.5	680067.9
MW14-102	5682278.7	680793.2
MW14-103	5683099.2	680740.6
MW18-104	5682648.9	680080.8
MW18-105	5682280.0	680070.2
MW18-106	5682664.2	680394.2
MW18-107	5682625.1	680726.1
MW19-108	5682179.2	680387.3
MW19-109	5681802.5	680679.1
MW19-110	5682057.8	680788.1
WW2/1475699	5682770.4	680988.2
WW4/350194	5682091.3	680256.7

0 0.25 0.5 1.0 km

SCALE 1:15,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

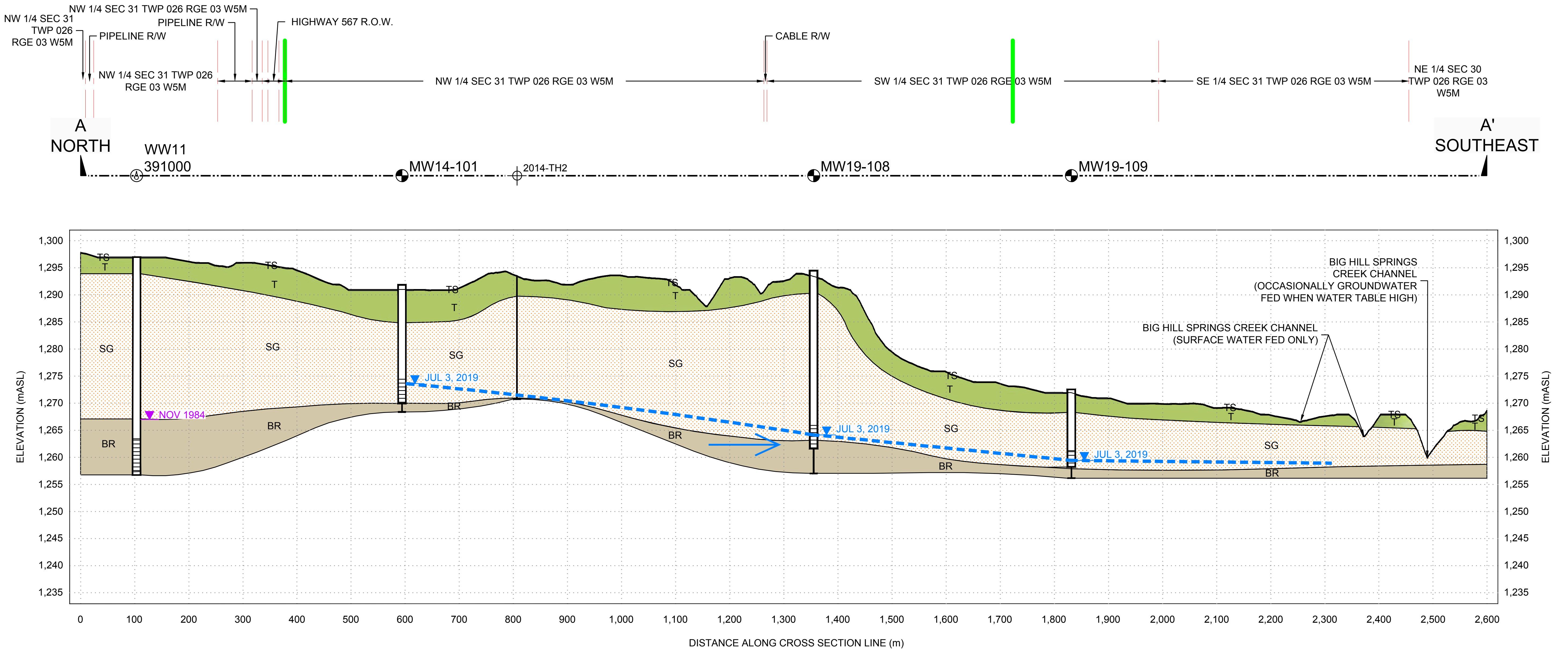
GROUNDWATER MONITORING PLAN

MONITORING WELL AND WATER WELL LOCATION PLAN

Date: January 10, 2023
Project No. 212.06650.00007
Drawing No. 3

SLR

Cadfile name: S_212-06650-00007-A5.dwg



NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

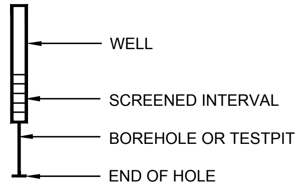
LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

LEGEND:

— · —	PROPERTY BOUNDARY
🟩	SITE LOCATION
⊕ ID	BOREHOLE (OTHERS)
◐ ID	BOREHOLE COMPLETED AS A MONITORING WELL
◎ ID	WATER WELL
▼	GROUNDWATER ELEVATION IN SAND AND GRAVEL
▼	GROUNDWATER POTENTIOMETRIC ELEVATION IN PASKAPOO FORMATION BEDROCK
- - -	INFERRED GROUNDWATER LEVEL
→	INFERRED GROUNDWATER FLOW DIRECTION

LEGEND:

A — A'	STRATIGRAPHIC CROSS SECTION A - A'
TS	TOPSOIL
T	TILL
SG	SAND AND GRAVEL
BR	BEDROCK



THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

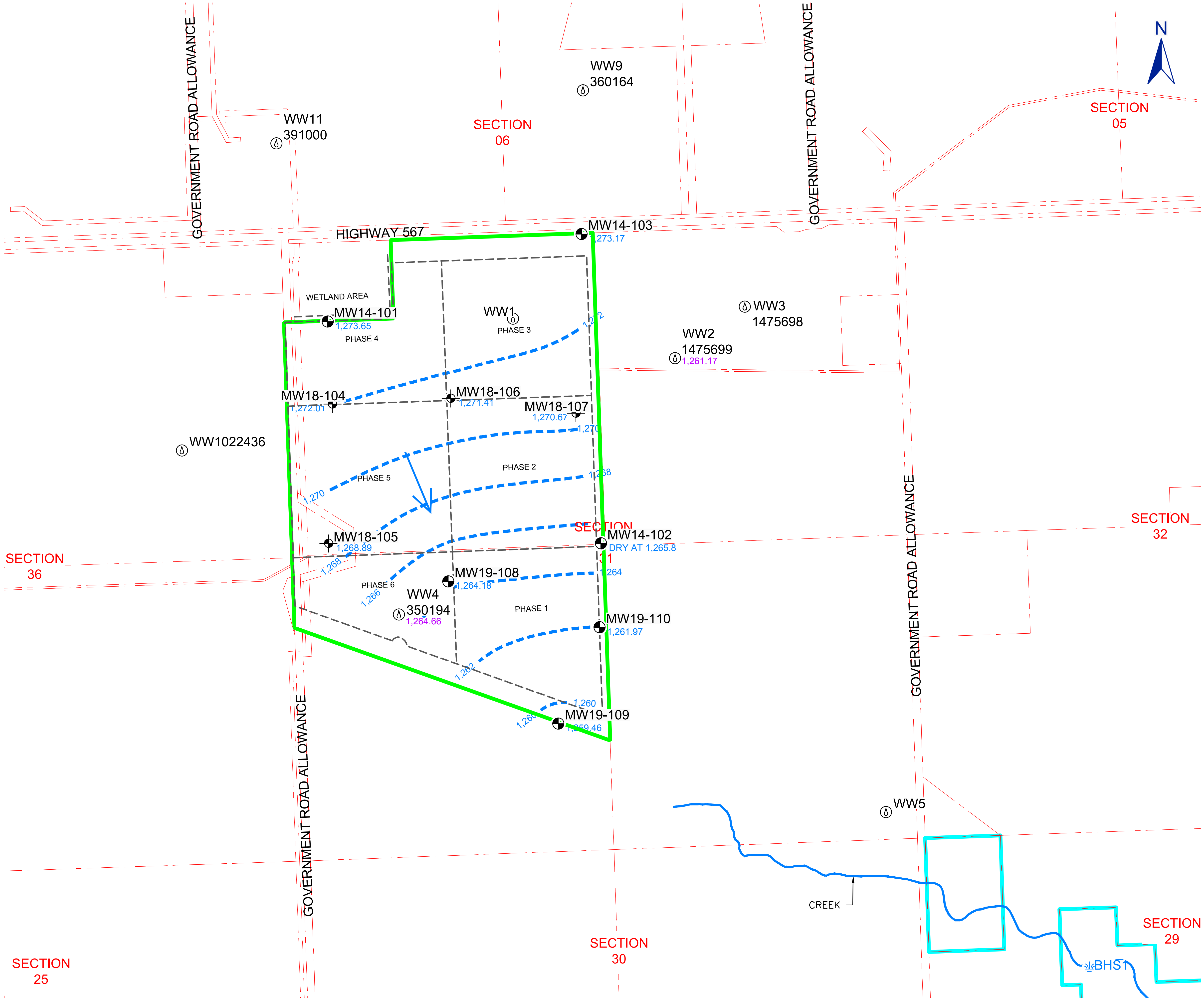
GROUNDWATER MONITORING PLAN

SCHEMATIC GEOLOGICAL SECTION A - A'

Date: January 10, 2023
Project No. 212.06650.00007
Drawing No. 4

SLR

Cadfile name: S_212-06650-00007-A5.dwg



NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

LEGEND:

— — —	PROPERTY BOUNDARY
🟩	SITE LOCATION
▭	BIG HILL SPRINGS PROVINCIAL PARK BOUNDARY
⌐ ‐ ‐ ¬	EXTRACTION PHASE BOUNDARIES
⌖ ID	BOREHOLE (OTHERS)
◐ ID	BOREHOLE COMPLETED AS A MONITORING WELL
⌖ ID	BOREHOLE COMPLETED AS A MONITORING WELL (OTHERS)
⓪ ID	WATER WELL
⚲	SURFACE WATER MONITORING POINT
	GROUNDWATER MONITORING RESULTS
1,260.73	GROUNDWATER ELEVATION IN SAND AND GRAVEL (mASL)
1,260 ‐ ‐ ‐ ‐	INFERRED GROUNDWATER ELEVATION CONTOUR IN SAND AND GRAVEL (INTERVAL 2.0 m)
→	INFERRED GROUNDWATER FLOW DIRECTION IN SAND AND GRAVEL
1,260.73	GROUNDWATER POTENTIOMETRIC ELEVATION IN PASKAPOO FORMATION BEDROCK (mASL)

WATER WELLS WITH EXACT LOCATIONS UNKNOWN ARE LISTED BELOW WITH THE LOCATIONS AVAILABLE FROM ALBERTA WELL RECORDS WHICH INDICATE LOCATIONS AT THE CENTROID OF THE 1/4 SECTIONS. THESE WATER WELLS ARE NOT SHOWN ON THE DRAWINGS.

ALBERTA WATER WELL RECORD NUMBER	LEGAL LAND LOCATION
2095665	SW 6-27-3 W5M
390998	SE 6-27-3 W5M
390999	SE 6-27-3 W5M
387449	NE 36-26-4 W5M
494773	NE 36-26-4 W5M
391598	NW 31-26-3 W5M
395786	NE 31-26-3 W5M

0 100 200 400 600 m

SCALE 1:10,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

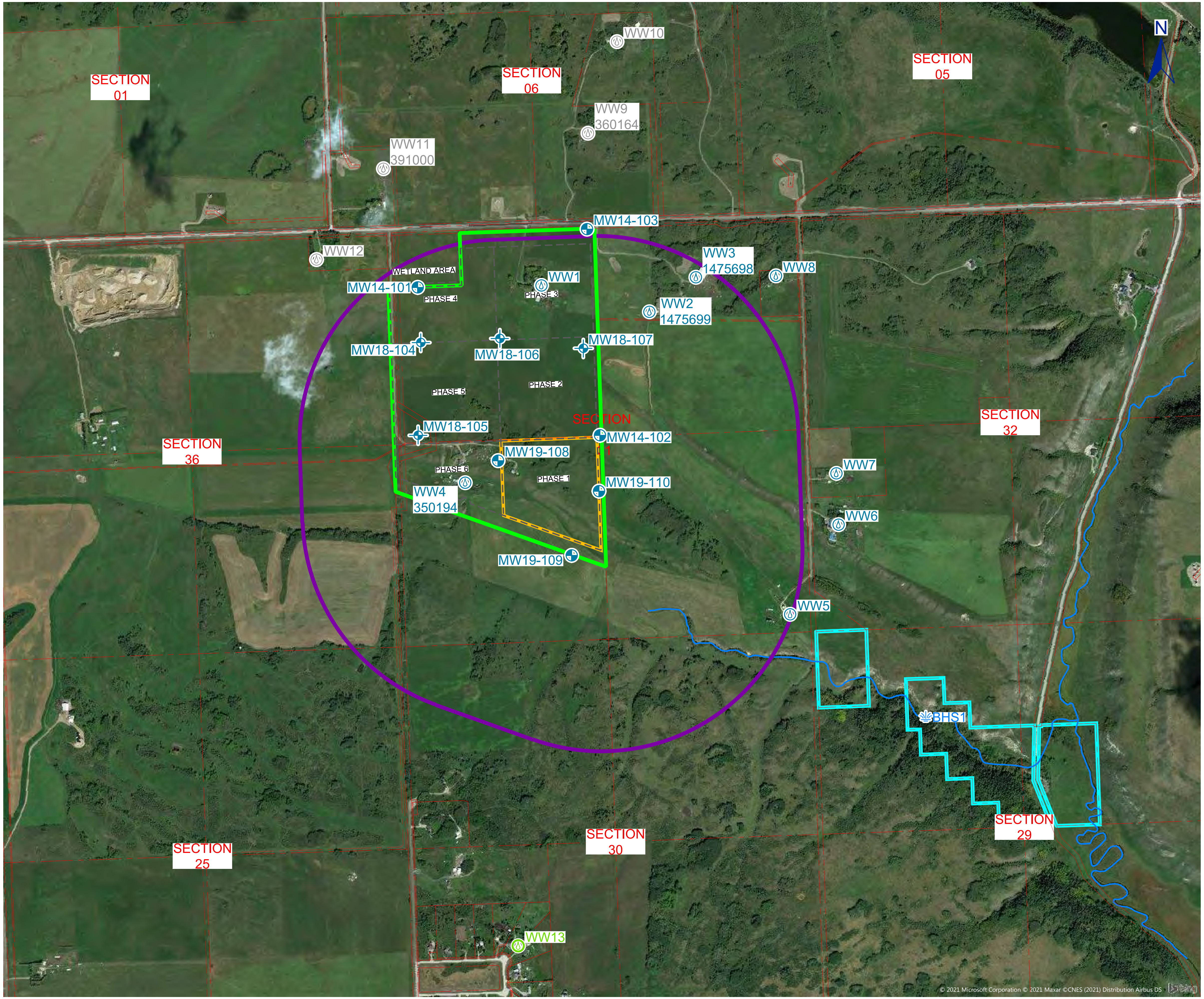
GROUNDWATER MONITORING PLAN

GROUNDWATER ELEVATIONS (JULY 3, 2019)

Date: January 10, 2023
Project No. 212.06650.00007
Drawing No. 5

SLR

Cadfile name: S_212-06650-00007-A5.dwg



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NOTES:

DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY. IMAGERY DATE: SEPTEMBER 9, 2016.

LEGEND:

— - —	PROPERTY BOUNDARY
🟩	PROJECT BOUNDARY
▭	BIG HILL SPRINGS PROVINCIAL PARK BOUNDARY
⬚	EXTRACTION (PIT) PHASE BOUNDARIES
🟧	PHASE I EXTRACTION (PIT) BOUNDARY
🟪	800 m RADIUS FROM PHASE I
◕ ID	BOREHOLE COMPLETED AS A MONITORING WELL TO BE INDLUDED IN PHASE I ROUTINE MONITORING
⌖ ID	BOREHOLE COMPLETED AS A MONITORING WELL (OTHERS) TO BE INCLUDED IN PHASE I ROUTINE MONITORING
○ ID	RESIDENTIAL WATER WELL TO BE INCLUDED IN PHASE I ROUTINE MONITORING
○ ID	RESIDENTIAL WATER WELL NOT INCLUDED IN PHASE I ROUTINE MONITORING
○ ID	ANNUAL REVIEW OF DATA COLLECTED BY OTHERS
⛲	SURFACE WATER MONITORING POINT

0 0.25 0.5 1.0 km

SCALE 1:15,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

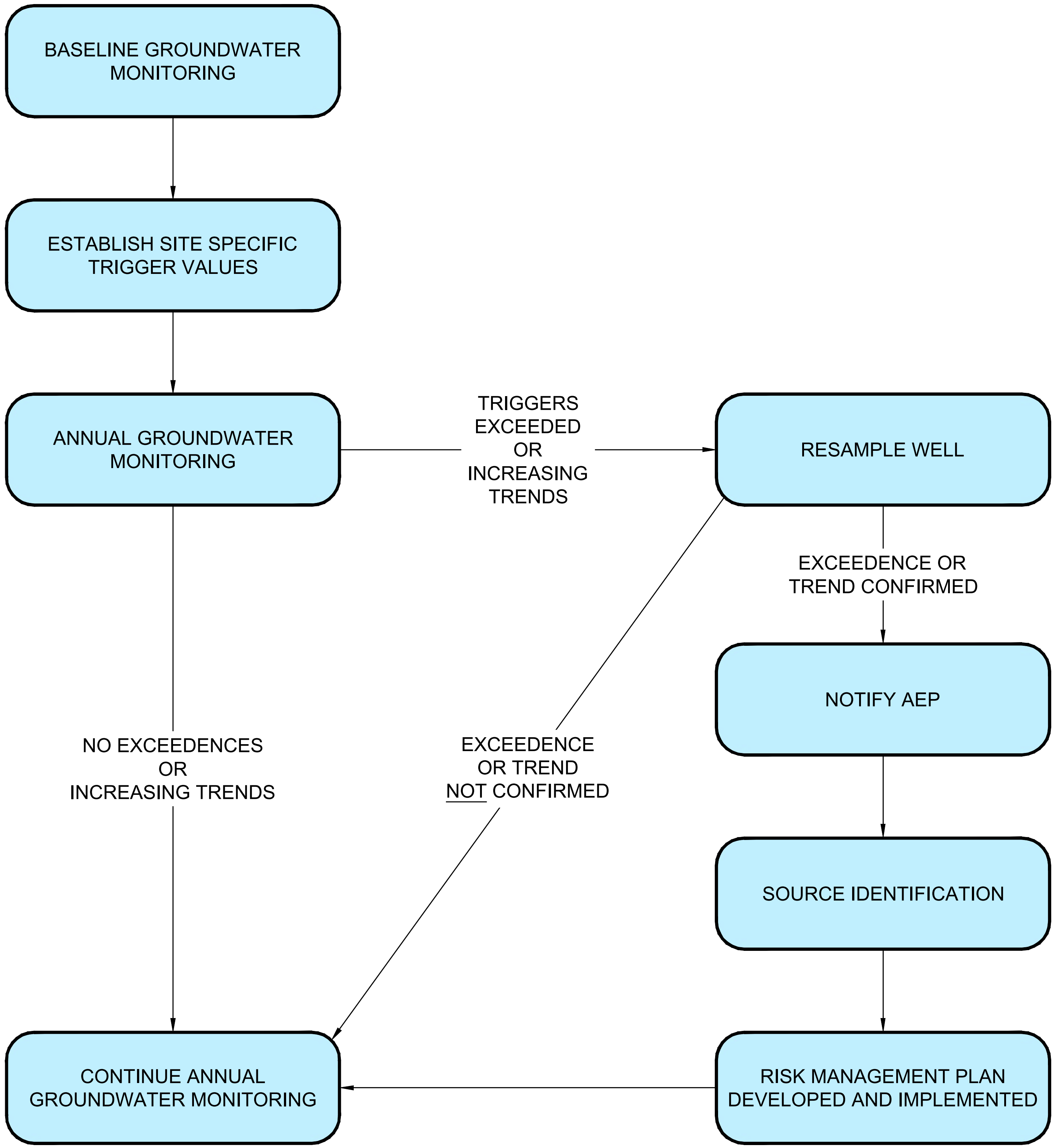
GROUNDWATER MONITORING PLAN

PHASE I MONITORING LOCATION PLAN

Date: January 10, 2023
Project No. 212.06650.00007
Drawing No. 6

SLR

Cadfile name: S_212-06650-00007-A5.dwg



NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

GROUNDWATER MONITORING PLAN

GROUNDWATER RESPONSE PLAN

Date: January 10, 2023
Project No. 212.06650.00007
Drawing No. 7

SLR

Cadfile name: S_212-06650-00007-A5.dwg

Appendix A Monitoring Well Construction Logs

Groundwater Monitoring Plan

Summit Pit Project

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00007

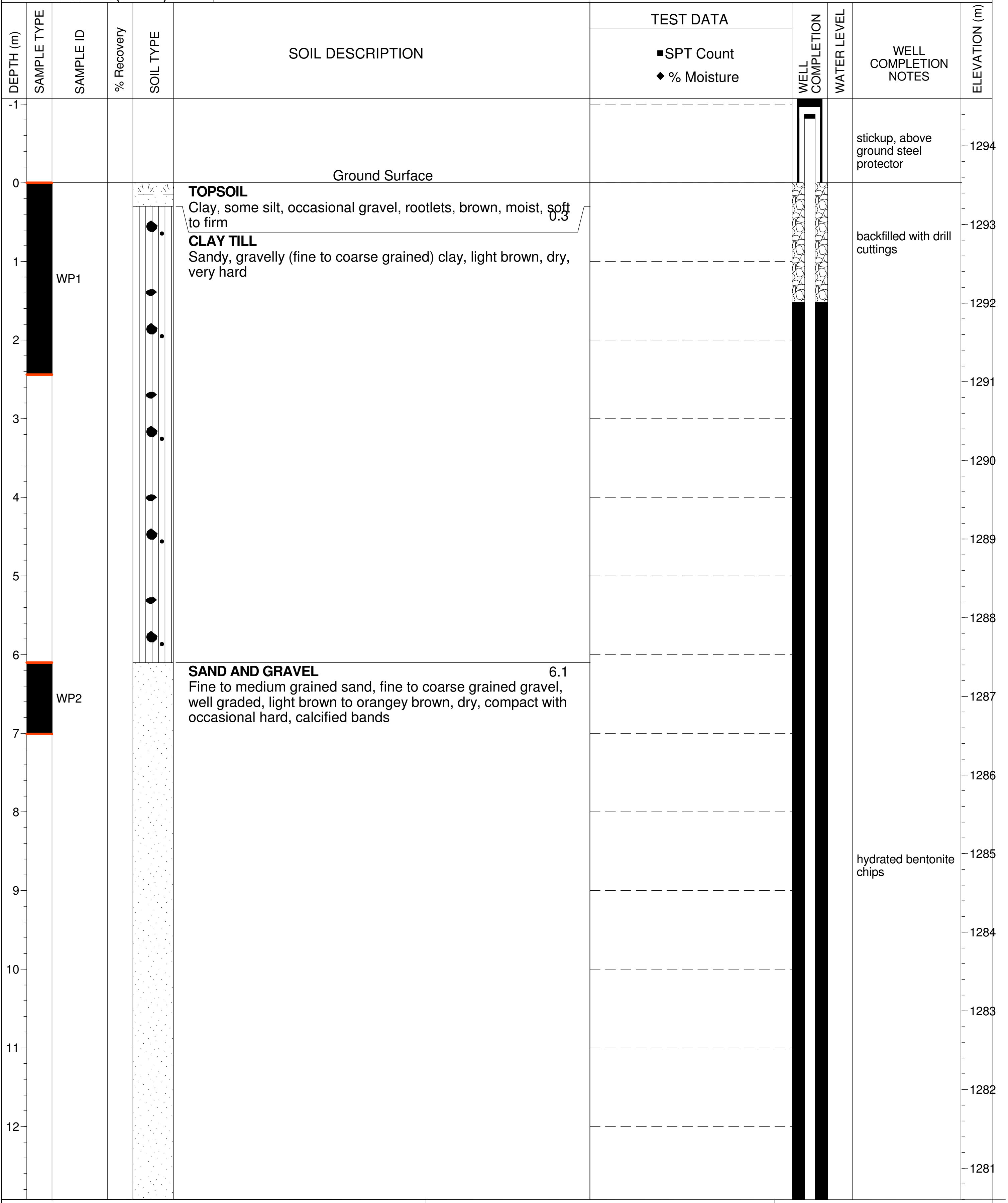
May 11, 2023

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-101
SURFACE ELEVATION: 1293.53 m
UTM COORDINATES
5682869 N
680066.4 E



Ground Surface

TOPSOIL 0.3
Clay, some silt, occasional gravel, rootlets, brown, moist, soft to firm

CLAY TILL
Sandy, gravelly (fine to coarse grained) clay, light brown, dry, very hard

SAND AND GRAVEL 6.1
Fine to medium grained sand, fine to coarse grained gravel, well graded, light brown to orangey brown, dry, compact with occasional hard, calcified bands

-1 to 0 m	stickup, above ground steel protector
0 to 1.5 m	backfilled with drill cuttings
below 1.5 m	hydrated bentonite chips

DRILLING METHOD: Becker Hammer

DRILL DATE: 30 September 2014 LOGGED BY: RT

Notes: ■ GRAB SAMPLE

Sheet 1 of 2

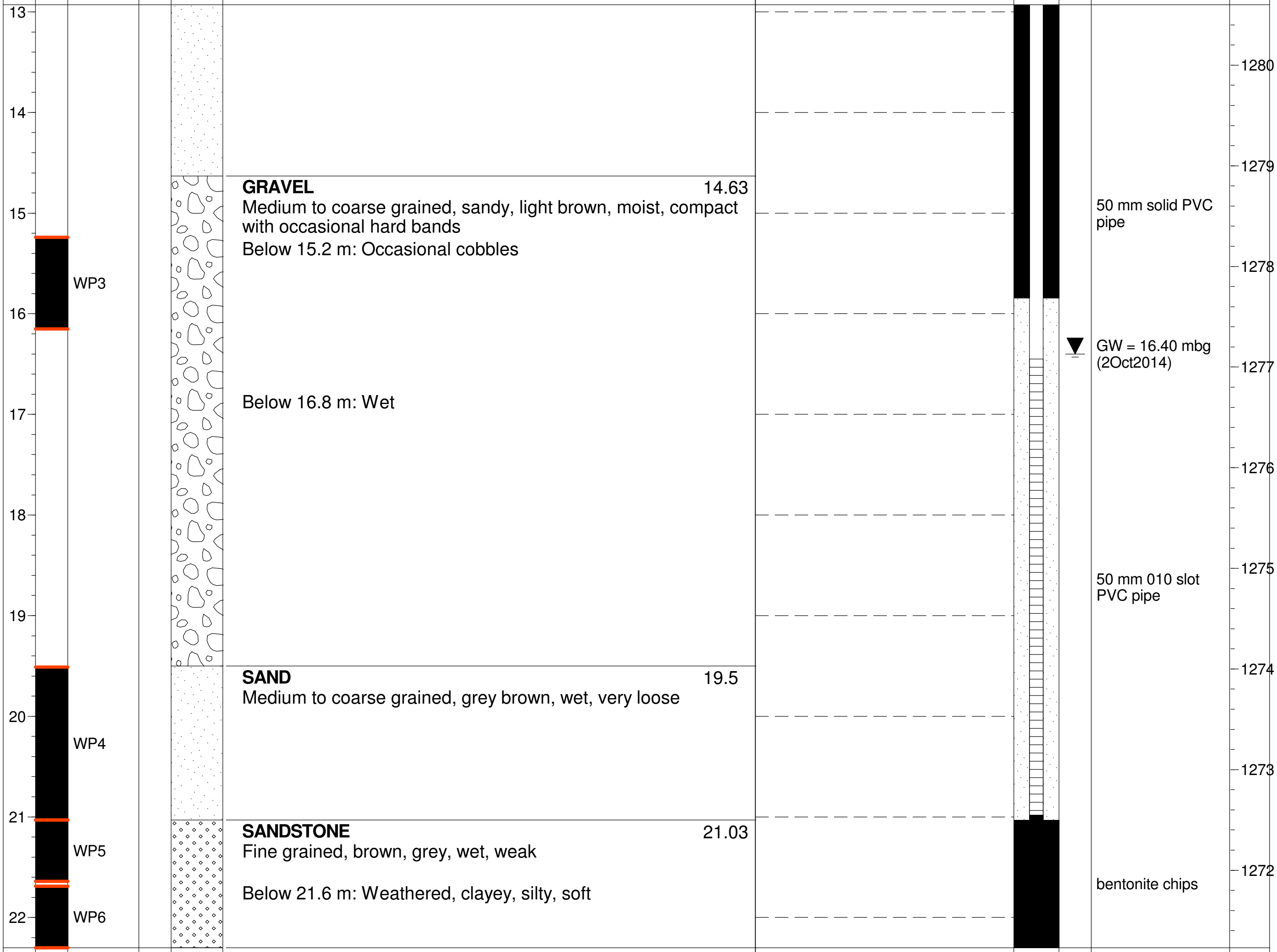
SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-101
SURFACE ELEVATION: 1293.53 m
UTM COORDINATES
5682869 N
680066.4 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
14.63					**GRAVEL** 14.63 Medium to coarse grained, sandy, light brown, moist, compact with occasional hard bands Below 15.2 m: Occasional cobbles				50 mm solid PVC pipe	
15.2–16.1	■	WP3								
16.4								▼	GW = 16.40 mbg (2Oct2014)	
16.8					Below 16.8 m: Wet					
19.5					**SAND** 19.5 Medium to coarse grained, grey brown, wet, very loose				50 mm 010 slot PVC pipe	
19.5–21.0	■	WP4								
21.03					**SANDSTONE** 21.03 Fine grained, brown, grey, wet, weak Below 21.6 m: Weathered, clayey, silty, soft				bentonite chips	
21.0–21.6	■	WP5								
21.6–22.3	■	WP6								
22.3					End of borehole at 22.3 m 22.3					



Well Completion Details:
Screened interval from 16.5 m to 21.0 m below surface
Elevation at top of pipe (TOP) = 1294.240 m

Groundwater Information:
Depth to groundwater from TOP = 17.11 m (2Oct2014)

DRILLING METHOD: Becker Hammer
DRILL DATE: 30 September 2014 LOGGED BY: RT

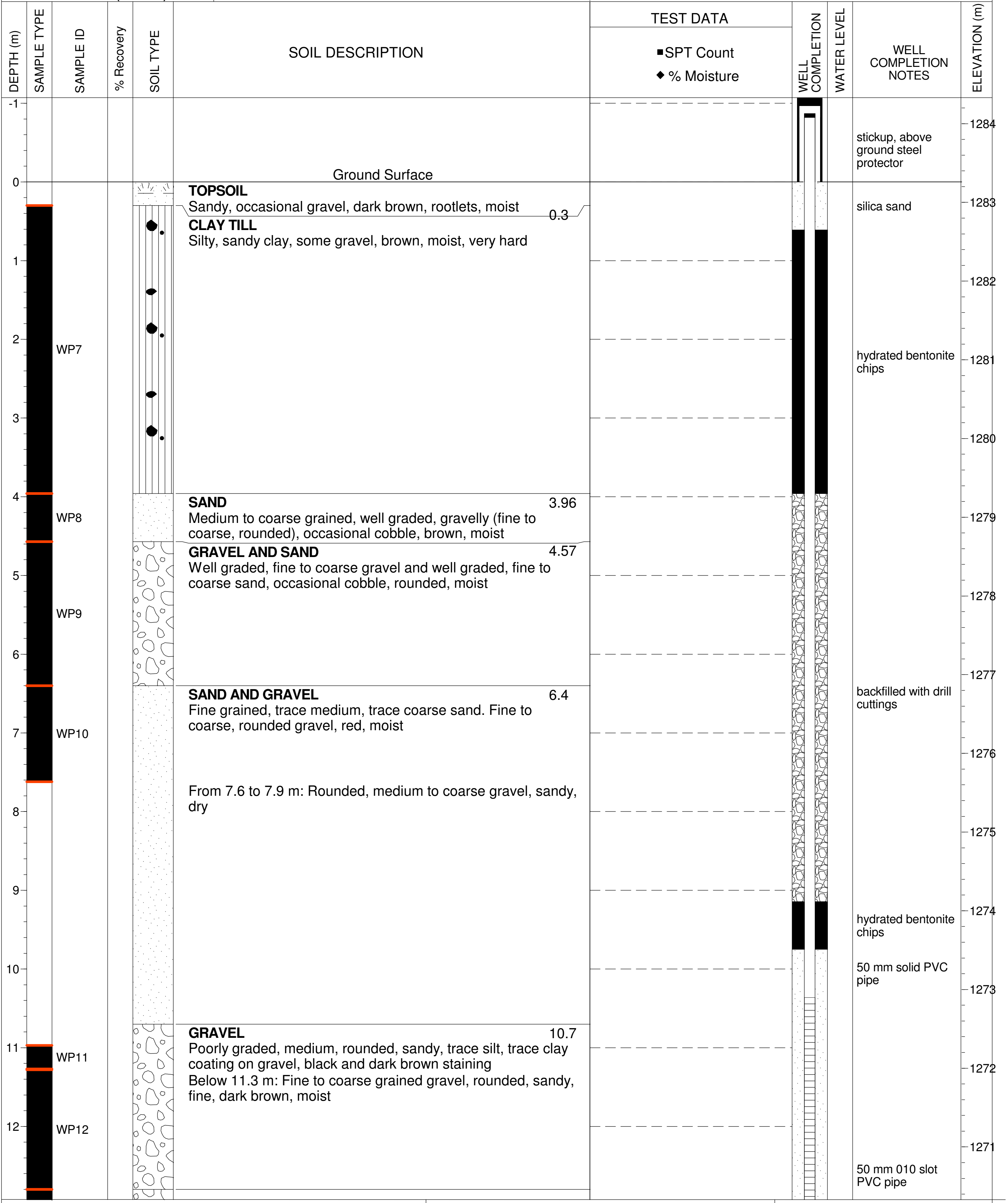
Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-102
SURFACE ELEVATION: 1283.26 m
UTM COORDINATES
5682280 N
680791.6 E



TOPSOIL
Sandy, occasional gravel, dark brown, rootlets, moist

CLAY TILL 0.3
Silty, sandy clay, some gravel, brown, moist, very hard

SAND 3.96
Medium to coarse grained, well graded, gravelly (fine to coarse, rounded), occasional cobble, brown, moist

GRAVEL AND SAND 4.57
Well graded, fine to coarse gravel and well graded, fine to coarse sand, occasional cobble, rounded, moist

SAND AND GRAVEL 6.4
Fine grained, trace medium, trace coarse sand. Fine to coarse, rounded gravel, red, moist

From 7.6 to 7.9 m: Rounded, medium to coarse gravel, sandy, dry

GRAVEL 10.7
Poorly graded, medium, rounded, sandy, trace silt, trace clay coating on gravel, black and dark brown staining
Below 11.3 m: Fine to coarse grained gravel, rounded, sandy, fine, dark brown, moist

stickup, above ground steel protector

silica sand

hydrated bentonite chips

backfilled with drill cuttings

hydrated bentonite chips

50 mm solid PVC pipe

50 mm 010 slot PVC pipe

DRILLING METHOD: Becker Hammer

DRILL DATE: 1 October 2014 LOGGED BY: MH

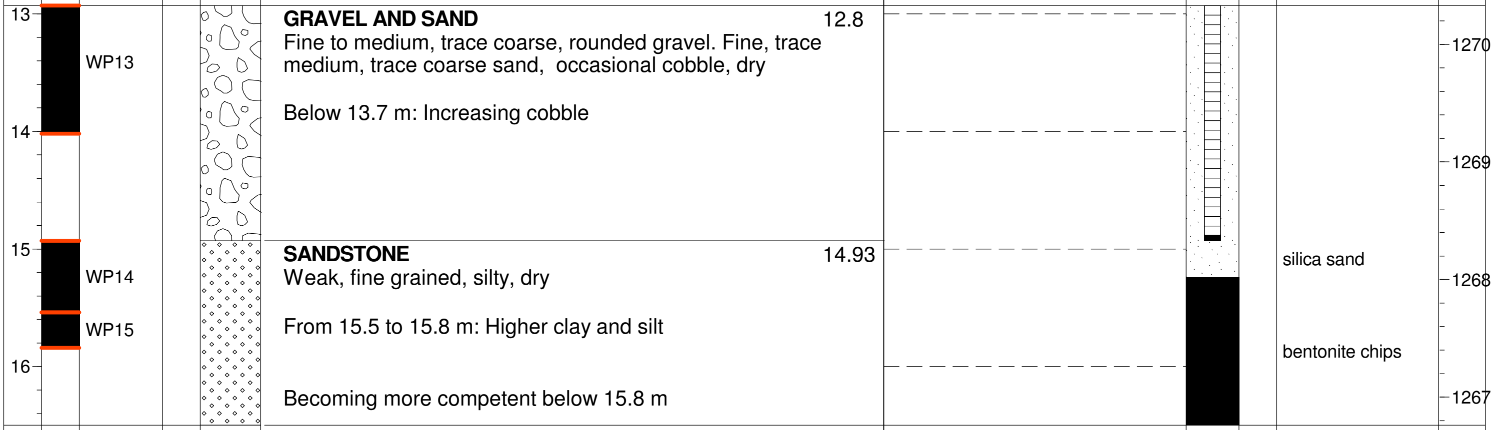
Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-102
SURFACE ELEVATION: 1283.26 m
UTM COORDINATES
5682280 N
680791.6 E



DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
13	■	WP13			**GRAVEL AND SAND** 12.8 Fine to medium, trace coarse, rounded gravel. Fine, trace medium, trace coarse sand, occasional cobble, dry Below 13.7 m: Increasing cobble					1270
14										1269
15	■	WP14 WP15			**SANDSTONE** 14.93 Weak, fine grained, silty, dry From 15.5 to 15.8 m: Higher clay and silt				silica sand	1268
16					Becoming more competent below 15.8 m				bentonite chips	1267
					End of borehole at 16.5 m 16.5 Well Completion Details: Screened interval from 10.4 m to 14.9 m below surface Elevation at top of pipe (TOP) = 1284.060 m					

DRILLING METHOD: Becker Hammer

DRILL DATE: 1 October 2014 LOGGED BY: MH

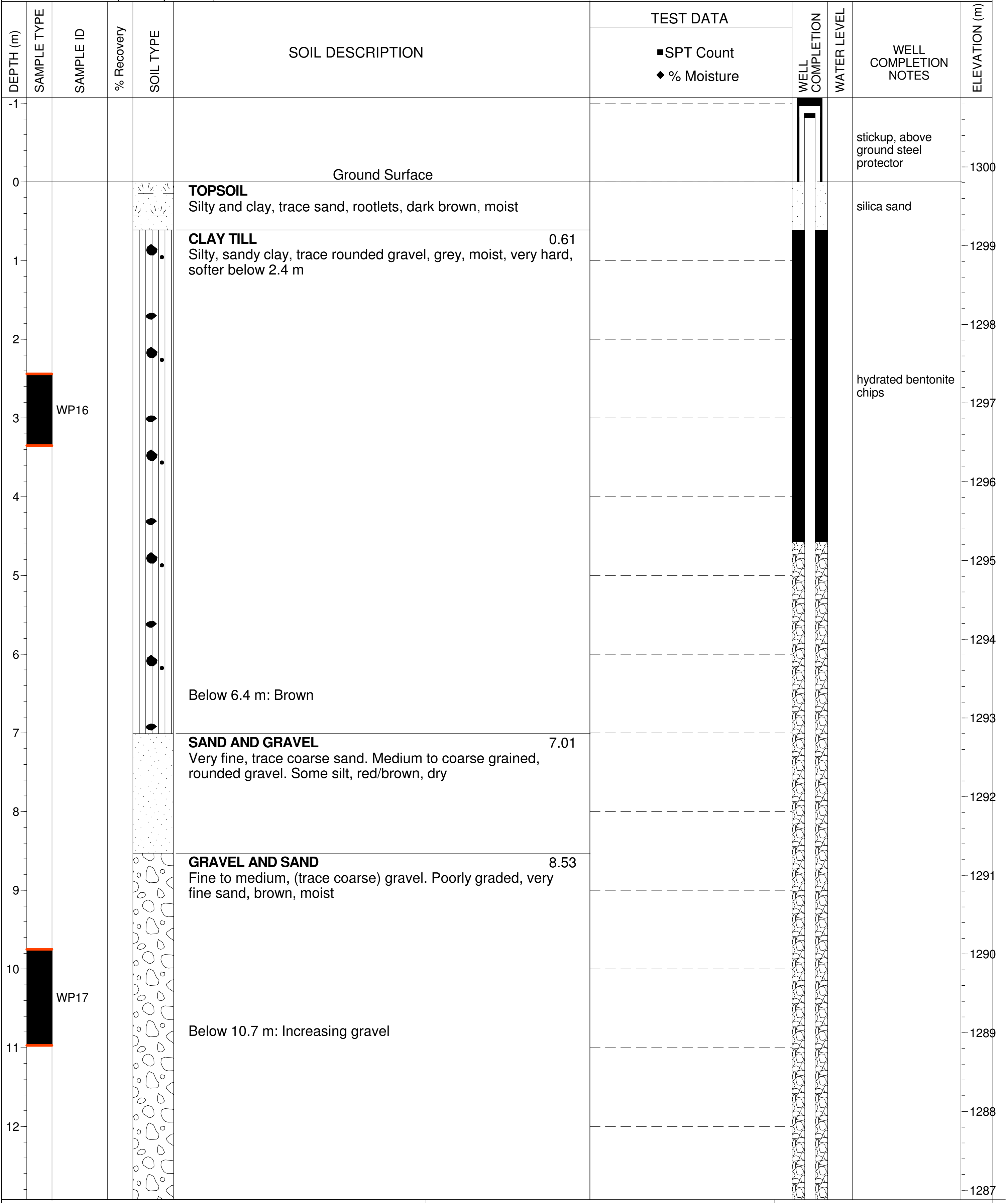
Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-103
SURFACE ELEVATION: 1299.81 m
UTM COORDINATES
5683100 N
680739 E



Ground Surface

TOPSOIL
Silty and clay, trace sand, rootlets, dark brown, moist

CLAY TILL 0.61
Silty, sandy clay, trace rounded gravel, grey, moist, very hard, softer below 2.4 m

Below 6.4 m: Brown

SAND AND GRAVEL 7.01
Very fine, trace coarse sand. Medium to coarse grained, rounded gravel. Some silt, red/brown, dry

GRAVEL AND SAND 8.53
Fine to medium, (trace coarse) gravel. Poorly graded, very fine sand, brown, moist

Below 10.7 m: Increasing gravel

stickup, above ground steel protector

silica sand

hydrated bentonite chips

DRILLING METHOD: Becker Hammer

DRILL DATE: 1 October 2014 LOGGED BY: MH

Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-103
SURFACE ELEVATION: 1299.81 m
UTM COORDINATES
5683100 N
680739 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
13					Below 12.8 m: Increasing gravel, some cobble					
									50 mm solid PVC pipe	
										1286
14					Below 14.0 m: Decreasing gravel, no cobble					
										1285
15										
										1284
16										
										1283
17					Below 16.8 m: Decreasing gravel					
										1282
18										
										1281
19	■	WP18								
					SAND AND GRAVEL 19.2 Poorly graded, very fine sand. Medium with trace fine and trace coarse gravel. Occasional cobble, red/brown, moist					
										1280
20										
										1279
21										
					Below 21.3 m: Increasing gravel					
										1278
22										
										1277
23										
					Below 23.2 m: 0.08 m clay lens					
								▼	GW = 23.49 mbg (2Oct2014)	
										1276
24										
									50 mm 010 slot PVC pipe	1275
25										
	■	WP19			Below 25.3 m: Wet gravel, very angular					
										1274
26										
										1273

DRILLING METHOD: Becker Hammer

DRILL DATE: 1 October 2014 LOGGED BY: MH

Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-103
SURFACE ELEVATION: 1299.81 m
UTM COORDINATES
5683100 N
680739 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
27										
									silica sand	
	■	WP20			**WEATHERED SILTSTONE** 27.4				hydrated bentonite chips	
	■	WP21			Clay and silt, some sand, grey with red striations, moist Below 27.7 m: Siltstone, grey, dry 27.7					

End of borehole at 27.7 m

Well Completion Details:
Screened interval from 22.6 m to 27.1 m below surface
Elevation at top of pipe (TOP) = 1300.720 m

Groundwater Information:
Depth to groundwater from TOP = 24.40 m (2Oct2014)

DRILLING METHOD: Becker Hammer

DRILL DATE: 1 October 2014 LOGGED BY: MH

Notes: ■ GRAB SAMPLE

MW18-104

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-06*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,650.0
EASTING: 680,079.0
ELEVATION: 1,294.0
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-26-18*
DATE COMPLETED: *06-26-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4*
EST. WL (m): *21.9m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
0		0.3	topsoil					0
		0.9	silty till			1	1	
		1.8	clay till, stiff			2	2	
5		3.0	sandy gravel, medium to fine sand thin clayey seam @ 5.6m	28.5	16.9	3 4	3 4	5
		1.8	sandy gravel, medium to fine sand	31.6	22	5	5	
		0.3	clay seam, moist	25.5	18.4			
		0.9	silty gravel, fine sand, dry	31.9	12.5	6	6	
10		1.2	gravel, clay, fine sand, moist	28.1	24.7	7	7	10
		0.3	clay seam					
		2.1	gravel, fine to medium sand, silty, poorly graded consolidated thin silt seams.	30.6	19.1	8	8	

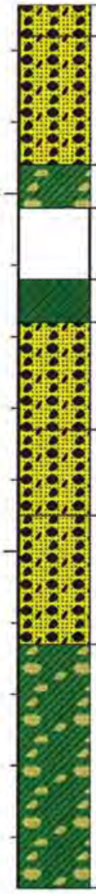
MW18-104

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: CALGARY
COUNTY: ROCKY VIEW
PROVINCE: ALBERTA
LOCATION: MOUNTAIN ASH
LOGGED BY: D.B.

BORING ID: MA-18-06
COORD. SYS: WGS84 - UTM ZONE 11N
RIG: B.L. - Track Mounted
NORTHING: 5,682,650.0
EASTING: 680,079.0
ELEVATION: 1,294.0
TOTAL DEPTH: 27.4m

DRILL METHOD: SONIC
DATE STARTED: 06-26-18
DATE COMPLETED: 06-26-18
TYPE SAMPLE: 4.0" CORE
CASED TO: 27.4
EST. WL (m): 21.9m



Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
		1.8	gravel, fine to medium sand, silty, poorly graded consolidated thin silt seams. 	29.7	17.5	9 10	9 10	
15		0.6	gravel, clay, fine sand, moist	33.7	11.4			15
		0.9	lost core, wet, likely saturated			11	11	
		0.6	clay, gravel	21.7	11.7			
		1.5	gravel, silt, fine sand, cobbles, poorly graded dry	24.3	19.8	12	12	
		1.2	gravel, silt/clay, fine sand, wet	22.4	19.5	13	13	
20		1.8	gravel, silt, fine sand, cobbles, poorly graded dry	18.5	25.8	14	14	20
		3.7	clay with sand and gravel, wet	25.8	17.6	15 16	15 16	

MW18-104

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-06*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,650.0
EASTING: 680,079.0
ELEVATION: 1,294.0
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-26-18*
DATE COMPLETED: *06-26-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4*
EST. WL (m): *21.9m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
25	🟩	2.4	siltstone			17	17	25
						18	18	

MW18-105

SAND & GRAVEL EXPLORATION LOG

PROPERTY:		**BORING ID:**	*MA-18-11*		
PLANT:	*CALGARY*	**COORD. SYS:**	*WGS84 - UTM ZONE 11N*	**DRILL METHOD:**	*SONIC*
COUNTY:	*ROCKY VIEW*	**RIG:**	*B.L. - Track Mounted*	**DATE STARTED:**	*06-25-18*
PROVINCE:	*ALBERTA*	NORTHING:	5,682,281.0	**DATE COMPLETED:**	*06-25-18*
LOCATION:	*MOUNTAIN ASH*	EASTING:	680,070.0	**TYPE SAMPLE:**	*4.0" CORE*
LOGGED BY:	*D.B.*	ELEVATION:	1,294.0	**CASED TO:**	*27.4m*
		TOTAL DEPTH:	*27.4m*	**EST. WL (m):**	*24.4m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
0	🟩	1.5	dry silt, becoming hard and consolidated			1	1	0
	🟨	2.4	clay till, hard, stiff			2 3	2 3	
5	🟨	2.1	sandy gravel, moderately to poorly graded sand / silt dry	34.1	23.2	4	4	5
	🟨	1.5	gravel, fine sand and silt, cobbles saturated from 6.7m to 7.6m, thin (<100mm) clay lense at bottom	28.2	24.9	5	5	
10	🟨	2.4	sandy gravel, moderately graded, some coarse sand dry	27.6	14.2	6 7	6 7	10
	🟨	0.6	sand, fine to medium, with silt, trace gravel consolidated, dry	1	0			
	🟨	0.9	gravel ,silt, clay seam at 11.6m saturated	42.6	20	8	8	
	🟨	0.6	sandy gravel, moderately graded, some coarse sand damp, use 25-33' as reference sample					
	🟩		clay, with sand and gravel, sticky					

MW18-105

2 OF 3

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: CALGARY
COUNTY: ROCKY VIEW
PROVINCE: ALBERTA
LOCATION: MOUNTAIN ASH
LOGGED BY: D.B.

BORING ID: MA-18-11
COORD. SYS: WGS84 - UTM ZONE 11N
RIG: B.L. - Track Mounted
NORTHING: 5,682,281.0
EASTING: 680,070.0
ELEVATION: 1,294.0
TOTAL DEPTH: 27.4m

DRILL METHOD: SONIC
DATE STARTED: 06-25-18
DATE COMPLETED: 06-25-18
TYPE SAMPLE: 4.0" CORE
CASED TO: 27.4m
EST. WL (m): 24.4m

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
	🟩	1.5	clay, with sand and gravel. sticky			9	9	
15	🟨	1.5	gravel, silty to sandy, damp at bottom	34.4	18	10	10	15
	🟩	1.8	gravel, higher clay content, damp	27.6	17.6	11	11	
20	🟨	3.0	gravel, sand, silt consolidated	23.3 25.2	24.4 17.6	12 13	12 13	20
	🟨	1.2	gravel, silt, sand, clay seams (<100mm thick)			14	14	
	🟨	3.0	coarse gravel, some sand, silt, poorly graded consolidated, dry	20.3	22.3	15 16	15 16	
	🟩		gravel, clay, sand	28.6	26.5			

MW18-105

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-11*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,281.0
EASTING: 680,070.0
ELEVATION: 1,294.0
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-25-18*
DATE COMPLETED: *06-25-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *24.4m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
25	▨	1.2	wet			17	17	25
	🟩	1.8	siltstone			18	18	

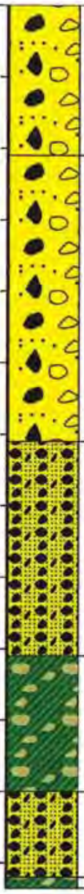
MW18-106

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-07*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,664.0
EASTING: 680,393.0
ELEVATION: 1,287.8
TOTAL DEPTH: *19.8m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-26-18*
DATE COMPLETED: *06-26-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *19.8m*
EST. WL (m): *15.2m*



Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
0		2.1	silty till, unconsolidated, tan			1	1	0
5		4.0	clay till, very stiff, hard, brown			2 3 4	2 3 4	5
		3.0	gravel, silty, poorly graded fine sand, some cobble, tan consolidated thin silt seams	37.2	19.3	5 6	5 6	
10		1.8	gravel, clay, fine sand, brown, wet	21.2	23.2	7	7	10
		1.2	gravel, silty, poorly graded fine sand, some cobble, tan dry	21.9	24.6	8	8	
			gravel, silt and clay, clay-rich seams					

MW18-106

2 OF 2

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-07*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,664.0
EASTING: 680,393.0
ELEVATION: 1,287.8
TOTAL DEPTH: *19.8m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-26-18*
DATE COMPLETED: *06-26-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *19.8m*
EST. WL (m): *15.2m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
	▨	1.5	gravel, silt and clay, clay-rich seams wet			9	9	
	🟨	1.5	gravel, silty, poorly graded fine sand, some cobble - increasing with depth, tan dry, getting wet near the bottom of run	30.3	24.1	10	10	
15	🟨	3.0	gravel, silt and clay, fine sand, medium sand seam (>150mm) @ 16.5m wet	11.7	47.3	11	11	15
						12	12	
	🟩	0.6	siltstone			13	13	
	🟨	0.6	sand and gravel, wet					
	🟩	0.3	siltstone / claystone					

MW18-107

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-08*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,628.0
EASTING: 680,724.0
ELEVATION: 1,292.1
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-28-18*
DATE COMPLETED: *06-28-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *21.3m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
0	🟨	3.0	silty till			1 2	1 2	0
	🟨	1.8	clay till, stiff, hard			3	3	
5	🟨	1.2	sandy gravel, fine to medium sand, moderately graded, brown	44.9	16	4	4	5
	🟨	2.1	gravel, fine sand, brown, wet	28.1	35.1	5	5	
	🟩	0.6	clay, some gravel	25.9	7.7	6	6	
	🟨	0.9	gravel, silt, fine sand, poorly graded, tan to brown dry,	37.9	14.7			
10	🟩	0.9	gravel, clay/silt, cobbles, brown wet	30.6	25.5	7	7	10
	🟨	1.5	sandy gravel, fine to medium sand, moderately graded, brown dry	48.8	12.3	8	8	
	🟩		gravel, clay/silt, cobbles, brown					

MW18-107

2 OF 3

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-08*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,628.0
EASTING: 680,724.0
ELEVATION: 1,292.1
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-28-18*
DATE COMPLETED: *06-28-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *21.3m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
	🟩	1.2	gravel, clay/silt, cobbles, brown wet			9	9	
	🟨	1.8	gravel, silt, fine sand, consolidated, dry	31	15.5	10	10	
15	🟩	1.8	gravel, fine sand, clay, some cobble wet to saturated	27.7	24.6	11	11	15
	🟨	1.2	gravel, silt, fine sand, poorly graded dry	31.6	19.6	12	12	
	🟩	1.2	clayey sand and gravel, cobbles, wet	20.8	23.2	13	13	
20	🟨	1.8	gravel, silt, fine sand, some cobble, consolidated, damp	35	23.8	14	14	20
	🟨	3.4	gravel, silty, fine sand, saturated	26.4	39.9	15 16	15 16	

MW18-107

3 OF 3

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-08*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,628.0
EASTING: 680,724.0
ELEVATION: 1,292.1
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-28-18*
DATE COMPLETED: *06-28-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *21.3m*

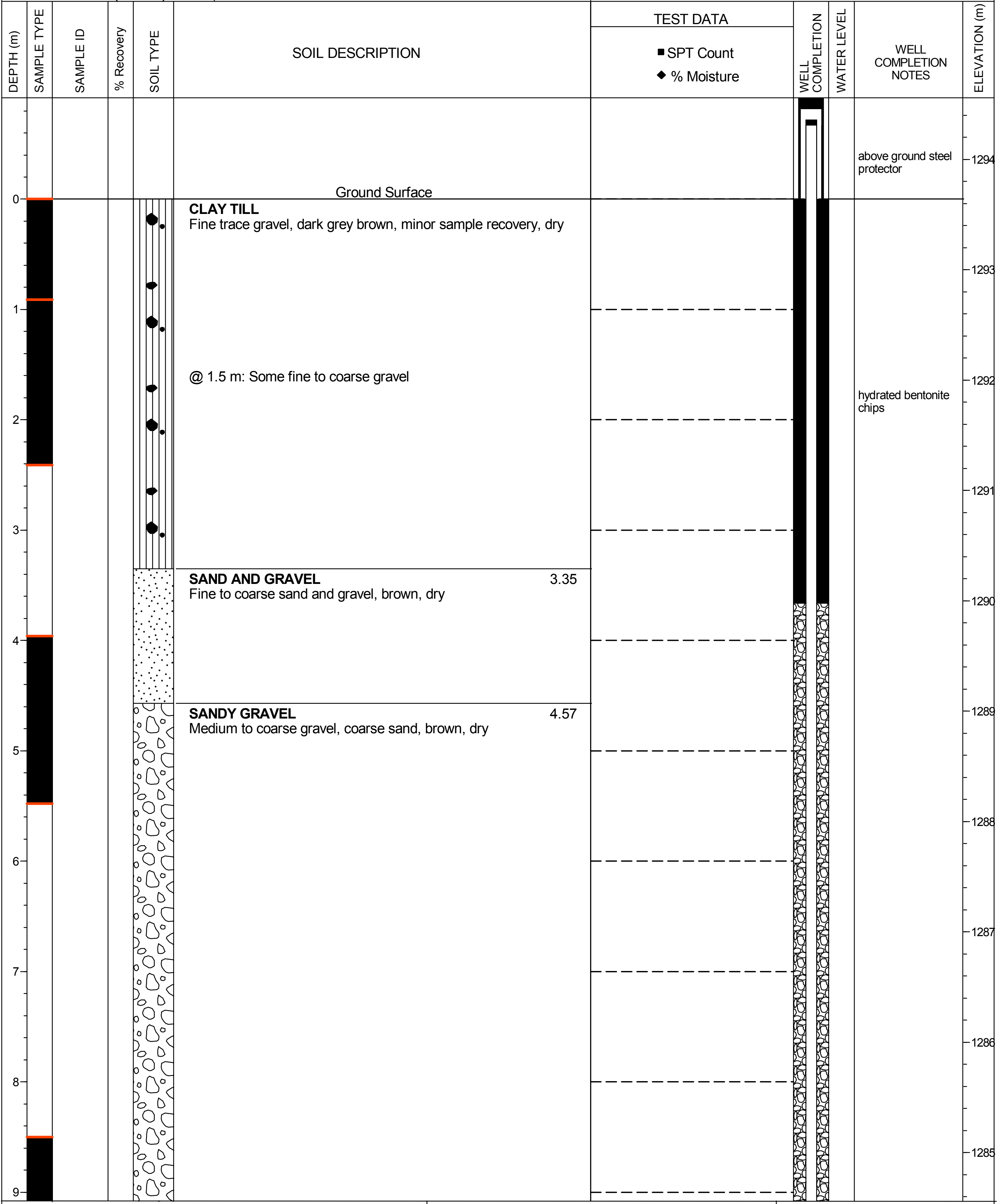
Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
25	🟩	2.7	claystone			17	17	25
						18	18	

SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-108
SURFACE ELEVATION: 1293.64 m
UTM COORDINATES
680386 N
5682182 E



Ground Surface

CLAY TILL
Fine trace gravel, dark grey brown, minor sample recovery, dry

@ 1.5 m: Some fine to coarse gravel

SAND AND GRAVEL 3.35
Fine to coarse sand and gravel, brown, dry

SANDY GRAVEL 4.57
Medium to coarse gravel, coarse sand, brown, dry

above ground steel protector

hydrated bentonite chips

DRILLING METHOD: Sonic/Odex

DRILL DATE: June 3, 2019

LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 1 of 4

SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-108
SURFACE ELEVATION: 1293.64 m

UTM COORDINATES
680386 N
5682182 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
	■				**GRAVELLY SAND** 9.14 Fine to coarse sand and gravel, yellow brown, dry					1284
10										1283
11										1282
12										1281
13										1280
14										1279
15										1278
16									slough and backfill	1277
17										1276
18										1275
19										

DRILLING METHOD: Sonic/Odex

DRILL DATE: June 3, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-108
SURFACE ELEVATION: 1293.64 m
UTM COORDINATES
680386 N
5682182 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
					@ 19.2 m: Trace silt present to 20.7 m					
										1274
20										
										1273
21										
										1272
22										
										1271
23										
										1270
24										
										1269
25										
										1268
26										
										1267
					SAND 26.8 Some gravel, brown, fine to coarse sand and gravel, dry					
27										
										1266
28										
										1265
29										

DRILLING METHOD: Sonic/Odex

DRILL DATE: June 3, 2019
LOGGED BY: NY

Notes: ■ GRAB SAMPLE

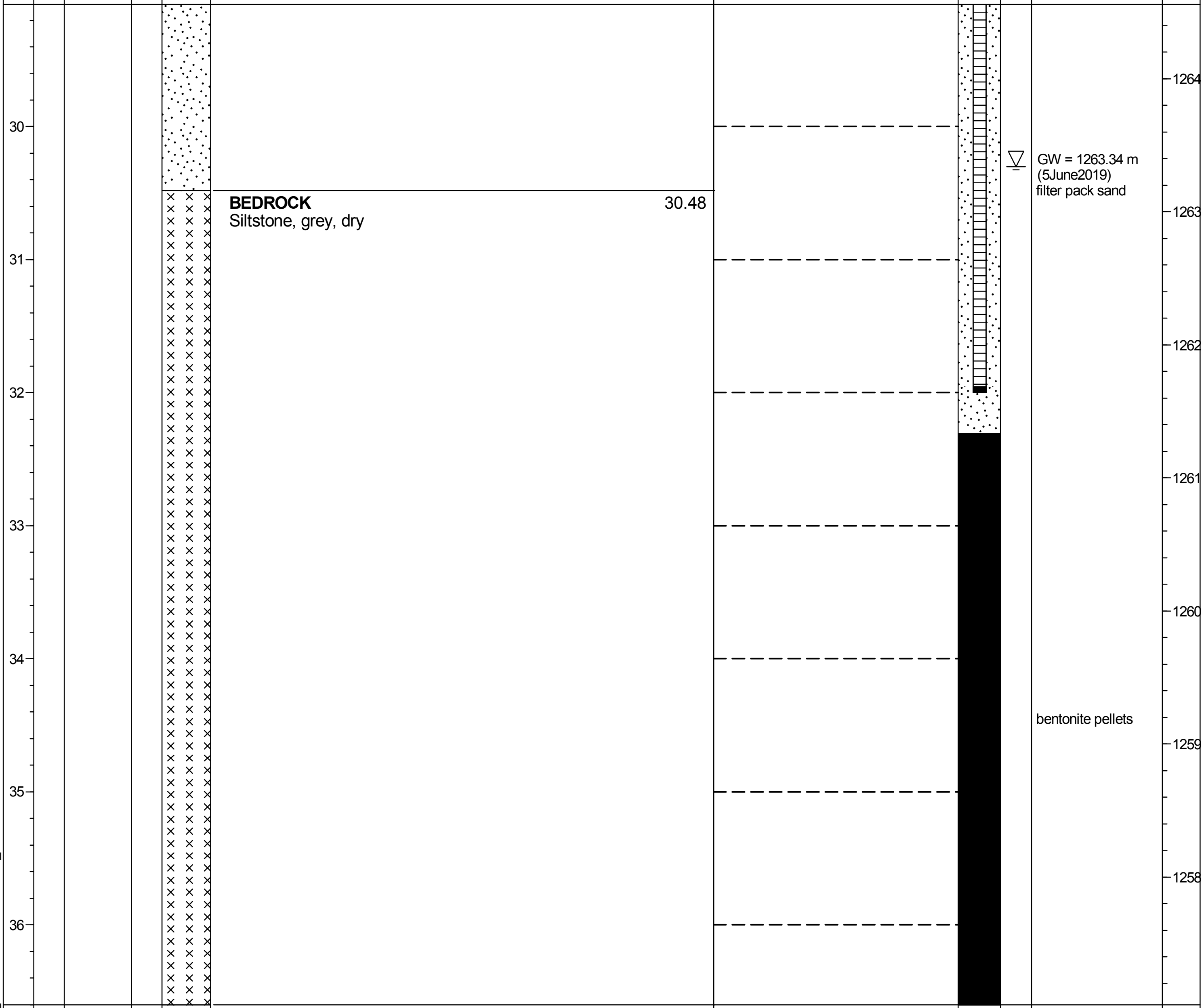
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-108
SURFACE ELEVATION: 1293.64 m
UTM COORDINATES
680386 N
5682182 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
30.48					**BEDROCK** Siltstone, grey, dry			∇	GW = 1263.34 m (5June2019) filter pack sand	
									bentonite pellets	
36.6					End of borehole at 36.6 m					



DRILLING METHOD: Sonic/Odex

DRILL DATE: June 3, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 4 of 4

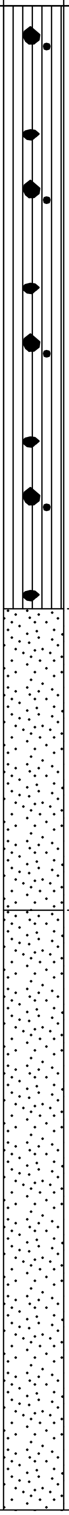
SLR CONSULTING (CANADA) LTD.

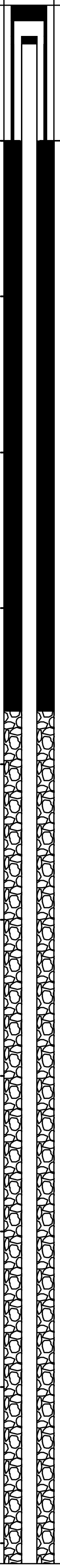
CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-109
SURFACE ELEVATION: 1271.68 m
UTM COORDINATES
5681803 N
680679 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
									above ground steel protector	1272
0					Ground Surface					
0					**CLAY TILL** Trace fine gravel, dark brown, moist					
										1271
1										
					@ 1.5 m: Some fine gravel					
									hydrated bentonite chips	1270
2										
										1269
3										
3.66					**SAND AND GRAVEL** Coarse sand, fine to coarse gravel, grey brown, dry					1268
4										
										1267
5										
5.49					**GRAVELLY SAND** Fine to coarse gravel and sand, grey brown, dry					1266
6										
										1265
7									slough and backfill	
										1264
8										
										1263
9										





DRILLING METHOD: ODEX Air Rotary Drilling
DRILL DATE: June 4, 2019
LOGGED BY: NY

Notes:

Sheet 1 of 2

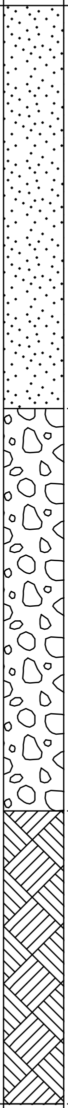
SLR CONSULTING (CANADA) LTD.

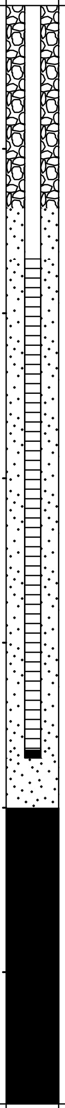
CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-109
SURFACE ELEVATION: 1271.68 m
UTM COORDINATES
5681803 N
680679 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
11.58					**SANDY GRAVEL** Fine to coarse gravel and sand, grey brown, dry			∇	filter pack sand GW = 1259.36 m (5June2019)	
14.02					**BEDROCK** Could not determine lithology with minimal returns				bentonite pellets	
15.8					End of borehole at 15.8 m					





Groundwater Information:
Depth to groundwater from TOP = 12.32 m (5June2019)

DRILLING METHOD: ODEX Air Rotary Drilling
DRILL DATE: June 4, 2019
LOGGED BY: NY

Notes:

Sheet 2 of 2

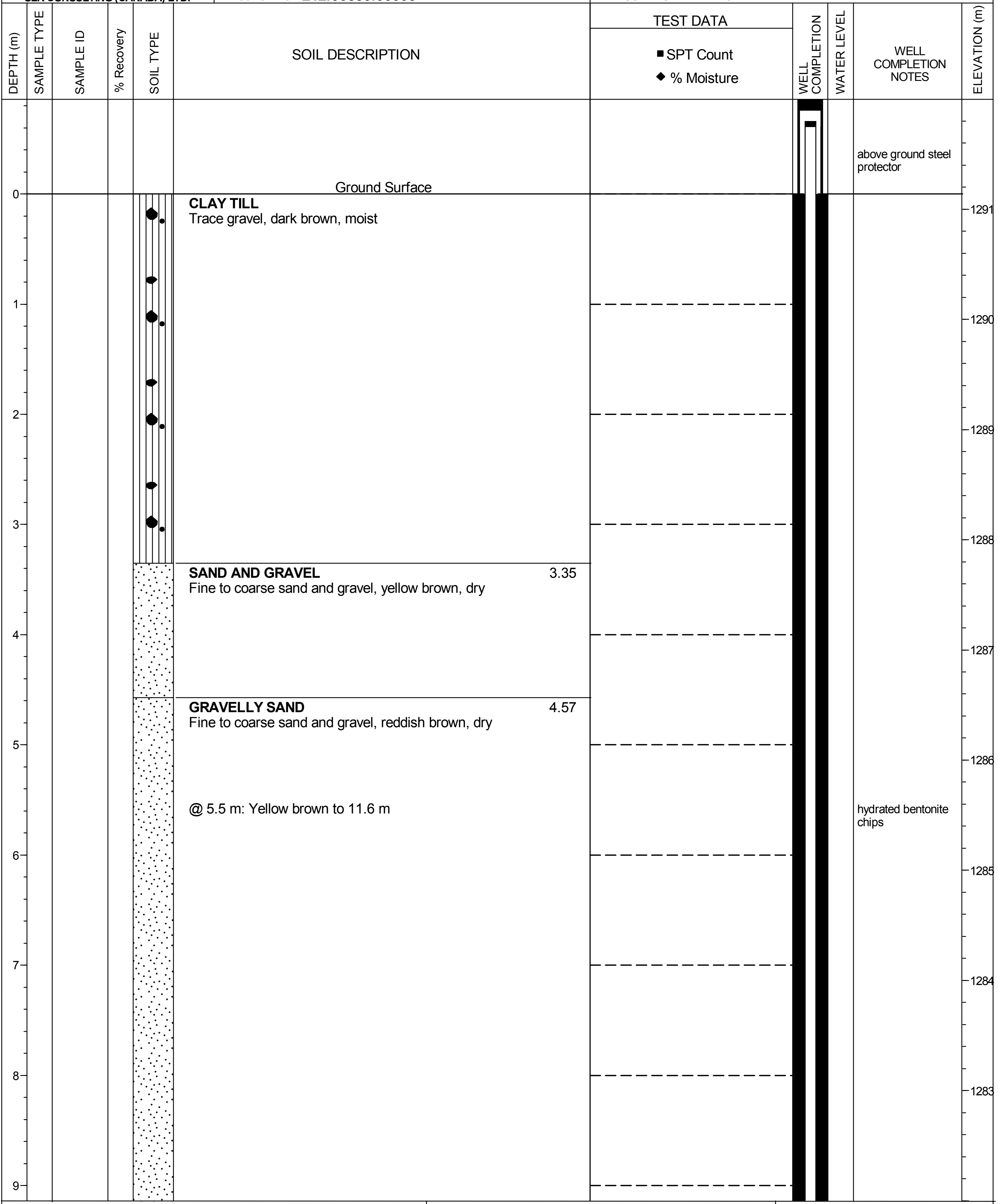
SLR

SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-110
SURFACE ELEVATION: 1291.14 m
UTM COORDINATES
5682058 N
680788 E



Ground Surface

CLAY TILL
Trace gravel, dark brown, moist

SAND AND GRAVEL 3.35
Fine to coarse sand and gravel, yellow brown, dry

GRAVELLY SAND 4.57
Fine to coarse sand and gravel, reddish brown, dry

@ 5.5 m: Yellow brown to 11.6 m

above ground steel protector

hydrated bentonite chips

DRILLING METHOD: ODEX Air Rotary Drilling

DRILL DATE: June 4, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 1 of 4

SLR

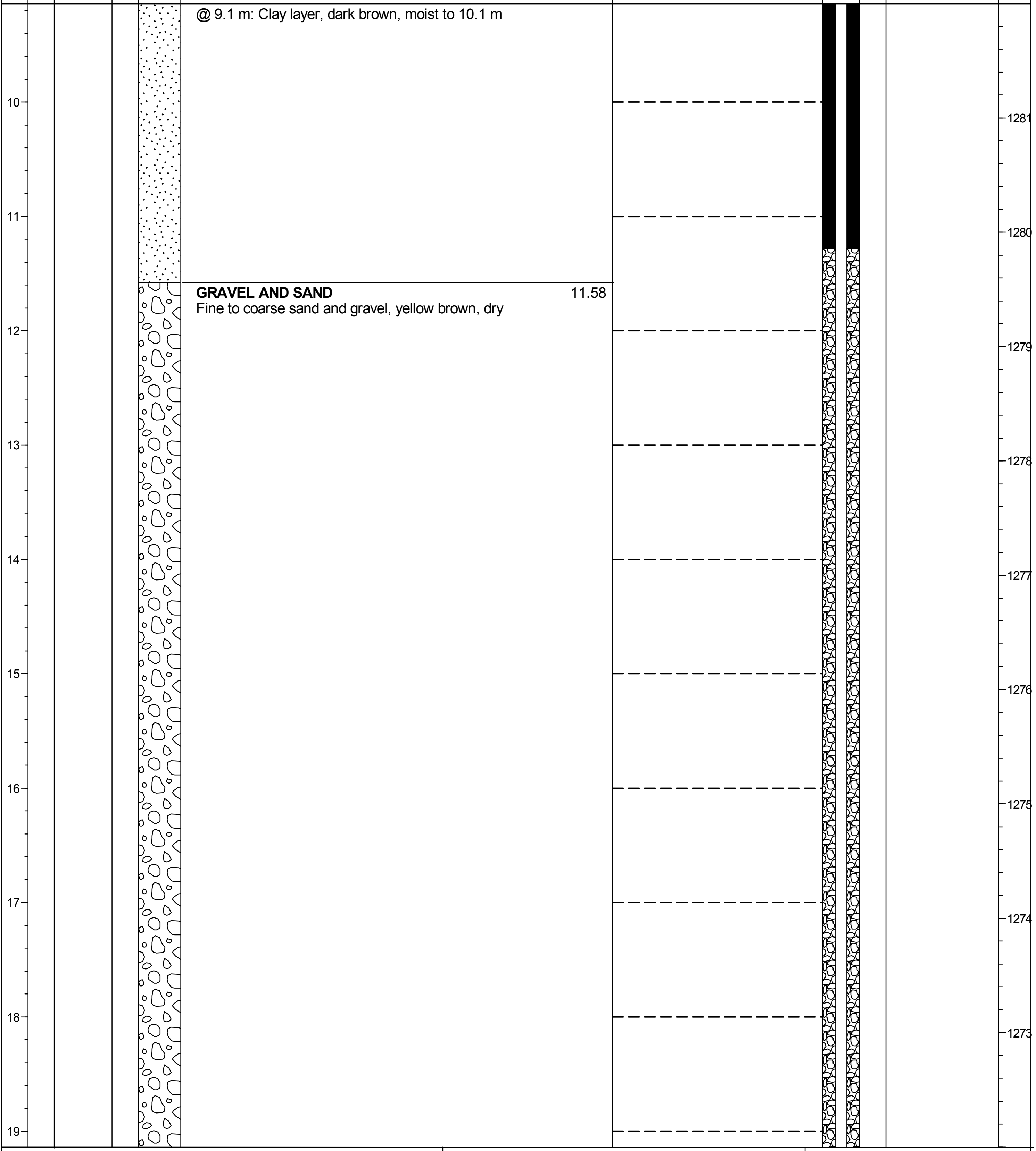
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-110
SURFACE ELEVATION: 1291.14 m
UTM COORDINATES 5682058 N
680788 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
					@ 9.1 m: Clay layer, dark brown, moist to 10.1 m					
					GRAVEL AND SAND 11.58 Fine to coarse sand and gravel, yellow brown, dry					



DRILLING METHOD: ODEX Air Rotary Drilling

DRILL DATE: June 4, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 2 of 4

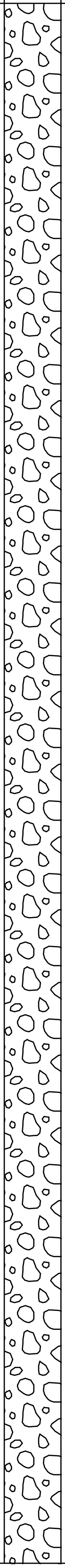
SLR

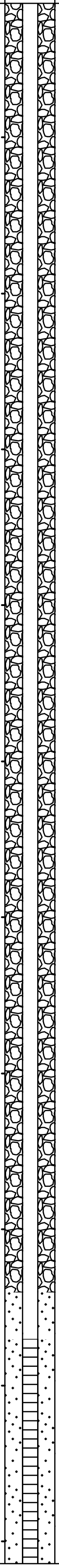
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-110
SURFACE ELEVATION: 1291.14 m
UTM COORDINATES
5682058 N
680788 E





DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
									slough and backfill	
20										1271
					@ 20.7 m: Grey - brown to 29.3 m					
21										1270
22										1269
23										1268
24										1267
25										1266
26										1265
27										1264
28										1263
								∇	GW = 1262.29 m (5June2019)	
29										

DRILLING METHOD: ODEX Air Rotary Drilling

DRILL DATE: June 4, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 3 of 4

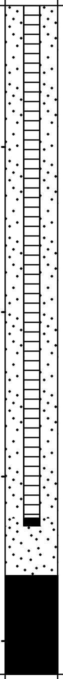
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-110
SURFACE ELEVATION: 1291.14 m
UTM COORDINATES
5682058 N
680788 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION		TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
	■				**BEDROCK** Siltstone, grey, dry	29.3					
30	■									filter pack sand	1261
31	■										1260
32											1259
33										bentonite pellets	1258
					End of borehole at 33.2 m	33.2					



Groundwater Information:
Depth to groundwater from TOP = 28.85 m (5June2019)

DRILLING METHOD: ODEX Air Rotary Drilling

DRILL DATE: June 4, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Appendix B Groundwater Hydrographs

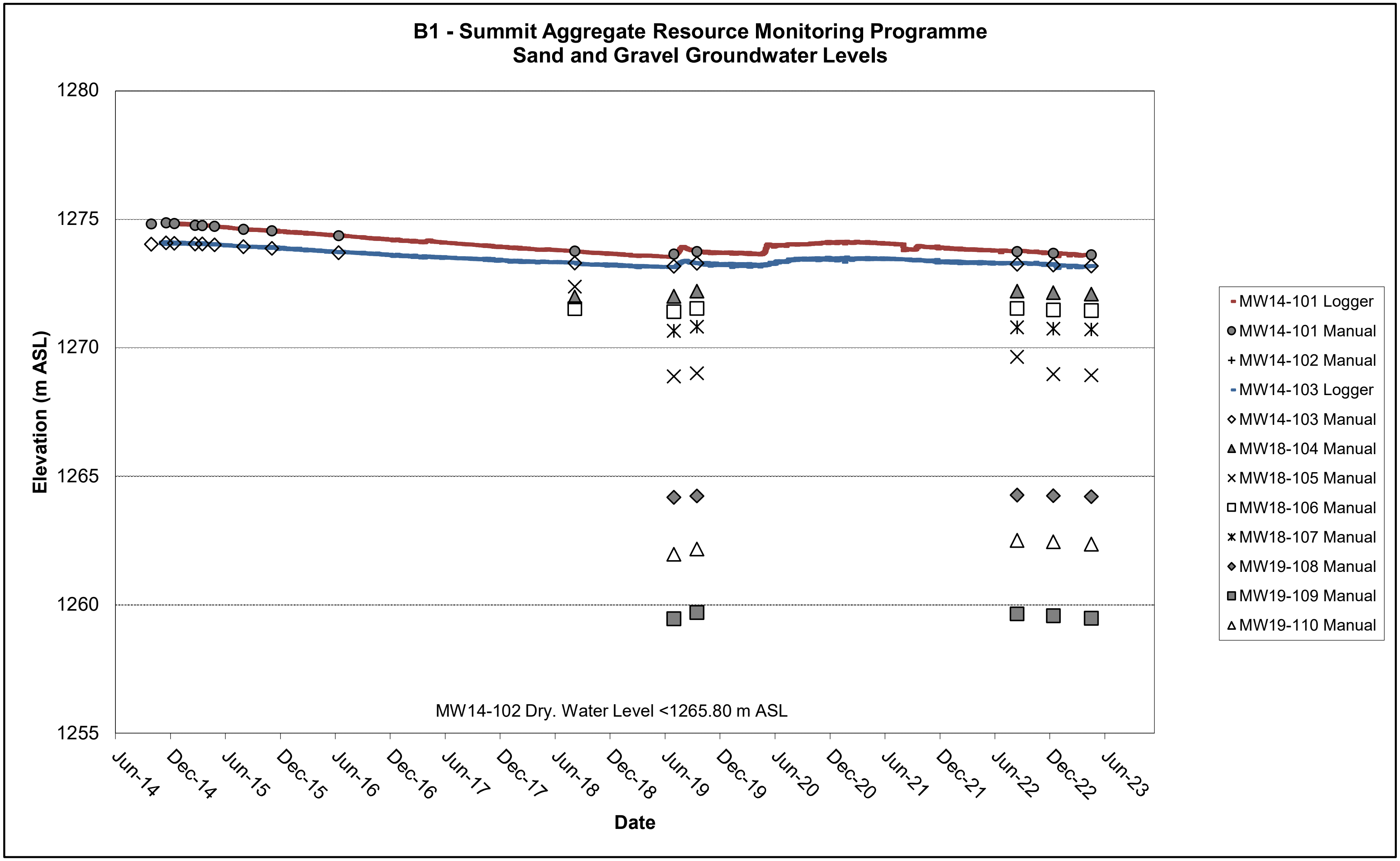
Groundwater Monitoring Plan

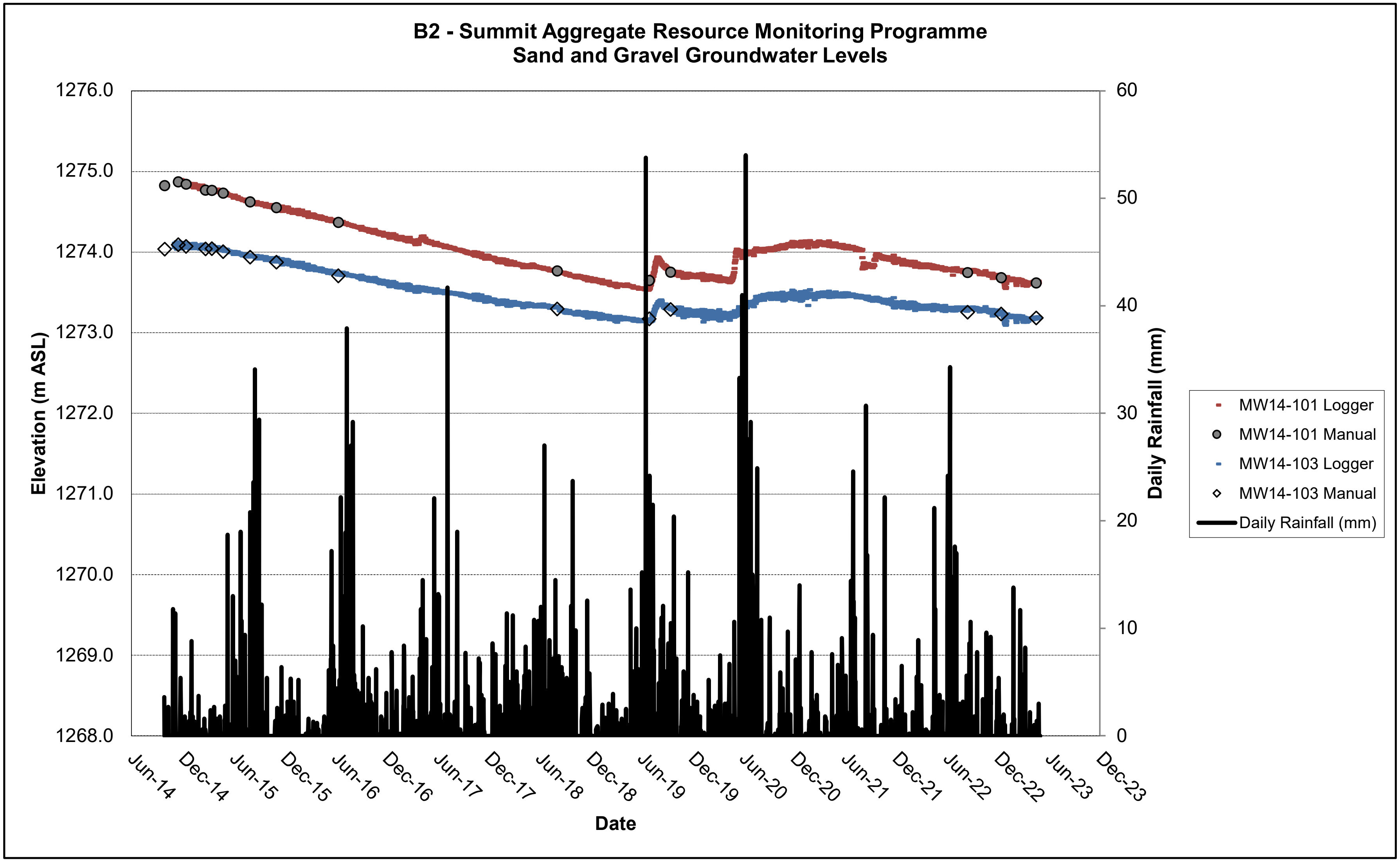
Summit Pit Project

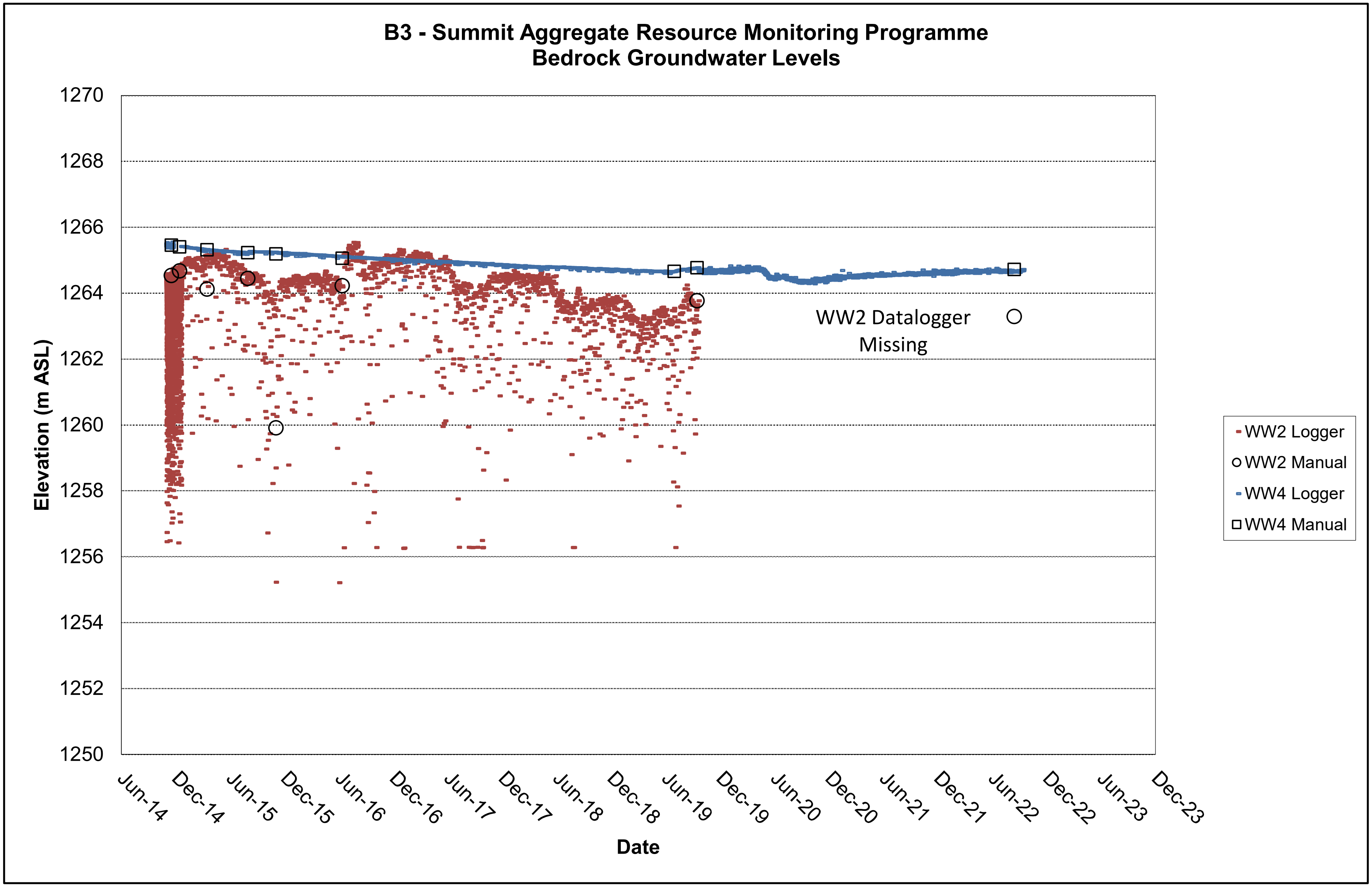
Mountain Ash Limited Partnership

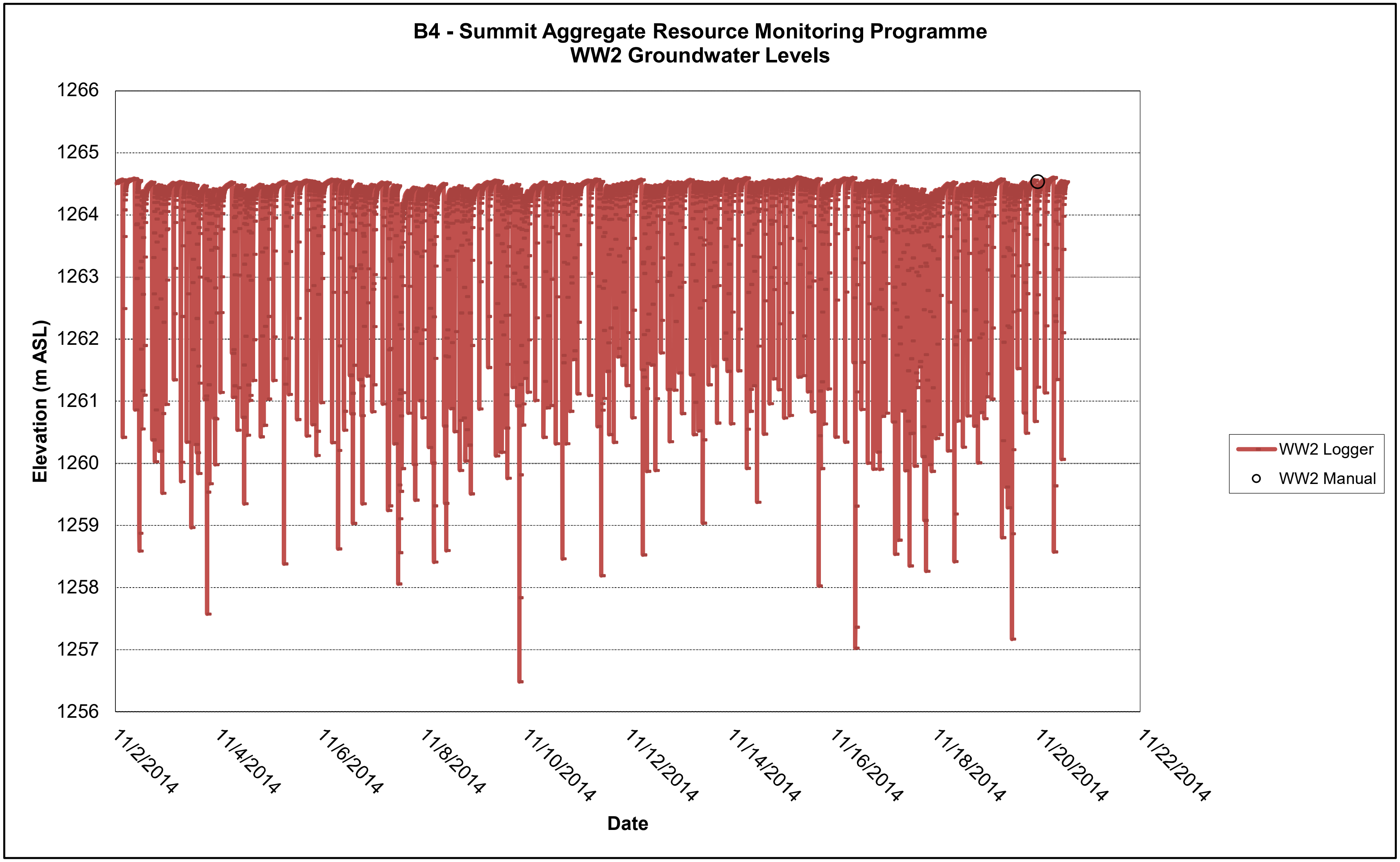
SLR Project No. 212.06650.00007

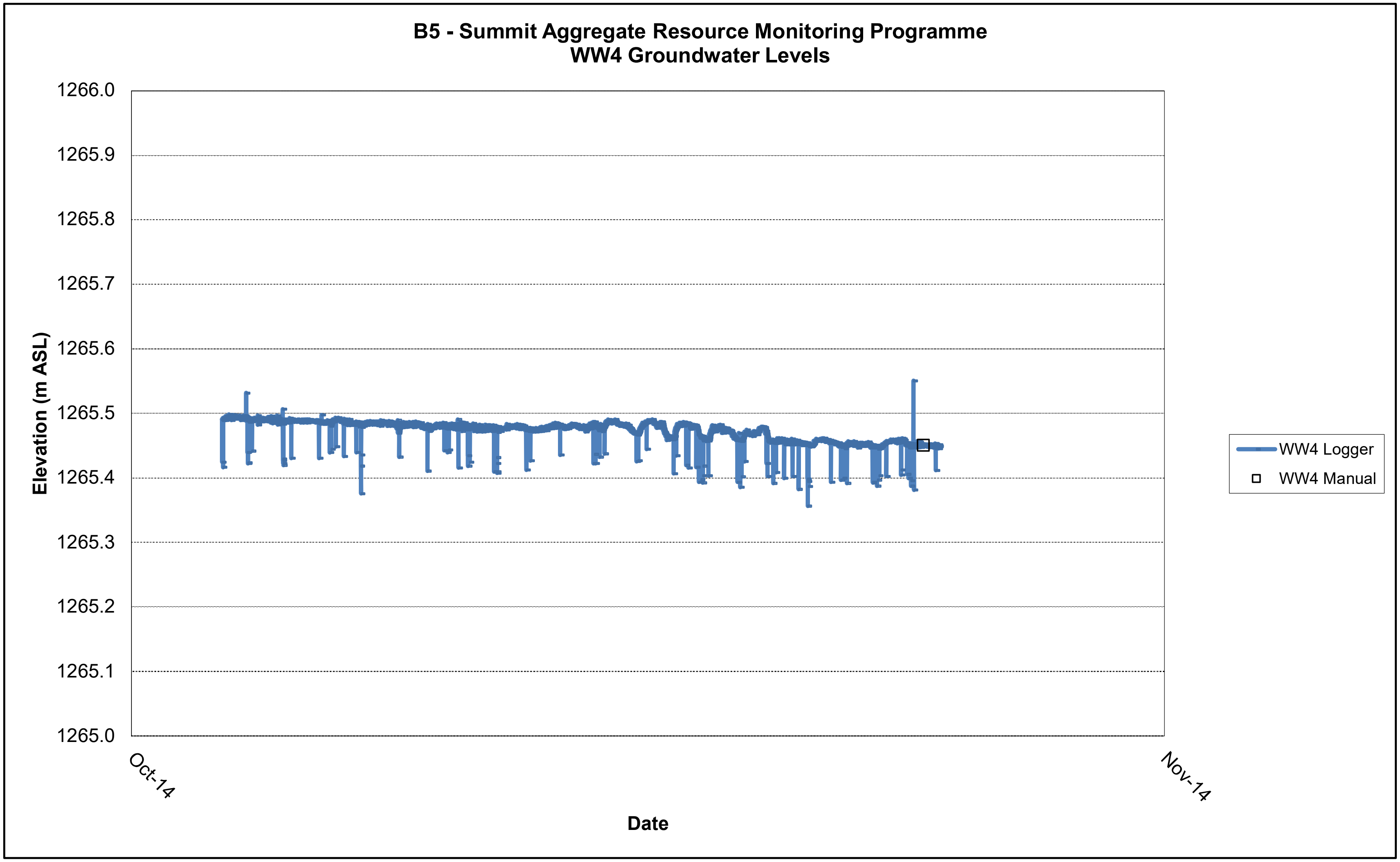
May 11, 2023


B1 - Summit Aggregate Resource Monitoring Programme
Sand and Gravel Groundwater Levels
Elevation (m ASL)
1280
1275
1270
1265
1260
1255
Date
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Jun-21
Dec-21
Jun-22
Dec-22
Jun-23
MW14-102 Dry. Water Level <1265.80 m ASL
MW14-101 Logger
MW14-101 Manual
MW14-102 Manual
MW14-103 Logger
MW14-103 Manual
MW18-104 Manual
MW18-105 Manual
MW18-106 Manual
MW18-107 Manual
MW19-108 Manual
MW19-109 Manual
MW19-110 Manual


B2 - Summit Aggregate Resource Monitoring Programme
Sand and Gravel Groundwater Levels
Elevation (m ASL)
1276.0
1275.0
1274.0
1273.0
1272.0
1271.0
1270.0
1269.0
1268.0
Daily Rainfall (mm)
60
50
40
30
20
10
0
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Jun-21
Dec-21
Jun-22
Dec-22
Jun-23
Dec-23
Date
MW14-101 Logger
MW14-101 Manual
MW14-103 Logger
MW14-103 Manual
Daily Rainfall (mm)


B3 - Summit Aggregate Resource Monitoring Programme
Bedrock Groundwater Levels
Elevation (m ASL)
1270
1268
1266
1264
1262
1260
1258
1256
1254
1252
1250
Date
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Dec-20
Jun-21
Dec-21
Jun-22
Dec-22
Jun-23
Dec-23
WW2 Datalogger Missing
WW2 Logger
WW2 Manual
WW4 Logger
WW4 Manual


B4 - Summit Aggregate Resource Monitoring Programme
WW2 Groundwater Levels
Elevation (m ASL)
1266
1265
1264
1263
1262
1261
1260
1259
1258
1257
1256
11/2/2014
11/4/2014
11/6/2014
11/8/2014
11/10/2014
11/12/2014
11/14/2014
11/16/2014
11/18/2014
11/20/2014
11/22/2014
Date
WW2 Logger
WW2 Manual


B5 - Summit Aggregate Resource Monitoring Programme
WW4 Groundwater Levels
1266.0
1265.9
1265.8
1265.7
1265.6
1265.5
1265.4
1265.3
1265.2
1265.1
1265.0
Elevation (m ASL)
Oct-14
Nov-14
Date
WW4 Logger
WW4 Manual

Appendix C Alberta Water Well Records

Groundwater Monitoring Plan

Summit Pit Project

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00007

May 11, 2023

Reconnaissance Report

View in Imperial

Export to Excel

Groundwater Wells

Please click the water Well ID to generate the Water Well Drilling Report.

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
350194	SW	31	26	3	5	LOU'S WATER WELL DRILLING	1990-03-09	35.05	New Well	Domestic		9		DAVIDSON, D.W.	15.24	54.55	14.12
360164	SE	6	27	3	5	AERO DRILLING & CONSULTING LTD.	1991-10-08	73.15	New Well	Domestic		10		BARGETZI, ERNIE	33.53	136.38	14.12
387449	NE	36	26	4	5	PARSONS DRLG	1962-08-10	33.83	New Well	Unknown		9		BRISTOW, C.R.	21.95	72.74	0.00
390998	SE	6	27	3	5	ALBERTA SOUTHERN EXPLORATION DRILLING LTD.	1987-02-11	65.53	New Well	Domestic & Stock		11		STRANGE, R.	45.72	36.37	16.84
390999	SE	6	27	3	5	ALBERTA SOUTHERN EXPLORATION DRILLING LTD.	1987-11-19	73.15	New Well	Stock		15		STRANGE, R.	39.62	45.46	16.84
391000	4	6	27	3	5	DIVERSIFIED DRILLING & EXPLORATION CO.	1984-11-07	40.23	New Well	Domestic & Stock	1	7		CIRCLE J RANCHES	28.96	68.19	13.97
391598	NW	31	26	3	5	PARSONS DRILLING		39.62	New Well	Domestic & Stock				MURRAY, R.J.			17.78
391599	NE	31	26	3	5	KRIEGER DRILLING LTD.		49.38	New Well-Decommissioned	Investigation		14		PARKER, G.L.	0.00		0.00
391600	NE	31	26	3	5	KRIEGER DRILLING LTD.	1981-10-14	27.43	New Well-Decommissioned	Domestic		9		PARKER, G.L.			0.00
395786	NE	31	26	3	5	PARSONS DRILLING	1981-11-19	62.48	New Well	Domestic & Stock		21		PARKER, G.L.	48.77	68.19	17.78
395793	NE	31	26	3	5	UNKNOWN DRILLER		62.48	Chemistry	Domestic				KIRK, S.			0.00
494773	NE	36	26	4	5	ALKEN BASIN DRILLING LTD.	1999-11-16	30.48	New Well	Stock		4	9	GOETJEN, MORRIE	22.25	63.65	13.97
498400	NW	31	26	3	5	MEDICINE VALLEY WATER WELLS	2001-05-14	74.68	New Well	Domestic		14	24	GIBBS, DAVE	10.82	9.09	13.97
1022436	9	36	26	4	5	AARON DRILLING INC.	2014-05-05	30.48	New Well	Investigation		6		LAFARGE CANADA INC			16.81
1475698	16	31	26	3	5	M&M DRILLING CO. LTD.	2003-01-14	39.62	New Well	Domestic		10	24	QUICK WAY FARMS LTD	32.00	45.46	14.13
1475699	15	31	26	3	5	M&M DRILLING CO. LTD.	2003-01-17	53.95	New Well	Domestic		10	24	QUICK WAY FARMS LTD	32.64	24.55	14.13
2095665	SW	6	27	3	5	UNKNOWNDRILLINGCOMP11		25.60	Well Inventory	Domestic & Stock		1		CIRCLE J RANCHES LTD			

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 350194
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1990/03/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
DAVIDSON, D.W.	P.O. BOX 970 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.259801 Longitude -114.414277
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Boulders
10.67		Sand & Gravel
12.19		Sand
15.24		Gravel
18.29		Gray Shale
22.86		Light Green Shale
28.96		Green Shale
32.00		Green Shale
35.05		Green Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1990/03/09	54.55	15.24

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
35.05 m		1990/03/02	1990/03/09

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	35.05

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.478 cm
Bottom at : 15.24 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.318 cm
Top at : 13.72 m
Bottom at : 35.05 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
22.86	35.05	0.318		25.40

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 15.24 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
LOU'S WATER WELL DRILLING

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	350194
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1990/03/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
DAVIDSON, D.W.	P.O. BOX 970 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.259801 Longitude -114.414277
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level   Measurement in Metric

Test Date	Start Time	Static Water Level
1990/03/09	12:00 AM	15.24 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 54.55 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
LOU'S WATER WELL DRILLING

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	360164
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1991/10/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BARGETZI, ERNIE	233 RATCLIFF PLACE SE, CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5		2	9110979	

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.274744 Longitude -114.405998

How Location Obtained

Not Verified

Elevation m

How Elevation Obtained

Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
9.45		Till & Clay
21.64		Gravel
25.30		Brown Shale
34.75		Gray Shale
39.62		Gray Sandstone
44.20		Gray Shale
51.82		Gray Sandstone
59.74		Gray Shale
66.75		Gray Sandstone
73.15		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 136.38 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1991/10/08	136.38	33.53

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
73.15 m		1991/10/08	1991/10/08

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	73.15

Surface Casing (if applicable)
Steel

Size OD : 14.12 cm

Wall Thickness : 0.620 cm

Bottom at : 24.99 m

Well Casing/Liner
Steel

Size OD : 11.43 cm

Wall Thickness : 0.396 cm

Top at : 18.29 m

Bottom at : 73.15 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
36.58	67.06	0.157		15.24

Perforated by Torch

Annular Seal Drive Shoe

Placed from 0.00 m to 24.99 m

Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment

Top Fittings Bottom Fittings

Pack

Type Grain Size

Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AERO DRILLING & CONSULTING LTD.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	360164
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1991/10/24

Well Identification and Location

Measurement in Metric

Owner Name	*Address*	*Town*	*Province*	*Country*	*Postal Code*
BARGETZI, ERNIE	233 RATCLIFF PLACE SE, CALGARY				

Location	*1/4 or LSD*	*SEC*	*TWP*	*RGE*	*W of MER*	*Lot*	*Block*	*Plan*	*Additional Description*
	SE	06	027	03	5		2	9110979	

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.274744 *Longitude* -114.405998

How Location Obtained

Not Verified

Elevation m

How Elevation Obtained

Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm

Is Artesian Flow

Rate L/min

Is Flow Control Installed

Describe

Recommended Pump Rate 136.38 L/min

Recommended Pump Intake Depth (From TOC) 0.00 m

Pump Installed

Depth m

Type

Make

H.P.

Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)

Depth m

Gas

Depth m

Well Disinfected Upon Completion

Geophysical Log Taken

Submitted to ESRD

Sample Collected for Potability

Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	*Start Time*	*Static Water Level*
1991/10/08	12:00 AM	33.53 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air

Removal Rate 136.38 L/min

Depth Withdrawn From 39.62 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	*Amount Taken*	*Diversion Date & Time*
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

UNKNOWN NA DRILLER

Certification No

1

Company Name

AERO DRILLING & CONSULTING LTD.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID 387449
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BRISTOW, C.R.	COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	36	026	04	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267032 Longitude -114.426119
How Location Obtained
Map

Elevation 1292.35 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Unknown

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.88		Yellow Clay
21.03		Gravel
23.77		Fine Grained Sand
25.91		Yellow Clay
26.82		Blue Clay
27.13		Hard Shale
28.04		Sand
32.00		Blue Shale & Sandstone Ledges
33.83		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1962/08/10	72.74	21.95

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
33.83 m			1962/08/10

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	33.83

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PARSONS DRLG

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID 387449
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BRISTOW, C.R.	COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	36	026	04	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267032 Longitude -114.426119
How Location Obtained
Map

Elevation 1292.35 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1962/08/10	12:00 AM	21.95 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 72.74 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PARSONS DRLG

Copy of Well report provided to owner
Date approval holder signed

Government
of Alberta ■

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	390998
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1987/03/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STRANGE, R.	P.O. BOX 981 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274744 Longitude -114.405998
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic & Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
7.62		Till
10.36		Gravel
11.58		Silty Clay
17.68		Weathered Shale
27.43		Shale
39.62		Sandstone
48.77		Shale
60.96		Sandstone
62.48		Shale
63.70		Sandstone
65.53		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 27.28 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1987/02/11	36.37	45.72

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
65.53 m		1987/02/10	1987/02/11

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	65.53

Surface Casing (if applicable)
Steel
Size OD : 16.84 cm
Wall Thickness : 0.478 cm
Bottom at : 18.29 m

Well Casing/Liner
Plastic
Size OD : 12.70 cm
Wall Thickness : 0.630 cm
Top at : 16.76 m
Bottom at : 65.53 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
47.24	59.44	0.000		0.10

Perforated by Machine

Annular Seal Driven
Placed from 0.00 m to 11.58 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial   Export to Excel

GIC Well ID	390998
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1987/03/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STRANGE, R.	P.O. BOX 981 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274744 Longitude -114.405998
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 27.28 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 62.48 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level   Measurement in Metric

Test Date	Start Time	Static Water Level
1987/02/11	12:00 AM	45.72 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 36.37 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Copy of Well report provided to owner   Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

GIC Well ID	390999
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1987/12/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STRANGE, R.	P.O. BOX 981 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.274744 Longitude -114.405998

How Location Obtained

Not Verified

Elevation m

How Elevation Obtained

Not Obtained

Drilling Information

Method of Drilling

Rotary

Proposed Well Use

Stock

Type of Work

New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
5.79		Till
8.84		Gravel
9.75		Till
16.76		Yellow Sandstone
20.12		Gray Sandstone
30.48		Shale
36.88		Sandstone
39.62		Shale
40.23		Moist Sandstone
50.29		Shale
51.82		Sandstone
58.22		Shale
64.01		Shale
71.32	Yes	Water Bearing Sandstone
73.15		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 31.82 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1987/11/19	45.46	39.62

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
73.15 m		1987/11/18	1987/11/19

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	73.15

Surface Casing (if applicable)

Steel

Size OD : 16.84 cm

Wall Thickness : 0.478 cm

Bottom at : 11.89 m

Well Casing/Liner

Plastic

Size OD : 12.70 cm

Wall Thickness : 0.630 cm

Top at : 9.14 m

Bottom at : 73.15 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
39.62	73.15	0.157		15.24

Perforated by Other

Annular Seal Driven

Placed from 0.00 m to 9.75 m

Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment

Top Fittings Bottom Fittings

Pack

Type Grain Size

Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

UNKNOWN NA DRILLER

Company Name

ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Certification No

1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial Export to Excel

GIC Well ID 390999
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1987/12/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STRANGE, R.	P.O. BOX 981 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274744 Longitude -114.405998
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 31.82 L/min
Recommended Pump Intake Depth (From TOC) 60.96 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
WATER OCCURES AT 130-132' @ 1 GPM, 210-234' @ 8-10 GPM.

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
1987/11/19	12:00 AM	39.62 m

Method of Water Removal
Type Air
Removal Rate 45.46 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government
of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	391000
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1984/12/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CIRCLE J RANCHES	RR2, COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	04	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.272936 Longitude -114.420414
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Domestic & Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.05		Yellow Clay
7.32		Cemented Gravel
19.51		Gravel
20.12		Cemented Gravel
29.87		Gravel & Boulders
32.92		Brown Shale & Sandstone
40.23	Yes	Brown Water Bearing Sandstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1984/11/07	68.19	28.96

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
40.23 m		1984/10/15	1984/11/07

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	40.23

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.620 cm
Bottom at : 31.09 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.318 cm
Top at : 0.00 m
Bottom at : 40.23 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
33.53	39.62	0.396		25.40

Perforated by Torch

Annular Seal Driven
Placed from 0.00 m to 1.22 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
DIVERSIFIED DRILLING & EXPLORATION CO.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID	391000
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1984/12/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CIRCLE J RANCHES	RR2, COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	04	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.272936 Longitude -114.420414
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	Start Time	Static Water Level
1984/11/07	12:00 AM	28.96 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 68.19 L/min
Depth Withdrawn From 32.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
DIVERSIFIED DRILLING & EXPLORATION CO.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	391598
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MURRAY, R.J.	511 19ST NW, CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.414280
How Location Obtained
Map

Elevation 1290.83 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Domestic & Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
39.62 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	39.62

Surface Casing (if applicable)
Steel
Size OD : 17.78 cm
Wall Thickness : 0.000 cm
Bottom at : 26.82 m

Well Casing/Liner
Steel
Size OD : 12.70 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 39.62 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
31.09	38.10	0.000		0.00

Perforated by

Annular Seal Drive Shoe
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PARSONS DRILLING

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial Export to Excel

GIC Well ID 391598
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MURRAY, R.J.	511 19ST NW, CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.414280
How Location Obtained
Map

Elevation 1290.83 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PARSONS DRILLING

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 391599
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Map

Elevation 1295.40 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Investigation

Type of Work
New Well-Abandoned

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
1.22		Gray Clay
4.27		Brown Clay
6.71		Brown Sandy Clay
11.89		Sandy Gravel
17.07		Medium Grained Gravel
18.90		Fine Grained Gravel
19.20		Sandstone
24.69		Fine Grained Sand
32.92		Fine Grained Gravel
36.27		Shale
36.58		Dark Shale
43.59		Clay & Shale
49.38		Unknown

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1981/10/10		0.00

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
49.38 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	49.38

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Driven
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
KRIEGER DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 391599
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Map

Elevation 1295.40 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS MED HARD WATER, NO SPECS FOR SURFACE CASING

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1981/10/10	12:00 AM	0.00 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal
Type Air
Removal Rate L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER
Certification No
1
Company Name
KRIEGER DRILLING LTD.
Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	391600
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1981/11/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.267033 Longitude -114.402748

How Location Obtained

Map

Elevation 1295.40 m

How Elevation Obtained

Estimated

Drilling Information

Method of Drilling

Rotary

Proposed Well Use

Domestic

Type of Work

New Well-Abandoned

Plugged 1981/10/14

Plugged with Unknown

Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
10.06		Sandy Till
17.68		Clay & Shale
20.12		Clay & Gravel
21.03		Shale
22.86		Clay & Silt
24.08		Gray Clay
26.82		Clay & Gravel
27.43		Lost Circulation

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
27.43 m		1981/10/11	1981/10/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	27.43

Surface Casing (if applicable)

Size OD : 0.00 cm

Wall Thickness : 0.000 cm

Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm

Wall Thickness : 0.000 cm

Top at : 0.00 m

Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m

Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment

Top Fittings

Bottom Fittings

Pack

Type

Grain Size

Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

UNKNOWN NA DRILLER

Certification No

1

Company Name

KRIEGER DRILLING LTD.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial Export to Excel

GIC Well ID 391600
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1981/11/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Map

Elevation 1295.40 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
KRIEGER DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government
of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 395786
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1982/02/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Domestic & Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
1.83		Brown Clay & Boulders
3.35		Gray Clay & Boulders
3.96		Boulders
10.97		Brown Clay & Gravel
13.72		Gravel
15.54		Brown Shale
21.64		Gray Hard Shale
23.16		Gray Hard Sandstone
25.30		Gray Shale
26.82		Gray Sandstone
27.74		Gray Shale
28.65		Gray Sandstone
29.26		Gray Soft Sandstone
30.78		Gray Hard Sandstone
34.75		Gray Firm Shale
36.88		Gray Hard Sandstone
43.89		Gray Firm Shale
45.11		Gray Hard Sandstone
54.86		Gray Shale
56.39	Yes	Gray Water Bearing Sandstone
62.48		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1981/11/19	68.19	48.77

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
62.48 m		1981/11/05	1981/11/19

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	62.48

Surface Casing (if applicable)
Steel
Size OD : 17.78 cm
Wall Thickness : 0.587 cm
Bottom at : 13.72 m

Well Casing/Liner
Steel
Size OD : 12.70 cm
Wall Thickness : 0.556 cm
Top at : 0.00 m
Bottom at : 62.48 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
48.16	61.87	0.953		40.64

Perforated by Torch

Annular Seal Drive Shoe
Placed from 0.00 m to 13.72 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PARSONS DRILLING

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	395786
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1982/02/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.267033 Longitude -114.402748

How Location Obtained

Map

Elevation m

How Elevation Obtained

Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm

Is Artesian Flow

Is Flow Control Installed

Rate L/min

Describe

Recommended Pump Rate 0.00 L/min

Pump Installed

Depth m

Recommended Pump Intake Depth (From TOC) 60.96 m

Type

Make

H.P.

Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)

Depth m

Well Disinfected Upon Completion

Gas

Depth m

Geophysical Log Taken

Submitted to ESRD

Sample Collected for Potability

Submitted to ESRD

Additional Comments on Well

DRILLER REPORTS WATER QUALITY AS TURBID

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	Start Time	Static Water Level
1981/11/19	12:00 AM	48.77 m

Method of Water Removal

Type Bailer

Removal Rate 68.19 L/min

Depth Withdrawn From 48.77 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

UNKNOWN NA DRILLER

Certification No

1

Company Name

PARSONS DRILLING

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 395793
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KIRK, S.	P.O. BOX 1295 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
62.48 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	62.48

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial
Export to Excel

GIC Well ID 395793
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KIRK, S.	P.O. BOX 1295 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID	494773
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1999/11/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GOETJEN, MORRIE	RR1, AIRDRIE			CANADA	T4B 2A3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	36	26	4	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267032 Longitude -114.426119
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.05		Brown Clay
23.16		Coarse Grained Gravel
29.26	Yes	Water Bearing Gravel
30.48		Brown Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 36.37 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1999/11/16	63.65	22.25

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
30.48 m		1999/11/15	1999/11/16

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	30.48

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.620 cm
Bottom at : 28.04 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Driven & Bentonite
Placed from 0.00 m to 28.04 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALKEN BASIN DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government
of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 494773
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1999/11/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GOETJEN, MORRIE	RR1, AIRDRIE			CANADA	T4B 2A3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	36	26	4	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267032 Longitude -114.426119
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 36.37 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 27.43 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas Yes
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 2'.

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1999/11/16	12:00 AM	22.25 m

Method of Water Removal
Type Air
Removal Rate 63.65 L/min
Depth Withdrawn From 30.48 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
	1:00	26.82
	2:00	24.38
	3:00	23.16
	4:00	22.71
	5:00	22.56
	6:00	22.40
	7:00	22.25
	8:00	22.25
	10:00	22.25

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALKEN BASIN DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	498400
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2001/06/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GIBBS, DAVE	P.O. BOX 1773 SPRUCE VIEW				T0M 1V0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.414280
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.57		Brown Clay & Rocks
8.23		Gray Sandstone
13.72		Gray Shale
19.51		Gray Sandy Shale
22.86		Gray Shale
24.08		Gray Sandstone
29.87		Gray Shale
30.78		Blue Shale
34.14		Gray Silty Shale
54.56		Gray Shale
57.30		Gray Sandstone
67.67		Gray Shale
71.63		Gray Sandy Shale
74.68		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 9.09 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2001/05/14	9.09	10.82

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
74.68 m		2001/05/07	2001/05/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	74.68

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.620 cm
Bottom at : 24.69 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.602 cm
Top at : 19.81 m
Bottom at : 74.68 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
24.69	74.68	0.635		20.32

Perforated by Saw

Annular Seal Driven
Placed from 0.00 m to 24.69 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
MEDICINE VALLEY WATER WELLS

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	498400
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2001/06/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GIBBS, DAVE	P.O. BOX 1773 SPRUCE VIEW				T0M 1V0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.414280
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 9.09 L/min
Recommended Pump Intake Depth (From TOC) 71.63 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 1'.

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
2001/05/14	12:00 AM	10.82 m

Method of Water Removal

Type Bailer
Removal Rate 9.09 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
	1:00	54.32
	2:00	53.77
	3:00	53.28
	4:00	52.88
	5:00	52.40
	6:00	52.09
	7:00	51.82
	8:00	51.58
	9:00	51.19
	10:00	50.81
	12:00	50.38
	14:00	50.05
	16:00	49.50
	20:00	48.05
	25:00	46.09
	30:00	44.84
	35:00	43.08
	40:00	41.53
	50:00	39.01
	60:00	36.32
	75:00	33.19
	90:00	30.57
	105:00	28.79
	120:00	26.93

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
MEDICINE VALLEY WATER WELLS

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	1022436
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/09/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
LAFARGE CANADA INC	115 QUARRY PARK BLVD	CALGARY	ALBERTA	CANADA	T2C 5G9

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	9	36	26	4	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.265686 Longitude -114.424418
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Hand held autonomous GPS 20-30m

Drilling Information

Method of Drilling
Rotary - Air

Type of Work
New Well

Proposed Well Use
Investigation

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
4.27		Brown Moist Clay
25.30		Gravel
28.35		Moist Gravel
29.26		Sandstone
30.48		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
30.48 m	28.35 m	2014/05/01	2014/05/05

Borehole

Diameter (cm)	From (m)	To (m)
20.02	0.00	25.60
15.56	25.60	30.48

Surface Casing (if applicable)
Steel
Size OD : 16.81 cm
Wall Thickness : 0.478 cm
Bottom at : 25.60 m

Well Casing/Liner
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Cement/Grout
Placed from 0.00 m to 25.60 m
Amount 150.00 Gallons

Other Seals

Type	At (m)
Driven	25.60

Screen Type Stainless Steel
Size OD : 14.12 cm

From (m)	To (m)	Slot Size (cm)
26.21	27.43	0.025

Attachment Telescoped
Top Fittings Packer
Bottom Fittings Tail Pipe

Pack
Type Natural
Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHRIS QUINLAN

Certification No
48135A

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/09/24

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	1022436
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/09/24

Well Identification and Location

Measurement in Metric

Owner Name	*Address*	*Town*	*Province*	*Country*	*Postal Code*
LAFARGE CANADA INC	115 QUARRY PARK BLVD	CALGARY	ALBERTA	CANADA	T2C 5G9

Location	*1/4 or LSD*	*SEC*	*TWP*	*RGE*	*W of MER*	*Lot*	*Block*	*Plan*	*Additional Description*
	9	36	26	4	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.265686 *Longitude* -114.424418

How Location Obtained

Hand held autonomous GPS 20-30m

Elevation m

How Elevation Obtained

Hand held autonomous GPS 20-30m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 91.44 cm

Is Artesian Flow

Rate L/min

Is Flow Control Installed

Describe

Recommended Pump Rate L/min

Recommended Pump Intake Depth (From TOC) m

Pump Installed

Depth m

Type

Make

H.P.

Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) *Depth* m

Gas *Depth* m

Well Disinfected Upon Completion Yes

Geophysical Log Taken

Submitted to ESRD

Sample Collected for Potability

Submitted to ESRD

Additional Comments on Well

PUMP TEST PERFORMED BY WATERLINE RESOURCES

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	*Start Time*	*Static Water Level*
		m

Method of Water Removal

Type

Removal Rate L/min

Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	*Amount Taken*	*Diversion Date & Time*
CITY OF CALGARY	9092.18 L	2014/04/29 8:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

CHRIS QUINLAN

Certification No

48135A

Company Name

AARON DRILLING INC.

Copy of Well report provided to owner

Yes

Date approval holder signed

2014/09/24

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial
Export to Excel

GIC Well ID 1475698
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
QUICK WAY FARMS LTD	P.O. BOX 1719	BROOKS	AB	CA	T1R 1C5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267444 Longitude -114.400639
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
2.13		Clay
21.03		Clay & Gravel
23.16		Clay
26.82		Gray Shale
28.65		Gray Sandy Shale
31.39		Gray Shale
31.70		Sandstone
33.53		Shale
35.97		Sandstone
39.62		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 36.37 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2003/01/15	45.46	32.00

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
39.62 m		2003/01/10	2003/01/14

Borehole

Diameter (cm)	From (m)	To (m)
22.23	0.00	39.62

Surface Casing (if applicable)
Steel
Size OD : 14.13 cm
Wall Thickness : 0.478 cm
Bottom at : 35.97 m

Well Casing/Liner
Unknown
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
32.00	35.97	0.318		25.40

Perforated by Torch

Annular Seal Driven & Bentonite
Placed from 0.00 m to 31.39 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings
Bottom Fittings

Pack
Type Unknown
Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
WILLIAM PENROD

Company Name
M&M DRILLING CO. LTD.

Certification No
A000187

Copy of Well report provided to owner
Date approval holder signed

Government
of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 1475698
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
QUICK WAY FARMS LTD	P.O. BOX 1719	BROOKS	AB	CA	T1R 1C5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267444 Longitude -114.400639
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 60.96 cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 36.37 L/min
Recommended Pump Intake Depth (From TOC) 35.05 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
FIELD TEST HARD WATER TDS 250, GPS # 51.2671333, N-51-16.0-2.8, W-114-24-2.3, -114.40038333, BOREHOLE DIAMETER 8.75" TO 103' & 6.25" TO 130'

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
2003/01/15	12:00 AM	32.00 m

Method of Water Removal

Type Pump
Removal Rate 45.46 L/min
Depth Withdrawn From 35.05 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
32.39	1:00	32.81
32.59	2:00	32.69
32.69	3:00	32.65
32.75	4:00	32.61
32.83	5:00	32.60
32.85	6:00	32.56
32.89	7:00	32.51
32.90	8:00	32.49
32.92	9:00	32.47
32.94	10:00	32.45
32.99	12:00	32.40
33.02	14:00	32.37
33.05	16:00	32.34
33.08	20:00	32.32
33.13	25:00	32.28
33.06	30:00	32.26
33.19	35:00	32.23
33.24	40:00	32.21
33.27	50:00	32.20
33.28	60:00	32.16
33.31	75:00	32.12
33.32	90:00	32.10
33.34	105:00	32.09
33.35	120:00	32.06

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
WILLIAM PENROD

Certification No
A000187

Company Name
M&M DRILLING CO. LTD.

Copy of Well report provided to owner
Date approval holder signed

Government
of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 1475699
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
QUICK WAY FARMS LTD	P.O. BOX 1719	BROOKS	AB	CA	T1R 1C5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	15	31	026	03	5				STOCK WELL

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267556 Longitude -114.405667
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
2.44		Clay & Rocks
27.43		Lost Circulation Gravel
28.96		Shattered Shale
32.92		Brown Sandstone
34.75		Gray Sandstone
45.72		Shale & Sandstone Ledges
47.24	Yes	Water Bearing Sandstone
50.29	Yes	Water Bearing Shale
50.90	Yes	Water Bearing Sandstone
53.95		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 27.28 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2003/01/20	24.55	32.64

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
53.95 m		2003/01/15	2003/01/17

Borehole

Diameter (cm)	From (m)	To (m)
22.23	0.00	53.95

Surface Casing (if applicable)
Steel
Size OD : 14.13 cm
Wall Thickness : 0.478 cm
Bottom at : 30.18 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.544 cm
Top at : 23.47 m
Bottom at : 53.95 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
43.28	50.90	0.635		25.40

Perforated by Saw

Annular Seal Driven & Bentonite
Placed from 0.00 m to 30.18 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
WILLIAM PENROD

Certification No
A000187

Company Name
M&M DRILLING CO. LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial
Export to Excel

GIC Well ID 1475699
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
QUICK WAY FARMS LTD	P.O. BOX 1719	BROOKS	AB	CA	T1R 1C5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	15	31	026	03	5				STOCK WELL

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267556 Longitude -114.405667
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 60.96 cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 27.28 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 42.67 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

FIELD TEST 300 TDS MOD HARD BAILED @ 7 IGM, GPS # 51-16-03.2, W-114-24-20.4, -114.4034, BOREHOLE DIAMETER 8.75" TO 99' & 5.125" 177', 90' - 95' SHATTERED SHALE (LOSS CIRCULATION),

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
2003/01/20	12:00 AM	32.64 m

Method of Water Removal

Type Pump
Removal Rate 24.55 L/min
Depth Withdrawn From 53.34 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
35.07	1:00	36.99
35.73	2:00	36.20
35.83	3:00	36.12
36.01	4:00	36.02
36.22	5:00	35.91
36.37	6:00	35.79
36.49	7:00	35.72
36.62	8:00	35.61
31.24	9:00	35.45
36.86	10:00	35.41
36.96	12:00	35.29
37.11	14:00	35.16
36.91	16:00	35.05
37.40	20:00	34.88
37.58	25:00	34.75
37.76	30:00	34.59
37.90	35:00	34.50
38.01	40:00	34.40
38.28	50:00	34.27
38.43	60:00	34.14
38.71	75:00	34.03
38.91	90:00	33.91
39.09	105:00	33.83
39.24	120:00	33.74

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
WILLIAM PENROD

Certification No
A000187

Company Name
M&M DRILLING CO. LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID	1556533
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION HOLE #5

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.258118 Longitude -114.396505

How Location Obtained

Differential corrected handheld GPS 5-10m

Elevation 1270.00 m

How Elevation Obtained

Differential corrected handheld GPS 5-10m

Drilling Information

Method of Drilling
Rotary - Mud

Type of Work
Other

Proposed Well Use
Monitoring

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Black Topsoil
6.40		Brown Clay
11.89		Gray Gravel
13.72		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
13.72 m	13.72 m	2014/05/08	2014/05/08

Borehole

Diameter (cm)	From (m)	To (m)
14.29	0.00	13.72

Surface Casing (if applicable)

Size OD : cm

Wall Thickness : cm

Bottom at : m

Well Casing/Liner

Plastic

Size OD : 6.35 cm

Wall Thickness : 0.516 cm

Top at : -0.91 m

Bottom at : 13.72 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Bentonite Chips/Tablets

Placed from 0.91 m to 9.75 m

Amount 300.00 Pounds

Other Seals

Type	At (m)

Screen Type Slotted PVC

Size OD : 6.35 cm

From (m)	To (m)	Slot Size (cm)
10.67	13.72	0.254

Attachment Attached To Casing

Top Fittings Riser Pipe

Bottom Fittings Plug

Pack

Type Sand

Grain Size 10-20

Amount 200.00 Pounds

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Certification No
46340A

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government of Alberta

Water Well Drilling Report

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View in Imperial Export to Excel

GIC Well ID 1556533
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION HOLE #5

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.258118 Longitude -114.396505
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1270.00 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 91.44 cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Well Disinfected Upon Completion Yes
Gas Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
LOCKABLE PROTECTOR PIPE INSTALLED AND CONCRETED INTO THE GROUND.

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
TOWN OF OKOTOKS	1818.44 L	2014/05/08 7:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Certification No
46340A

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government
of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID	1556534
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION WELL #6

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.257155 Longitude -114.394328
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1277.00 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Drilling Information

Method of Drilling
Rotary - Mud

Proposed Well Use
Monitoring

Type of Work
Other

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
5.79		Brown Sandy Clay & Rocks
8.84		Gray Gravel
10.97		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
10.97 m	10.97 m	2014/05/12	2014/05/12

Borehole

Diameter (cm)	From (m)	To (m)
14.29	0.00	10.97

Surface Casing (if applicable)
Size OD : cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Plastic
Size OD : 6.35 cm
Wall Thickness : 0.518 cm
Top at : -0.91 m
Bottom at : 10.97 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Bentonite Chips/Tablets
Placed from 0.91 m to 7.01 m
Amount 200.00 Pounds

Other Seals

Type	At (m)

Screen Type Slotted PVC
Size OD : 6.35 cm

From (m)	To (m)	Slot Size (cm)

Attachment Attached To Casing
Top Fittings Riser Pipe Bottom Fittings Plug

Pack
Type Sand Grain Size 10-20
Amount 200.00 Pounds

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Certification No
46340A

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

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GIC Well ID	1556534
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION WELL #6

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.257155 Longitude -114.394328

How Location Obtained

Differential corrected handheld GPS 5-10m

Elevation 1277.00 m

How Elevation Obtained

Differential corrected handheld GPS 5-10m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 91.44 cm

Is Artesian Flow

Is Flow Control Installed

Rate L/min

Describe

Recommended Pump Rate L/min

Pump Installed

Depth m

Recommended Pump Intake Depth (From TOC) m

Type

Make

H.P.

Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)

Depth m

Well Disinfected Upon Completion Yes

Gas

Depth m

Geophysical Log Taken

Submitted to ESRD

Sample Collected for Potability

Submitted to ESRD

Additional Comments on Well

INSTALLED LOCKABLE PROTECTOR CASING AND CONCRETED INTO THE GROUND.

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type

Removal Rate L/min

Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
TOWN OF OKOTOKS	2727.66 L	2014/05/12 7:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well	Certification No	
CHAD NIEMANS	46340A	
Company Name	**Copy of Well report provided to owner**	**Date approval holder signed**
NIEMANS DRILLING (1980) LTD.	Yes	2014/06/04

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID 1556535
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION WELL #7

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.255906 Longitude -114.392635
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1273.00 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Drilling Information

Method of Drilling
Rotary - Mud

Proposed Well Use
Monitoring

Type of Work
Other

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.66		Brown Clay & Rocks
11.28		Gray Gravel
12.19		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
12.19 m	12.19 m	2014/05/13	2014/05/13

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Size OD : cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Plastic
Size OD : 6.35 cm
Wall Thickness : 0.518 cm
Top at : -0.91 m
Bottom at : 12.19 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Bentonite Chips/Tablets
Placed from 0.91 m to 8.23 m
Amount 250.00 Pounds

Other Seals

Type	At (m)

Screen Type Plastic
Size OD : 6.35 cm

From (m)	To (m)	Slot Size (cm)
9.14	12.19	0.000

Attachment Attached To Casing
Top Fittings Riser Pipe Bottom Fittings Plug

Pack
Type Sand Grain Size 10-20
Amount 200.00 Pounds

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Company Name
NIEMANS DRILLING (1980) LTD.

Certification No
46340A

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID 1556535
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION WELL #7

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.255906 Longitude -114.392635
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1273.00 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 91.44 cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion Yes
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
INSTALLED LOCKABLE PROTECTOR CASING AND CONCRETED INTO THE GROUND.

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
TOWN OF OKOTOKS	1818.44 L	2014/05/12 7:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Certification No
46340A

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial Export to Excel

GIC Well ID	2095665
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/12/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CIRCLE J RANCHES LTD	RR 2	COCHRANE	ALBERTA	CANADA	T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	6	27	3	5				M. GILES

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274608 Longitude -114.417737
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic & Stock

Type of Work
Well Inventory

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
25.60		Old Well

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
25.60 m		1934/06/30	

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Size OD : cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from m to m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN DRILLER11

Certification No
11

Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	2095665
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/12/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CIRCLE J RANCHES LTD	RR 2	COCHRANE	ALBERTA	CANADA	T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	6	27	3	5				M. GILES

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274608 Longitude -114.417737
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

ORIGINAL WELL REPORT NOT IN GIC. THE FOLLOWING INFORMATION WAS TAKEN FROM DROUGHT EMERGENCY GROUNDWATER TESTING PROGRAM APPLICATION RECEIVED ON DECEMBER 04, 1984. OWNER REPORTS THIS WELL WAS BAILED OUT TO 4 FEET OF WATER, TOOK 1 DAY TO RECOVER, WERE GETTING 1 GPM CONSISTENTLY. OWNER REPORTS THAT WELL WAS CONSTRUCTED IN APPROXIMATELY 1934 AND IS APPROXIMATELY 84 FEET DEEP. ALREADY DRILLED ANOTHER WELL 391000.

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well	Certification No
UNKNOWN DRILLER11	11

Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner
Date approval holder signed

Appendix D Residential Well Assessment Questionnaires

Groundwater Monitoring Plan

Summit Pit Project

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00007

May 11, 2023

Water Well Reconnaissance Survey

SLR

SITE RECONNAISSANCE CHECKLIST

Project Name: WATERMAN AGGREGATE RESOURCE

Project Number: 203-50065.00001 **SLR Staff:** R. TILL

Street Address: [redacted] - NW 31-26-3 W5M - 35181 BIG HILL SPRINGS ROAD

Property Type: Private Residence ☑ Commerical/Industrial ☐ Other

Person/Resident Interviewed: JULIE THORESON, BRUCE WATERMAN

Date of Visit: 29 OCT 2014 **Time:** 10:15

1. Well Owner Information

Name: BRUCE WATERMAN

Street Address:

Contact Number: Home: Business: Cell:

Email Address:

2. Well User/Occupant of the Residence Using the Well

Same as Well Owner ☐

If different from well owner please fill out details below:

Name: JULIE THORESON

Street Address:

Contact Number: Home: Business: Cell:

Email Address:

3. Well Details

Well Location Lot: NW 31-26-3 W5M Concession: Township:

3A. Well Use

Water Use: NO DRINKING, USES BOTTLED WATER

Domestic: ☑ No. of people using water from the well: 1

Livestock: ☑ No. of livestock using water from the well: 7 HORSES + SHEEP + GOAT

Lawn Watering: ☐ Acres/area covered: Approximate Amount:

Irrigation: ☐ Acres/area covered: Approximate Amount:

3A. Well Use Continued

Additional Equipment: Pool: ☐ Jacuzzi/Hot Tub: ☐ Landscape water feature/fountain: ☐

Other:

Private waste and water disposal: Type (ex. Speptic tank): SEPTIC TANK

System description: 1000 GAL TANK

Distance to Well 75ft Direction from well (N, S, E, or W) W

Well is Uphill ☐ Downhill ☐ Same Grade ☑ as the waste water system

3B. Well Construction Details

Construction/Installation Date: UNKNOWN PRE-1960 Contractor:

Type of Installation: Drilled ☑ Dug ☐ Other:

Diameter: 6/8 INCH Well Depth (m): ~ 400ft

Screen? UNKNOWN YES ☐ NO ☐

Screen length (m)

Depth to top of screen (m)

MOE Record Number:

Confirmed ☐ Inferred ☐

Is the well accesible for sampling? YES ☐ NO ☑

If no provide details: WELL HEAD APPROXIMATELY 2m BELOW GROUND LEVEL IN A PIT

Location of measurement (top of pipe (TOP), ground surface): —

SLR staff member collecting the measurement: —

Date of original measurement: — Original/initial water level depth (m)

Subsequent water level measurements

Date						
Depth (m)						
Staff						

3C. Pumping Equipment

Pump Type: Suction-lift ☐ Pumping Capacity

Positive-submergence ☐ Age

How is the pump lubricated?

Depth of intake setting: Original (m) Present (m) 100+ft Pumping Rate (L/s)

Storage Tank: Type: CISTERN Capacity: 1000 GAL

Additional Features: Chlorinator ☐ Water softener ☐ Water filter ☐ Filter type:

NO TREATMENT

4. Well History

How long have you owned, operated or lived on this property? 7 YEARS

Have you ever experienced any previous problems with your well? SAND IN WELL

If so, when? ONGOING

What was the cause of the previous problem:

Drought		Pump Failure	
Plugging		Increased usage	
Interference		Contamination	✓

If the problem was contamination, what water quality changes were apparent? (Note any differences in taste, odour, colour or clarity)

SAND IN CISTERN, PIPES ETC

What action was taken to overcome this problem? FLUSHING, + CHLORINATED

What were the effects of this action? CLEARED PROBLEM BUT PROBLEM CAME BACK

Did you ever have your well?

deepend, YES ☐ NO ☑

cleaned, YES ☑ NO ☐ SHOCKED

or a new well YES ☐ NO ☑

If so why?

Outline briefly any previous repairs or changes in pumping equipment, and dates

5. Sample Details – TAKEN FROM KITCHEN TAP – (NO TREATMENT ON SITE)

Date: 29/10/14

Sample Collected? YES ☑ NO ☐

Sample Name/Number: WW1

Number of Bottles: 2

Field Analysis

Harness

Iron

Conductivity

pH

Temperature

Other

6. Contact Details

Permission for future monitoring? YES ☑ NO ☐

Well Aware Booklet:

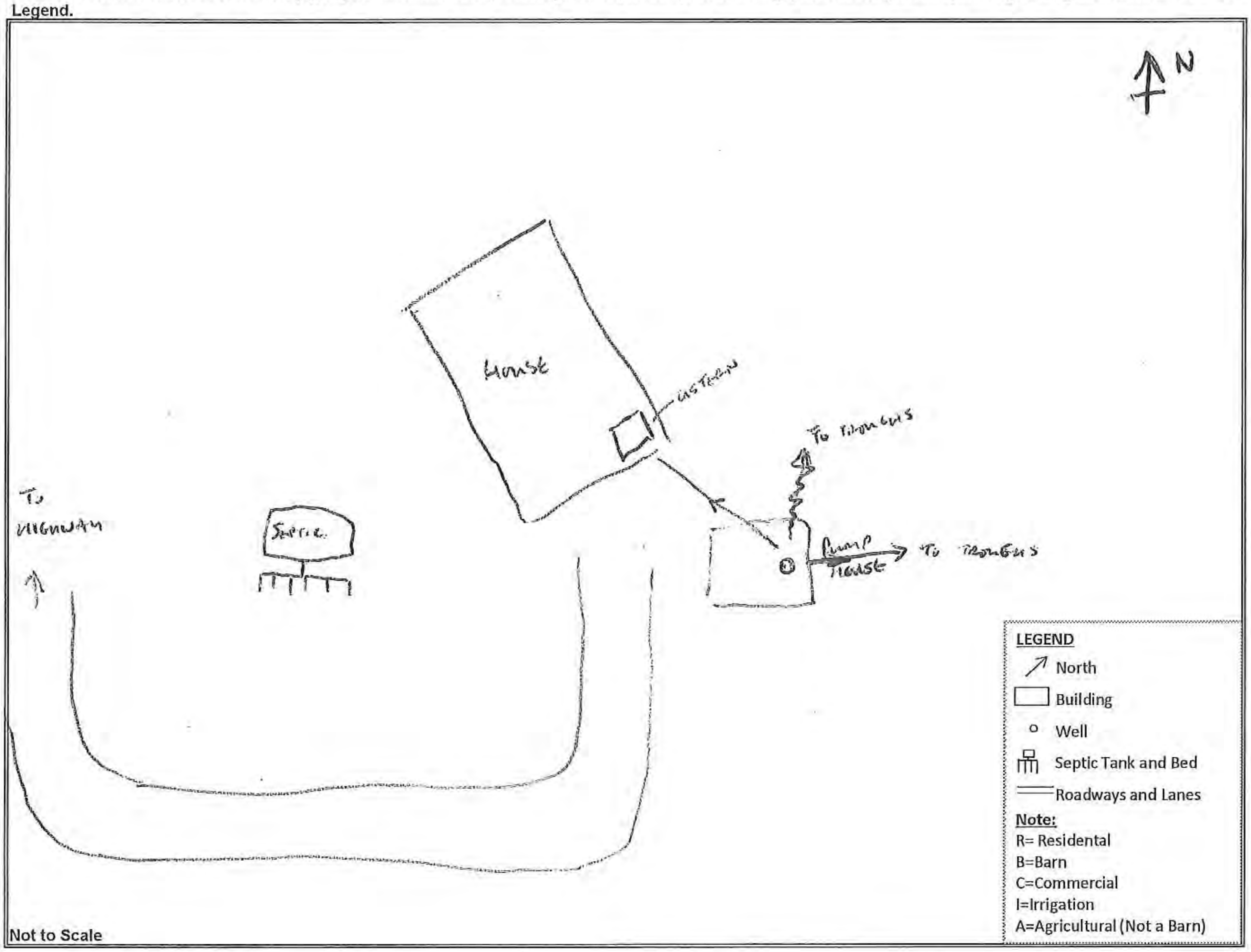
Perferred contact time/method: call/contact ahead ☑ site visit ☐

Contact by: email ☐ phone ☑ perferred contact number:

preferred contact time (evening, weekday, morning, etc.): ANY TIME DURING DAY

7. Well Location Sketch

Notes: shown location of water well(s), septic tanks and beds, laneways/roads, fences, site buildings, north arrow, and any distinguishing site features. Include Legend.



Well GPS ____________ , ____________ , ____________

8. Site Photograph Log

Number of Photos Taken: ____________

Photograph Number/Name	**Description**

Water Well Reconnaissance Survey

SITE RECONNAISSANCE CHECKLIST

Project Name: WATERMAN AGGREGATE RESOURCE

Project Number: 203.50065.00001 **SLR Staff:** R. TILL

Street Address: SE 31-26-3 WSM

Property Type: Private Residence ☑ Commerical/Industrial ☐ Other

Person/Resident Interviewed: MRS PARKER

Date of Visit: PHONE CALL 10 DEC 2014 **Time:** 16:30

1. Well Owner Information

Name: MRS PARKER

Street Address: Box 123 SE 31 26 3 WSM

Contact Number: Home: Business: Cell:

Email Address:

2. Well User/Occupant of the Residence Using the Well

Same as Well Owner ☑

If different from well owner please fill out details below:

Name:

Street Address:

Contact Number: Home: Business: Cell:

Email Address:

3. Well Details

Well Location Lot: IN HOUSE **Concession:** SE 31-26-3 WSM **Township:**

3A. Well Use

4 WELLS

Water Use:

Domestic: ☑ **No. of people using water from the well:** 2

Livestock: ☑ **No. of livestock using water from the well:** 100 HEAD CATTLE

Lawn Watering: ☐ **Acres/area covered:** **Approximate Amount:**

Irrigation: ☐ **Acres/area covered:** **Approximate Amount:**

3 ARTESIAN WELLS

3A. Well Use Continued

Additional Equipment: Pool: ☐ Jacuzzi/Hot Tub: ☐ Landscape water feature/fountain: ☐

Other:

Private waste and water disposal: Type (ex. Spectic tank): SEPTIC TANK

System description:

Distance to Well: 100 ft Direction from well (N, S, E, or W): DEPENDS ON WELL

Well is: Uphill ☑ Downhill ☐ Same Grade ☐ as the waste water system

3B. Well Construction Details

Construction/Installation Date: 1920's Contractor: OWNER

Type of Installation: Drilled ☐ Dug ☑ Other:

Diameter: 6" or 8" Well Depth (m): 20 - 25 feet

Screen? YES ☑ NO ☐

Screen length (m)

Depth to top of screen (m)

MOE Record Number:

Confirmed ☐ Inferred ☐

Is the well accesible for sampling? YES ☐ NO ☑

If no provide details: IN THE HOUSE

Location of measurement (top of pipe (TOP), ground surface):

SLR staff member collecting the measurement:

Date of original measurement: Original/initial water level depth (m) 3 ARTESIAN - 10 ft BELOW GROUND

Subsequent water level measurements

Date						
Depth (m)						
Staff						

3C. Pumping Equipment

Pump Type: Suction-lift ☐ SUBMERSIBLE Pumping Capacity

Positive-submergence ☐ Age

How is the pump lubricated?

Depth of intake setting: Original (m) Present (m) Pumping Rate (L/s)

Storage Tank: NO Type: Capacity:

Additional Features: NO TREATMENT Chlorinator ☐ Water softener ☐ Water filter ☐ Filter type:

4. Well History

How long have you owned, operated or lived on this property? 1955

Have you ever experienced any previous problems with your well? NO

If so, when?

What was the cause of the previous problem:

Drought	✓	Pump Failure	✓
Plugging	✓	Increased usage	✓
Interference	✓	Contamination	✓

If the problem was contamination, what water quality changes were apparent? (Note any differences in taste, odour, colour or clarity)

What action was taken to overcome this problem?

What were the effects of this action?

Did you ever have your well?

deepend,	YES	☐	NO	☑
cleaned,	YES	☐	NO	☑
or a new well	YES	☐	NO	☑

If so why?

Outline briefly any previous repairs or changes in pumping equipment, and dates 1966/67 PumPS

5. Sample Details

Date:

Sample Collected? YES ☐ NO ☐

Sample Name/Number:

Number of Bottles:

Field Analysis

Harness

Iron

Conductivity

pH

Temperature

Other

6. Contact Details

Permission for future monitoring? YES ☐ NO ☑ – NOT UNTIL AFTER XMAS

Well Aware Booklet:

Perferred contact time/method: call/contact ahead ☐ site visit ☐

Contact by: email ☐ phone ☐ perferred contact number:

preferred contact time (evening, weekday, morning, etc.):

7. Well Location Sketch

Notes: shown location of water well(s), septic tanks and beds, laneways/roads, fences, site buildings, north arrow, and any distinguishing site features. Include Legend.

LEGEND

↗ North

▭ Building

○ Well

⊓ Septic Tank and Bed

═ Roadways and Lanes

Note:

R= Residental

B=Barn

C=Commercial

I=Irrigation

A=Agricultural (Not a Barn)

Not to Scale

Well GPS ____________, ____________, ____________

8. Site Photograph Log

Number of Photos Taken: ____________

Photograph Number/Name	**Description**

Water Well Reconnaissance Survey

SITE RECONNAISSANCE CHECKLIST

Project Name: WATERMAN AGGREGATE RESOURCE

Project Number: 203.50065.00001 **SLR Staff:** R. TILL

Street Address: NE 31-26-3 . WSM

Property Type: Private Residence ☑ Commerical/Industrial ☐ Other

Person/Resident Interviewed: CALVIN B[redacted] RAWN.

Date of Visit: 29 OCT 2014 **Time:** 12:00

1. Well Owner Information

Name: CALVIN RAWN

Street Address: AS ABOVE

Contact Number: **Home:** **Business:** **Cell:** (

Email Address:

2. Well User/Occupant of the Residence Using the Well

Same as Well Owner ☑

If different from well owner please fill out details below:

Name:

Street Address:

Contact Number: **Home:** **Business:** **Cell:**

Email Address:

3. Well Details

Well Location **Lot:** NE 31-26-3 WSM **Concession:** **Township:**

3A. Well Use

2 WELLS

Water Use:

Domestic: ☑ **No. of people using water from the well:** 5 (WW2)

Livestock: ☑ **No. of livestock using water from the well:** 40 HORSES (WW3)

Lawn Watering: ☐ **Acres/area covered:** **Approximate Amount:**

Irrigation: ☐ **Acres/area covered:** **Approximate Amount:**

3A. Well Use Continued

Additional Equipment: Pool: ☐ Jacuzzi/Hot Tub: ☐ Landscape water feature/fountain: ☐

Other:

Private waste and water disposal: Type (ex. Spectic tank): SEPTIC TANK

System description:

Distance to Well 2-300 ft Direction from well (N, S, E, or W) EAST

Well is Uphill ☐ Downhill ☐ Same Grade ☑ as the waste water system

3B. Well Construction Details

Construction/Installation Date: Contractor:

Type of Installation: Drilled ☑ Dug ☐ Other:

Diameter: 6 INCH Well Depth (m): HOUSE 177 + BARN 135 ft

Screen? YES ☐ NO ☐

Screen length (m)

Depth to top of screen (m)

MOE Record Number:

Confirmed ☐ Inferred ☐

Is the well accesible for sampling? YES ☑ (WW2) NO ☑ (WW3)

If no provide details: WW3 BLOCKED @ 27.5mbTOP

Location of measurement (top of pipe (TOP), ground surface): TOP

SLR staff member collecting the measurement: ROBERT TILL

Date of original measurement: 29/OCT/2014 Original/initial water level depth (m) 29.65 mbTOP (WW2)

Subsequent water level measurements - WW2 - LOGGER INSTALLED

Date						
Depth (m)						
Staff						

3C. Pumping Equipment

Pump Type: Suction-lift ☐ SUBMERSIBLE Pumping Capacity —

Positive-submergence ☐ Age 10 YRS + 5 YRS

How is the pump lubricated?

Depth of intake setting: Original (m) Present (m) WW2 160ft + WW3 125ft Pumping Rate (L/s)

Storage Tank: Type: CISTERN Capacity: WW2 400 GAL (HOUSE) + WW3 750 GAL

Additional Features: Chlorinator ☐ Water softener ☑ HOUSE Water filter ☑ HOUSE Filter type: PARTICULATE

4. Well History

How long have you owned, operated or lived on this property? 10 YRS

Have you ever experienced any previous problems with your well? NO

If so, when?

What was the cause of the previous problem:

Drought	—	Pump Failure	—
Plugging	—	Increased usage	—
Interference	—	Contamination	—

If the problem was contamination, what water quality changes were apparent? (Note any differences in taste, odour, colour or clarity)

N/A

What action was taken to overcome this problem? N/A

What were the effects of this action? N/A

Did you ever have your well?

deepend,	YES	☐	NO	☑
cleaned,	YES	☐	NO	☑
or a new well	YES	☐	NO	☑

If so why?

Outline briefly any previous repairs or changes in pumping equipment, and dates REPLACED HOUSE PUMP

5. Sample Details

WW2 - STANDPIPE AT BACK OF PUMP HOUSE, WW3 - HOSE IN STABLES (NO TREATMENT)

Date: 29 OCT 2014

Sample Collected? YES ☑ NO ☐

Sample Name/Number: WW2 + WW3

Number of Bottles: 2 EACH

Field Analysis

Harness

Iron

Conductivity 577 µS/cm

pH 7.62

Temperature 6.4°C

Other

6. Contact Details

Permission for future monitoring? YES ☑ NO ☐

Well Aware Booklet: —

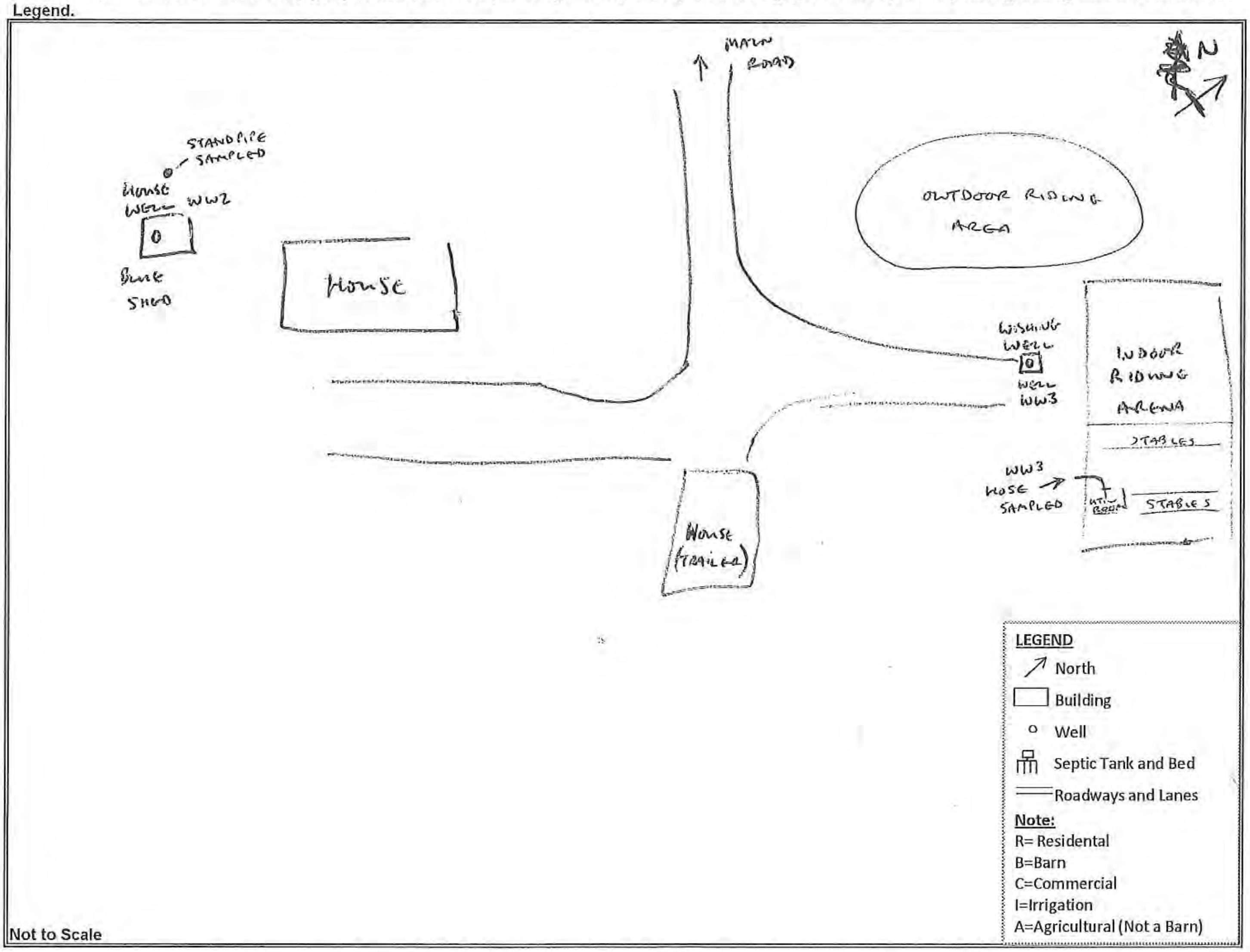
Perferred contact time/method: call/contact ahead ☑ site visit ☐

Contact by: email ☐ phone ☐ perferred contact number: —

preferred contact time (evening, weekday, morning, etc.): DURING DAY - ANY REASONABLE HOUR

7. Well Location Sketch

Notes: shown location of water well(s), septic tanks and beds, laneways/roads, fences, site buildings, north arrow, and any distinguishing site features. Include Legend.



Not to Scale

Well GPS WW2 - 0680992 m , 5682772 m WW3 - 0681169 m , 5682906 m

8. Site Photograph Log

Number of Photos Taken: ____________

Photograph Number/Name	Description

SLR

Water Well Reconnaissance Survey

SITE RECONNAISSANCE CHECKLIST

Project Name: WATERMAN AGGREGATE RESOURCE

Project Number: 203.50065.00001 **SLR Staff:** R. TILL

Street Address: SW 31-26-03 W5M

Property Type: Private Residence ☑ Commerical/Industrial ☐ Other

Person/Resident Interviewed: JOHN NUGTER

Date of Visit: 30 OCTOBER 2014 **Time:** 11:20

1. Well Owner Information

Name: JOHN NUGTER

Street Address: AS ABOVE

Contact Number: Home: Business: Cell:

Email Address:

2. Well User/Occupant of the Residence Using the Well

Same as Well Owner ☑

If different from well owner please fill out details below:

Name:

Street Address:

Contact Number: Home: Business: Cell:

Email Address:

3. Well Details

Well Location Lot: SW.31-26-03 W5M **Concession:** **Township:**

3A. Well Use

Water Use:

Domestic:	☑	No. of people using water from the well:	3
Livestock:	☑	No. of livestock using water from the well:	25 CATTLE, 5 HORSES
Lawn Watering:	☐	Acres/area covered:	Approximate Amount:
Irrigation:	☐	Acres/area covered:	Approximate Amount:

3A. Well Use Continued

Additional Equipment: Pool: ☐ Jacuzzi/Hot Tub: ☐ Landscape water feature/fountain: ☐

Other:

Private waste and water disposal: Type (ex. Spectic tank): SEPTIC TANKS (2 TANKS)

System description: 1 TANK FOR HOUSE + 1 FOR RENTAL HOUSE

Distance to Well Direction from well (N, S, E, or W)

Well is Uphill ☐ Downhill ☐ Same Grade ☐ as the waste water system

3B. Well Construction Details

Construction/Installation Date: 1990 Contractor: LOU'S WATER WELL DRILLING

Type of Installation: Drilled ☑ Dug ☐ Other:

Diameter: Well Depth ([illegible]): 115 ft

Screen? YES ☑ NO ☐

Screen length (m)

Depth to top of screen (m)

MOE Record Number:
350194

Confirmed ☑ Inferred ☐

Is the well accesible for sampling? YES ☑ NO ☐

If no provide details:

Location of measurement (top of pipe (TOP), ground surface): [illegible] TOP

SLR staff member collecting the measurement: ROBERT TILL

Date of original measurement: 30 OCTOBER 2014 Original/initial water level depth (m) 11.734 mbTOC

Subsequent water level measurements

Date						
Depth (m)						
Staff						

3C. Pumping Equipment

Pump Type: Suction-lift ☐ Positive-submergence ☐ SUBMERSIBLE

Pumping Capacity 30 GAL/MIN

Age 2006

How is the pump lubricated?

Depth of intake setting: Original (m) Present (m) 100ft ? Pumping Rate (L/s)

Storage Tank: Type: N/A Capacity:

Additional Features: Chlorinator ☐ Water softener ☐ Water filter ☐ Filter type:

NO TREATMENT

4. Well History

How long have you owned, operated or lived on this property? 17 YEARS

Have you ever experienced any previous problems with your well? NO

If so, when?

What was the cause of the previous problem:

Drought ______ Pump Failure ______

Plugging ______ Increased usage ______

Interference ______ Contamination ______

If the problem was contamination, what water quality changes were apparent? (Note any differences in taste, odour, colour or clarity)

What action was taken to overcome this problem?

What were the effects of this action?

Did you ever have your well?

deepend, YES ☐ NO ☑

cleaned, YES ☐ NO ☑

or a new well YES ☐ NO ☑

If so why?

Outline briefly any previous repairs or changes in pumping equipment, and dates CHANGED PUMP 2006

5. Sample Details

Date: 30 OCT 2014

Sample Collected? YES ☑ NO ☐

Sample Name/Number: WW4

Number of Bottles: 2

Field Analysis

Harness ______ Iron ______ Conductivity 606 µS/cm

pH 5.44 ? Temperature 5.1°C Other ______

6. Contact Details

Permission for future monitoring? YES ☑ NO ☐

Well Aware Booklet:

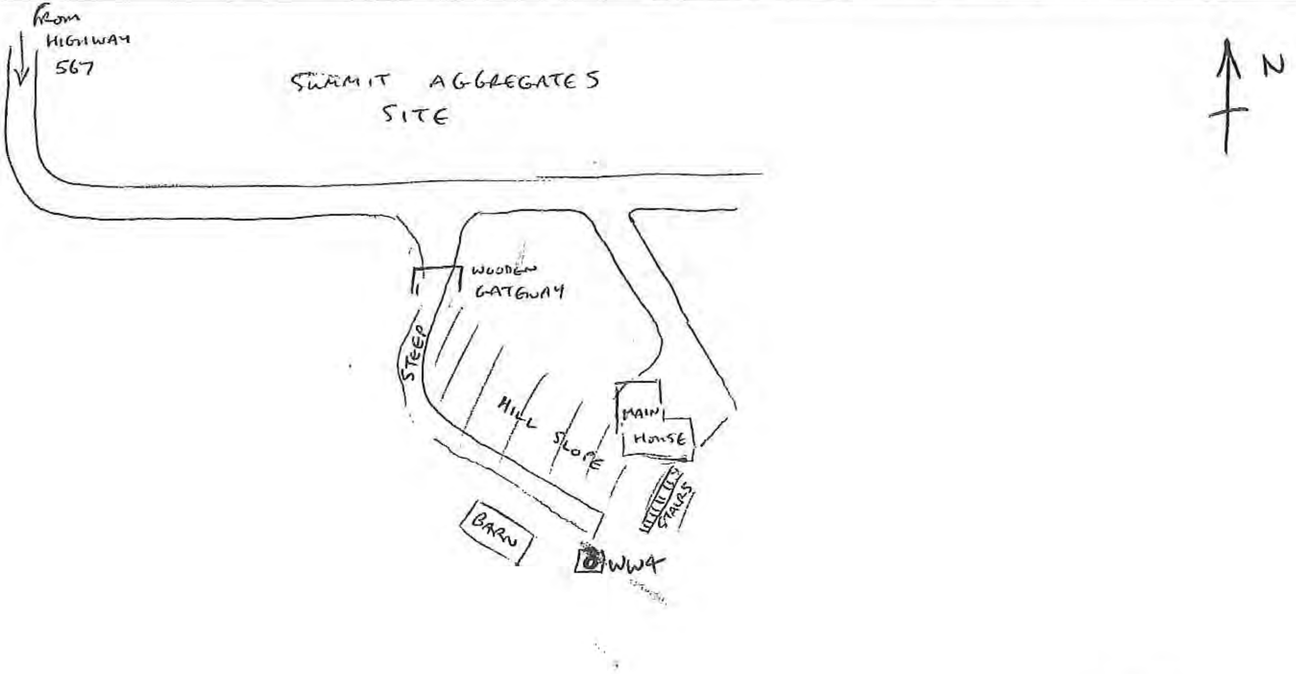
Perferred contact time/method: call/contact ahead ☑ site visit ☐

Contact by: email ☐ phone ☑ perferred contact number:

preferred contact time (evening, weekday, morning, etc.):

7. Well Location Sketch

Notes: shown location of water well(s), septic tanks and beds, laneways/roads, fences, site buildings, north arrow, and any distinguishing site features. Include Legend.



LEGEND

- ↗ North
- ▭ Building
- ○ Well
- Septic Tank and Bed
- ═ Roadways and Lanes

Note:

R= Residental
B=Barn
C=Commercial
I=Irrigation
A=Agricultural (Not a Barn)

Not to Scale

Well GPS 0680258 . 5682090 .

8. Site Photograph Log

Number of Photos Taken:

Photograph Number/Name	**Description**

Appendix I

Hydrogeological Assessment Report

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

SLR
global environmental solutions

Mountain Ash Limited Partnership Aggregate Operation
NW and SW 31-26-03 W5M, Rocky View County, Alberta

Hydrogeological Assessment Report

MOUNTAIN ASH
LIMITED PARTNERSHIP

January 2020
SLR Project No.: 212.06650.00003

HYDROGEOLOGICAL ASSESSMENT REPORT

MOUNTAIN ASH LIMITED PARTNERSHIP AGGREGATE OPERATION
NW AND SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

SLR Project No.: 212.06650.00003

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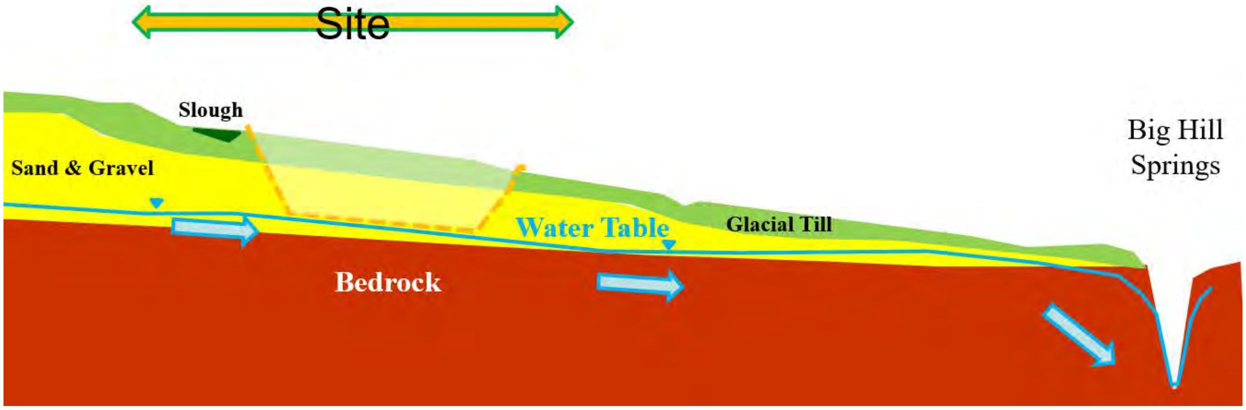
EXECUTIVE SUMMARY

Mountain Ash Limited Partnership (MALP) is proposing to develop an aggregate resource at Section 31, Township 26, Range 3, west of the 5th Meridian in Rocky View County. SLR Consulting (Canada) Ltd. (SLR) was retained to conduct a hydrogeological investigation of this potential aggregate resource development. The objective is to provide a description of baseline hydrogeological conditions in the vicinity of the proposed MALP aggregate resource. We review the potential impacts of the development on groundwater quality and quantity. Based on this we provide mitigation measures to support the development and operation of the aggregate resource being conducted with minimal impact to existing local water users. This includes neighbouring domestic wells, nearby natural heritage features like Big Hill Creek, and the Big Hill Springs Provincial Park. As the ensuing report will identify, it is anticipated that this can be successfully achieved.

The proposed development is an aggregate resource to be worked in six counter-clockwise phases starting in the southeast corner. The sand and gravel will be extracted under dry conditions. No dewatering of the underlying aquifer is planned. In this manner groundwater resources will be protected.

This report creates a picture of the regional setting of the area based on published sources of information such as published geological maps and water well records. Field investigation was undertaken to find local wells, and to drill and install monitoring wells on the site. The soils were scientifically logged for the geologic profile and it was found that the site fit in well with the regional setting. From this, an examination of potential impacts was undertaken and appropriate mitigation was identified. As will be seen in the report, no adverse net impact of the operations on the hydrologic / hydrogeologic setting is predicted.

The two large sloughs in the northwest corner of the site are to be retained on the landscape. A wetland assessment has been undertaken and is covered elsewhere. No streams are located on, or flow from the site, and thus hydrologic impacts are not possible. The following schematic illustrates the hydrogeologic profile found at the site. Given the distances involved, it has been vertically stretched to better show the individual layers and thus is not to scale.



The sloughs are surface water fed and perched on the 4 to 6-metre-thick blanket of dense glacial till which limits the leakage of water into the ground. Beneath the till lies the target sand and gravel deposit which is 11 to 20 metres thick, and generally dry. The water table is close to the bottom of this deposit and sometimes in the underlying bedrock. This bedrock is the Paskapoo Formation bedrock composed of sandstone, siltstone, mudstone and shale. Although not a very good aquifer, it is permeable enough to provide local water supply and is tapped by the few wells in the area. Groundwater flows to the southeast and eventually discharges in Big Hill Springs at the Provincial Park. The report identifies that this function will not be altered; there may be a slight increase in discharge when the pit is operating, due to the capture of rainfall directly into the sand. It was found that groundwater quality in the sand and gravel and the bedrock is very similar to that in Big Hill Springs.

We have considered the possibility of impacts from manmade sources such as fuels and solvents during the operational phase of the pit. We have also considered natural sources such as suspended solids from reworking of the material on site. These potential effects will be mitigated by using best handling practices as outlined in the *Code of Practice for Pits* (Alberta, 2004), other codes of best practice and adhering to regulatory approval conditions.

Under the current excavation scheme the overall risk of any significant negative impacts on water resources as a result of the development are negligible. This is based on the fact that the aggregate resource will not be mined into the water table and therefore no anticipated changes are possible to the groundwater flow system.

The following mitigation and design measures are recommended to reduce the chance of water quality pollution:

- Develop the site on a phased basis to minimize the working area and allow for progressive site restoration;
- Minimize the size of each working area to reduce the potential for generation of suspended sediment in storm water; and
- Commission settlement ponds and surface infiltration features early in the scheme development and manage all runoff generated during operations onsite; and
- Implement a groundwater monitoring program to monitor the existing groundwater flow system and give early warning of any unanticipated changes.

The effects of the development of an aggregate resource above the water table at this site will be minimal on the surface and groundwater regimes, particularly if the mitigation and design measures discussed above are implemented. **It is predicted that there will be no adverse net impact of development at the site on surface water or groundwater users in the vicinity**.

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1.0 INTRODUCTION

SLR Consulting (Canada) Ltd. (SLR) was retained by Mountain Ash Limited Partnership (MALP) to conduct a hydrogeological assessment of a proposed aggregate resource in Rocky View County, Alberta. The assessment and description of baseline hydrogeological conditions within the vicinity of the site is required to ensure the development and operation of the aggregate resource is conducted with minimal impact to existing local water users and the natural environment. This includes neighbouring domestic wells and the Big Hill Springs Provincial Park.

1.1 Site Description

Mountain Ash Limited Partnership (MALP) wishes to develop a site at the western half of Section 31, Township 26, Range 3, west of the 5th Meridian (Sec 31, Twp 26, Rge 3, W5M) for the purposes of aggregate extraction. The site location is shown on Drawing 1.

The northern part of the proposed site (Northwest quarter of Sec 31, Twp 26, Rge 3, W5M), is currently zoned by the Rocky View County as Natural Resource Industrial District and the southern part (Southwest quarter of Sec 31, Twp 26, Rge 3, W5M) is zoned Ranch and Farm District (Rocky View County, 2019). Its current use is ranch farming by a tenant occupier who lives in a dwelling on the site and ranches cattle, horses and sheep, and uses some of the land as hay pasture. There are two large sloughs in the northwest corner considered as Class II gramminoid marsh wetlands and a number of other, smaller wetlands mainly classified as Class I farmed through wetlands. A detailed description of the wetlands on site is provided in SLR (2020a; 2020b).

1.2 Physiography, Topography and Geomorphology

The Project Site is situated in the Southern Alberta Upland physiographic region of the interior plains division (Pettapiece, 1986). The geomorphological characteristics of this physiographic region are provided by the proximity of bedrock to the surface which causes a varied topography with elevations up to 1,650 metres (m) above sea level (asl) to the west. The site is located at an average elevation of approximately 1,280 masl. The site slopes to the southeast from the topographic high to the north and hosts a low-relief valley feature running northwest to southeast across NW Sec 31, Twp 26, Rge 3, W5M. In SW Sec 31, Twp 26, Rge 3, W5M, the topography slopes steeply southwesterly into the valley running west-northwest to east-southeast which leads to Big Hill Springs Creek. The site is in the Bighill Creek watershed and the study area topography based on LiDAR data is presented on Drawing 2.

The physiographic region coincides with the Foothills natural region which comprises dissected plateaus and rolling uplands with surficial geology comprising glacial till and abundant fluvial deposits. The climate in this natural sub-region is typically characterised by cool summers and cold winters but highly influenced by the periodic warm Chinook winds (Downing and Pettapiece, 2006). Compared to the rest of the country, Alberta has relatively low precipitation in the lee of the mountains and total average annual rainfall in the area is 450 to 500 millimetres (mm) per year (Alberta Agriculture, Food and Rural Development, 2000).

1.3 Proposed Development

The western half of Section 31 covers a total area of approximately 130 hectares (320 acres). The ultimate extraction footprint will be 83.4 ha (206 acres). The property will be operated and permitted in six phases of uneven size, depending upon setbacks, with operations and permitting commencing initially for the southeast parcel. This is called Phase 1 and comprises about 14.4 ha (35.5 acres) and is expected to take 5 years to extract. It should be noted that the two sloughs in the northwest corner will be retained and Phase 4 will be developed on the lands south and east of them. Each of the subsequent phases is anticipated to take approximately 5 years to extract.

Based on drilling investigations at the site, there is 4 m to 6 m of glacial till overburden overlying approximately 20 m of sand and gravel. The till soils will be stripped and stockpiled for future use in the post-development restoration. The sand and gravel is the target deposit for extraction and lies immediately above the underlying bedrock. Groundwater in assessment boreholes was noted at between 20 m and 24 m below ground surface (m bgs) and above the bedrock. It is anticipated that the site will be worked to 1.0 m above the maximum recorded groundwater level within the gravel deposit and will therefore be worked dry, with no requirement for operational or permanent dewatering. Actual depths will be determined with progressive investigation of water levels as the aggregate resource is developed.

1.4 Objectives

The objectives of this hydrogeological assessment are to provide detailed baseline data which would fulfil the information requirements within the Alberta Code of Practice for Pits (Alberta Government, 2004) and inform the development of the aggregate resource. The report is intended to provide the following:

- A general description of the geological features of the proposed aggregate resource site including the surficial geology and bedrock geology;
- A description of the hydrogeology at the site in context with the local and regional study areas;
- Hydrogeological impact assessment of the quarry development on the surrounding groundwater aquifers (e.g. groundwater draw-down) and provide detail on how the impacts will be avoided or mitigated, to establish net impact; and
- A description of any monitoring programs which will be designed to provide information on effects on groundwater quality and quantity.

In order to achieve these objectives, the results section of this report is split into two main parts, the first of which relates to the geological environment and the second of which relates to the hydrogeology.

2.0 METHODOLOGY

The hydrogeological investigation was divided into two main parts, the first comprising a desktop study and review of available data, with the second comprising a water well field verified survey, several drilling investigations, hydraulic conductivity testing and groundwater monitoring and sampling.

2.1 Desktop Study

A desktop study of existing records was undertaken to obtain regional and local information about the site conditions and site setting. These included:

- Alberta Environment and Parks (AEP) records;
- Historic water well drilling reports;

- Regional and local mapping resources;
- Aerial photographs; and
- Any available operational/environmental documents relating to the site.

This desktop study also included review of existing information that MALP (Formerly Summit Aggregates) collected previously and included aggregate quality analyses (Appendix A) which helped interpret the geologic conditions for the property prior to the SLR and subsequent site investigations. The preliminary desktop review was used to determine:

- the geology and hydrogeology beneath the site;
- locations of surface water bodies in the area;
- the local topography and drainage; and
- the locations of potential sensitive receptors (wells, wetlands and springs).

A initial site reconnaissance was conducted on September 18, 2014 to provide ground-truth for observations made in the initial review and to establish some general characteristics concerning the hydrology of the area. The site visit also included an examination of the creek flowing from Big Hill Springs to the highest upstream point accessible within the Provincial Park. Many other site visits (13) have been made by SLR staff since that time for monitoring and assessment purposes.

2.2 Field Investigation

Following the initial desktop study, field assessments were carried out in accordance with SLR's standard field investigation procedures. This included the following items:

- Water well field verified survey;
- Drilling investigations and monitoring well installation;
- Hydraulic conductivity testing; and
- Groundwater monitoring and sampling.

The methodology behind these aspects of the field investigation is outlined in the following sections.

2.2.1 Water Well Field Verified Survey

After the review of historical water well records, a field verified door to door survey to confirm the location of water wells within 500 m of the property boundaries was undertaken. This field verified survey involved filling out a questionnaire with the well owners on well locations, depths, use, history and any other water related information such as drainage or septic disposal practices at available households. Further details are provided in Section 4.1 below.

2.2.2 SLR Drilling Investigation and Monitoring Well Installation

The first round of monitoring well installation was conducted by SLR from September 30 to October 2, 2014, utilizing a truck mounted drill rig equipped with 150 mm diameter Becker Hammer supplied and operated by Great West Drilling of Calgary, Alberta. Three boreholes (MW14-101, MW14-102 and MW14-103) were drilled to depths between 16.5 m bgs and 27.7 m bgs around the perimeter of the NW quarter section, where they were drilled until refusal was achieved in the upper bedrock. Soil samples were collected from the air flush centrifuge at ground surface where the cuttings were logged by a qualified geologist.

A second round of monitoring well installation was undertaken by MALP as part of further aggregate assessment in June 2018 across the NW quarter section, the borehole logs from which are presented in Appendix A. Four monitoring wells were completed as MW18-104, MW18-105, MW18-106 and MW18-107, please reference Drawing 3 for locations.

A third round of monitoring well installation was undertaken by SLR Consulting from June 3 to June 5, 2019 utilizing a track-mounted drill rig equipped with 150 mm diameter ODEX supplied and operated by Ernco Drilling of Red Deer, Alberta. Three boreholes (MW19-108, MW19-109 and MW19-110) were drilled to depths between 15.8 m bgs and 36.6 m bgs in the SW quarter section, where they were drilled down to bedrock or until groundwater was encountered. Soil samples were collected from the air flush at ground surface where the cuttings were logged.

Monitoring wells were installed in ten of the boreholes as indicated above. The monitoring wells were screened either at the base of the sand and gravel unit or across the upper bedrock / sand and gravel interface to ensure the water table could be measured. The wells were installed to characterize groundwater quality and depth to the water table within the sand and gravel and upper bedrock. The wells were constructed of 50 mm diameter schedule 40 polyvinyl chloride (PVC) pipe with threaded joints. The screened portion of the well was comprised of 0.25 mm horizontal slots (10 Slot) and the annulus was backfilled with silica sand from the bottom of the screen to approximately 0.3 m above the top of the screen. A hydrated bentonite chip seal was placed around the annulus of the solid section of stand pipe above the screened section to within approximately 0.5 m of ground surface. A 50 mm diameter slip cap was placed on the bottom of the well and a 50 mm diameter j-plug was placed on the top of the monitoring well. An above ground steel protective cover with a lockable lid was concreted in place above the top of the wells. Borehole geological information and well construction details are provided in the SLR well logs in Appendix B and those by others are provided in Appendix A.

2.2.3 Hydraulic Conductivity Testing

Hydraulic conductivity tests were conducted on MW14-101 and MW14-103 and comprised a series of rising head slug tests on both wells and a short pumping and recovery test on MW14-101. Yield tests on two private wells were undertaken utilizing the existing water distribution systems at both WW2 and WW4; however, the test in WW4 was not usable for analysis due to interference from the domestic water system. To obtain hydraulic conductivity values, the slug tests were analysed using the Bouwer-Rice method and the recovery tests were analysed using the Theis recovery method, both hosted in the AquiferTest (v3.5) software. A copy of the analysis undertaken is presented in Appendix E. Hydraulic conductivity results from the tests are reported in Section 4.2 below.

2.2.4 Groundwater and Surface Water Monitoring and Sampling

Groundwater monitoring events were carried out on 12 occasions in monitoring wells MW14-101, MW14-102 and MW14-103, on eight occasions in two residential wells (WW2 and WW4), three occasions in MW18-104, MW18-105 and MW18-106, and two occasions in MW18-107, MW19-108, MW19-109 and MW19-110. Depth to groundwater was measured using a Solinst water level meter.

Groundwater samples have been collected from the accessible residential wells in the Paskapoo Formation bedrock and the sand and gravel monitoring wells. The furthest publically accessible upstream point of the stream flowing from Big Hill Springs was sampled within the Big Hill Springs Provincial Park. Residential well samples were collected from a point within the household system before any water quality treatment and after a purge of 15 minutes or until field parameters were deemed to have stabilized. The monitoring wells in the sand and gravel were purged using a submersible pump or bailers until groundwater chemistry parameters including pH, electrical conductivity (EC), dissolved oxygen and temperature were considered to have stabilized. Water samples were placed in appropriate sample containers provided by the laboratory and preservative supplied by the laboratory was added to the samples where required. The samples were submitted to KaizenLAB or Bureau Veritas Laboratories of Calgary for testing, both of which are Canadian Association for Laboratory Accreditation (CALA) accredited laboratories.

The water quality samples from both residential wells and site monitoring wells were analysed for general chemistry and total metals for comparison purposes. Results of the water quality sampling are provided in Tables A1 to A3 (appended) and the laboratory analytical certificates provided in Appendix G. Historical water quality analysis for residential well 360164 was provided by the householder and the report is provided as Appendix H (Baseline Water Resource Inc., June 2013).

3.0 GEOLOGY

Drawing 3 shows the lines of three vertical cross-sections (Drawings 5, 6 and 7) that run northwest to southeast along the direction of groundwater flow to the springs (A-A’), southwest to northeast across the upper valley (B-B’) onsite, and southwest to northeast through the site (C-C’) further down valley. They have been prepared to illustrate the relationship between the various geological units in the study area and are referred to in the following subsections.

3.1 Surficial Topsoil

Topsoil in the M.D. of Rocky View County has developed on materials of glacial origin and are therefore heavily influenced by the nature of the parent geologic material. The topsoil lying at surface in the vicinity of the project site is comprised of the Dunvargan Series which are formed from moderately fine textured till with less than 20% coarse material. The Dunvargan Series soils are moderately well drained soils with a typical profile being a thick black soil of greater than 15 centimetre (cm) topsoil; however, in the Rocky View County they are associated with less well developed variants with less than 15 cm topsoil thickness (Turchenek and Fawcett, 1994). Based on the onsite drilling, the surficial soils range in thickness from 30 cm to 60 cm.

In summary, the topsoil is relatively thin, fine grained, with significant organic content and tends to temporarily retain water. It is this layer that supports vegetative growth and land use such as range land or cropping, as well as natural ecosystems.

3.2 Surficial Geology

Surficial geology in the vicinity of the Project site has been determined from the published geology maps (Shetsen, 1987). Two primary layers are found. The upper strata are predominantly comprised of Pleistocene-age moraine draped over the underlying sand and gravel. This moraine consists of an unsorted mixture of clay, silt, sand and gravel with local water-sorted material and is called a glacial till. The till in the vicinity of the site is of a relatively consistent thickness with a flat to undulating topography which reflects the topography of underlying deposits which in turn reflect the shape of the bedrock surface below. Underlying the draped moraine at the site is sand and gravel of glaciofluvial origin, which formed on the slopes and base of meltwater channels draining melting ice sheets (Shetsen, 1981).

Borehole logs from aggregate assessment at the site (Almor Testing Services Ltd, 2014; 2017a; 2017b and 2018) and hydrogeological investigations as part of this assessment are included as Appendix A and Appendix B, respectively. The borehole logs indicate that surficial deposits over the majority of the site include approximately 3 m to 6 m of silty, sandy or gravelly clay till and topsoil (this overburden will have to be moved to extract the underlying aggregate deposits). Beneath the clay till is the sand and gravel deposit of interest, which is generally a well graded mixture of sand and gravel containing occasional beds of pure sand or pure gravel up to 2 m thick. Some layers were difficult to drill and are interpreted to be hard, and are potentially calcified bands. Based on the drilling results, the sand and gravel generally vary in thickness between 10 m and 27 m, with an average thickness of approximately 18 m in those areas investigated.

3.3 Bedrock Geology

Consolidated bedrock underlies the unconsolidated soils at a depth of 15 to 28 m, and represents the basement to site operations where not saturated. Structurally, the site is located several kilometres east of the furthest extent of the main Cordilleran Deformation, and as such is relatively flat-lying bedrock with little folding or faulting compared to older bedrock further west in the Disturbed Belt. The bedrock beneath the sand and gravel at the site consists of Tertiary, Palaeocene age (55 to 65 million years old) sedimentary rocks of the Upper Paskapoo Formation. The Paskapoo formation comprises grey to greenish grey, thickly bedded, calcareous sandstone interbedded with siltstone or mudstone and minor conglomerate or thin limestone beds (Alberta Geological Survey, 1999). The test drilling at this site found grey sandstones and siltstones. The bedrock was derived from sediments eroded from the Rocky Mountains during a period of uplift and erosion and carried east by river systems which drained the mountains. The sandstones within the Paskapoo are a complex series of stacked river channel deposits separated by floodplain siltstone and mudstone deposits (Hamblin, 2004).

Outcrops of the Paskapoo Formation sandstone can be seen in the steep slopes of the Big Hill Springs Provincial Park southeast of the site. A number of domestic well records from the immediate vicinity identify sandstone and shale[1] beneath and surrounding the site.

4.0 HYDROGEOLOGY

The hydrogeological regime at the application site and the surrounding area is described in the following sub sections:

- Field verified survey to establish groundwater wells and use;
- Aquifer properties;
- Groundwater levels and flow; and
- Water quality assessment.

The hydrogeological data has been used to develop a conceptual site model that has in turn been used to assess potential impacts associated with the proposed development. The conceptual site model has also been used to determine appropriate mitigation measures.

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[1] It is common for drillers to use the term “shale” to describe mudstones and siltstones, as the differences are subtle and they all share a common fine grained appearance to the untrained eye.

4.1 Field Verified Water Well Survey

The objectives of the field verified water well survey were to establish residential well use, baseline water quality conditions and to provide an assessment of the hydraulic parameters within the aquifers utilised by local residences adjacent to the site. Initially, a water well record search was undertaken by obtaining records from the Alberta Water Wells database which are presented in Appendix C (updated in 2019). This was followed by a door-to-door survey (October to December 2014) of residences within a 500 m radius of the site with visits on a number of occasions to those houses where no resident was at home. Where possible the formal well records were correlated with the actual wells in the field. It is considered that the 1,600 m radius required for a Water Act application is not appropriate for this project as no water body is to be disturbed by the development which will be worked dry and much of that greater area is not in the same groundwater flow field. A number of properties were surveyed and sampled and/or yield tested in order to further assess the relevant aquifer units. At each residential well, a questionnaire was completed to determine the type of well, well completion details, water levels and whether the well user has any issues with water quality or quantity. The questionnaires completed at the residential wells are provided in Appendix D.

The majority of local wells (for which there are records) are utilized for domestic or commercial purposes. The Alberta records indicated a total of 17 wells within 500 m of the Project site with two of those decommissioned (391599 and 391600) and one with very little available detail (395793). Drawing 3 presents the locations of the wells identified from the records search and the door-to-door survey for which Table 1 summarizes the information collected. The majority of drilled wells are drilled to between 30 m and 75 m bgs and are screened within the Paskapoo Formation.

Two drilled wells (WW1 and WW4) are on the site at the residences of the current tenants; however, all of the other drilled wells recorded are greater than 100 m from the site boundary. With respect to the WW1 property, there is a well listed in the records for this property (494800); however, the geology recorded in this record is completely different than the rest of the area. It had been concluded that it is an improperly recorded location in the digital records kept by AEP and has not been used in the analysis.

Dug wells identified at location WW5 (four wells in total) are between 6.1 m and 7.6 m deep according to details provided by the householder. This location is in the bottom of the valley at the southeast end of Section 31. No lithological logs are available for the dug wells; however, based on their estimated depth and the lithological details provided in nearby drilled wells to the east, it is inferred that they are completed in the sand and gravel deposits. The well owners reported that the static water level is 3 m bgs. Although this was unconfirmed by direct measurement, it is a reasonable estimate, given the shallow nature of the wells.

Table 1
Water Wells within 500 Metres

Well Interview Number	Alberta Water Well Record Number	No. of Wells	Well Owner	Easting (UTM)	Northing (UTM)	Well Depth (m)	Drilled / Dug	Distance (m) and Direction from Site
WW1	Unknown	1	Waterman	680559[1]	5682875	Unknown	Drilled	On site
WW2	1475699	1	Rawn	680988[1]	5682770	50.9	Drilled	200m E
WW3	1475698	1	Rawn	681173[1]	5682907	36.0	Drilled	400m E
WW4	350194	1	Nugter	680257[1]	5682091	35.1	Drilled	160m S
WW5	N/A	4	Parker	681547[1]	5681568	6.1 – 7.6	Dug	
N/A	391000	1		679932[2]	5683339	39.6	Drilled	
N/A	360164	1	Carroll	680744[1]	5683480	67.1	Drilled	350m N
N/A	1022436	1	Lafarge Canada Inc.	679682[2]	5682526	30.5	Drilled	
N/A	387449	1	Lafarge Canada Inc.	See Note[3]	NE Quarter, S36-T26-R4	33.8	Drilled	
N/A	494773	1	Lafarge Canada Inc.	See Note[3]	NE Quarter, S36-T26-R4	30.5	Drilled	
N/A	2095665	1	Unknown	See Note[3]	SW Quarter, S6-T27-R3	25.6	Drilled	
N/A	390998	1	Unknown	See Note[3]	SE Quarter, S6-T27-R3	65.5	Drilled	
N/A	390999	1	Unknown	See Note[3]	SE Quarter, S6-T27-R3	73.2	Drilled	
N/A	391598	1	Unknown	See Note[3]	NW Quarter, S3-T26-R3	39.6	Drilled	On site
N/A	395786	1	Unknown	See Note[3]	NE Quarter, S31-T26-R3	62.5	Drilled	

Notes:
1. Location based on GPS measurement in the field.
2. Location based on Abacus Datagraphics database.
3. Wells plotted at quarter-section centroid in Abacus Datagraphics database. Not likely actual location.

4.2 Aquifer Properties

A number of different geological units with different hydraulic properties are present in the study area. The distinct units are discussed here in order with depth from surface (and increasing geological age). The testing of two monitoring wells and two residential wells was undertaken and details of the work are provided below.

4.2.1 Surficial Unconsolidated Deposits

Surficial deposits of unconsolidated soils consist of till overlying sand and gravel deposits as described in Section 3.2 above. Groundwater flows in the intergranular pores in these soils, and the rate of flow is proportional to the hydraulic conductivity of the soil. For example, the hydraulic conductivity is low where clay rich material infills these pores, but is significantly higher where clean sand and gravel is present.

Since the upper glacial till that caps the site is not saturated, no groundwater monitors were installed and therefore no field testing for hydraulic conductivity was undertaken. These soils are not typically aquifers, as their hydraulic conductivity is in the range of 10^{-8} to 10^{-7} m/s (Freeze and Cherry, 1979), but they do act as a protective layer for underlying deposits.

As described in Section 2.2.3, a number of slug and pumping and recovery tests were undertaken on monitoring wells MW14-101 and MW14-103 which are screened in the sand and gravel. The slug tests were conducted using bailers with instantaneous head changes in the wells and the pumping and recovery test (MW14-101) was undertaken by pumping for approximately 20 minutes until water levels stabilised. The slug tests determined hydraulic conductivities of approximately 2×10^{-4} m/s to 3×10^{-4} m/s. The pumping and recovery test indicated hydraulic conductivities of 1×10^{-4} m/s. It is considered that the longer pumping and recovery test gives a better idea of the bulk sand and gravel properties due to its larger radius of influence around the wells. These values nonetheless fall in a narrow range and are typical of sand and gravel aquifers.

4.2.2 Paskapoo Formation Bedrock

The Paskapoo Formation is the most significant aquifer formation in western Alberta and potentially the Prairie region, and although of regional importance as a whole, the isolated nature of the main sandstone units can provide variable success for residential wells. Only the sandstone facies of the Paskapoo Formation demonstrate any significant intergranular porosity; however, the pore spaces may be filled with calcareous cement in some areas. Bedding planes, joints and structural fractures contribute to a secondary permeability of the bedrock as well. Based on water well records in the area and the drilling at this site, much of the formation in this area is primarily comprised of fine-grained bedrock such as siltstone, mudstone and shale which demonstrate low intergranular porosity. Secondary fracture porosity is likely to be responsible for the yields obtained from residential wells in the vicinity of the site and generally provides lower yields within wells completed within mudstone and siltstone than sandstone (Geological Survey of Canada, 2007; Ozaray and Barnes, 1977). The majority of residential wells in the area are drilled into the Paskapoo Formation indicating that the aquifer is locally important for groundwater supplies.

An in-situ variable head permeability test has been undertaken in residential well WW2 by undertaking a short term pumping and recovery test. One other residential well (WW4) was tested; however, due to interference by the particular characteristics of the method of operation of the existing water distribution system, very little analysis could be undertaken on the test results. No other residential wells were available for yield testing. Test results were analysed using the Cooper-Jacob Time Drawdown method as hosted by AquiferTest (v3.5) software to obtain hydraulic conductivity values. A copy of the analysis undertaken is presented in Appendix E. The test results show that the Paskapoo Formation penetrated by WW2 has an approximate hydraulic conductivity of 2 x 10^{-7} m/s with a transmissivity of 5 x 10^{-6} m^2/s. The well record corresponding to WW2 is 1475699 (Appendix C), which shows the water bearing layers to be mostly sandstone and shale at a depth of 45 m. The hydraulic conductivity value obtained reflects this fractured bedrock.

Water levels in WW2 and WW4 were measured over a 1-month period at five-minute intervals by a water level transducer and data logger to assess the responses of the wells to their normal use. The first month of data collected is provided in graphical form in Appendix F. Water levels in WW2 respond significantly to normal domestic use with drawdown up to 8 m seen during normal household use. This contrasts with the response of WW4 to normal use as the well shows a maximum drawdown of approximately 0.11 m. The slow aquifer response in WW2 and fast aquifer response in WW4 also were seen during the yield tests where WW2 had drawdown of >7 m at a flow rate of approximately 12 Litres per minute (L/min) and WW4 had drawdown of just 0.09 m at a flow rate of approximately 39 L/min. The contrast between the performances of the two wells demonstrates the variability of the hydraulic properties of the bedrock in the Paskapoo Formation.

4.2.3 Summary

In summary, the hydraulic conductivity values for the various aquifer units may be compared:

- The glacial sand and gravel deposits had an approximate hydraulic conductivity of 1 x 10^{-4} m/s to 3 x 10^{-4} m/s; and
- The Paskapoo Formation hydraulic conductivity was 2 x 10^{-7} m/s, but can vary.

While it is recognized that these measurements do not establish the full range for each unit, they do provide insight into the aquifer characteristics. It is commonly held (Freeze and Cherry, 1979; Fetter 2001) that useable aquifers have a hydraulic conductivity of greater than 10^{-6} m/s. Only low yield wells (such as some residential wells which only periodically draw water at relatively low rates) are possible below that value. The Paskapoo Formation has a value lower than this, which indicates a low yield aquifer in parts; however, the performance of WW4 indicates that higher yield wells can also be achieved. The Specific Capacity of WW2 is 1.85 L/min/m, and that of WW4 is 433 L/min/m. This is a 234 times difference, and assuming the same saturated thickness (and similar length of pumping time) it can be estimated that the conductivity of the Paskapoo Formation at WW4 is potentially two orders of magnitude higher than at WW2.

4.3 Groundwater Levels and Flow

Initially, a total of three groundwater monitoring wells were installed in the sand and gravel at the site in September / October 2014. These monitoring wells were drilled to prove bedrock and then backfilled with bentonite to the base of the sand and gravel. The wells are screened from the base of the sand and gravel to the top of the saturated zone (MW14-101 and MW14-103); however, MW14-102 has remained dry for the period of monitoring included in this report, indicating that the water table is at least seasonally in the bedrock in some areas of the site. Further monitoring wells were installed at the site in 2018 and 2019 as part of site investigations and were screened either at the base of the sand and gravel or across the sand and gravel / bedrock interface to ensure the water table was intersected.

The locations of these monitoring wells and their groundwater elevations (on July 3, 2019) are presented on Drawing 4. The information from these wells has been supplemented with groundwater level information from residential wells WW2 and WW4 also presented in Drawing 4.

The groundwater monitoring points completed at the site have been subject to periodic groundwater elevation monitoring between October 2014 and September 2019. Sand and gravel wells MW14-101 and MW14-103 and residential wells WW2 and WW4 have been recording continuous groundwater levels using data loggers from 29 October 2014. Groundwater hydrographs of monitoring data to date are presented in Appendix F, a review of which shows:

- The highest manual groundwater elevations are recorded in the sand and gravel at MW14-101 (1,274.87 masl) on 20 November 2014;
- The lowest groundwater elevations are recorded in the sand and gravel in the valley at MW19-109 (1,259.46 masl) on 3 July 2019;
- A downward vertical gradient between the sand and gravel deposits and the underlying Paskapoo Formation is likely. Based on the potentiometric surface in the sand and gravel on Drawing 4, the water level is likely about 1,271 masl at WW2, and the approximate static water level in the bedrock at WW2 is around 1,263 masl (the measured level on Drawing 4 is affected by pumping at the well). The higher total head in the overburden than the bedrock dictates a component of downward vertical groundwater flow from the sand and gravel to the bedrock. The amount of downward groundwater flow is probably limited due to the relatively lower hydraulic conductivity of the underlying bedrock, inhibiting drainage to depth;
- Minimal fluctuation in the groundwater levels within the sand and gravel indicates very little or no influence from pumping within residential wells in the area. Groundwater levels within the sand and gravel have been gradually falling over the initial four or five years of monitoring, with a drop of approximately 0.9 to 1.3 m in the period. Levels have rebounded somewhat (0.1 m) in the months between July and September 2019 due to the higher than average rainfall totals in the area in spring and summer 2019; and
- As discussed in Section 4.2.2 above, variable response to the pumping from normal use in residential wells WW2 and WW4 is seen in the hydrographs with large fluctuations in WW2 as compared with WW4. This is indicative of the differing performance of the wells due to variability of the hydraulic conductivity within the Paskapoo Formation.

Using site groundwater observation data, Drawing 4 shows the inferred potentiometric groundwater surface (drawn in blue) in the sand and gravel at site as recorded on 3 July 2019. Drawing 4 shows that the horizontal flow direction in the sand and gravel is towards the south-southeast and the Big Hill Springs valley.

The potentiometric surface within the Paskapoo Formation cannot be drawn based on just two far apart data points (WW2 and WW4). Examination of historical water levels at other wells based on the water well records show that the elevation of the potentiometric surface is between about 1,266 and 1,268 masl in the area of the site, which is near the bedrock surface. If one assumes the bedrock potentiometric surface is near ground level at the Big Hill Springs, which is about 1,240 masl, then there is strong lateral gradient southeast towards the springs at which point groundwater is observed discharging to the surface.

4.3.1 Groundwater / Surface Water Interactions

Two large sloughs located in the northwestern corner of the site have a surface elevation of approximately 1,290 masl and are perched on the 6 m of low permeability fine grained till. The presence of freestanding water is seasonal based on observations made at the site, with water levels generally decreasing through summer and autumn. Monitoring well MW14-101 located close to one of the sloughs has a groundwater elevation in the sand and gravel of approximately 1,274 masl, which is well below the base of the till (at about 1,284 masl). This demonstrates that the sloughs are not fed by groundwater from the sand and gravel. Thus, it is inferred that the sloughs are fed by rainfall and snowmelt from the local catchment and from the catchment across Highway 567 transported by the culvert located beneath the highway. These sloughs will be retained on the landscape and this small area will not be developed for aggregate extraction.

Since groundwater from beneath this site flows southeasterly towards the Big Hill Springs, and this is a significant feature in the natural heritage of the County, it represents an offsite interaction of groundwater with surface water. Section 5 of this report discusses potential impacts to this feature. For the purpose of this report; no specific investigation of the springs has been undertaken, other than a site visit to identify general features and the sampling of water quality. Bedrock outcrops can be seen on the valley walls surrounding the stream and springs and thus it is inferred that the host valley is incised into the bedrock. Ozaray & and Barnes, 1977, reports that spring flow is in the order of 40 L/s and water temperature is typically less than 5°C.

4.4 Water Quality Assessment

Groundwater samples have been collected from the accessible residential wells in the Paskapoo Formation bedrock, the sand and gravel monitoring wells and the furthest publically accessible upstream discharge point at Big Hill Springs. Sampling methodologies are described in Section 2.2.4, above and Laboratory analysis certificates are provided in Appendix G.

In order to compare groundwater and surface water quality at this site, a Piper plot showing the relationship between the relative abundance of the major cations and anions in the sampled water has been prepared (Figure 1). These plots include all groundwater and chemistry results from all groundwater monitoring wells on site and are typically helpful in understanding any differences between water types.

On all three plots the sand and gravel aquifer, bedrock aquifer and Big Hill Springs water occupies a very small area exhibiting a calcium and magnesium-rich water with little chloride or sulphate and with high alkalinity (expressed as HCO_3+CO_3). This is typical of clean meteoric water and indicates that water in both the aquifers and the springs is heavily influenced by recharge from rainfall. Often on these diagrams there can be a wider spread in the water “fingerprint”; however, the tight grouping here indicates very similar water between the three sources. In addition, the total dissolved solids in these three water sources generally lie in a fairly narrow range of 210 to 360 mg/L (Tables A1, A2 and A3, appended). On this basis, it is concluded that this is the same water type for the sand and gravel, the Paskapoo bedrock, and the discharge from Big Hill Springs. The updated groundwater and spring water chemistry supports the conclusion that the groundwater within the saturated sand and gravel recharges the Paskapoo Formation bedrock and also provides baseflow to the Big Hill Springs.

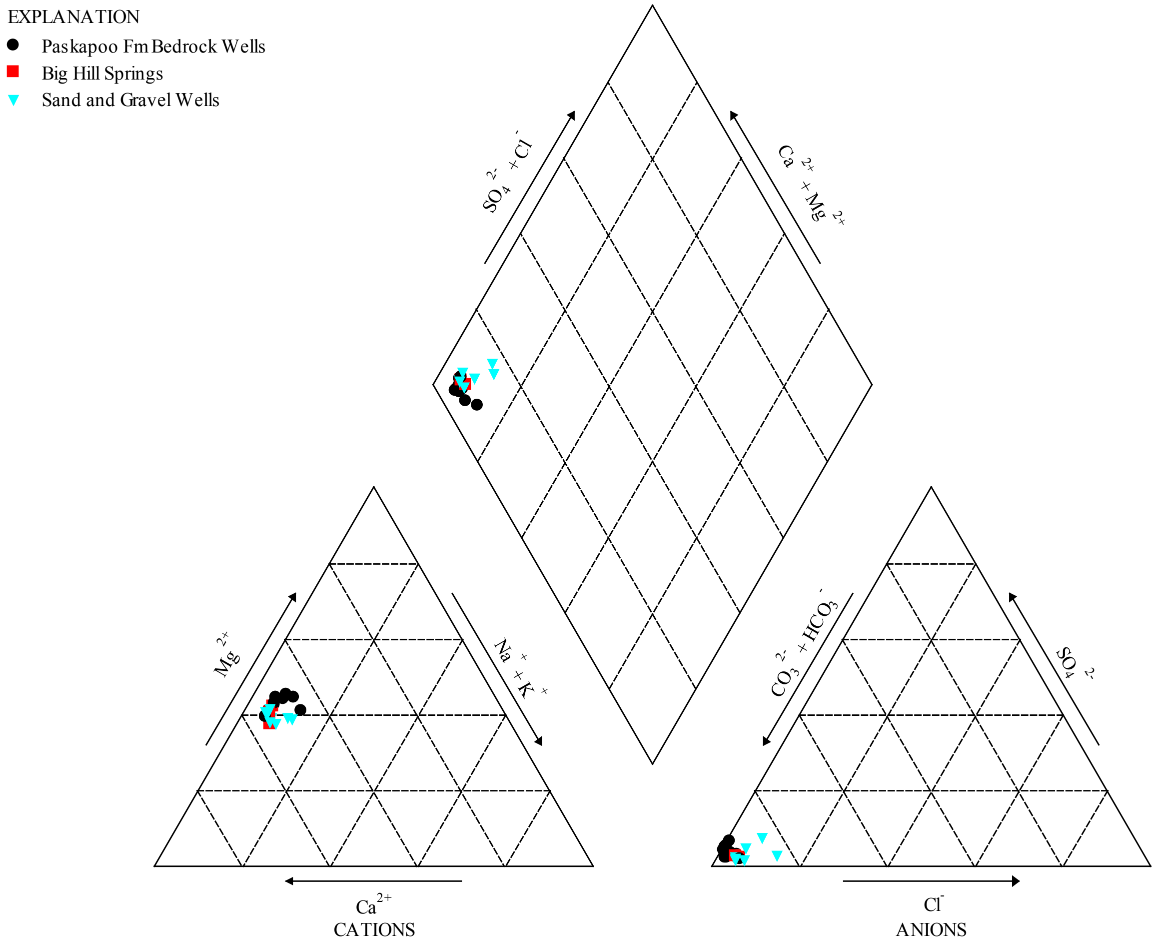

Figure 1
Piper Plot of Groundwater and Surface Water Quality Collected to Date

4.4.1 Surficial Deposits

Table A1 (appended) indicates that groundwater in the sand and gravel deposit is of poor quality for drinking. The Canadian Drinking Water Quality (CDWQ) standards set maximum allowable concentrations (MAC) for 16 parameters for drinking water purposes. A number of these were exceeded in several monitoring wells, including trace metals arsenic, barium, cadmium, chromium, lead, manganese and mercury, and microbiological parameters total coliforms and E. Coli. Other CDWQ guidelines that were exceeded were the aesthetic objective parameters aluminium and iron. Groundwater from a number of the monitoring wells exceeded guidelines for turbidity, which is a parameter that is included because it shows when water is not clear, may contain sediment, and can also mask bacteria counts. The Piper plot in Figure 1 (above) indicates that the sand and gravel samples lie in a zone of Ca-Mg-HCO_3 waters, which indicates an influence from meteoric waters and recharge from rainfall, coupled with the influence of the host soils/bedrock. Of note, the pH was moderately alkaline at 7.8 to 8.2, which is typical of groundwater in these sediments.

The low concentrations of dissolved parameters in the surficial deposits is indicative of recharge from rainfall having a short residence time in the subsurface, where fewer elements have time to dissolve in the groundwater. Not much of the trace metals are dissolved into the water, but the guidelines are so low that they can be exceeded without contributing significantly to the dissolved load. The high turbidity and total metals in a number of the monitoring wells is potentially artificial and not indicative of the actual water quality. This may have been caused by insufficient development of the monitoring wells before sampling due to the breakdown of the purge pump in both 2014 and 2019, and an undue influence of suspended sediment. The August 2015 sampling in MW14-103 did not experience this problem and sufficient purging and development occurred before the sample was collected on this occasion. The turbidity and concentrations of aluminium, iron and manganese, plus a number of other metals showed a significant reduction from those in November 2014 in the August 2015 sampling.

4.4.2 Paskapoo Formation Bedrock

Table A2 (appended) indicates that groundwater in the Paskapoo Formation is of relatively good quality for drinking, with all parameters meeting the Canadian Drinking Water Quality (CDWQ) guidelines except a single exceedance of total coliforms in WW4. E.Coli was not detected in WW4 which indicates that the coliforms were not related to fecal contamination, however they do indicate that the well could be vulnerable to bacterial contamination, especially with no treatment at that property[2]. pH values were moderately high (7.9 to 8.1) in all samples, indicating slightly more alkaline conditions within the bedrock as compared to the sand and gravel. The Piper plot in Figure 1 indicates that the majority of bedrock samples lie in a zone of Ca-Mg-HCO_3 waters, which again indicates an influence from meteoric waters and recharge from rainfall.

4.4.3 Big Hill Springs

Table A3 (appended) summarizes the water quality results of the water samples taken from the creek downstream from the springs at Big Hill Springs Provincial Park on October 30, 2014, August 4, 2015 and July 10, 2019. Since this groundwater discharge is the source for a surface water stream, and at the point of sampling is within that stream, it is compared to the CWQG Protection for Aquatic Life (PAL) guideline. The PAL has guidelines for 20 parameters of the sampling suite. The sample met 17 of the guidelines for these parameters indicating that water discharging from the spring is generally of good quality. It is noted that total coliforms and E.Coli concentrations exceed the CDWQ drinking water guidelines; however there is no CWQG bacteria guideline for the protection of aquatic life. The high concentrations are consistent with the presence of livestock in the stream catchment and of which evidence was abundant adjacent to the property line at the sampling location. Only aluminium and selenium exceeded the PAL guideline in these natural waters. Of minor note, the laboratory detection limit for mercury (0.001 mg/L) in 2014 and 2015 exceeded the guideline (0.000026 mg/L) and thus the “non-detect” reported in Table A3 may or may not meet the lower guideline. Mercury sources in this geologic setting are not common, nor will the proposed aggregate operation be a source of mercury. Mercury concentrations measured in 2019 fell below the guideline. Since this water is the source for the stream, the downstream biota will be acclimatized to this form of the natural water quality.

The Piper plot in Figure 1 indicates that the Big Hill Spring sample also lies in a zone of Ca-Mg-HCO_3 water, which again indicates an influence from meteoric waters and recharge from rainfall. Due to the similarity between concentrations within the sand and gravel aquifer, bedrock

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[2] This well is ultimately scheduled for removal once the aggregate extraction is operational, but is expected to be used in the interim.

aquifer and the spring water, it is clear that the spring water is the same, regardless of which pathway it travelled.

4.5 Water Balance

It is often useful to prepare a water balance for a site in order to understand its hydrogeologic function and against which potential impacts can be compared. This section identifies the basic water balance for the site, where "water in" must equal "water out" within the constraints of the measurements. To do this for this site, we first examine the "water in" which is the precipitation available for groundwater recharge or runoff. This is then calibrated against simple groundwater flow calculations to demonstrate the water balance.

4.5.1 Water Budget

The meteorological station No. 3031093 at the Calgary International Airport has been used to quantify average annual precipitation amounts. This station was selected for its length of record and similarity of terrain. The period of 1981 to 2012 has been used to calculate long term averages which are used in this analysis. Table 2 summarizes the results.

Table 2
Average Annual Water Budget (Calgary YYC)

Month	Ave. Monthly Temperature °C	Precipitation (Snow + Rain) mm	Actual Evapotranspiration mm	Surplus mm	Deficit mm
January	-7.1	9.6	6.5	3.1	
February	-5.5	9.8	8.7	1.1	
March	-1.6	17.9	16.3	1.6	
April	4.5	27.2	35.3		-8.1
May	9.7	58.1	63.8		-5.7
June	13.7	95.2	89.0	6.2	
July	16.6	66.0	101.1		-35.1
August	15.8	57.8	72.2		-14.4
September	11.1	44.0	42.7	1.3	
October	5.2	15.2	18.6		-3.4
November	-2.4	13.0	4.8	8.2	
December	-6.7	10.3	2.9	7.4	
Annual Totals		424.1	461.9	28.9	-66.7
Annual Average	4.5			Net Deficit = -37.8	

Notes:
Weather Station: Elevation: 1,084 masl; Latitude 51°06'50" N; Longitude 114°01'13" W; WMO #71877
Based on a soil moisture storage of 150 mm

At this station, which will have similar results to the Cochrane area, an average annual precipitation of about 424 mm per year occurs. This is typical of the region in the lee of the Rocky Mountains. Examination of this period of record shows that the two wettest years were 1998 and 2005, where upwards of 537 mm fell. The two driest years were 1983 (295 mm) and 2001 (319 mm). Based on Table 5, the wettest months are May to September, with little precipitation over the winter months of December to February (around 10 mm per month on average). The area is known for intensive rainfalls, and the highest month in this period of record was June 2005 when 248 mm fell (almost half the year's precipitation). It should be noted that 386 mm of precipitation has fallen from January 1 to August 31, 2019, which is significantly higher than the same period in an average year (342 mm). The highest monthly rainfall for 2019 fell in June with 135 mm being recorded.

The water budget has been calculated by the method of Thornthwaite and Mather (1957), which uses the monthly average temperatures, latitude, and soil moisture storage to calculate the actual evapotranspiration (AET). The AET is that water that is lost back to the atmosphere by evaporation and plant uptake (transpiration). The calculations indicate there is a net annual deficit of about 38 mm each year. To examine the range of results, a water budget was calculated for the driest and wettest years in the period of record, with the results being presented in Table 3 below.

Table 3
Comparison of Water Budgets in Wet and Dry Years

	Precipitation	Actual Evapotranspiration	Surplus/Deficit
Hottest/driest (1983)	295	384	-89
Average Annual	424	462	-38
Coldest/wettest (1998)	538	488	50

It can be seen that when the precipitation rises, the evapotranspirative uptake increases as well in response to the available water. However, in the wetter years there is still a surplus available for infiltration and runoff.

With reference to the average annual condition shown in Table 6, the months vary as well. The deficits typically occur in the hotter months, despite increased rainfall. Surplus occurs in the cooler months when evaporation is low, and when there is no plant uptake. In these months the soil moisture is replenished, and in the months where there is a deficit, that storage is tapped by the plant rooting systems.

4.5.2 Surplus Partitioning

Section 4.5.1 reports an average annual deficit of about 38 mm. In years when there is a surplus, that surplus water may be partitioned between infiltration and runoff. Using the method of MOEE (1993), which calculates partitioning factors based on topography, soil type and ground cover, an estimate of the annual infiltration and runoff can be derived. Table 4 is reproduced from this manual below, from which the infiltration factors are selected.

Table 4
Infiltration Factors

Description of Area/Development Site	Value of Infiltration Factor
TOPOGRAPHY	
1. Flat and average slope not exceeding 0.6 m per km	0.30
2. Rolling land, average slope of 2.8 m to 3.8 m per km	0.20
3. Hilly land, average slope of 28 m to 47 m per km	0.10
SOIL	
1. Tight impervious clay	0.10
2. Medium combinations of clay and loam	0.20
3. Open sandy loam	0.40
COVER	
1. Cultivated lands	0.10
2. Woodlands	0.20

Reproduced from MOEE (1995), Technical Guidelines for the Preparation of Hydrogeological Studies for Land Development Applications.

In this case the fine-grained soils are assigned a factor of 0.2 and the open pasture land cover is given the factor 0.1. The topographic factor is slightly more complex, as there are flat areas sloped down valley, and valley sidewalls with steeper slopes that favor runoff over infiltration. The flat areas have slopes that range from 0.9% to 2%, and are assigned a factor of 0.14. Therefore for the flatter slopes the infiltration factor is 0.2 + 0.1 + 0.14 = 0.44. The steeper slopes range from 2.7% to 23%, and are assigned a factor of 0.1, according to the MOEE (1993) methodology. Therefore, for the steeper slopes the infiltration factor is 0.2 + 0.1 + 0.1 = 0.4. These infiltration factors are multiplied by the surplus in any given year to estimate the rate of groundwater recharge, the remainder being lost to runoff.

4.5.3 Existing Site Water Balance

The final step in the water balance is to judge the contribution of the site to the ground water system. Since the full site is not to be developed, we do not assess those lands that will not change. MALP plan to develop 74 acres (29.83 ha) in the first two phases over ten years. The area of future aggregate extraction is another 132 acres (53.57 ha). To determine volumes available for recharge the maximum surplus (50 mm = 0.05 m) determined above is multiplied by the area. For the full development area (206 acres, or 83.4 hectares) the maximum annual surplus volume of water in a wet year would be 83.4 ha X 10,000 m^2/ha X 0.05 m/yr. = 41,700 m^3/yr.

The flatter areas comprise approximately 55.5 ha and the steeper slopes comprise approximately 27.9 ha, having infiltration factors of 0.44 and 0.40, respectively. The flatter area is 66.5% of the development area, and thus the infiltration in that portion can be calculated by multiplying that volume by the infiltration factor:

$$41{,}700\ m^3/yr.\ X\ 0.665\ X\ 0.44 = 12{,}201\ m^3/yr.$$

The steeper area is 33.5% of the development area, and thus the infiltration in that portion can be calculated by multiplying that volume by the steep area infiltration factor:

$$41,700 \text{ m}^3/\text{yr. X } 0.335 \text{ X } 0.40 = 5,587.8 \text{ m}^3/\text{yr.}$$

Therefore, the total infiltration under existing conditions for the development area (in wet year) is the ensuing sum of 17,789 m^3/yr. The difference between this and the total surplus of 41,700 m^3/yr.; therefore, is lost to run off, that is 23,911 m^3/yr.

It is always wise to independently cross-check this kind of calculation, which is based on meteorological data and estimates of soil, vegetative cover and topography. This can be done by examining the groundwater conditions that receive the water. In this case the Darcy Principle for groundwater flow is used, based on the site geometry and measured range of hydraulic conductivity, and lateral hydraulic gradients. Darcy found that groundwater flow can be quantified in the following manner:

$$Q = K \text{ x } dh/dL \text{ x } A$$

Where Q is the volumetric flux, K is the horizontal hydraulic conductivity, dh/dL is the horizontal gradient and A is the vertical area (height X breadth) of the sand and gravel available for groundwater flow. In this case the measured range of K for the sand and gravel is $1 \text{ x } 10^{-4}$ to $3 \text{ x } 10^{-4}$ m/s, as reported in Section 4.2.1. The lateral hydraulic gradient (dh/dL) is a minimum of 0.0095 m/m, measured from Drawing 4 where the 2 m (dh) contours are about 210 m (dL) apart. The vertical area, A is not actually known, however it is estimated to be 800 m wide, and the above equation can be used to determine its height. Finally, Q is known because it is necessary to see if the 17,789 m^3/yr can pass through this soil. The flow of 17,789 m^3/yr can be converted to consistent units with the above and is equal to $5.6 \text{ x } 10^{-4}$ m^3/s. Rearranging Darcy's equation:

$$Q = K \text{ x } dh/dL \text{ x } A$$

$$Q = K \text{ x } dh/dL \text{ x } (h \text{ x } b)\text{, or}$$

$$K \text{ x } dh/dL \text{ x } (h \text{ x } b) = Q\text{, and rearranging,}$$

$$h = Q / (K \text{ x } dh/dL \text{ x } b)$$

$$= 5.6 \text{ x } 10^{-4} \text{ m}^3/\text{s} / (1 \text{ x } 10^{-4} \text{ m/s x } 0.0095 \text{ x } 800 \text{ m})$$

$$= 0.74 \text{ m}$$

Since the aquifer is many times thicker than this, it is concluded it can easily convey the recharge water generated by this site in a wet year. The reader should be aware that there is groundwater moving onsite from the northwest as well, and this calculation is intended to see if the site water can move in addition to that. Of some interest, the 17,789 m^3/yr. is equivalent to about 0.56 L/s, which is therefore the site's contribution (in a wet year) to the 40 L/s reported coming from the Big Hill Springs, which has a much wider groundwater catchment.

4.6 Conceptual Model Discussion

Using the above findings, a conceptual model has been constructed to aid the reader in understanding the site setting. This conceptual model is further used in Section 5 to conduct an impact analysis of the proposed aggregate extraction operation. Underlying the site is the Paskapoo Formation bedrock, composed of sandstone, siltstone, mudstone and shale, which serves as the aquifer for most local wells. During deglaciation, this area became a drainage pathway and there is a blanket of outwash sand and gravels lying directly on the bedrock. This deposit has been excavated elsewhere for aggregate, and is the target deposit for MALP's proposed operations. The sand and gravel is 10 to 27 m thick and hosts the water table at depth, but is not a consistent aquifer which has potentially poor water quality, and is only used for domestic purposes in isolated locations (e.g. WW5). Finally, the whole site is blanketed by up to 6 m of fine grained glacial till soils, left when the ice melted. This low permeability blanket restricts the infiltration of precipitation. The site slopes to the southeast from the topographic high to the north and hosts a low-relief valley feature running northwest to southeast across NW Sec 31, Twp 26, Rge 3, W5M. In SW Sec 31, Twp 26, Rge 3, W5M the topography slopes steeply southwesterly into the valley running west-northwest to east-southeast which leads to Big Hill Springs Creek.

The site lies in an area in the lee of the Rocky Mountains and as such is relatively dry. Evapotranspiration on average exceeds precipitation and there is an average annual deficit in the water balance. On the other hand, there is soil moisture storage in the fine-grained soils at surface, so some water is captured in the wet months and helps sustain plants in the drier months. There is a surplus in wetter years. For these reasons the sand and gravel is largely unsaturated and carries groundwater flow along its base above the bedrock. There is also a recharge of the bedrock aquifer from the sand and gravel, so much so that the sand and gravel at test well MW14-102 is dry. Drainage is not complete however, as further downgradient towards the Big Hill Springs Provincial Park some shallow private wells (WW5) in the sand and gravel have enough water in them.

Few residential wells are completed in the sand and gravel deposits due to their limited saturated area, with most residential wells being completed in the bedrock. Water quality in the two aquifers (surficial deposits and bedrock) are very similar to that in Big Hill Springs and are typical of clean meteoric water which indicates that water in both the aquifers and the spring is heavily influenced by recharge from rainfall. It is considered likely, based on the water quality data and the inferred groundwater flow direction in the sand and gravel that a significant contribution to the spring water at Big Hill Springs is provided by groundwater in both aquifers.

The cross-sections run northwest to southeast along the direction of groundwater flow to the springs (A-A'), southwest to northeast across the upper valley (B-B') onsite, and southwest to northeast through the site (C-C') further down valley. They have been prepared to illustrate the relationship between the various geological units in the study area. The likely groundwater flow path shown on Drawing 5 demonstrates the relationship between recharge and discharge areas. The relatively low permeability of the bedrock (even when fractured) is responsible for the perched water table within the sand and gravel. Groundwater recharge occurs in higher areas where overburden is thin or absent and in areas where there are standing water bodies and sloughs perched on top of the low permeability glacial till. Lateral discharge from the aquifers occurs at Big Hill Springs.

5.0 HYDROGEOLOGICAL IMPACT ASSESSMENT

The above sections describe the existing setting where the proposed aggregate resource extraction will be developed. The purpose of impact assessment is to examine how the proposed facility will operate in that setting, and to determine if any adverse effects could be anticipated. The next step is to consider mitigation strategies to ensure the adverse effects are avoided or corrected. In the ideal case the net effects (the effects of the facility after mitigation) are determined and judged for acceptability within existing practice and regulation.

5.1 Hydrogeological Impact Assessment Criteria

The criteria used here to assess impacts can be expressed simply as “water quantity” and “water quality”. Water quantity refers to potential effects on water levels in wells and wetlands, groundwater flow volumes, and spring discharge volumes. Water quality refers to the potential changes in groundwater quality and/or surface water quality as might be caused by the facility.

5.2 Potential Impacts on Water Quantity

With respect to surface water, there are no streams on or emanating from this site. The presence of the sloughs in the northwest corner is the only surface water feature, and they are seasonal. Examination of the aggregate resource development plan (reproduced on Drawing 3) shows that these lands will be retained in their natural state. Topographically, their catchment area is uphill to the north and west, and thus the development of the aggregate resource downhill to the south will not affect normal overland flow to the sloughs. It can be concluded that there will be no impact to these features.

With respect to groundwater, potential effects include changes to the groundwater levels and/or groundwater flow volumes or directions. It is proposed that the sand and gravel would be worked dry; with the base of the excavation lying 1.0 m above the maximum recorded groundwater level within the deposits, therefore no dewatering is proposed. Based on this, groundwater flow directions will remain the same and there should not be a reduction in groundwater flow volumes, a positive feature as this means no reduction in flow at the Big Hill Springs.

In fact, due to the removal of the lower permeability overburden exposing the more permeable sand and gravel below, recharge to the aquifer is expected to increase. Examination of Table 7 shows that the soil factor increases from 0.2 (for the glacial till) to 0.4 for the sand and gravel. This increases the overall infiltration factor from 0.44 to 0.64 for the flatter areas. The steeper areas will be levelled and will increase from 0.4 to 0.64 as well. Therefore, the calculation for existing conditions shown in Section 4.5.3 can be conducted again with these higher factors. Without listing the details here, the contribution to groundwater (in a wet year) increases from 17,789 m^3/yr to 26,688 m^3/yr due to infiltration. Further to this, there will be no runoff leaving the site due to the management of precipitation falling on the site by infiltration. It is expected that this will be an additional 15,012 m^3/yr, and thus a total of 41,700 m^3/yr of groundwater recharge will occur in a wet year and with the full excavation developed and open. This is conservative, as the site will be progressively restored, returning infiltration conditions to close to their natural state as each phase progresses. With respect to the springs, this amount of water is about 1.3 L/s (an increase of 0.76 L/s) in comparison to the reported Big Hill Springs flow of 40 L/s. It can be concluded that this is a positive impact, but a very minor one. In a drier year there will be no change, other than the momentary capture of any higher intensity storms.

The fine-grained overburden soils removed for sand and gravel extraction would be used to restore the site to an agricultural use. It is anticipated that the final site grade would provide a similar overall average slope to the site as the pre-development state and therefore would have infiltration rates of a similar magnitude. In a dry year or an average year, where there is no surplus, groundwater conditions would remain similar to existing conditions.

5.3 Potential Impacts on Groundwater and Surface Water Quality

During the operational phase of working, the main potential source of water pollution is from manmade sources such as fuels and solvents and natural sources such as suspended solids from reworking of the material on site. These of course are mitigated by best handling practices under the Code of Practice for Pits (Alberta, 2004). The first step in impact assessment is to describe the potential problems to be addressed.

During the aggregate extraction and associated processing (crushing, screening, conveying), there is potential for onsite runoff water to become affected by suspended solids due to surface runoff from working areas, stockpiles and haul roads. In addition, wash water from the crushing plant can convey a heavy suspended sediment load. Without appropriate mitigation measures employed, it is considered that the likelihood of occurrence of this water containing suspended solids loading is high, although with the base of the excavation below ground there is no surface discharge from the site. Thus, the magnitude of impact would be low from a surface water perspective. From a groundwater perspective, the infiltration of these waters into the porous sand and gravel however would mean the capture of the fine sediment in the underlying soils, which may potentially lead to eventual blinding of the near surface. Mitigation measures are proposed as discussed in Section 5.4 below.

During the aggregate extraction and associated works, the use of diesel powered equipment has the potential to cause local impacts should there be any accidental spillage of fuels or lubricants. The specific unmitigated impact of any accidental spillage of raw materials, fuels and lubricants would be on the water quality of the sand and gravel aquifer, since there is no surface water discharge. The implications for unmitigated releases to groundwater are for the down-gradient receptors including the Big Hill Springs approximately 800 m downgradient and nearby groundwater users. It is considered that in the short to medium term the likelihood for contamination of groundwater associated with accidental spillage is low but nevertheless appropriate mitigation measures should be employed. The magnitude of an impact under these conditions could be locally severe, due to the removal of the low permeability glacial till and a significant thickness of unsaturated sand and gravel. It is unlikely that the Environmental Protection and Enhancement Act would be breached offsite unless the spill were directly adjacent to the property boundary. For this reason, the potential overall impact is therefore considered to be of significance to water quality. Therefore, mitigation measures are proposed as discussed in Section 5.4 below.

5.4 Mitigation Measures

Sections 5.2 and 5.3 above identify the potential impacts of the proposed development at the site, and also identify where mitigation measures are required to reduce these potential impacts to acceptable levels. Proposed mitigation measures, over and above those already identified and included in the scheme design, are identified below and for ease of reference are detailed in terms of water quantity and water quality (subdivided further by surface or groundwater). The mitigation measures either reduce the likelihood of an event occurring or reduce the magnitude of the consequences if the event does occur.

It should be noted that several of the mitigation measures proposed below would have a positive effect on more than one potential impact.

The development and restoration of the site would be undertaken using technical guidance including the Code of Practice for Pits (Albert Government, 2004), relevant EPEA rules and other codes of best practice in order to limit the potential for contamination of both ground and surface waters.

5.4.1 Water Quantity

It is concluded that under the current excavation scheme the overall risk of any significant negative impacts are negligible. This is based on no anticipated changes to the groundwater flow system. However, as an additional safeguard the current groundwater monitoring programmes should continue to be undertaken in order to give an early warning of any potential impacts (either short or long term) on the groundwater resources within the vicinity of the site.

The environmental monitoring programme should include the following:

- Water levels within the perimeter monitoring boreholes and the nearby residential water users at WW2 and WW4 should be monitored regularly by manual measurements and continuously by pressure transducers equipped with data loggers. This will protect both the surrounding water users and the proponent (from frivolous claims);
- Routine inspections to confirm that there are no signs of groundwater entering the excavation and which would indicate that the base of the excavation was below the maximum groundwater level. These should be documented in writing and with photographic confirmation of conditions so found;
- As the base of the excavation is lowered to near the anticipated depth (1.0 m above maximum recorded water level) shallow confirmatory monitoring wells should be installed (on a temporary basis) to refine the actual position of the water table. This information should be surveyed for elevation and location to the site datum to permit revision of any necessary pit design; and
- All monitoring data should be subject to routine review and interpretation to ensure no unanticipated problems exist or go unaddressed.

5.4.2 Groundwater and Surface Water Quality

In order to further reduce the potential risk of impacts to water quality pollution a number of mitigation measures are proposed, and these would be incorporated into the scheme development. The proposed measures include the following:

- The Application site is developed on a phased basis in order to minimise the working area and allow progressive restoration;
- The size of the working areas are minimised in order to reduce the potential for generation of suspended sediment in storm water;
- Settlement ponds and surface infiltration features are commissioned early in the scheme development and all runoff generated at site (including runoff from overburden storage areas and areas of stockpiling) is actively controlled and routed to these ponds as necessary; and
- In addition to the formal settlement ponds and infiltration features, temporary catch basins and sumps are used to collect, gather and manage surface water runoff generated at site within the working areas.

To prevent the discharge of suspended solids from the access road and Plant Site these areas should be developed with appropriate cross-falls to allow immediate drainage to ditches. All drainage would be routed to lined site settlement ponds to ensure no blinding of aquifer soils by sediment occurs.

Given these proposed mitigation measures the risk of unacceptable impacts is low. Nonetheless it is recommended that the following monitoring is undertaken:

- Frequent inspection of the water treatment ponds for erosion or other problems should be undertaken and documented by site operatives to ensure their efficacy; and
- Discharge from the water treatment ponds should only be made in accordance with approval from AEP, i.e. in accordance with the site's EPEA approval.

The threat of accidental spillage of fuels and oils or a vehicular accident occurring on site poses a risk to the groundwater. Standard mitigation measures for training, spill prevention, traffic and handling as per best practices are considered appropriate, along with an effective Emergency Response Plan. Bulk fuel storage would be undertaken in accordance with the *Guide to the Code of Practice for Pits (2004)* and be located in areas where thick clay overburden is still present. Storage would also be in accordance with the *Guidelines for Secondary Containment for Above Ground Storage Tanks (2015).*

The above measures would significantly reduce the likelihood of suspended solids or other pollutants being discharged from the Application site, such that the overall risk is reduced to near zero.

5.5 Net Effects Assessment

After consideration of the mitigation measures detailed in Section 5.4 it may be concluded that the proposed development can be implemented with no adverse net impact to the groundwater or surface water environment. This is based on the fact that the excavation will be operated above the water table, and there is no direct offsite discharge of surface water. No impact is expected on downgradient wells or the Big Hill Spring. A slight benefit will be felt from the additional infiltration of precipitation surplus in that spring flow should increase during wet years.

5.5.1 Cumulative Effects of Multiple Operations

It is noted that several sand and gravel operations are proposed for the immediate surrounding area in addition to the MALP proposal and the currently operating Hillstone Aggregates pit. All are below ground facilities with no surface water discharge.

The same stringent operating procedures will need to be adopted by the other proposed operations to prevent contamination of the underlying aquifers and surface water by fuels, lubricants and sediments. This will include the same high level of preventative mitigation measures and Emergency Response preparations. Based on these factors, the likelihood of a pollution incident is low and therefore the cumulative risk to water quality is negligible from multiple operations in the area.

The water balance indicates that recharge to the underlying aquifers increases when an operation removes the low hydraulic conductivity till material and exposes the sand and gravel to precipitation. As a much larger area will be open at any one time with multiple pits operating together, this will proportionally increase the recharge to the aquifer and therefore the discharge from Big Hill Springs. To illustrate the potential change to groundwater recharge (and discharge at Big Hill Springs) due to multiple pits operating in the same area we have made some simplistic and conservative assumptions below. This is because we do not have details of the proposed phasing and working at the other sites. Assuming conservatively that four additional pits (including the MALP operation) are opened and each has the same total area as used in the calculations in Section 4.5.3 (83.4 Ha) the total operating recharge in a wet year would be 41,700 m^3/yr x 4 = 166,800 m^3/yr. This compares to the current, undeveloped recharge of 17,789 m^3/yr x 4 = 71,156 m^3/yr, as an increase in recharge to the underlying sand and gravel of 95,644 m^3/yr. This would equate to an increase in flow at Big Hill Springs of approximately 3.0 L/s, which is less than a 10% increase from the 40 L/s quoted in the literature (Ozaray & and Barnes, 1977). This small increase in flow at the Big Hill Springs is overly conservative, as it is known that progressive restoration is planned for the MALP site and is likely to be proposed at the other sites. The real increase will be significantly lower, based on progressive restoration, and therefore the development of multiple sites is likely to provide a small beneficial impact to flow at Big Hill Springs and recharge to the underlying aquifers.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the above physical setting, study results and analyses the following conclusions are offered.

6.1 Conclusions

The site lies in an area of substantive sand and gravel, overlain by a blanket of fine grained soils. In an average meteorological year there is a slight moisture deficit and therefore no groundwater recharge. The water table lies in the bottom of the sand and gravel, moving laterally along the top of and recharging the Paskapoo Formation bedrock. In wetter years a small surplus contributes to the water table at this site, which appears to be maintained by groundwater flow from the northwest. Most local residential wells draw water from the bedrock formation with the exception of some shallow dug wells at location WW5, 1 km southeast of the site. No drawdown of these wells is expected as there will be no dewatering required for extraction of the aggregate. Groundwater from under this site eventually discharges at the Big Hill Springs.

There are no surface water streams or springs on this site, and two sloughs in the northwest corner (fed by storm runoff and perched on the glacial till overburden) will be retained as the site develops. During site development and after site closure, there will be no surface water discharge from the site. When storm water is abundant enough to move on the ground surface it will collect in the lower parts of the site (below existing grade) and ultimately infiltrate into the sand and gravel aquifer. There will be no dewatering of the aquifer because the site sits above the water table, and in fact in wetter years there will be slight augmentation of the groundwater from site infiltration. This will mean a slight increase in spring flow at Big Hill Springs, but probably not at a perceptible level.

Effects of the operation of an aggregate resource development above the water table at this site will be minimal on the ground and surface water, particularly if the mitigation measures discussed in Section 5 of this report are implemented. It is predicted that there will be no adverse net impact of the site.

6.2 Recommendations

Based on the above discussion and conclusions, the following recommendations are provided.

1) The mitigation measures discussed above are implemented as part of the final design;
2) Determination of ultimate excavation depths are based on future monitoring of water table levels beneath the extraction area, through periodic use of temporary shallow groundwater monitoring wells. Monitoring of those wells should include determining their position by survey to the site datum, and documentation of seasonal results to support any re-design thus instigated. The excavation floor should be at least 1.0 m above the maximum recorded water table level;
3) The storm runoff water is directed to sedimentation ponds, designed to ensure clear water discharges. The discharge should be to an unlined infiltration pond for return to the aquifer;
4) Best handling and storage practices for fuels and lubricants are implemented as per the *Guide to the Code of Practice for Pits (2004)* and the *Guidelines for Secondary Containment for Above Ground Storage Tanks (2015)* to minimize the risk of accidental spillage of contaminants at this site; and
5) A monitoring program as described above is implemented to document the lack of effect of the site, and to allow the operators to respond to any unanticipated problems that may occur.

7.0 REFERENCES

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8.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR Consulting (Canada) Ltd. (SLR) for Mountain Ash Limited Partnership, hereafter referred to as the “Client”. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. It is intended for the sole and exclusive use of Mountain Ash Limited Partnership. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of SLR.

This report has been prepared for specific application to this site and site conditions existing at the time work for the report was completed. Any conclusions or recommendations made in this report reflect SLR’s professional opinion.

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Nothing in this report is intended to constitute or provide a legal opinion. SLR makes no representation as to the requirements of compliance with environmental laws, rules, regulations or policies established by federal, provincial or local government bodies. Revisions to the regulatory standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions and recommendations in this report may be necessary.

The Client may submit this report to Albert Environment and Parks and/or related Alberta environmental regulatory authorities or persons for review and comment purposes.

TABLES

Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003

Table A1
Sand and Gravel Monitoring Well Groundwater Quality Results

Parameter	Guideline (CDWQ)	Units	MW14-101	MW14-103		MW18-104	MW18-105	MW18-106	MW18-107	MW19-108	MW19-109	MW19-110
			20-Nov-14	20-Nov-14	4-Aug-15	4-Jul-19	4-Jul-19	4-Jul-19	4-Jul-19	4-Jul-19	5-Jul-19	10-Jul-19
Total Aluminum[1]	0.1 (OG)	mg/L	**0.164**	**5.57**	**0.109**	**3.7**	**5.4**	**13**	**7**	**15**	**95**	**10**
Total Antimony	0.006 (MAC)	mg/L	<0.00050	<0.00050	<0.00050	0.0049	0.006	0.0048	0.00079	0.0022	0.0034	<0.00060
Total Arsenic	0.01 (MAC)	mg/L	0.00035	0.007858	0.000336	0.0044	0.0056	**0.017**	0.0076	0.0086	**0.071**	0.0084
Total Barium	1 (MAC)	mg/L	0.424	0.7	0.332	0.61	**2.8**	**1.1**	0.79	**1.1**	**7.2**	**2.2**
Bicarbonate (as HCO3)	NV	mg/L	382	380	375	310	320	360	370	390	350	330
Total Boron	5 (MAC)	mg/L	<0.020	<0.020	<0.020	0.025	0.021	<0.020	<0.020	0.029	0.087	<0.020
Total Cadmium	0.005 (MAC)	mg/L	0.000016	0.00029	<0.000005	0.00036	**0.0055**	0.00095	0.00033	0.00095	**0.01**	0.0042
Dissolved Calcium	NV	mg/L	76	75	73	63	69	73	71	74	77	62
Chloride	<250 (AO)	mg/L	10.5	7.8	8.8	29.0	13.0	9.3	10.0	14.0	18	8.4
Total Chromium	0.05 (MAC)	mg/L	<0.0010	0.0076	0.0016	0.018	0.0046	**0.081**	0.025	0.038	**0.19**	0.019
Total Copper	2 (MAC) / 1 (AO)	mg/L	<0.0010	0.0093	0.0013	0.064	0.11	0.11	0.018	0.038	0.29	0.032
Total Iron	<0.3 (AO)	mg/L	0.28	**12**	0.22	**7.6**	**49**	**37**	**17**	**29**	**190**	**10**
Total Lead	0.005 (MAC)	mg/L	0.00031	0.00464	<0.00030	0.0049	**0.025**	**0.019**	**0.0075**	**0.024**	**0.15**	**0.019**
Total Mercury	0.001 (MAC)	mg/L	<0.00010	<0.00010	<0.00020	0.00003	**0.0013**	0.00032	0.000048	0.000067	**0.00208**	0.000002
Dissolved Magnesium	NV	mg/L	33.7	33.4	32.6	30	32	31	32	32	37	30
Total Manganese	0.12 (MAC) / 0.02 (AO)	mg/L	0.02	**0.93**	0.01	**0.62**	**2.90**	**1.90**	**0.60**	**0.74**	**8.9**	**7.3**
Total Molybdenum	NV	mg/L	0.0008	0.00184	0.00086	0.015	0.0014	0.005	0.0021	0.0065	0.023	0.0015
Total Nickel	NV	mg/L	<0.00050	0.01196	0.00051	0.02	0.015	0.036	0.014	0.047	0.41	0.065
Nitrate-N	10 (MAC)	mg/L	1.19	5.22	1.801	0.97	2.6	2.3	2	2.4	1.7	1.9
Nitrite-N	1 (MAC)	mg/L	<0.05	<0.05	<0.005	0.098	<0.010	<0.010	0.034	0.048	0.065	<0.010
Dissolved Potassium	NV	mg/L	4.8	4.3	3.9	4.1	2.9	3.3	3	3.4	6.3	2.7
pH[2]	7.0 -10.5		7.9	7.8	8	7.91	8.05	7.87	7.8	7.91	8.19	7.82
Total Selenium	0.05 (MAC)	mg/L	<0.00060	0.00112	0.00087	0.00049	0.00093	0.0011	0.00094	0.0013	0.00059	0.00096
Total Silver	NV	mg/L	<0.000070	<0.000070	<0.000070	0.00044	<0.00010	0.0017	0.0001	0.0003	0.0025	<0.00010
Dissolved Sodium	<200 (AO)	mg/L	6	8.8	7.9	13	5.7	9	6.6	12	18	6
Sulphate	<500 (AO)	mg/L	8.88	11.9	10.56	9.2	5.8	7.6	6.6	17	26	8.1
Total Thallium	NV	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	0.00023	0.0002	<0.00020	0.00028	0.0026	0.00024
Total Dissolved Solids (calculated)[3]	<500 (AO)	mg/L	337	354	333	310	300	320	320	350	360	290
Turbidity	1 (OG)	NTU	**9.6**	**680**	**8**	**130**	**>4000**	**3100**	**53**	**670**	**>4000**	<0.10
Total Uranium	0.02 (MAC)	mg/L	0.001697	0.002014	0.001563	0.0019	0.012	0.003	0.0027	0.0047	0.016	0.006
Total Zinc	<5 (AO)	mg/L	<0.020	0.033	<0.020	0.072	0.19	0.13	0.037	0.15	1.2	0.14
Total Coliforms	<1 (MAC)	MPN/100 mL	-	-	<1	**>24000**	**<100**	**1100**	**>2400**	**<10**	**120000**	**180**
E.Coli	<1 (MAC)	MPN/100 mL	-	-	<1	**10**	**<100**	**<10**	<1.0	**<10**	**100**	**63**

Notes:

NV = no value

OG = Operational Guidance

AO = Aesthetic Objective

MAC = Maximum Allowable Concentration

Canadian Drinking Water Quality CDWQ Guidelines: September 2019

1. Aluminum Aesthetic Objective (CDWQ - AO): Conventional Treatment Plants <0.1 mg/L (100 ug/L), Other Treatment Systems <0.2 mg/L (200 ug/L)
2. pH Objective (CDWQ): 7.0 - 10.5
3. Calculated result only includes measured parameters. Actual TDS may be higher.

BOLD RED – Exceeds guideline

Table A2
Paskapoo Formation Residential Well Groundwater Quality Results

Parameter	Guideline (CDWQ)	Units	WW1		WW2			WW3		WW4		
			29-Oct-14	4-Aug-15	29-Oct-14	4-Aug-15	10-Jul-19	29-Oct-14	4-Aug-15	30-Oct-14	4-Aug-15	5-Jul-19
Total Aluminum[1]	0.1 (OG)	mg/L	0.0068	0.011	<0.0050	<0.0050	0.006	0.0061	<0.0050	<0.0050	<0.0050	0.0041
Total Antimony	0.006 (MAC)	mg/L	0.00088	<0.00050	0.00059	<0.00050	<0.00060	<0.00050	<0.00050	<0.00050	<0.00050	<0.00060
Total Arsenic	0.01 (MAC)	mg/L	0.000126	0.000132	0.000165	0.000205	<0.00020	0.000143	0.000121	0.000192	0.000194	0.00032
Total Barium	1 (MAC)	mg/L	0.282	0.284	0.128	0.142	0.11	0.221	0.225	0.385	0.391	0.36
Bicarbonate (as HCO3)	NV	mg/L	366.6	359.6	380.6	375.1	350	391.6	377.7	371.8	365.2	340
Total Boron	5 (MAC)	mg/L	0.022	<0.020	0.032	<0.020	0.023	<0.020	<0.020	<0.020	<0.020	<0.020
Total Cadmium	0.005 (MAC)	mg/L	0.000013	<0.000005	0.000016	0.000024	0.000029	0.00004	0.000024	0.000008	<0.000005	<0.000020
Dissolved Calcium	NV	mg/L	70.3	68.2	63.6	63.4	55	73.2	69.7	75.3	72	80
Chloride	<250 (AO)	mg/L	4.29	4.49	1.38	1.93	2	10.31	5.88	10.86	10.95	12
Total Chromium	0.05 (MAC)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0012
Total Copper	2 (MAC) / 1 (AO)	mg/L	0.0317	0.013	0.0022	0.0016	0.0045	0.125	0.0057	0.0017	0.0018	0.034
Total Iron	<0.3 (AO)	mg/L	0.015	0.014	0.018	0.04	<0.060	<0.010	<0.010	0.017	0.044	0.3
Total Lead	0.005 (MAC)	mg/L	0.00127	0.00048	<0.00030	<0.00030	0.00054	0.00302	<0.00030	<0.00030	<0.00030	0.011
Total Mercury	0.001 (MAC)	mg/L	<0.00010	<0.00020	<0.00010	<0.00020	<0.0000020	<0.00010	<0.00020	<0.00010	<0.00020	<0.0000020
Dissolved Magnesium	NV	mg/L	35.1	31.8	37.3	35	30	39.9	35.5	35.2	31.5	35
Total Manganese	0.12 (MAC) / 0.02 (AO)	mg/L	<0.0010	<0.0010	0.004	0.0042	0.012	0.0014	<0.0010	<0.0010	<0.0010	<0.0040
Total Molybdenum	NV	mg/L	0.00148	0.00147	0.00222	0.00193	0.0014	0.00113	0.00104	0.00076	0.00066	0.00065
Total Nickel	NV	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	0.0006	0.00174	<0.00050	<0.00050	<0.00050	<0.00050
Nitrate-N	10 (MAC)	mg/L	1.67	1.658	0.78	1.054	0.37	1.87	1.889	3.02	3.314	3.2
Nitrite-N	1 (MAC)	mg/L	<0.05	<0.005	<0.05	<0.005	<0.010	<0.05	<0.005	<0.05	<0.005	<0.010
Dissolved Potassium	NV	mg/L	3.3	3.2	2.8	2.6	2	3.1	3	3.1	2.9	3
pH[2]	7.0 -10.5		8.1	8	8	8.1	7.95	7.9	8	8	8	8.13
Total Selenium	0.05 (MAC)	mg/L	0.00084	<0.00060	0.00112	0.00105	0.00052	0.0007	0.00085	0.0018	0.00096	0.00093
Total Silver	NV	mg/L	<0.000070	<0.00007	<0.00007	<0.00007	<0.00010	<0.00007	<0.00007	<0.00007	<0.00007	0.00012
Dissolved Sodium	<200 (AO)	mg/L	7.2	7	13.8	9.3	17	7.8	7.6	7.1	6.5	7.7
Sulphate	<500 (AO)	mg/L	6.95	7.51	15.82	12.85	20	10.33	11.09	7.66	6.77	5.9
Total Thallium	NV	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Total Dissolved Solids (calculated)[3]	<500 (AO)	mg/L	318	310	328	317	300	349	330	339	328	330
Turbidity	1 (OG)	NTU	0.2	0.31	0.2	1.23	0.31	0.2	0.25	0.6	0.23	0.66
Total Uranium	0.02 (MAC)	mg/L	0.001299	0.001241	0.001023	0.001214	0.00091	0.001744	0.001688	0.001785	0.001672	0.0021
Total Zinc	<5 (AO)	mg/L	<0.020	<0.020	0.024	<0.020	0.046	0.205	<0.020	0.029	0.031	0.99
Total Coliforms	<1 (MAC)	MPN/100 mL	-	<1	-	<1	1	-	<1	-	<1	**11**
E.Coli	<1 (MAC)	MPN/100 mL	-	<1	-	<1	<1	-	<1	-	<1	<1

Notes:

NV = no value

OG = Operational Guidance

AO = Aesthetic Objective

MAC = Maximum Allowable Concentration

Canadian Drinking Water Quality CDWQ Guidelines: September 2019

1. Aluminum Aesthetic Objective (CDWQ - AO): Conventional Treatment Plants <0.1 mg/L (100 ug/L), Other Treatment Systems <0.2 mg/L (200 ug/L)
2. pH Objective (CDWQ): 7.0 - 10.5
3. Calculated result only includes measured parameters. Actual TDS may be higher.

BOLD RED – Exceeds guideline

Table A3
Big Hill Springs Water Quality Results

Parameter	Guideline (CWQG PAL Freshwater)	Units	BHS1		
			30-Oct-14	4-Aug-15	10-Jul-19
Hardness (as CaCO3)	NV	mg/L	336	317	200
Total Aluminum[1]	0.1	mg/L	0.0182	0.0144	**0.3**
Total Antimony	NV	mg/L	<0.00050	<0.00050	<0.00060
Total Arsenic	0.005	mg/L	0.000153	0.000146	0.00061
Total Barium	NV	mg/L	0.304	0.313	0.21
Bicarbonate (as HCO3)	NV	mg/L	376.1	371	240
Total Boron[2]	1.5	mg/L	0.024	<0.020	<0.020
Total Cadmium[3]	0.00009	mg/L	0.000032	0.000008	0.000034
Dissolved Calcium	NV	mg/L	74.1	72	48
Chloride[4]	120	mg/L	9.6	10.12	8.2
Total Chromium[5]	0.001	mg/L	<0.0010	<0.0010	0.001
Total Copper[6]	0.004	mg/L	<0.0010	0.001	0.0013
Total Iron	0.3	mg/L	0.027	0.019	0.25
Total Lead[7]	0.007	mg/L	<0.00030	<0.00030	<0.00020
Total Mercury	0.000026	mg/L	**<0.00010**	**<0.00020**	0.0000025
Dissolved Magnesium	NV	mg/L	36.7	33.3	20
Total Manganese	NV	mg/L	0.0019	0.0012	<0.0040
Total Molybdenum	0.073	mg/L	0.00141	0.00089	0.00038
Total Nickel[8]	0.15	mg/L	<0.00050	<0.00050	0.00088
Nitrate-N[9]	2.9	mg/L	2.83	**3.037**	1.4
Nitrite-N	0.06	mg/L	<0.05	<0.005	<0.010
Dissolved Potassium	NV	mg/L	3.4	3.3	4.8
pH	6.5-9		8.2	8.2	8.07
Total Selenium	0.001	mg/L	**0.00218**	**0.0013**	0.00068
Total Silver	0.00025	mg/L	<0.000070	<0.000070	<0.00010
Dissolved Sodium	NV	mg/L	7.8	7.5	5
Sulphate	NV	mg/L	9.36	8.36	4.7
Total Thallium	0.0008	mg/L	<0.00020	<0.00020	<0.00020
Total Dissolved Solids (calculated)[10]	NV	mg/L	342	334	210
Turbidity	NV	NTU	0.8	1.07	5.1
Total Uranium[11]	0.015	mg/L	0.001953	0.001875	0.0013
Total Zinc	0.007	mg/L	**<0.020**	**<0.020**	<0.0030
Total Coliforms	NV	MPN	-	2420	>2400
E.Coli	NV	MPN	-	1733	1600

Notes:

NV = no value

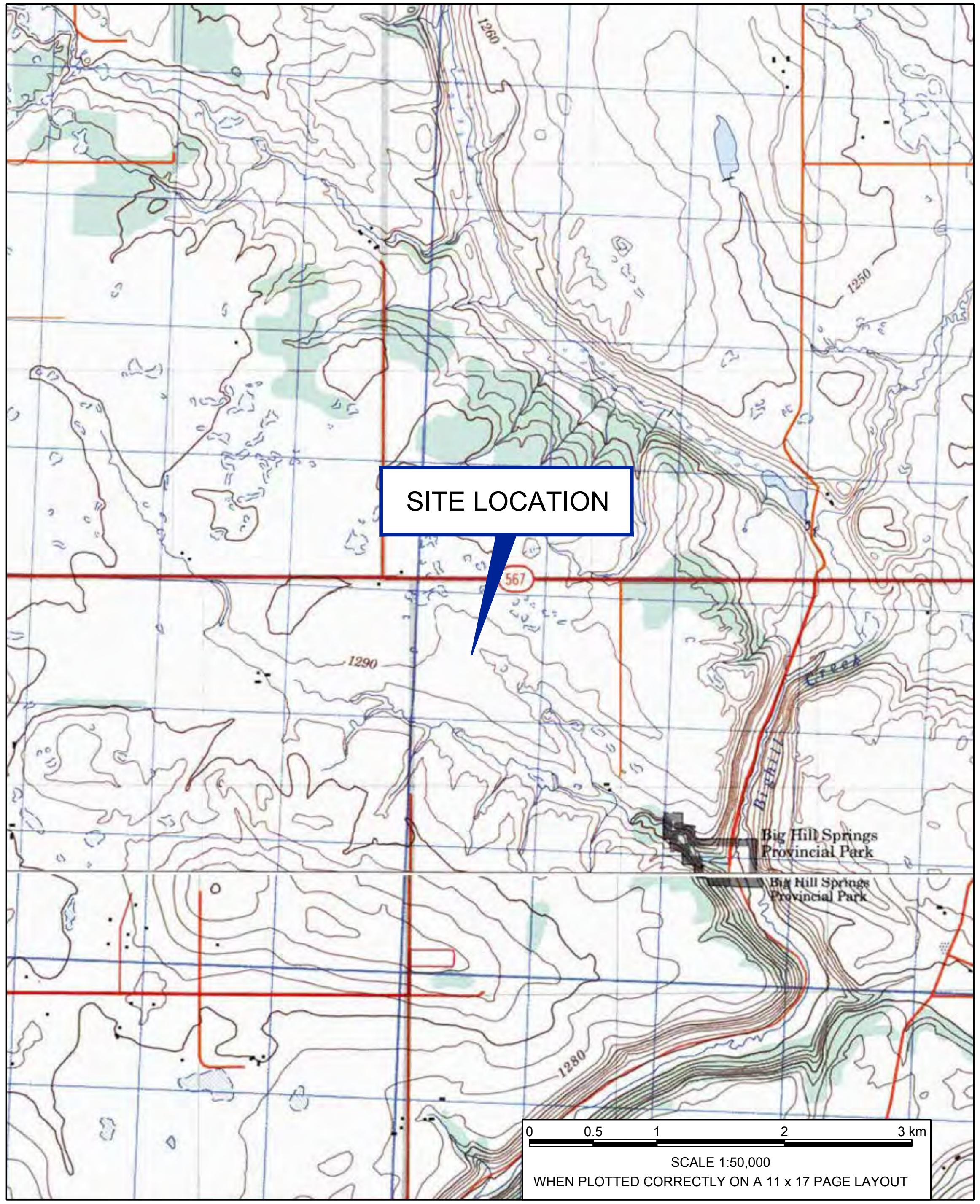
Canadian Water Quality Guidelines (CWQG) Protection for Aquatic Life (PAL) Freshwater Guidelines Updated to September 2019

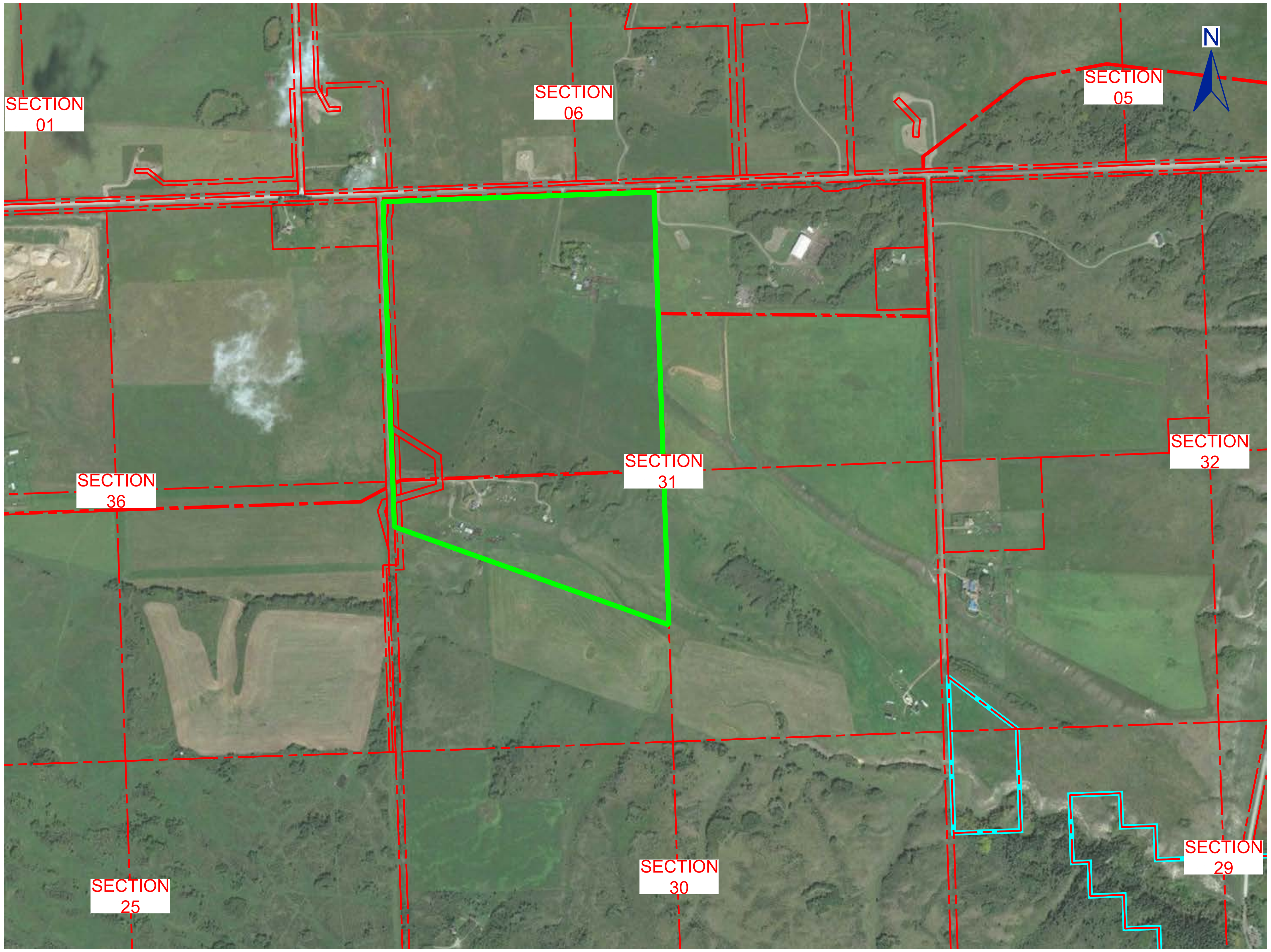
1. Aluminum Guideline (CWQG Aquatic Life - Freshwater): if pH < 6.5 then 0.005 mg/L (5 ug/L), else if pH >= 6.5 then 0.1 mg/L (100 ug/L)
2. Boron Guideline value is for long term exposure. Short term exposure value is 29 mg/L
3. Cadmium Guideline value is for long term exposure. Short term exposure value is 0.001 mg/L
4. Chloride Guideline value is for long term exposure. Short term exposure value is 640 mg/L
5. Chromium Guideline value is for hexavalent chromium as conservative value. Trivalent chromium guideline is 0.0089 mg/L.
6. Copper Guideline (CWQG Aquatic Life - Freshwater): if hardness (as $CaCO_{3)}$ < 82 mg/L then 0.002 mg/L (2 ug/L), if CaCO3 = 83-180 mg/L then is calculated using an equation, if CaCO3 >180 mg/L then 0.004 mg/L (4 ug/L),
7. Lead Guideline (CWQG Aquatic Life - Freshwater): if hardness (as CaCO3) < 60 mg/L then 0.001 mg/L (1 ug/L), if CaCO3 = 60-180 mg/L then is calculated using an equation, if CaCO3 = >180 mg/L then 0.007 mg/L (7 ug/L)
8. Nickel Guideline (CWQG Aquatic Life - Freshwater): if hardness (as CaCO3) < 60 mg/L then 0.025 mg/L (25 ug/L), if CaCO3 = 60-180 mg/L then is calculated using an equation, if CaCO3 > 180 mg/L then 0.150 mg/L (150 ug/L),
9. Nitrate Canadian Water Quality Guidelines (CWQG) for Aquatic Life represents lower value for "Long Term Exposure". Short Term exposure value is 124 for Freshwater
10. Calculated result only includes measured parameters. Actual TDS may be higher.
11. Uranium Guideline value is for long term exposure. Short term exposure value is 0.033 mg/L

BOLD RED – Indicates Exceeds guideline

DRAWINGS

Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003





NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY. IMAGERY DATE: SEPTEMBER 9, 2016.

LEGEND:

🟥	PROPERTY BOUNDARY
🟩	SUBJECT BOUNDARY
🟦	BIG HILL SPRINGS PROVINCIAL PARK

0 100 200 400 600 800 m

SCALE 1:12,500
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

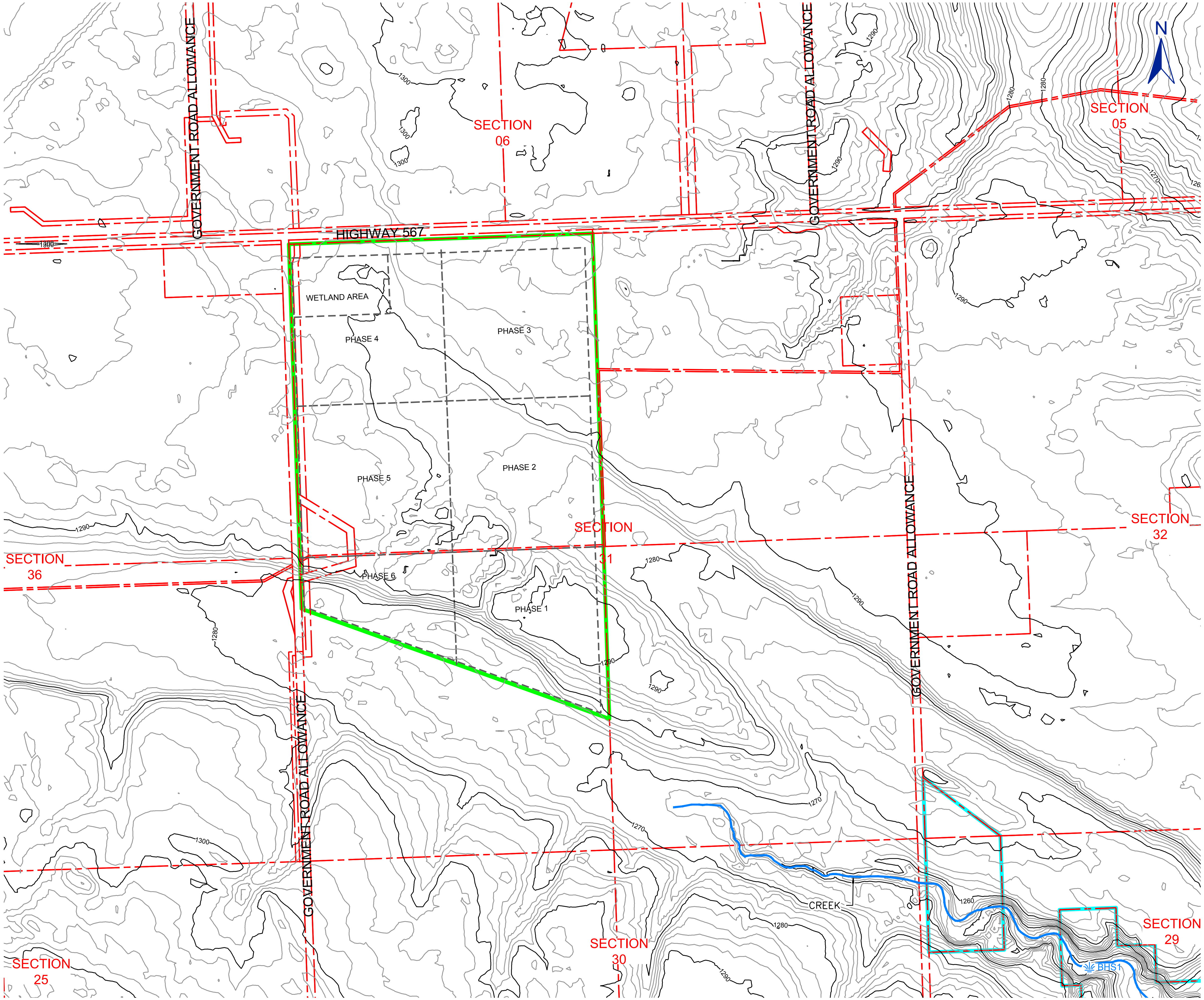
HYDROGEOLOGICAL ASSESSMENT

SITE LOCATION &
STUDY AREA

Date: January 14, 2020
Project No. 212.06650.00003
Drawing No. 1

SLR
global environmental solutions

Cadfile name: S_212-06650-00003-A6.dwg



NOTES:
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LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

LEGEND:

🟥 — - —	PROPERTY BOUNDARY
🟩	SITE LOCATION
▭	BIG HILL SPRINGS PROVINCIAL PARK BOUNDARY
┆	EXTRACTION PHASE BOUNDARIES
——1250——	MAJOR CONTOUR INTERVALS - GROUND SURFACE 10 m INVERVALS FROM LIDAR DATA
——	MINOR CONTOUR INTERVALS - GROUND SURFACE 2 m INTERVALS FROM LIDAR DATA

0 100 200 400 600 m

SCALE 1:10,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

HYDROGEOLOGICAL ASSESSMENT

STUDY AREA TOPOGRAPHY

Date:	January 14, 2020	Drawing No.
Project No.	212.06650.00003	2

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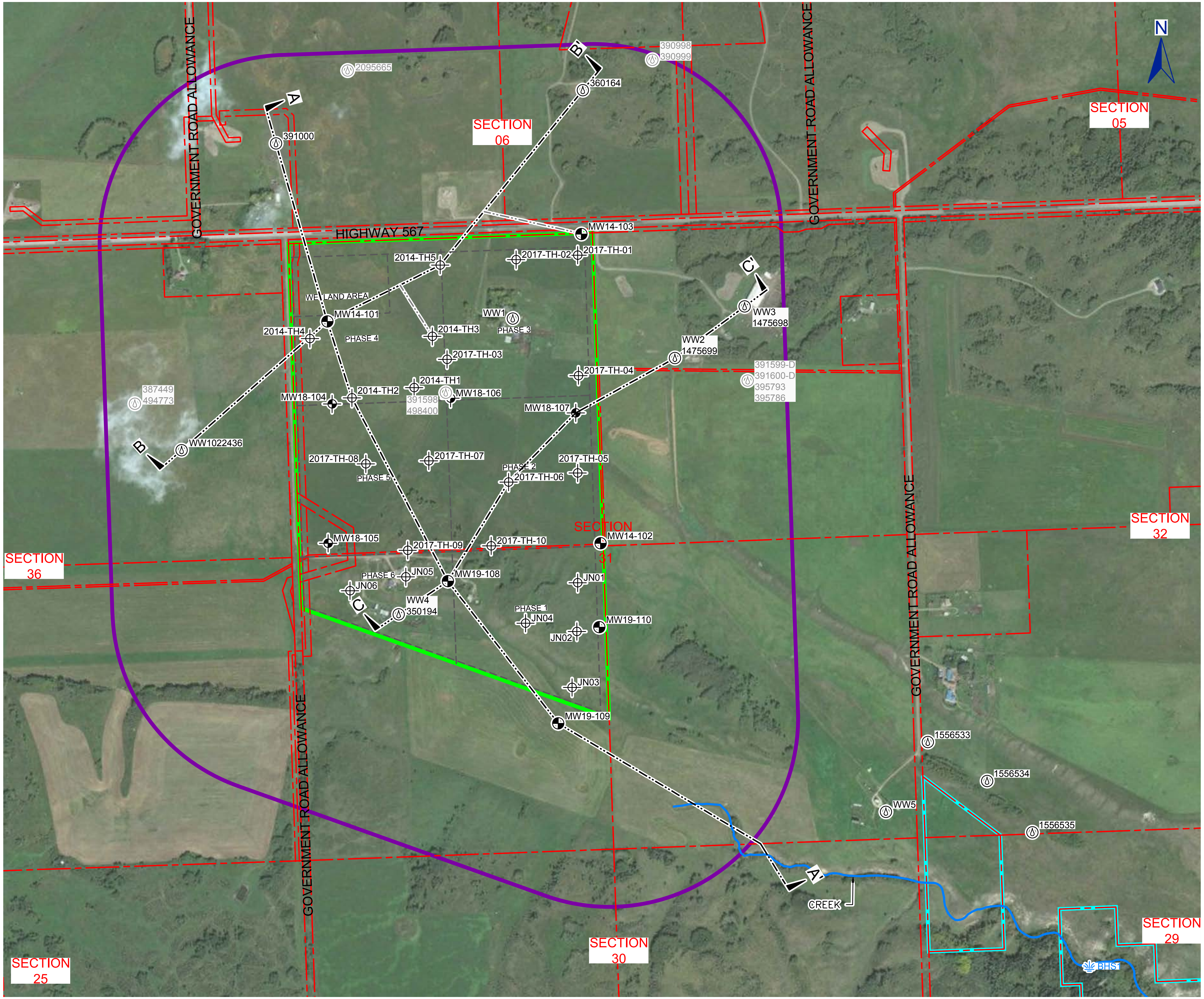
Cadfile name: S_212-06650-00003-A6.dwg



NOTES:

DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY. IMAGERY DATE: SEPTEMBER 9, 2016.

LEGEND:

PROPERTY BOUNDARY
SITE LOCATION
BIG HILL SPRINGS PROVINCIAL PARK BOUNDARY
EXTRACTION PHASE BOUNDARIES
500 m RADIUS FROM SITE
ID BOREHOLE (OTHERS)
ID BOREHOLE COMPLETED AS A MONITORING WELL
ID BOREHOLE COMPLETED AS A MONITORING WELL (OTHERS)
ID WATER WELL
ID WATER WELL (WELL PLOTTED AT QUARTER SECTION CENTROID BASED ON DATABASE. EXACT LOCATION WITHIN QUARTER SECTION IS UNKNOWN)
ID-D WATER WELL (DECOMMISSIONED)
SURFACE WATER MONITORING POINT
A A' STRATIGRAPHIC CROSS SECTION LINE
LINE OF STRATIGRAPHIC PROJECTION

STATION ID	NORTHING	EASTING
MW14-101	5682867.5	680067.9
MW14-102	5682278.7	680793.2
MW14-103	5683099.2	680740.6
MW18-104	5682648.9	680080.8
MW18-105	5682280.0	680070.2
MW18-106	5682664.2	680394.2
MW18-107	5682625.1	680726.1
MW19-108	5682179.2	680387.3
MW19-109	5681802.5	680679.1
MW19-110	5682057.8	680788.1
WW2/1475699	5682770.4	680988.2
WW4/350194	5682091.3	680256.7

0 100 200 400 600 m

SCALE 1:10,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

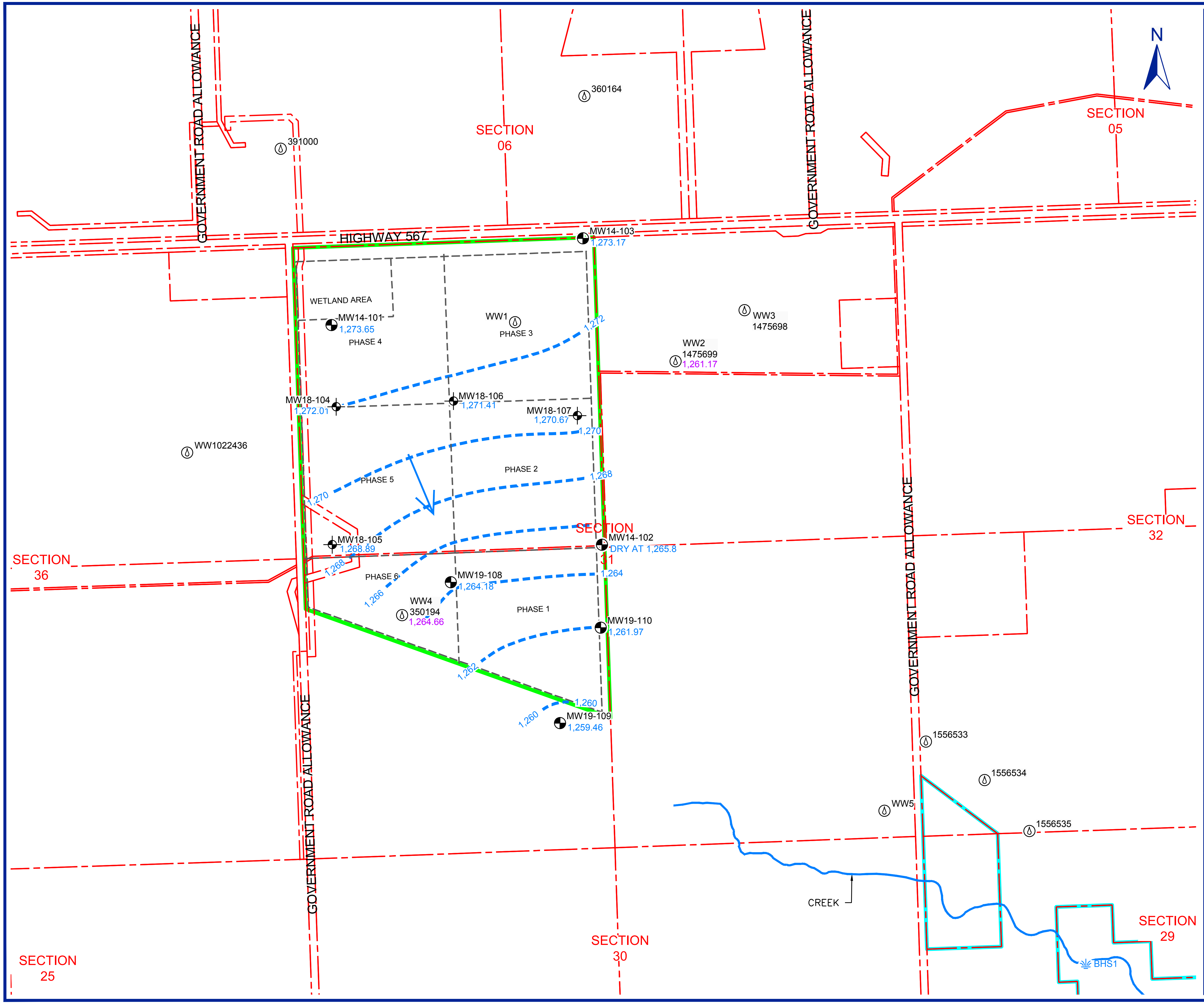
HYDROGEOLOGICAL ASSESSMENT

BOREHOLE, MONITORING WELL AND WATER WELL LOCATION PLAN

Date: January 14, 2020
Project No. 212.06650.00003
Drawing No. 3

SLR
global environmental solutions

Cadfile name: S_212-06650-00003-A6.dwg



NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

LEGEND:

— - —	PROPERTY BOUNDARY
🟩	SITE LOCATION
🟥	BIG HILL SPRINGS PROVINCIAL PARK BOUNDARY
▭	EXTRACTION PHASE BOUNDARIES
⊕ ID	BOREHOLE (OTHERS)
● ID	BOREHOLE COMPLETED AS A MONITORING WELL
● ID	BOREHOLE COMPLETED AS A MONITORING WELL (OTHERS)
◯ ID	WATER WELL
	SURFACE WATER MONITORING POINT
	GROUNDWATER MONITORING RESULTS
1,260.73	GROUNDWATER ELEVATION IN SAND AND GRAVEL (mASL)
1,260 - - -	INFERRED GROUNDWATER ELEVATION CONTOUR IN SAND AND GRAVEL (INTERVAL 2.0 m)
→	INFERRED GROUNDWATER FLOW DIRECTION IN SAND AND GRAVEL
1,260.73	GROUNDWATER POTENTIOMETRIC ELEVATION IN PASKAPOO FORMATION BEDROCK (mASL)

WATER WELLS WITH EXACT LOCATIONS UNKNOWN ARE LISTED BELOW WITH THE LOCATIONS AVAILABLE FROM ALBERTA WELL RECORDS WHICH INDICATE LOCATIONS AT THE CENTROID OF THE 1/4 SECTIONS. THESE WATER WELLS ARE NOT SHOWN ON THE DRAWINGS.

ALBERTA WATER WELL RECORD NUMBER	LEGAL LAND LOCATION
2095665	SW 6-27-3 W5M
390998	SE 6-27-3 W5M
390999	SE 6-27-3 W5M
387449	NE 36-26-4 W5M
494773	NE 36-26-4 W5M
391598	NW 31-26-3 W5M
395786	NE 31-26-3 W5M

0 100 200 400 600 m

SCALE 1:10,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

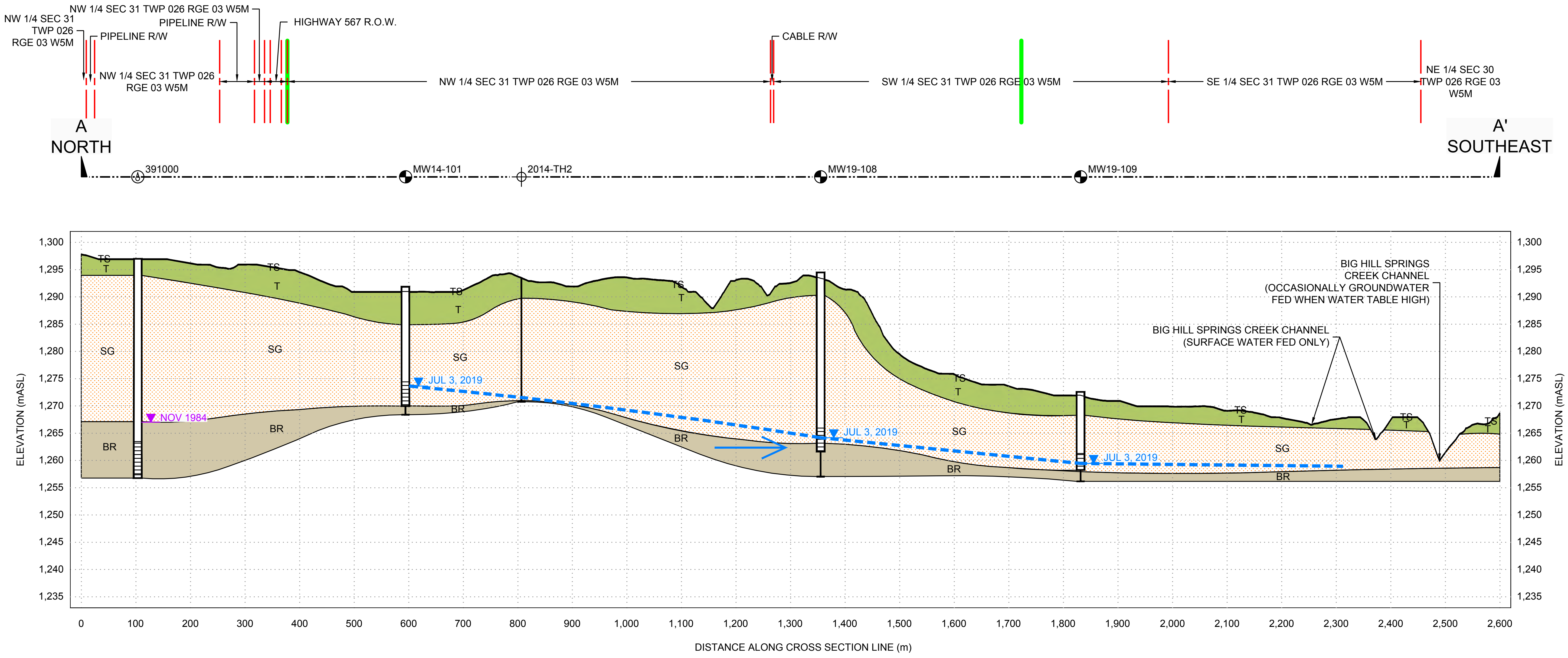
HYDROGEOLOGICAL ASSESSMENT

GROUNDWATER ELEVATIONS (JULY 3, 2019)

Date: January 14, 2020
Project No. 212.06650.00003
Drawing No. 4

SLR global environmental solutions

Cadfile name: S_212-06650-00003-A6.dwg



NOTES:
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LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

LEGEND:

🟥	PROPERTY BOUNDARY
🟩	SITE LOCATION
⌖ ID	BOREHOLE (OTHERS)
◐ ID	BOREHOLE COMPLETED AS A MONITORING WELL
○ ID	WATER WELL
▼	GROUNDWATER ELEVATION IN SAND AND GRAVEL
▼	GROUNDWATER POTENTIOMETRIC ELEVATION IN PASKAPOO FORMATION BEDROCK
- - -	INFERRED GROUNDWATER LEVEL
→	INFERRED GROUNDWATER FLOW DIRECTION

LEGEND:

A A'	STRATIGRAPHIC CROSS SECTION A - A'
TS	TOPSOIL
T	TILL
SG	SAND AND GRAVEL
BR	BEDROCK
	WELL
	SCREENED INTERVAL
	BOREHOLE OR TESTPIT
	END OF HOLE

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

HYDROGEOLOGICAL ASSESSMENT

SCHEMATIC GEOLOGICAL SECTION A - A'

Date: January 14, 2020
Project No. 212.06650.00003
Drawing No. 5

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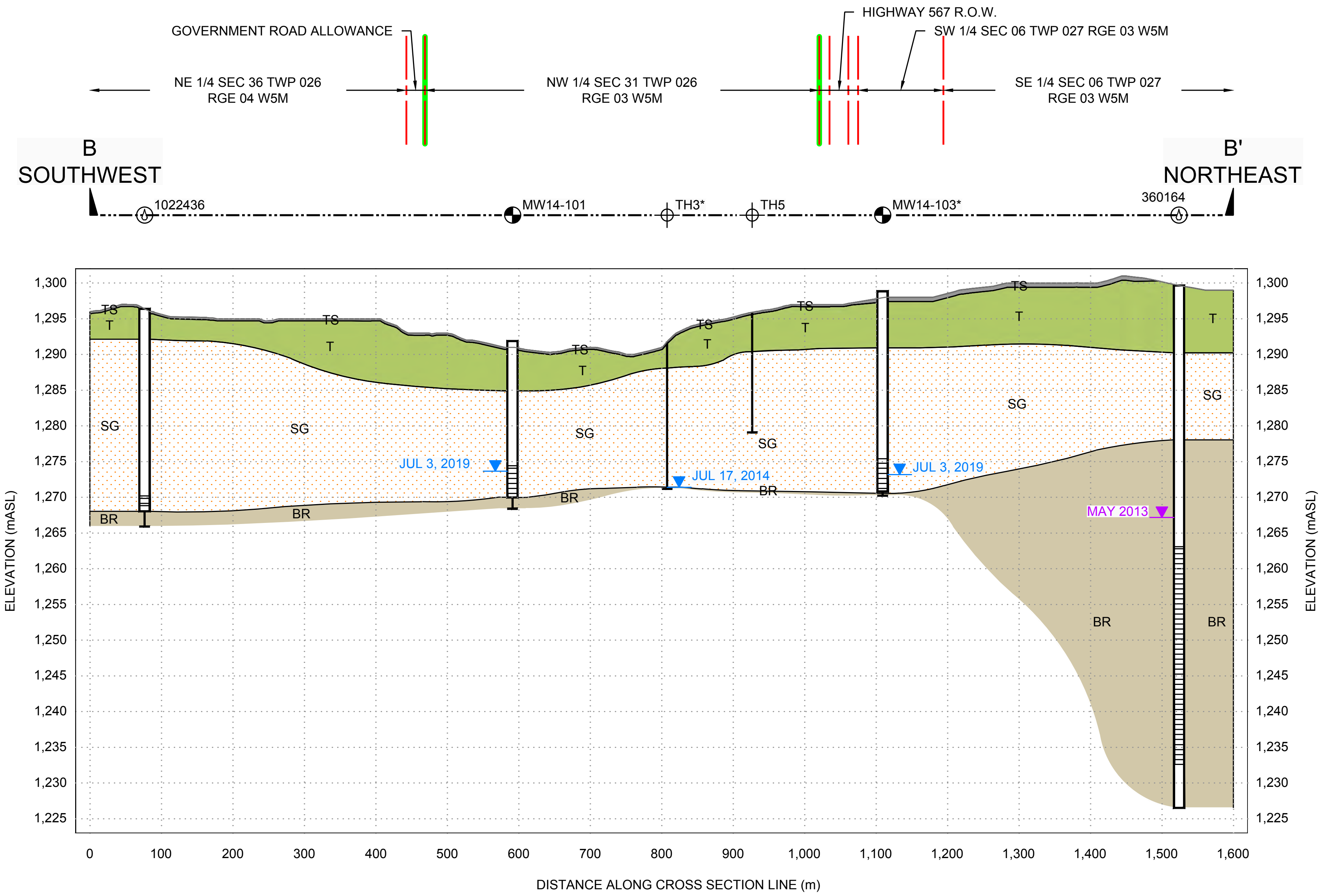
Cadfile name: S_212-06650-00003-A6.dwg



NOTES:
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LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

LEGEND:
- PROPERTY BOUNDARY
- SITE LOCATION
- ⌖ ID BOREHOLE (OTHERS)
- ◐ ID BOREHOLE COMPLETED AS A MONITORING WELL
- ◎ ID WATER WELL
- ▼ GROUNDWATER ELEVATION IN SAND AND GRAVEL
- ▼ GROUNDWATER POTENTIOMETRIC ELEVATION IN PASKAPOO FORMATION BEDROCK
- B ▲.—..—.▲ B' STATIGRAPHIC CROSS SECTION B - B'

LEGEND:

TS	TOPSOIL
T	TILL
SG	SAND AND GRAVEL
BR	BEDROCK

- WELL
- SCREENED INTERVAL
- BOREHOLE OR TESTPIT
- END OF HOLE

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

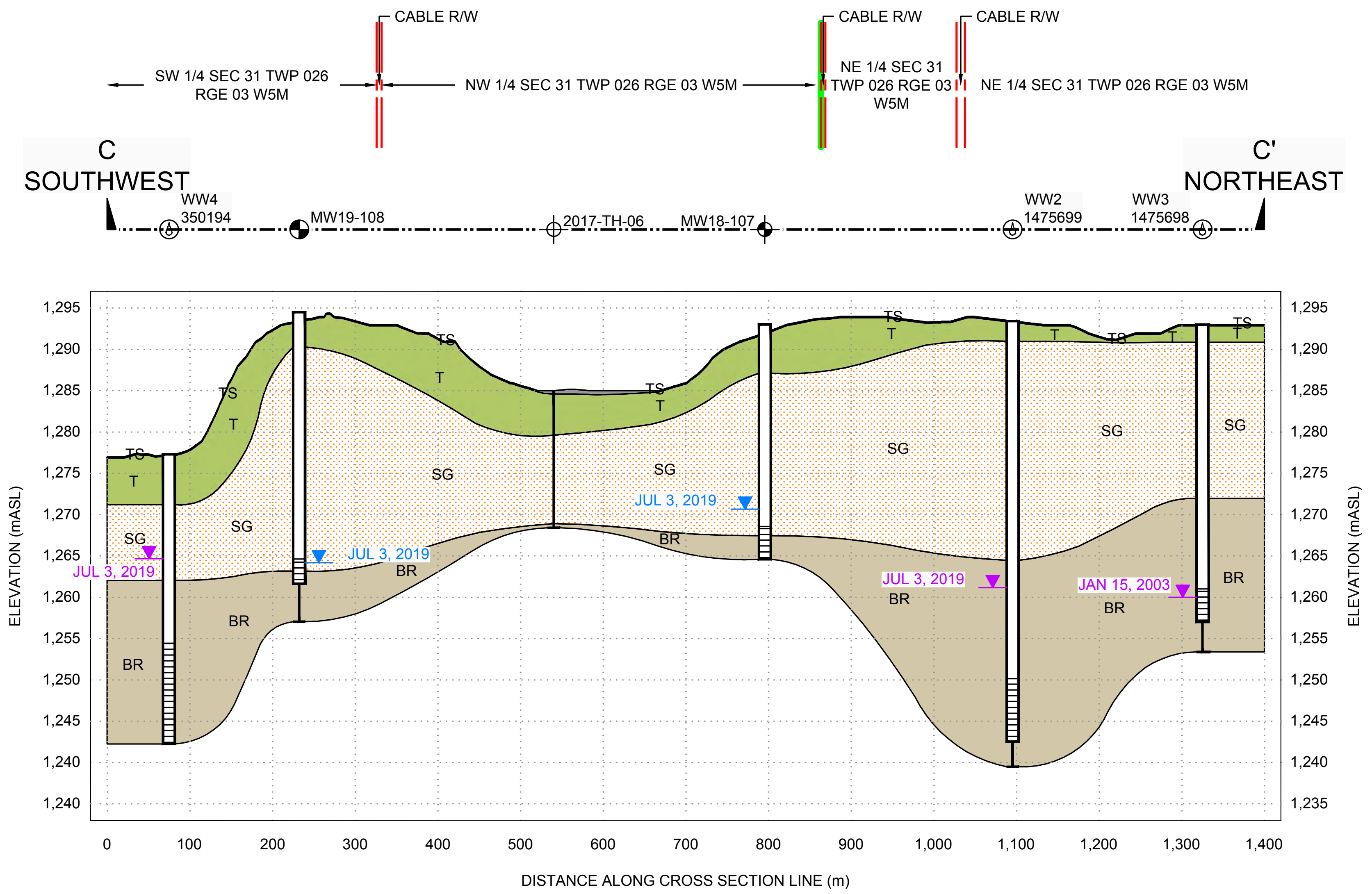
HYDROGEOLOGICAL ASSESSMENT

SCHEMATIC GEOLOGICAL SECTION B - B'

Date: January 14, 2020
Project No. 212.06650.00003
Drawing No. 6

SLR
global environmental solutions

Cadfile name: S_212-06650-00003-A6.dwg



NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

LEGEND:
PROPERTY BOUNDARY
SITE LOCATION
ID BOREHOLE (OTHERS)
ID BOREHOLE COMPLETED AS A MONITORING WELL
ID BOREHOLE COMPLETED AS A MONITORING WELL (OTHERS)
ID WATER WELL
DATE GROUNDWATER ELEVATION IN SAND AND GRAVEL
DATE GROUNDWATER POTENTIOMETRIC ELEVATION IN PASKAPOO FORMATION BEDROCK

LEGEND:
C C' STRATIGRAPHIC CROSS SECTION C - C'

TS	TOPSOIL
T	TILL
SG	SAND AND GRAVEL
BR	BEDROCK

WELL
SCREENED INTERVAL
BOREHOLE OR TESTPIT
END OF HOLE

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
AGGREGATE OPERATION
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

HYDROGEOLOGICAL ASSESSMENT

SCHEMATIC GEOLOGICAL SECTION C - C'

Date: January 14, 2020
Project No. 212.06650.00003
Drawing No. 7

SLR global environmental solutions

Cadfile name: S_212-06650-00003-A6.dwg

APPENDIX A
Site Gravel Investigation Results and Logs

Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003

ALMOR TESTING SERVICES LTD.

7505 - 40 STREET S.E., CALGARY, AB T2C 2H5 PHONE (403) 236-8880 • FAX (403) 236-1707

2014 08 27

099-89-14

Summit Aggregates
10919 - 84 Street SE
Calgary, Alberta
T2C 5A6

Attention: Mr. Tige Brady, C.E.T.

Re: Waterman Pit Gravel Investigation
Highway 567, RR 40

We were retained to observe the advancement of test holes, within the proposed Waterman gravel borrow pit, located south of Highway 567 and east of Range Road 40, on July 18 and 19, 2014.

At that time, five (5) test holes, designated as TH1 to TH5, were advanced at the approximate locations shown on the attached Site Plan. The test holes were advanced using a diesel hammer rig operated by Great West Drilling, of Calgary, Alberta. The total depth of the test holes ranged from 16.8m to 22.8m, below existing ground surface. Gravel samples were obtained at regular intervals and returned to our laboratory for further classification and analysis. Groundwater was observed in four (4) test holes (TH1 to TH4) at completion of drilling, perched on top of the bedrock.

Enclosed are five (5) Test Hole Logs, recorded during drilling and four (4) Aggregate Gradation Analyses conducted on representative samples from TH1, TH2, TH3 and TH5. Also enclosed are the results of LA Abrasion testing conducted on representative samples from TH1, TH3, TH4 and TH5, by Curtis Engineering Ltd.

We trust this meets with your present requirements.

Respectfully submitted,
ALMOR TESTING SERVICES LTD.

Abdul Alemi, E.I.T.
AA:ms:A04665

Attachments

PROJECT: WATERMAN GRAVEL PIT ASSESSMENT
SH 567 & RR40

CLIENT: SUMMIT AGGREGATES

PROJECT NO.

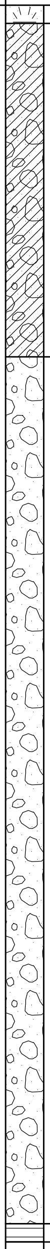
HOLE NO. TH1

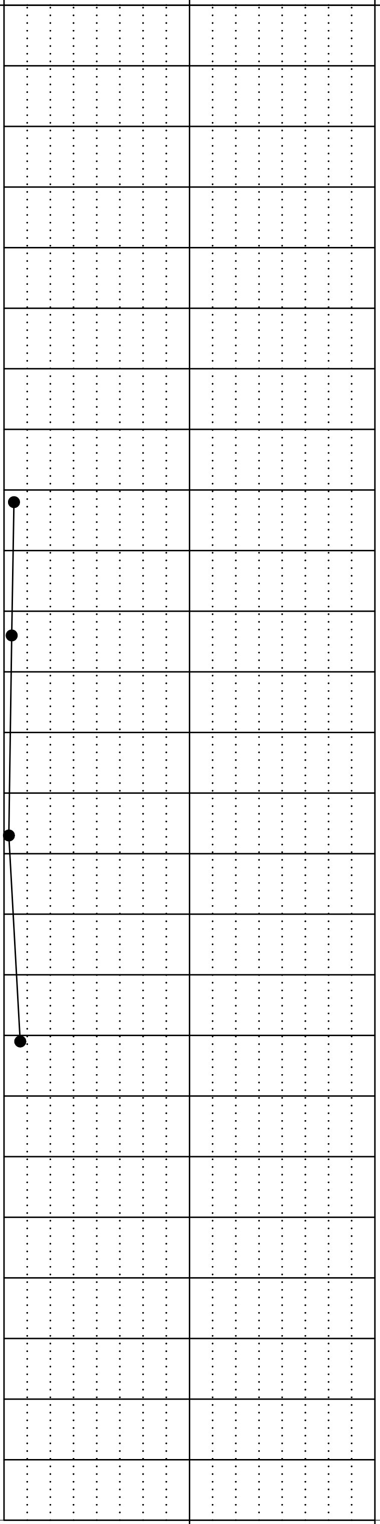
DRILL TYPE BECKER HAMMER

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT LIQUID LIMIT 20 40 60	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
0	**TOPSOIL/ORGANICS**						
0.2–5.8	**Silty CLAY (TILL)** brown, trace sand, trace to some gravel, stiff, moist						
5.8	**Sandy GRAVEL** brown, silty, compact, fine to coarse grained, poorly graded, damp						
8.5	- compact to dense below 8.5m						
8.2		27	B		●		
9.4	- some cobble below 9.4m						
10.3	- sand layer approx. 0.6m thick	34	B		●		
13.3	- sand layer approx. 0.6m thick	45	B		●		
14.5	- sand layer approx. 0.6m thick						
17		56	B		●		Gravel 65.1 % Sand 31.8 % Silt and Clay 3.1 %
17.4							▼ At completion
20.1	**CLAYSHALE (BEDROCK)**						
20.4	**END OF TEST HOLE AT 20.4m** - groundwater level 17.4m at completion - test hole backfilled with soil cuttings						





ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m^3 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 20.4 m

DATE DRILLED July 18, 2014

LOGGED BY Abdul Alemi

PLATE NO. 1

PROJECT: WATERMAN GRAVEL PIT ASSESSMENT
SH 567 & RR40

CLIENT: SUMMIT AGGREGATES

PROJECT NO.

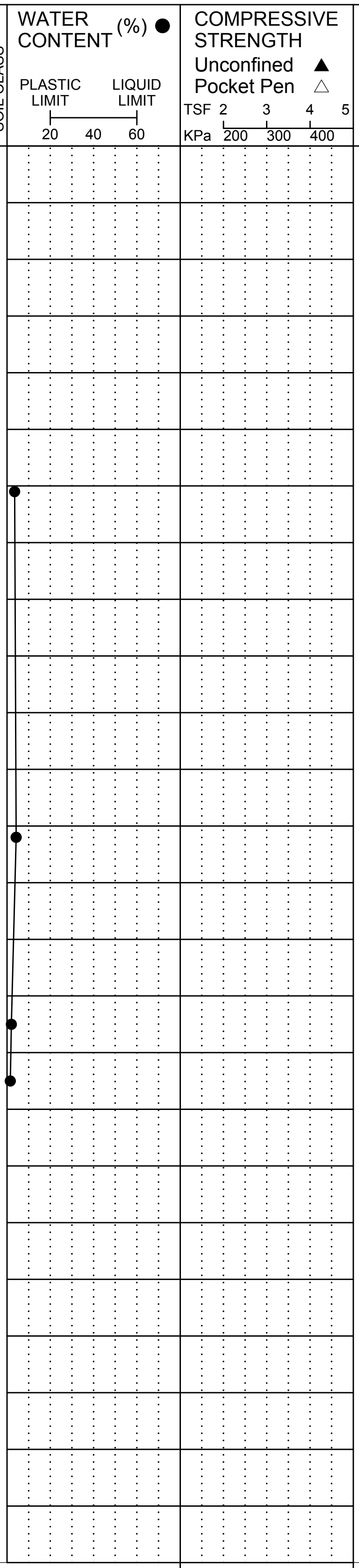
HOLE NO. TH2

DRILL TYPE BECKER HAMMER

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	OTHER TESTS
0	**TOPSOIL/ORGANICS**				
1	**Silty CLAY (TILL)** brown, trace sand, trace gravel, stiff, moist	2			
4	**Sandy GRAVEL** brown, silty, compact, fine to coarse grained, poorly graded, damp	12			
5	- occasional cobble below 5.2m	18			
6		20	B		
10	- some cobble below 10.1m - sand layer approx. 0.6m thick	34			
12	- highly oxidized below 11.9m	40	B		Gravel 57.6 % Sand 31.2 % Silt and Clay 11.2 %
15	- sand layer approx. 0.6m thick	50	B		
16		54	B		
19	- sand layer approx. 0.6m thick	62			
21	- saturated sand layer at 21.0m	69			▼ At completion
22.8	**SANDSTONE (BEDROCK)**	75			
	END OF TEST HOLE AT 22.8m - groundwater level 21.0m at completion - test hole backfilled with soil cuttings				



ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 22.8 m

DATE DRILLED July 18, 2014

LOGGED BY Abdul Alemi

PLATE NO. 2

PROJECT: WATERMAN GRAVEL PIT ASSESSMENT
SH 567 & RR40

CLIENT: SUMMIT AGGREGATES

PROJECT NO.

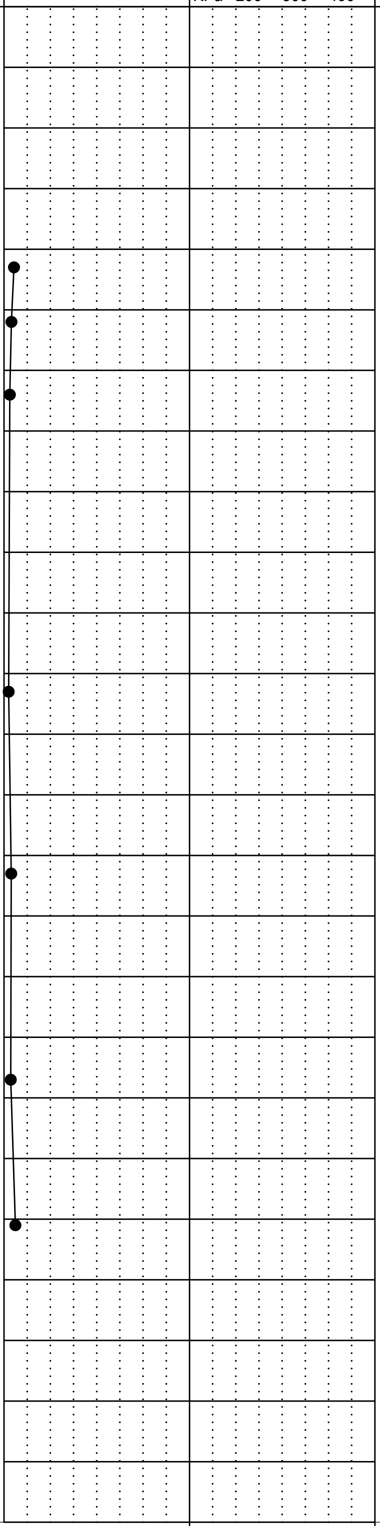
HOLE NO. TH3

DRILL TYPE BECKER HAMMER

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	OTHER TESTS
0	**TOPSOIL/ORGANICS**	0		
0.2	**Silty CLAY (TILL)** brown, trace sand, trace to some gravel, stiff, moist			
3.7	**Sandy GRAVEL** brown, trace clay, silty, compact, fine to coarse grained, poorly graded, damp	12	B (14), B (17)	
6.1	- highly oxidized below 6.1m	20	B (21)	Gravel 60.7 % Sand 28.0 % Silt and Clay 11.3 %
6.7	- occasional cobble below 6.7m	22		
8.5	- occasional fine grained sand layer below 8.5m	28		
11	- sand layer approx. 0.6m thick	36	B (37)	
13.7	- some cobble below 13.7m	46	B (47)	Gravel 59.8 % Sand 29.8 % Silt and Clay 10.4 %
15	- becoming compact to dense	50		
16.8	- sand layer approx. 0.6m thick	55	B (58)	Gravel 62.1 % Sand 29.6 % Silt and Clay 8.3 %
20	- coarse grained sand layer approx. 0.6m thick	66	B (66)	▼ At completion
20.6	**SANDSTONE (BEDROCK)**	67		
	END OF TEST HOLE AT 20.6m - groundwater level 20.4m at completion - test hole backfilled with soil cuttings			



MOD UNIFIED SOIL CLASS

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

PENETRATION RESISTANCE ■ 20 40 60
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

COMPLETION DEPTH 20.6 m

DATE DRILLED July 17, 2014

LOGGED BY Abdul Alemi

PLATE NO. 3

PROJECT: WATERMAN GRAVEL PIT ASSESSMENT
SH 567 & RR40

CLIENT: SUMMIT AGGREGATES

PROJECT NO.

HOLE NO. TH4

DRILL TYPE BECKER HAMMER

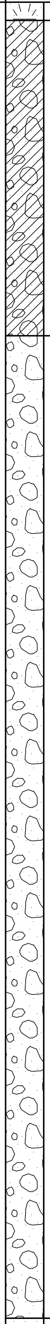
GEODETIC ELEVATION (m)

DATUM

DEPTH (m) | SOIL DESCRIPTION | DEPTH (ft) | SAMPLE TYPE | MOD UNIFIED SOIL CLASS | WATER CONTENT (%) ● PLASTIC LIMIT LIQUID LIMIT 20 40 60 | COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400 | OTHER TESTS

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80



TOPSOIL/ORGANICS

Silty CLAY (TILL) brown, trace sand, trace gravel, stiff, low to medium plastic, moist

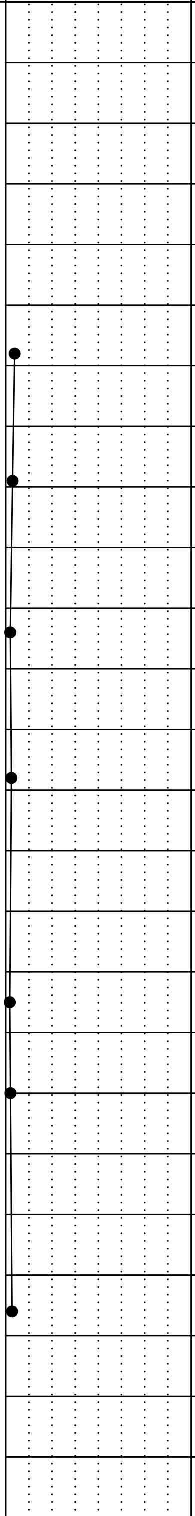
Sandy GRAVEL brown, trace clay, silty, compact, fine to coarse grained, poorly graded, damp

- sand layer approx. 0.6m thick
- occasional cobble below 10.1m
- some cobble below 12.2m
- sand layer approx. 0.6m thick
- coarse grained sand layer approx. 0.6m thick
- saturated below 18.9m

SANDSTONE (BEDROCK)

END OF TEST HOLE AT 21.9m
- groundwater level 18.9m at completion
- test hole backfilled with soil cuttings

SAMPLE TYPE: B B B B B B B



▼ At completion

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 21.9 m

DATE DRILLED July 17, 2014

LOGGED BY Abdul Alemi

PLATE NO. 4

PROJECT: WATERMAN GRAVEL PIT ASSESSMENT
SH 567 & RR40

CLIENT: SUMMIT AGGREGATES

PROJECT NO.

HOLE NO. TH5

DRILL TYPE BECKER HAMMER

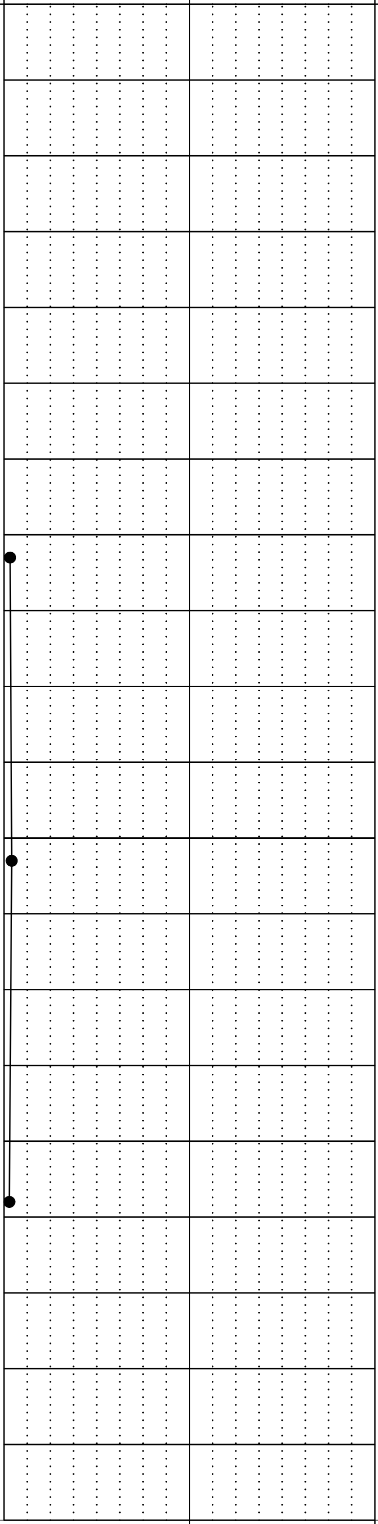
GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	OTHER TESTS
0	**TOPSOIL/ORGANICS**				
	Silty CLAY (TILL) brown, trace sand, trace gravel, stiff, low to medium plastic, moist				
5.5	**Sandy GRAVEL** brown, trace clay, silty, compact, fine to coarse grained, poorly graded, damp				
7.2		24	B		
	- occasional cobble below 7.6m				
	- sand layer approx. 0.3m thick				
11.2		37	B		Gravel 68.4 % Sand 27.8 % Silt and Clay 3.8 %
12.1		40	B		
	- some cobble below 12.8m				
	- becoming compact to dense				
15.8		52	B		Gravel 71.2 % Sand 22.8 % Silt and Clay 6.0 %
	- becoming dense				
16.8	**END OF TEST HOLE AT16.8m** - test hole dry at completion - test hole backfilled with soil cuttings				

WATER CONTENT (%) ●
PLASTIC LIMIT — LIQUID LIMIT
20 40 60

COMPRESSIVE STRENGTH
Unconfined ▲
Pocket Pen △
TSF 2 3 4 5
KPa 200 300 400



KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
Date Measured

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

COMPLETION DEPTH 16.8 m

DATE DRILLED July 18, 2014

LOGGED BY Abdul Alemi

PLATE NO. 5

7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Summit Aggregates

Attention Tige Brady

Project Gravel Pit Investigation
Waterman Pit, Hwy567 & RR40

Job No.

Date Sampled	July 18/14	**By**	AA
Date Received	July 18/14	**By**	AA
Date Tested	July 22/14	**By**	JC,KW

Aggregate Type Sandy GRAVEL
Aggregate Source Existing Material

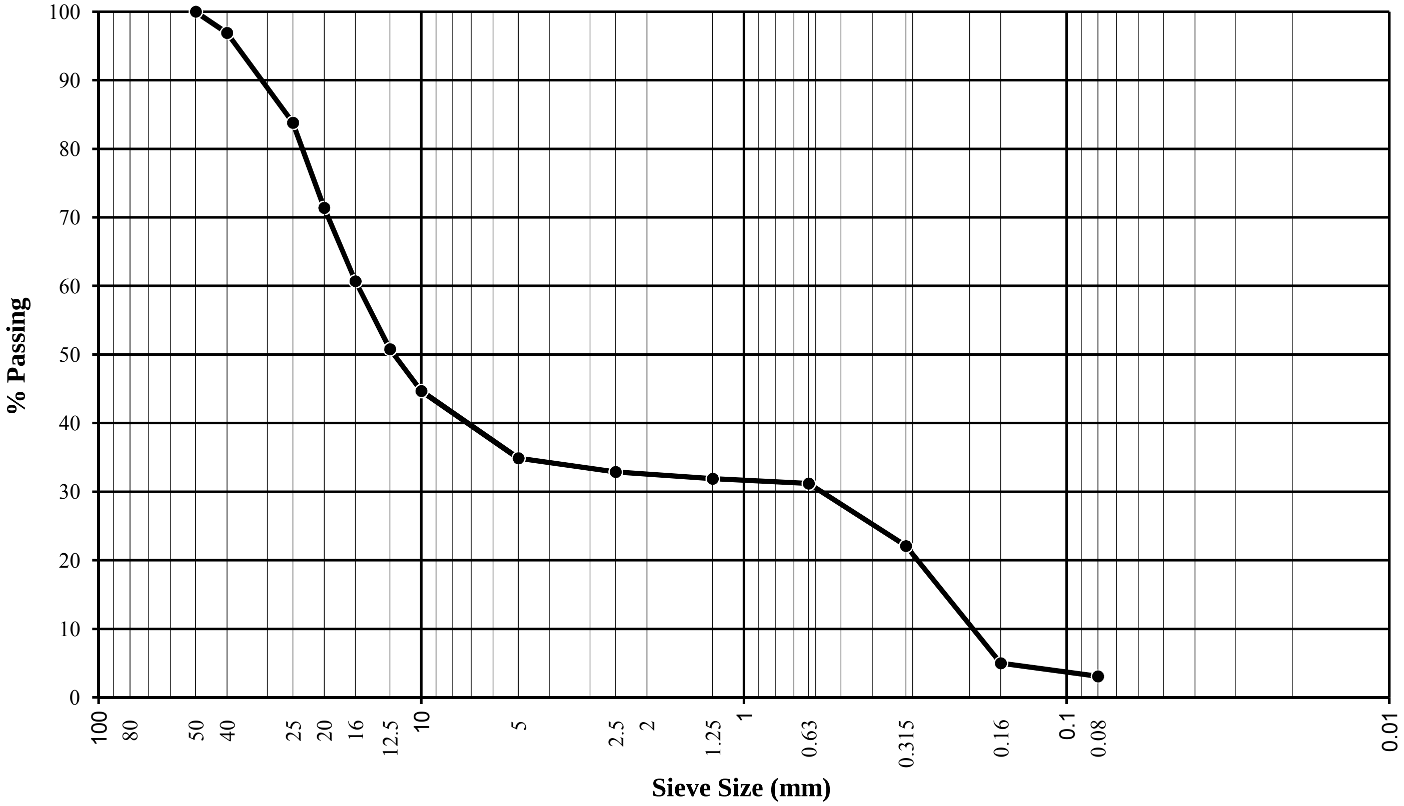
Classification GP
C_C= 0.1
C_U= 76.8

Specification

Comments

TH # 1 @ 55-57ft.
Moisture Content = 7.0%

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80			
50	100.0		
40	96.9		
25	83.8		
20	71.4		
16	60.7		
12.5	50.8		
10	44.7		
5	34.9		
2.5	32.9		
1.25	31.9		
0.63	31.2		
0.315	22.1		
0.16	5.0		
0.08	3.1		



ALMOR
7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Summit Aggregates

Attention Tige Brady

Project Gravel Pit Investigation
Waterman Pit, Hwy567 & RR40

Job No.			
Date Sampled	July 18/14	**By**	AA
Date Received	July 18/14	**By**	AA
Date Tested	July 22/14	**By**	JC,KW

Aggregate Type Silty, Sandy GRAVEL
Aggregate Source Existing Material

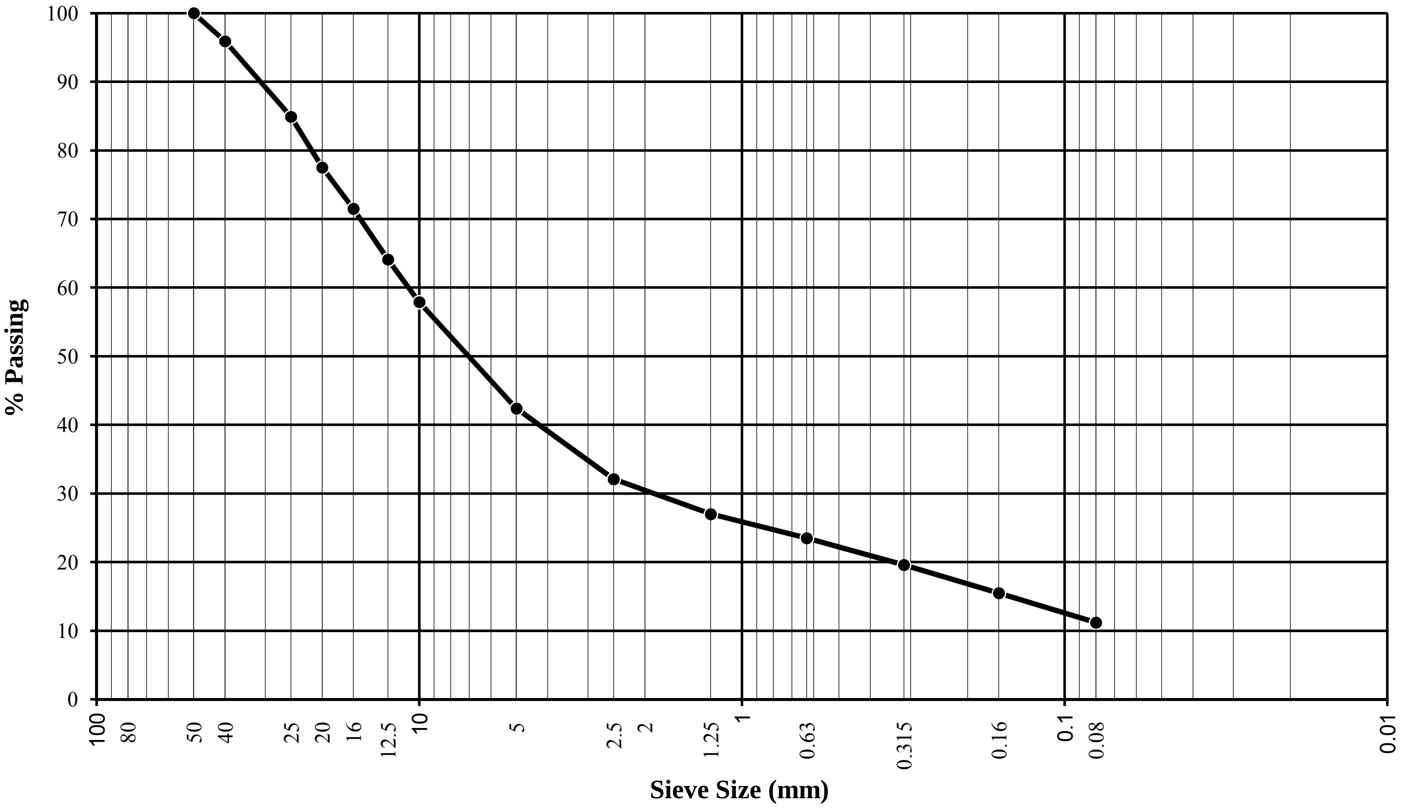
Classification GP-GM
C_C= 3.3
C_U= 135.6

Specification

Comments

TH # 2 @ 39-40ft.
Moisture Content = 4.2%

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80			
50	100.0		
40	95.9		
25	84.9		
20	77.5		
16	71.5		
12.5	64.1		
10	57.9		
5	42.4		
2.5	32.1		
1.25	27.0		
0.63	23.5		
0.315	19.6		
0.16	15.5		
0.08	11.2		



ALMOR
7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Summit Aggregates

Attention Tige Brady

Project Gravel Pit Investigation
Waterman Pit, Hwy567 & RR40

Job No.			
Date Sampled	July 17/14	**By**	AA
Date Received	July 18/14	**By**	AA
Date Tested	July 22/14	**By**	JC,KW

Aggregate Type Silty, Sandy GRAVEL
Aggregate Source Existing Material

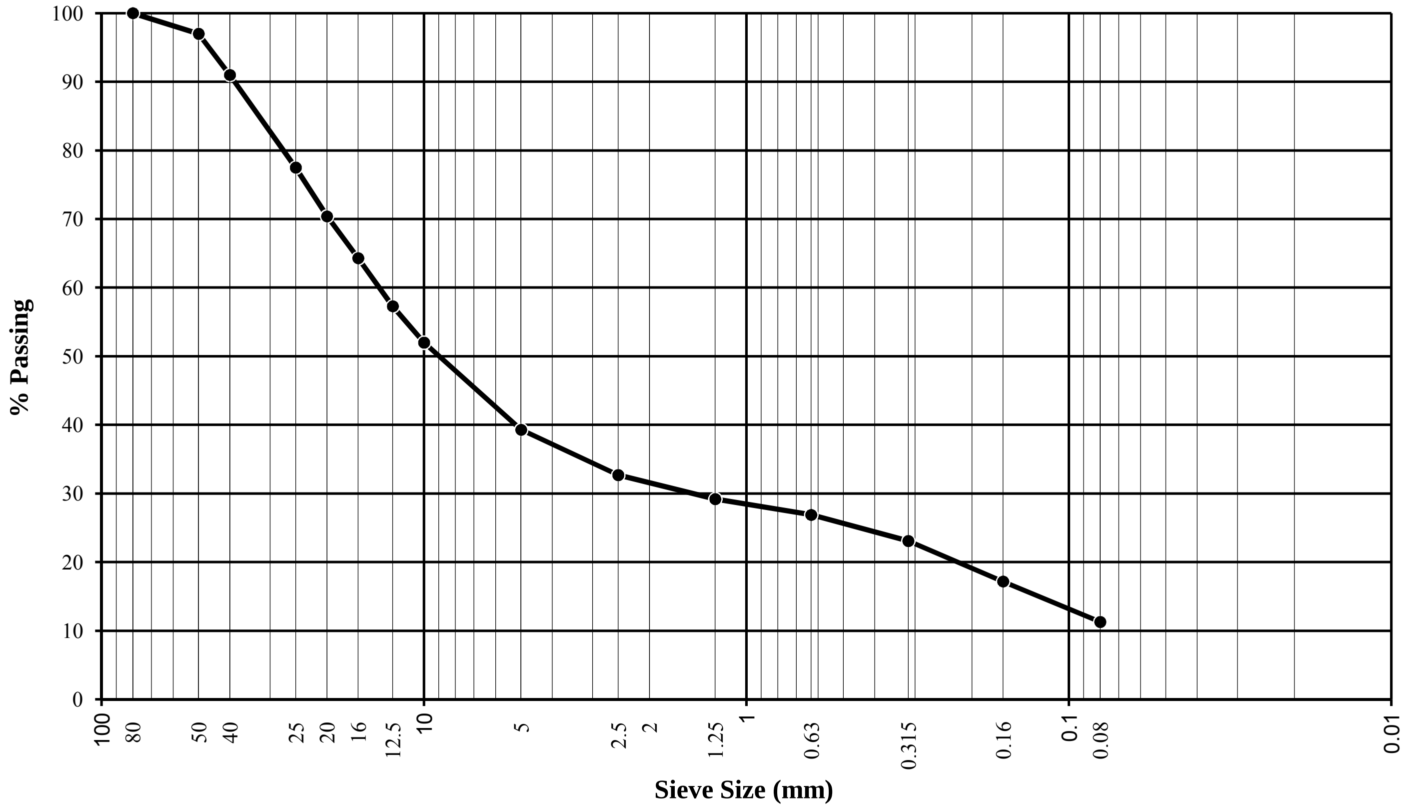
Classification GW-GM
C_C= 1.8
C_U= 173.0

Specification

Comments

TH # 3 @ 20-25ft.
Moisture Content = 2.5%

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	97.0		
40	91.0		
25	77.5		
20	70.4		
16	64.3		
12.5	57.3		
10	52.0		
5	39.3		
2.5	32.7		
1.25	29.2		
0.63	26.9		
0.315	23.1		
0.16	17.2		
0.08	11.3		



7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Summit Aggregates

Attention Tige Brady

Project Gravel Pit Investigation
Waterman Pit, Hwy567 & RR40

Job No.				
Date Sampled	July 18/14	**By**	AA
Date Received	July 18/14	**By**	AA
Date Tested	July 24/14	**By**	AA,KC

Aggregate Type Silty, Sandy GRAVEL
Aggregate Source Existing Material

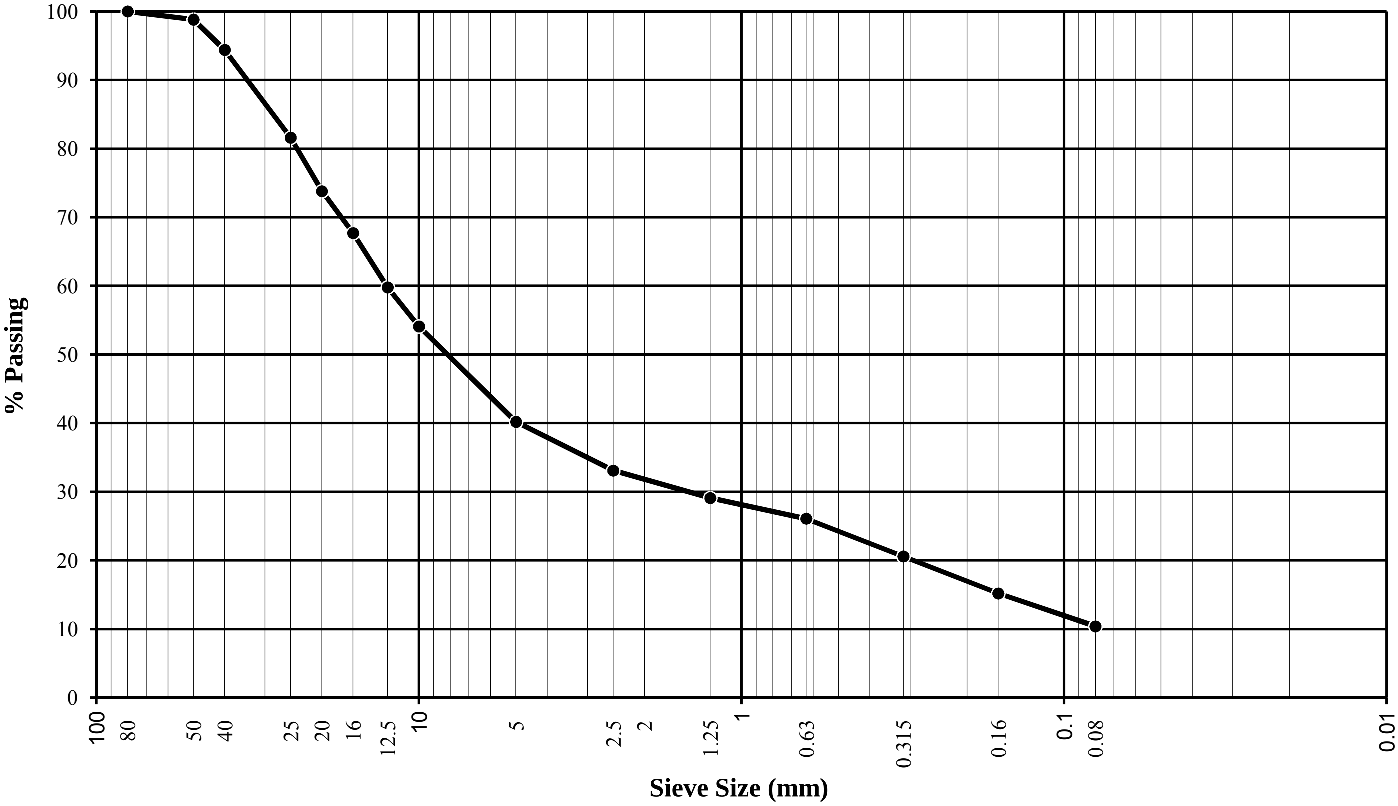
Classification GW-GM
C_C= 2.0
C_U= 157.4

Specification

Comments

TH # 3 @ 46-49ft.
Moisture Content = 2.3%
(L A Abrasion Sample # 2)

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	98.8		
40	94.4		
25	81.6		
20	73.8		
16	67.7		
12.5	59.8		
10	54.1		
5	40.2		
2.5	33.1		
1.25	29.1		
0.63	26.1		
0.315	20.6		
0.16	15.2		
0.08	10.4		



ALMOR
7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report
ASTM C-136

Client Summit Aggregates

Attention Tige Brady

Project Gravel Pit Investigation
Waterman Pit, Hwy567 & RR40

Job No.			
Date Sampled	July 17/14	**By**	AA
Date Received	July 18/14	**By**	AA
Date Tested	July 22/14	**By**	JC,KW

Aggregate Type Sandy GRAVEL
Aggregate Source Existing Material

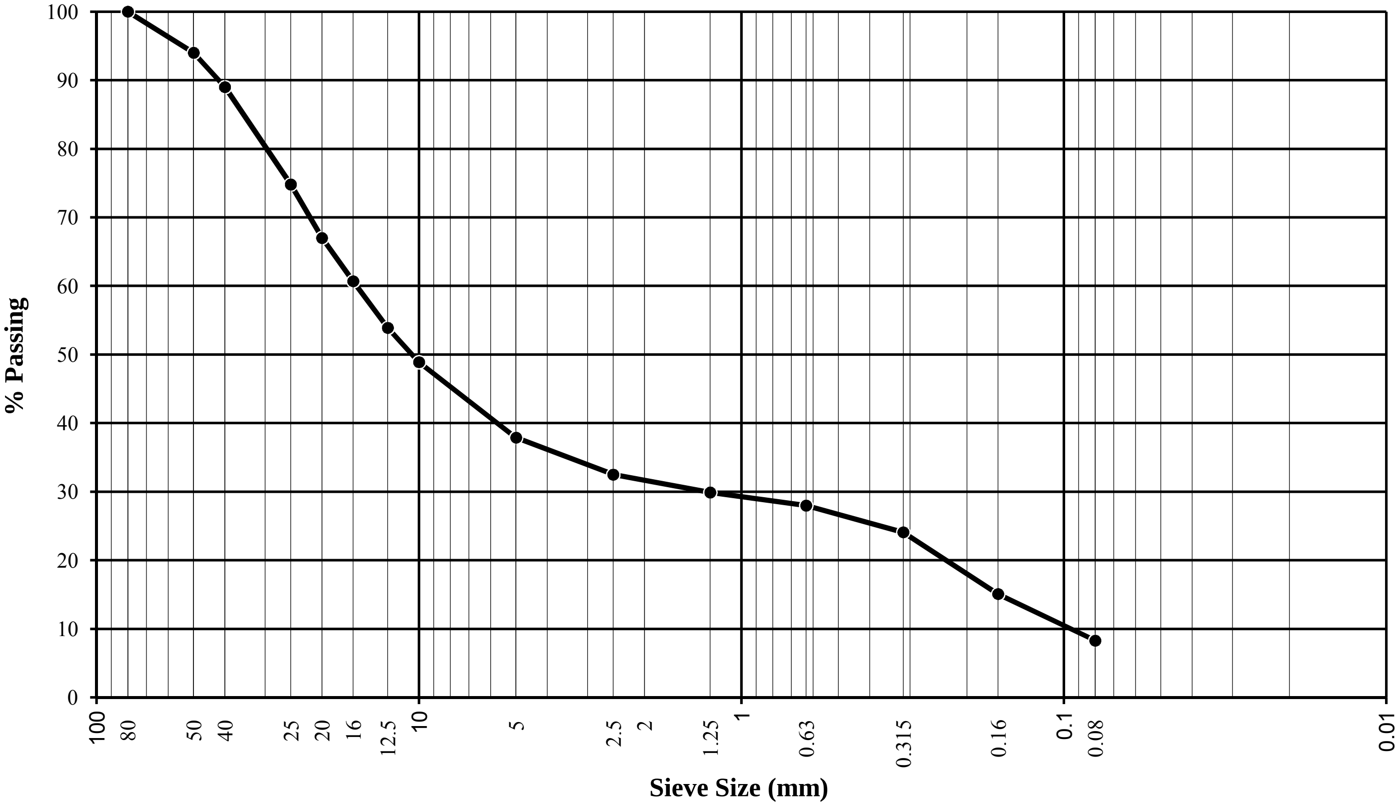
Classification GW-GM
C_C= 1.1
C_U= 156.1

Specification

Comments

TH # 3 @ 57-59ft.
Moisture Content = 0.9%

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	94.0		
40	89.0		
25	74.8		
20	67.0		
16	60.7		
12.5	53.9		
10	48.9		
5	37.9		
2.5	32.5		
1.25	29.9		
0.63	28.0		
0.315	24.1		
0.16	15.1		
0.08	8.3		



7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Summit Aggregates

Attention Tige Brady

Project Gravel Pit Investigation
Waterman Pit, Hwy567 & RR40

Job No.			
Date Sampled	July 18/14	**By**	AA
Date Received	July 18/14	**By**	AA
Date Tested	July 22/14	**By**	JC,KW

Aggregate Type Sandy GRAVEL
Aggregate Source Existing Material

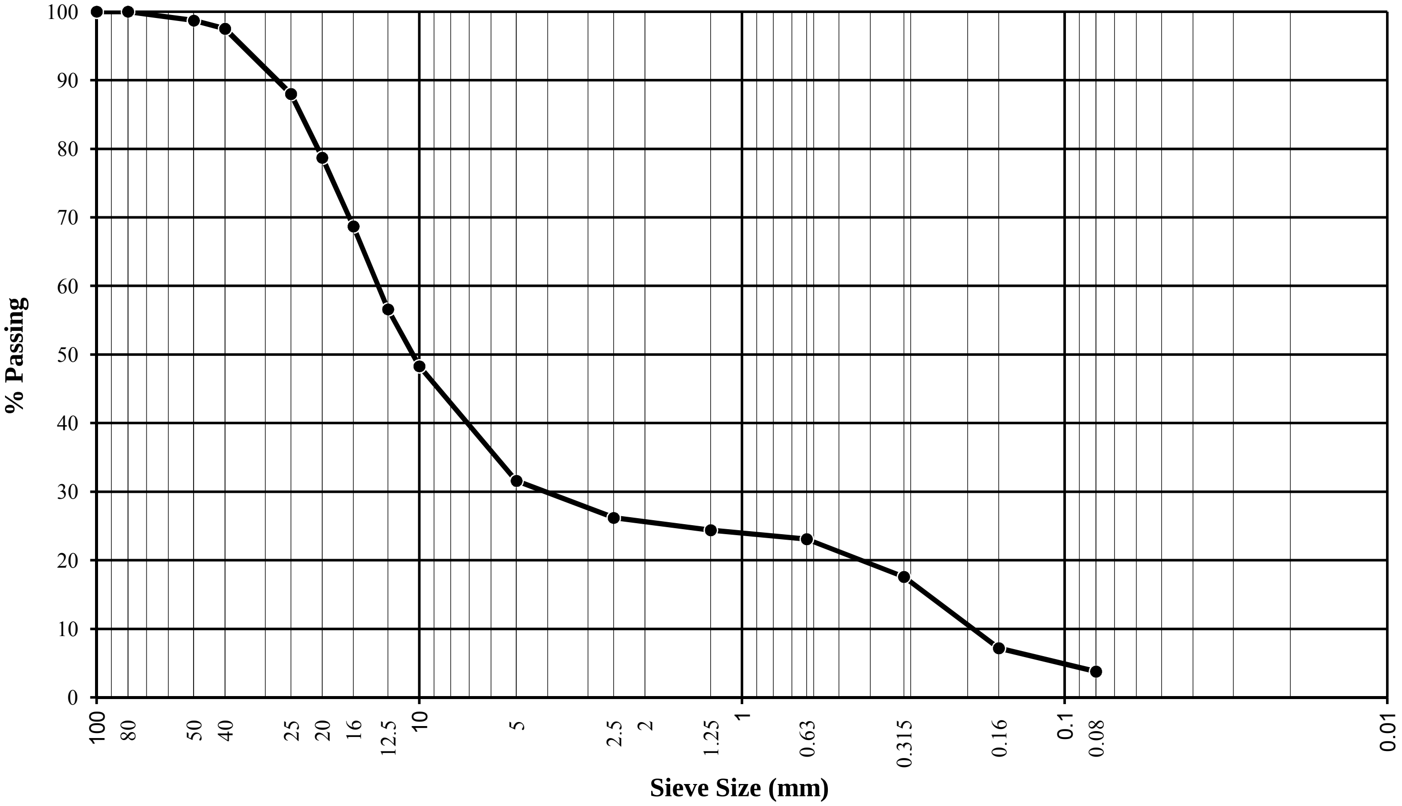
Classification GP
C_C= 6.3
C_U= 67.0

Specification

Comments

TH # 5 @ 36-38ft.
Moisture Content = 3.3%

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	98.7		
40	97.5		
25	88.0		
20	78.7		
16	68.7		
12.5	56.6		
10	48.3		
5	31.6		
2.5	26.2		
1.25	24.4		
0.63	23.1		
0.315	17.6		
0.16	7.2		
0.08	3.8		



ALMOR
7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report
ASTM C-136

Client Summit Aggregates

Attention Tige Brady

Project Gravel Pit Investigation
Waterman Pit, Hwy567 & RR40

Job No.
Date Sampled July 18/14 **By** AA
Date Received July 18/14 **By** AA
Date Tested July 22/14 **By** JC,KW

Aggregate Type Sandy GRAVEL
Aggregate Source Existing Material

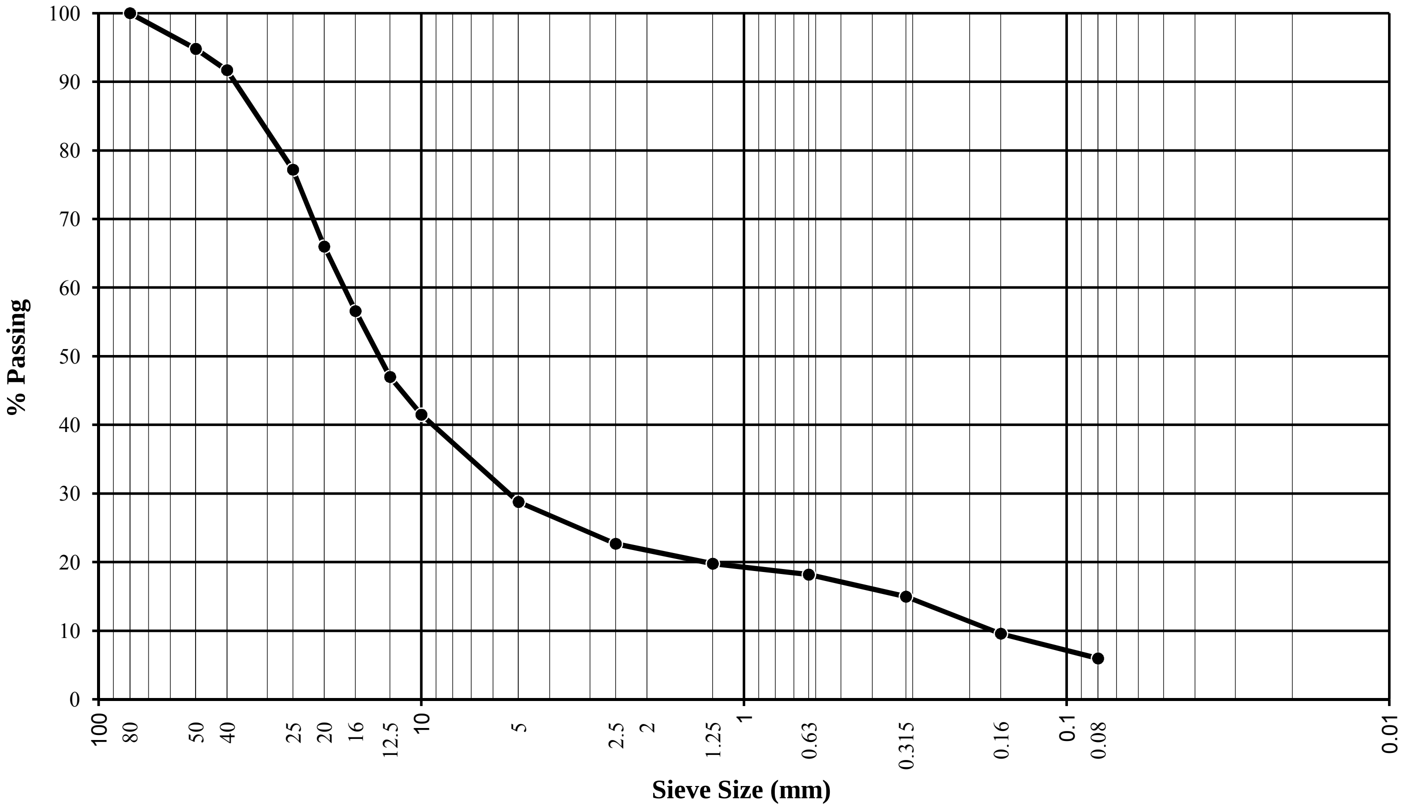
Classification GP
C_C= 10.0
C_U= 101.2

Specification

Comments

TH # 5 @ 51-53ft.
Moisture Content = 2.3%

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	94.8		
40	91.7		
25	77.2		
20	66.0		
16	56.6		
12.5	47.0		
10	41.5		
5	28.8		
2.5	22.7		
1.25	19.8		
0.63	18.2		
0.315	15.0		
0.16	9.6		
0.08	6.0		



CURTIS ENGINEERING ASSOCIATES LTD.
CALGARY CANMORE

1A, 820 – 28 Street NE
Calgary, Alberta T2A 6K1
Ph: 403-273-5868
Fax: 403-273-5957
geotechnical@curtisengineering.ca

August 1, 2014
File: 313-Misc.

Almor Testing Service
7505 40 Street SE
Calgary, AB T2C 2H5

Email: general@almor.com

Attention: Barry Martin

RE: LA Abrasion Testing (ASTM C131, ASTM C-535)

Curtis Engineering Associates Ltd. ran ASTM C-131 Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine on two (2) samples. Additionally two (2) samples were tested in accordance with ASTM C-535 Standard Test Method for resistance to degradation of large-size coarse aggregate by apbrasion and impact in the Los Angeles machine. The samples delivered to our office washed, split, and dried. The sample was then run through the test process and the results are tabulated below.

Sample ID	Gradin	Mass Prior To Test (g)	Mass After Test (g)	Mass Loss Due to Test (g)	Percent Loss (%)
1	A	4999.3	3580.9	1418.4	28.4
2	A	4998.6	3657.6	1341.0	26.8
3	2	10061.5	8033.8	2027.7	20.2
4	2	9975.5	8219.9	1755.6	17.6

We trust that the above is sufficient for your requirements. Should you need further information, please call.

Yours very truly,

Curtis Engineering Associates Ltd.

Michael Staple, B.Sc., P.Eng.
Geotechnical Engineer

MS/rwc

PLAN SHOWING
DRILL HOLE LOCATION
WATERMAN AGGREGATE
RESOURCE
NW $\frac{1}{4}$ SECTION 31 TWP 26 RGE 3 W5M
UTM, NAD83 Z11
MD OF ROCKY VIEW COUNTY

LEGEND

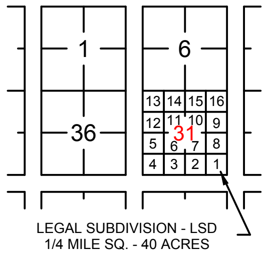
—	PROPERTY LINE
x	PROPOSED TESTHOLE LOCATION

SUMMIT
AGGREGATES LTD.

1111 Auburn Bay SE
Calgary, Alberta T3M

LEGAL LAND DESCRIPTION

NW 1/4 SECTION 31 TWP 26 RGE 3 W5M



LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

DATE: June 23, 2014	DRAWN BY: T BRADY
SCALE: 5,500	DRAWING: FIGURE 3
DATE REVISED: July 20, 2014	REVISED BY: T BRADY-

FILE: 2014 Waterman Aggregates Resource (COP).dwg

AIR PHOTO TAKEN : JULY 04, 2012

DATE PRINTED: June 23, 2014

ALMOR TESTING SERVICES LTD.

7505 - 40 STREET S.E., CALGARY, AB T2C 2H5 PHONE (403) 236-8880 · FAX (403) 236-1707

2017 11 20

099-86-17

Mountain Ash Limited Partnership

Attention: Mr. Tige Brady, C.E.T.
tige.brady@telus.net

Re: Gravel Pit Investigation
Summit Pit Phase 2
Highway 567 and Range Road 40
Rockyview County, Alberta

Almor Testing Services Ltd. observed and obtained gravel samples, during the advancement of ten (10) test holes, at the subject site from July 31 to August 5, 2017. Test holes designated as TH1 through TH10 were advanced in the triangular area of the northeast to southwest portion of the quarter of Section 31, Township Road 26, Range Road 3, W5M. The test holes were advanced using a Becker Hammer drill rig, operated by Great West Drilling of Calgary, Alberta. Refer to Figure 1 in Appendix 'A' for the approximate test hole locations.

Test hole depths ranged from a minimum of 14.1m (TH5) to a maximum of 27.6m (TH10). The thickness of the granular deposit in the test holes ranged from a minimum 9.3m (TH5) to a maximum 23.0m (TH9). The mean average thickness of the granular deposit encountered is 17.5m and ground water elevation ranged between 13.5m (TH5) to 25.5m (TH8).

Samples were obtained for gradation analysis, representative of the granular deposit encountered below the silty clay overburden. Eighteen (18) Gradation Analyses and one (1) Hydrometer Test were performed on samples from Test Hole No.'s 1 through 10. The Test Hole logs and the results of the Gradation Analyses are attached in Appendix 'B'. The Gradation Analyses of the samples indicated fines contents (material passing the 80 μm sieve size) in the range of 5.9% to 19.5%.

The fines content of the gravel samples obtained using a Becker Hammer drill rig is typically higher due to the crushing or fracture of the rocks during pounding of the hammer casing into gravels by the drill rig. A fines content to a maximum of 10% is generally considered desirable for gravels used for structural purposes (roads construction, foundation base, etc.). Aggregates for use in the manufacture of concrete and asphalt products typically have more stringent fines content requirements. In order to estimate the insitu fine content of gravel at the site, three (3) test pits were advanced in close proximity of Test Hole No.'s 2, 5 and 8 and gravel samples were obtained. The Test Pit logs and the results of the Gradation Analyses of the test pit samples are attached in Appendix 'B'. Table 1 compares the fine content of gravel samples obtained using Becker Hammer drill rig and from the test pits.

.../2

TABLE 1
Fine Content Comparison of Gravel Samples
Becker Hammer Drilling vs Test Pits

TP/TH No.	Depth (m)	Fines Content (%)
TP1	5.0 - 6.0	3.1
TH5	5.0 - 6.0	7.8
TP2	5.0 - 6.0	3.1
TH8	5.0 - 6.0	12.1
TP3	5.0 - 6.0	4.0
TH8	5.0 - 6.0	12.1

Table 1 indicates the fines content of the samples obtained using Becker Hammer drill rig is almost 2 to 3 times higher than those obtained from test pits. It is anticipated that the granular material recovered during a commercial mining operation would yield lower fines contents than what is indicated by the samples recovered during this investigation using a hammer rig.

A cursory examination of the coarse aggregate was completed on representative samples and is presented in Table 2. The examination was done by visual means only. This examination is not meant to replace a proper petrographic analysis, which is recommended after crushing operations have commenced.

TABLE 2

Type of Aggregate	Category	Quantity (%)
Quartzite	Good	40.0
Carbonite	Good & Fair	25.0
Sandstone	Good & Fair	30.0
Chert	Fair	4.0
Iron Concretion	Poor & Deleterious	1.0

Los Angeles Abrasion testing of a representative sample was conducted by Curtis Engineering of Calgary, Alberta and is attached in Appendix 'C', with a value of 32.3%. The City of Calgary specification for granular base and granular subbase is an L.A. Abrasion loss of maximum of 45%.

Overall, the aggregates and gradation of the gravels at the test hole locations are suitable for producing aggregates required in the construction industry, with some sorting and blending sand seams.

The volume of the gravel has been estimated based on the limited bore holes advanced and is presented in Appendix 'D'.

.../3

The overburden in the subject areas consisted of topsoil/browns overlying silty clay till.

The topsoil/browns were encountered in all test hole locations and ranged from100 to 300mm in thickness. A Grain Size Distribution test conducted on a topsoil/browns indicated a Gravel content of 0.2%, Sand content of 11.8%, Silt of 67.3%, Clay 20.7% and an Organic Content of 12.6%.

Below topsoil/browns, silty clay till was encountered in all test hole locations. The thickness of silty clay overburden ranged from 4000mm to 9000mm, resulting in an average thickness of 5100mm. The silty clay till overburden had a Moisture Content of approximately 7.7%. An Atterberg Limit test conducted on silty clay till soil indicated a Liquid Limit of 36, a Plastic Limit of 12, resulting in a Plasticity Index of 24. This classifieds the soil as a medium plastic clay (CI).

The attached Appendix 'E' details tests performed on the overburden soils.

The silty clay and topsoil overburden can be utilized for grading during the pit rehabilitation stages of the gravel pit.

We trust this meets with your present requirements.

Respectfully submitted,
ALMOR TESTING SERVICES LTD.

J.B. MONTGOMERY

J.B. Montgomery

* APEGA Permit to Practice #P2260

J.B. Montgomery, P.Eng.
AA: rn:A06227

APPENDIX A

PLAN SHOWING
SITE PLAN AND TESTHOLE LOCATION
SUMMIT PIT
NW ¼ SECTION 31 TWP 26 RGE 3 W5M
UTM, NAD83 Z11
ROCKY VIEW COUNTY

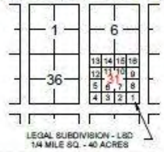
LEGEND

🟥	PROPERTY LINES
🟨	LIMIT OF DISTURBANCE
▭	CURRENT MINING PHASING
☒	2017 TEST HOLE WITH BECKER HAMMER RIG
☒	2014 GROUND WATER MONITORING WELLS
☒	2014 TESTHOLE WITH BECKER HAMMER
☒	2017 EXCAVATOR TEST PIT

TACT GROUP INC

SITE 9 BOX 39 RR 1
COhcrane, Alberta T4C 1A1

LEGAL LAND DESCRIPTION
NW 1/4 SECTION 31 TWP 26 RGE 3 W5M



DATE: October 02, 2017	DRAWN BY: T BRADY
SCALE: 1:4,000	DRAWING: 1 OF 1
DATE REVISED: __________	REVISED BY: __________

FILE: 2017 Project/ 2017 Summit Pit.dwg

AIR PHOTO TAKEN : JULY 04, 2012

DATE PRINTED: October 18, 2017

APPENDIX B

PROJECT: GRAVEL PIT ASSESSMENT
SUMMIT PIT PHASE TWO

PROJECT NO.

HOLE NO. TH1

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	OTHER TESTS
	Silty CLAY stiff to very stiff, medium plastic, trace to some sand, mottled olive, damp to moist	
1		
2	**Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist	
3		Gravel 20.8 % Sand 22.3 % Silt 31.2 % Clay 25.7 %
4		
5		
6		
7		
8		
9	- becoming sandy, trace cobble	
	Silty GRAVEL compact to dense, trace clay, some sand, fine to coarse grained, poorly graded, brown, damp	
10		Gravel 53.1 % Sand 33.9 % Silt 10.5 % Clay 2.5 %
11	- cleaner below 11.0 m	
12		
13	- becoming damp to moist	
14	- trace to some cobble below 14.0 m	
15		
16		
17		Gravel 61.9 % Sand 29.7 % Silt & Clay 8.4 %
18		
19	- occasional fine grained sand lens below 18.5 m	
20		
21		
22		
23		Gravel 18.6 % Sand 72.6 % Silt & Clay 8.8 %
24		
25	- becoming wet to saturated below 25.0 m	
26		
27		Gravel 65.0 % Sand 29.1 % Silt & Clay 5.9 %
28	**SILTSTONE (BEDROCK)** **END OF TEST HOLE AT 27.5m**	
29	- no standpipe installed - test hole dry at completion	
30	- test hole backfilled with soil cuttings	

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98

SAMPLE TYPE

MOD UNIFIED SOIL CLASS

WATER CONTENT (%) ●
PLASTIC LIMIT LIQUID LIMIT
20 40 60

COMPRESSIVE STRENGTH
Unconfined ▲
Pocket Pen △
TSF 2 3 4 5
KPa 200 300 400

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
Date Measured

COMPLETION DEPTH 28 m

DATE DRILLED July 31, 2017

LOGGED BY Abdul Alemi

PLATE NO. 1

PROJECT:	GRAVEL PIT ASSESSMENT SUMMIT PIT PHASE TWO
CLIENT:	MOUNTAIN ASH LIMITED PARTNERSHIP
PROJECT NO.	
HOLE NO.	TH2
DRILL TYPE	DIESEL HAMMER RIG
GEODETIC ELEVATION (m)	
DATUM	

DEPTH (m) | SOIL DESCRIPTION | DEPTH (ft) | SAMPLE TYPE | MOD UNIFIED SOIL CLASS | WATER CONTENT (%) ● | PLASTIC LIMIT 20 40 60 LIQUID LIMIT | COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400 | OTHER TESTS

DEPTH (m)	SOIL DESCRIPTION	OTHER TESTS
0 – 6.0	**Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist - becoming sandy, low plastic, olive/yellow	
6.0 – 7.0	**Sandy SILT** compact to dense, non to low plastic, some gravel to gravelly, brown, damp	
7.0 – 21.2	**Silty GRAVEL** compact to dense, some sand to sandy, fine to coarse grained, poorly graded, brown, damp - occasional fine grained sand/silt lens below 8.0 m	
12.5		Gravel 58.3 % Sand 31.7 % Silt & Clay 10.0 %
18.3	- becoming fine to medium grained	
19.5	- trace cobble below 19.2 m	
20.3	- becoming moist to wet	
20.5		Gravel 64.4 % Sand 16.1 % Silt & Clay 19.5 %
21.2	**END OF TEST HOLE AT 21.2m** (Hammer Refusal) - no standpipe installed - test hole dry at completion - test hole backfilled with soil cuttings	

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

COMPLETION DEPTH	21.2 m	DATE DRILLED	July 31, 2017
LOGGED BY	Abdul Alemi	PLATE NO.	2

PROJECT: GRAVEL PIT ASSESSMENT
SUMMIT PIT PHASE TWO

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

HOLE NO. TH3

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT / LIQUID LIMIT 20 40 60	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
1 2	**Silty CLAY (TILL)**	2 4 6					Gravel 0.2 % Sand 11.8 % Silt 67.3 % Clay 20.7 %
3 4	**Sandy SILT** compact, non to low plastic, some gravel to gravelly, brown, damp	8 10 12					Gravel 48.8 % Sand 33.6 % Silt & Clay 17.6 %
5 6 7 8 9 10 11 12 13 14 15	**Silty GRAVEL** compact, some sand to sandy, fine to coarse grained, poorly graded, brown, damp - trace cobble below 8. m - trace to some cobble below 10.0 m	14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48					
16	**Silty SAND** compact, some gravel, fine to coarse grained, poorly graded, brown, damp	50 52					Gravel 27.2 % Sand 54.3 % Silt & Clay 18.5 %
17 18	**Silty GRAVEL** compact, some sand to sandy, fine to coarse grained, poorly graded, brown, damp	54 56 58					
19 20 21 22	**SILTSTONE (BEDROCK)**	60 62 64 66 68 70 72					Gravel 71 % Sand 20.3 % Silt & Clay 8.7 %
23 24	**END OF TEST HOLE AT 22.5m** (Hammer Refusal) - no standpipe installed - test hole dry at completion - test hole backfilled with soil cuttings	74 76 78 80					

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

WET UNIT WEIGHT ○ KN/m³ 16 18 20 22; PCF 100 120 140

PENETRATION RESISTANCE ■ 20 40 60

☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 22.5 m

DATE DRILLED August 1, 2017

LOGGED BY Abdul Alemi

PLATE NO. 3

PROJECT: GRAVEL PIT ASSESSMENT
SUMMIT PIT PHASE TWO

PROJECT NO.

HOLE NO. TH4

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

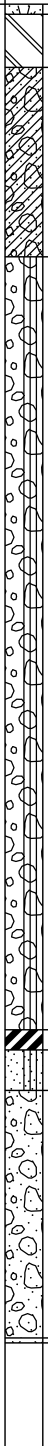
DATUM

DEPTH (m) | SOIL DESCRIPTION | DEPTH (ft) | SAMPLE TYPE | MOD UNIFIED SOIL CLASS

WATER CONTENT (%) ●
PLASTIC LIMIT — LIQUID LIMIT
20 40 60

COMPRESSIVE STRENGTH
Unconfined ▲
Pocket Pen △
TSF 2 3 4 5
KPa 200 300 400

OTHER TESTS



TOPSOIL

Silty CLAY stiff to very stiff, medium plastic, trace to some sand, olive, damp to moist

Silty CLAY (TILL) stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist

Silty GRAVEL compact, some sand to sandy, fine to coarse grained, poorly graded, brown, damp

- trace cobble below 10.0 m

- occasional fine grained sand lens below 14.5 m

CLAY very stiff to hard, high plastic, trace to some silt, trace sand, olive/yellow, moist

Silty SAND compact, trace gravel, fine to coarse grained, poorly graded, brown, damp

Sandy GRAVEL dense, trace to some silt, fine to coarse grained, poorly graded, brown, damp

SILTSTONE (BEDROCK)

END OF TEST HOLE AT 26.5m
- no standpipe installed
- groundwater level 23.0m at completion
- test hole backfilled with soil cuttings

Gravel 52.1 %
Sand 32.1 %
Silt & Clay 15.8 %

Gravel 31.2 %
Sand 55.5 %
Silt & Clay 13.3 %

Gravel 64.2 %
Sand 28.2 %
Silt & Clay 7.6 %

▼ At completion

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 27 m

DATE DRILLED August 2, 2017

LOGGED BY Abdul Alemi

PLATE NO. 4

PROJECT: GRAVEL PIT ASSESSMENT
SUMMIT PIT PHASE TWO

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

HOLE NO. TH5

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT – LIQUID LIMIT 20 40 60	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
	TOPSOIL						
1–4	**Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist	2–14					
5–14	**Silty GRAVEL** compact, some sand to sandy, trace cobble, fine to coarse grained, poorly graded, brown, damp	16–46					Gravel 59.6 % Sand 32.6 % Silt & Clay 7.8 % ▼ At completion
	SANDSTONE (BEDROCK)	48					
15	**MUDSTONE (BEDROCK)**	50					
16–19	**END OF TEST HOLE AT 15.6m** - no standpipe installed - groundwater level 13.5m at completion - test hole backfilled with soil cuttings	52–64					

DEPTH (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

DEPTH (ft): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 15.6 m

DATE DRILLED August 2, 2017

LOGGED BY Abdul Alemi

PLATE NO. 5

PROJECT: GRAVEL PIT ASSESSMENT
SUMMIT PIT PHASE TWO

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

HOLE NO. TH6

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT / LIQUID LIMIT 20 40 60	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
0 – 5.6	**PREDRILLED**	2, 4, 6, 8, 10, 12, 14, 16, 18					
5.6 – 11.0	**Sandy GRAVEL** compact, some silt, fine to coarse grained, poorly graded, brown, damp - trace cobble below 8.5 m	20, 22, 24, 26, 28, 30, 32, 34, 36					
11.0 – 11.8	**Silty SAND** compact to dense, trace gravel, fine to coarse grained, poorly graded, brown, damp	38					Gravel 23.3 % Sand 58.7 % Silt & Clay 18.0 %
11.8 – 16.2	**Sandy GRAVEL** compact to dense, some silt, fine to coarse grained, poorly graded, brown, damp - trace cobble below 13.4 m - becoming wet to saturated	40, 42, 44, 46, 48, 50, 52					▼ At completion
16.2	**SANDSTONE (BEDROCK)**	54					

END OF TEST HOLE AT 16.2m
- no standpipe installed
- groundwater level 15.8m at completion
- test hole backfilled with soil cuttings

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

WET UNIT WEIGHT ○ KN/m³ 16 18 20 22; PCF 100 120 140

PENETRATION RESISTANCE ■ 20 40 60
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 16.8 m

DATE DRILLED August 3, 2017

LOGGED BY Abdul Alemi

PLATE NO. 6

PROJECT:	GRAVEL PIT ASSESSMENT SUMMIT PIT PHASE TWO	PROJECT NO.	
		HOLE NO.	TH7
CLIENT:	MOUNTAIN ASH LIMITED PARTNERSHIP	DRILL TYPE	DIESEL HAMMER RIG
GEODETIC ELEVATION (m)		DATUM	

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT 20 40 60 LIQUID LIMIT	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
0	**PREDRILLED**						
1.4	**Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist						
2.5	**Silty GRAVEL** compact, trace to some sand, fine to coarse grained, poorly graded, olive, damp						
5.5	- trace cobble below 5.3 m						
19.3	- becomiing moist to wet						
20.0	- saturated below 19.8 m						▼ At completion
21.5	**SANDSTONE (BEDROCK)**						
22	**END OF TEST HOLE AT 21.6m** - no standpipe installed - groundwater level 19.8m at completion - test hole backfilled with soil cuttings						

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

WET UNIT WEIGHT ○ KN/m³ 16 18 20 22 PCF 100 120 140

PENETRATION RESISTANCE ■ 20 40 60

☐ SPT ◪ Case ■ Cone ◩ BT Pen

GROUNDWATER ▼ Date Measured

COMPLETION DEPTH	22.1 m	DATE DRILLED	August 3, 2017
LOGGED BY	Abdul Alemi	PLATE NO.	7

PROJECT: GRAVEL PIT ASSESSMENT
SUMMIT PIT PHASE TWO

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

HOLE NO. TH8

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

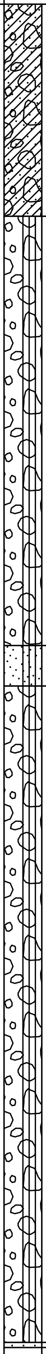
DATUM

SAMPLE TYPE

MOD UNIFIED SOIL CLASS

WATER CONTENT (%) ●
PLASTIC LIMIT LIQUID LIMIT
20 40 60

COMPRESSIVE STRENGTH
Unconfined ▲
Pocket Pen △
TSF 2 3 4 5
KPa 200 300 400



DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	OTHER TESTS
1	**Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist	2 4	
2		6 8	
3		10	
4		12 14	
5	**Silty GRAVEL** compact, trace to some sand, fine to coarse grained, poorly graded, olive, damp	16 18	
6		20	Gravel 58.5 % Sand 29.4 % Silt & Clay 12.1 %
7		22 24	
8		26	
9	- occasional coarse grained sand lens below 9.0 m	28 30	
10		32 34	
11		36	
12		38 40	
13	**Silty SAND** compact to dense, trace gravel, fine to coarse grained, poorly graded, brown, damp	42 44	
14	**Sandy GRAVEL** compact to dense, some silt, fine to coarse grained, poorly graded, brown, damp	46	
15		48 50	
16		52 54	
17		56	
18		58 60	
19		62	
20		64 66	
21		68 70	
22		72	
23		74 76	Gravel 56.2 % Sand 36.9 % Silt & Clay 6.9 %
24	- moist below 23.5 m	78 80	
25	- becoming wet	82	▼ At completion
26	- saturated below 25.5 m	84 86	
27	**SANDSTONE (BEDROCK)** **END OF TEST HOLE AT 26.6m**	88 90	
28	- no standpipe installed - groundwater level 25.5m at completion	92	
29	- test hole backfilled with soil cuttings	94 96	

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 27.1 m

DATE DRILLED August 4, 2017

LOGGED BY Jeremy Crawford

PLATE NO. 8

PROJECT: GRAVEL PIT ASSESSMENT
SUMMIT PIT PHASE TWO

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

HOLE NO. TH9

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

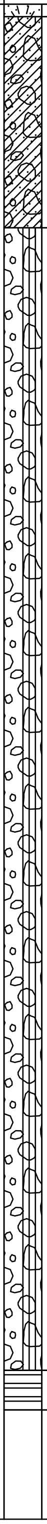
DATUM

SAMPLE TYPE

MOD UNIFIED SOIL CLASS

WATER CONTENT (%) ●
PLASTIC LIMIT — LIQUID LIMIT
20 40 60

COMPRESSIVE STRENGTH
Unconfined ▲
Pocket Pen △
TSF 2 3 4 5
KPa 200 300 400



DEPTH (m)	SOIL DESCRIPTION	OTHER TESTS
	TOPSOIL	
1	**Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist	
2		
3		
4		
5	**Sandy GRAVEL** compact, some silt to silty, fine to coarse grained, poorly graded, olive, damp	
6		
7		Gravel 56.9 % Sand 33.7 % Silt & Clay 9.4 %
8	- fine to medium grained below 8.0 m	
9		
10		
11		
12		
13		
14		
15		
16	- some silt below 16.0 m	
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28	**MUDSTONE (BEDROCK)**	
29	**END OF TEST HOLE AT 28.3m** - no standpipe installed - test hole dry at completion - test hole backfilled with soil cuttings	
30		

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 28.3 m

DATE DRILLED August 5, 2017

LOGGED BY Abdul Alemi

PLATE NO. 9

PROJECT: GRAVEL PIT ASSESSMENT
SUMMIT PIT PHASE TWO

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

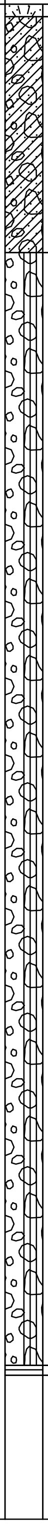
HOLE NO. TH10

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT LIQUID LIMIT 20 40 60	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
	TOPSOIL						
1	**Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace to some gravel, grey, damp to moist	2					
2		4 6					
3		8 10					
4		12 14					
5	**Silty GRAVEL** compact, some sand to sandy, fine to coarse grained, poorly graded, olive, damp	16 18					
6		20					
7		22 24					
8		26 28					
9	- occasional high plastic clay lens below 8.5 m	30					
10	- becoming fine grained	32 34					Gravel 69.0 % Sand 23.4 % Silt & Clay 7.6 %
11		36 38					
12		40					
13		42 44					
14		46 48					
15	- occasional fine grained sand lens below 15.0 m	50					
16		52 54					
17		56 58					Gravel 12.6 % Sand 66.2 % Silt & Clay 21.2 %
18		60					
19		62 64					
20		66					
21		68 70					
22		72 74					
23		76					
24		78 80					
25		82 84					
26		86					
27		88 90					
28	**MUDSTONE (BEDROCK)** **END OF TEST HOLE AT 27.6m**	92					
29	- no standpipe installed - test hole dry at completion	94 96					
30	- test hole backfilled with soil cuttings	98					



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TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
Date Measured

COMPLETION DEPTH 28 m

DATE DRILLED August 5, 2017

LOGGED BY Abdul Alemi

PLATE NO. 10

EXPLANATION OF SOIL DESCRIPTIONS AND SYMBOLS SHOWN ON TEST HOLE LOGS

The test hole logs summarize the results of field investigations and, if applicable, also laboratory test data. It should be appreciated that conditions established at a test hole location may not be representative of subsurface conditions across the investigated site. Transitions of the soil stratigraphy, either classified or graphically shown, are gradual, rather than the distinct unit boundaries presented.

SOIL DESCRIPTION AND CLASSIFICATION

Soils are described according to their appearance, lithological composition and probable mode of deposition (genetic type). Expected engineering properties and behaviour of the materials are interpreted relative to the soil type and laboratory test results.

I) DEFINITION OF SOIL TYPES

Material		Grain Size
Boulders		Larger than 300mm
Cobbles		75mm - 300mm
Gravel	- Coarse	19mm - 75mm
	- Fine	5mm - 19mm
Sand	- Coarse	2mm - 5mm
	- Medium	425um - 2mm
	- Fine	75um - 425um
Silt and Clay		Smaller than 75um

II) COMPOSITION OF SOIL

2.1 Principal Component - Major soil type representing at least 50% by weight of material.

2.2 Minor Component - Minor soil types identified by the following terms with respect to their percentages by weight of material:

“Trace” : 1% - 10%
“Some” : 10% - 20%
Modifier “Y” : 20% - 30%
Connector “and” : 30% - 50%

III) CONSISTENCY OR STRENGTH OF SOIL

3.1 Coarse Grained Soils - (Principal Component larger than 75um). The following terms are used relative to the Standard Penetration Test (SPT), ASTM D1586:

Description	No. of Blows per Foot
Very Loose	Less than 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	Over 50

3.2 Fine Grained Soils - (Principal Component smaller than 75um). The following terms are used relative to the unconfined strength and Standard Penetration Test (SPT), ASTM D1586:

Description	Unconfined Compressive Strength kPa (tsf)		No. Blows per Foot
Very Soft	Less than - 24	(0.25)	Less than 2
Soft	24 - 48	(0.25 - 0.5)	2 - 4
Firm	48 - 96	(0.5 - 1.0)	4 - 8
Stiff	96 - 190	(1.0 - 2.0)	8 - 15
Very Stiff	190 - 380	(2.0 - 4.0)	15 - 30
Hard	> 380	(4.0)	Over 30

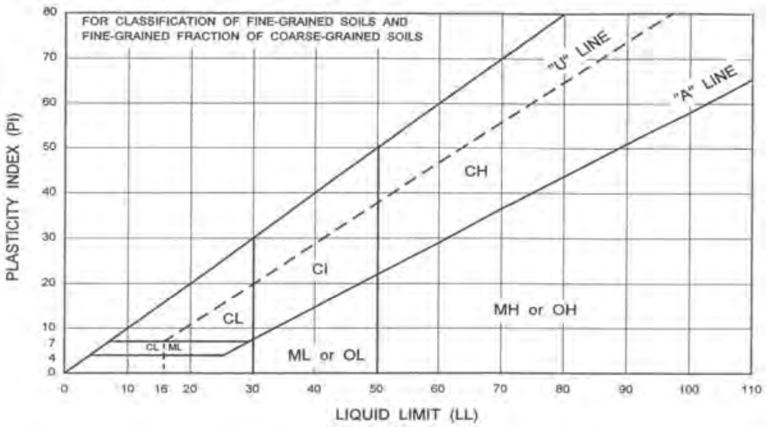
SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
HIGHLY ORGANIC SOILS			**PT**	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR AND OFTEN FIBROUS TEXTURE	
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS (MORE THAN HALF COARSE FRACTION LARGER THAN NO. 4 SIEVE)	CLEAN GRAVELS	**GW**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES. <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$; $C_c = \frac{(D_{30})^2}{D_{10} \text{ x } D_{60}} = 1 \text{ to } 3$	
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES. <5% FINES	NOT MEETING ALL ABOVE REQUIREMENTS	
		DIRTY GRAVELS	**GM**	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES. >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR $I_p < 4$	
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES. >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE OR $I_p > 7$	
	SANDS (MORE THAN HALF COARSE FRACTION LARGER THAN NO. 4 SIEVE SIZE)	CLEAN SANDS	**SW**	WELL-GRADED SANDS, GRAVELLY SANDS. <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$; $C_c = \frac{(D_{30})^2}{D_{10} \text{ x } D_{60}} = 1 \text{ to } 3$	
			SP	POORLY-GRADED SANDS, OR GRAVELLY SANDS. <5% FINES	NOT MEETING ALL ABOVE REQUIREMENTS	
		DIRTY SANDS	**SM**	SILTY SANDS, SAND-SILT MIXTURES. >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR Ip < 4	
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES. >12% FINES	ATTERBERG LIMITS ABOVE '"A" LINE OR Ip > 7	
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE SIZE)	SILTS BELOW "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		**ML**	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	$W_L < 50$	SEE PLASTICITY CHART BELOW
			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	$W_L > 50$	
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		**CL**	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS	$W_L < 30$	
			CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	$W_L > 30, < 50$	
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	$W_L > 50$	
	ORGANIC SILTS AND CLAYS BELOW "A" LINE ON PLASTICITY CHART		**OL**	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	$W_L < 50$	
			OH	ORGANIC CLAYS OF HIGH PLASTICITY	$W_L > 50$	

1. All sieve sizes mentioned on this chart are U.S. Standard, ASTM E11.

2. Boundary classifications possessing characteristics of two groups are given combined group symbols, eg. GW-GC is a well graded gravel sand mixture with clay binder between 5% and 12%.

3. Soil fractions and limiting textural boundaries are in accordance with the United Soil Classification System, except that an inorganic clay of medium plasticity (C) is recognized.



Plasticity Chart

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ROCK CLASSIFICATION AND DESCRIPTION

The following factors are usually incorporated in a test hole log for adequate engineering geotechnical description:

Rock Name. Established names for igneous, metamorphic and sedimentary rocks are used. This could include established local names rather than the actual rock name. It is believed that for engineering purposes classification by mechanical properties is more significant than classified by mineralogy and texture.

Alteration and Weathering State. The following grades are used: fresh, slightly weathered, moderately weathered, highly weathered and decomposed. In some cases of decomposed rocks the material may exhibit plasticity and soil mechanics classification could be used.

Structure and Discontinuities. This includes comments on discontinuities (bedding planes or separation along foliation planes and fissures in igneous or sedimentary rocks) and veins in relation to their type, orientation, frequency, infilling and surface structures. RQD percentage of core fractions that are 100mm (4 in.) or greater in length, relative to length of solid core recovered (defined by Deere et al. as the Rock Quality Designation) is indicative of the fractured state.

Assessment of Strength. The field assessment of rock strength can be aided by simple tests such as the use of a hammer or penknife and supplemented by laboratory testing. Any rock with a strength significantly less than 1 MPa (145 psi) could be described with reference to soil mechanics practice.

Ancillary Geological Information. This might include dip, identification of infill, etc.

TEST DATA AND SAMPLE TYPES

Data obtained from laboratory and field testing are shown in appropriate columns on the test hole logs and at the corresponding depth interval. Abbreviations and graphic symbols are as follows:

w	moisture content	*pp*	pocket penetrometer test
W_P or PL	plastic limit (ASTM D 424)	*Y*	unit weight of soil or rock
W_L or LL	liquid limit (ASTM D 423)	*Y*d	dry unit weight
Ip or PI	Plastic index (LL-PL)	q_u	unconfined compressive strength
☐	undisturbed shelby tube sample or rock core	RQD	rock quality designation
☐	disturbed SPT sample		
B	disturbed bag sample		

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Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	July 31/17	**By**	AA
Date Received	July 31/17	**By**	AA
Date Tested	Aug 2/17	**By**	BM

Aggregate Type Sandy Gravel, trace silt/clay

Aggregate Source

Classification GP-GM

C_C= 3.1

C_U= 119.8

Specification

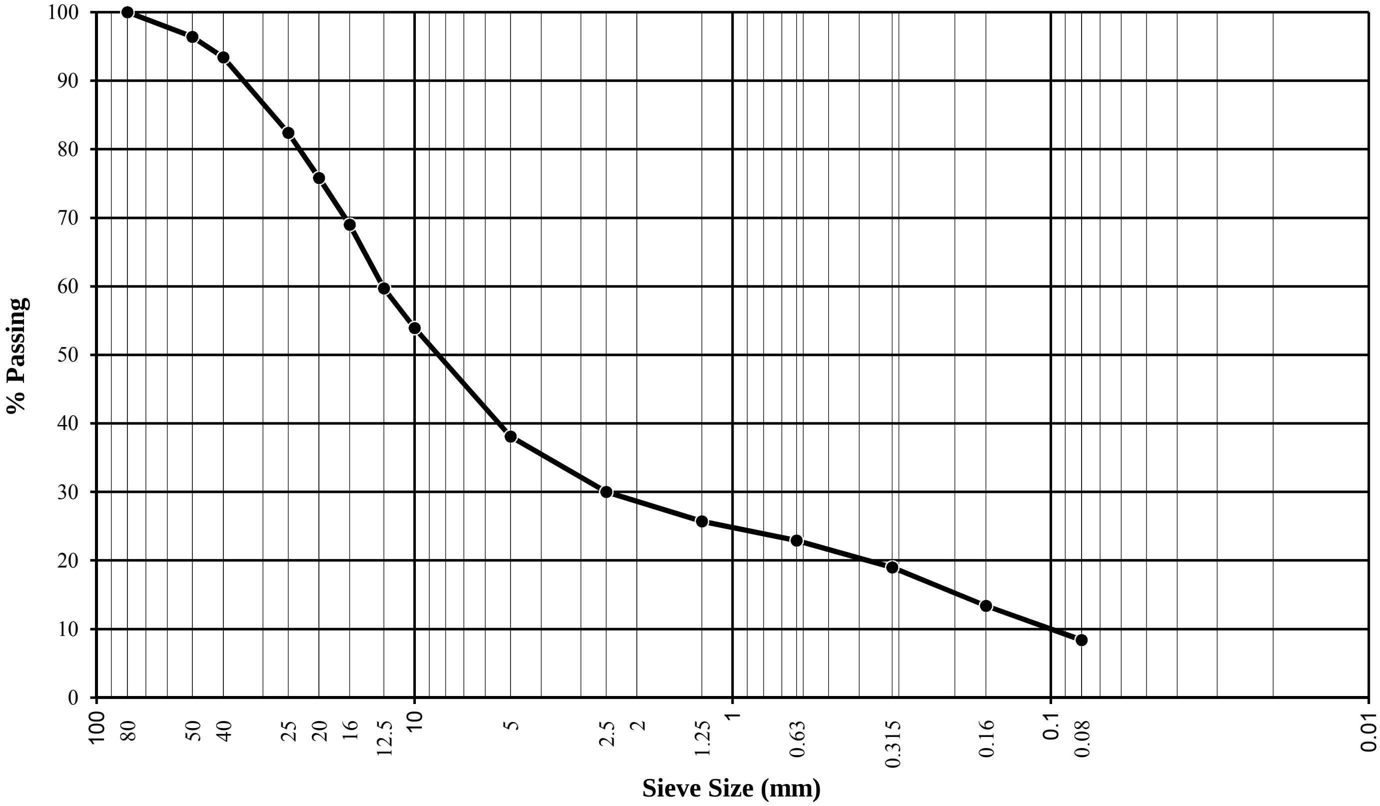
Comments

Gavel	61.9 %
Sand	29.7 %
Silt/Clay	8.4 %

TH 1

Depth 16 - 17m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	96.4		
40	93.4		
25	82.4		
20	75.8		
16	69.0		
12.5	59.7		
10	53.9		
5	38.1		
2.5	30.0		
1.25	25.7		
0.63	22.9		
0.315	19.0		
0.16	13.4		
0.08	8.4		



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Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 1/17	**By**	AA
Date Received	Aug 1/17	**By**	AA
Date Tested	Aug 2/17	**By**	BM

Aggregate Type Sand, some gravel, trace silt/clay

Aggregate Source

Classification SP-SM

C_C= 1.5

C_U= 5.1

Specification

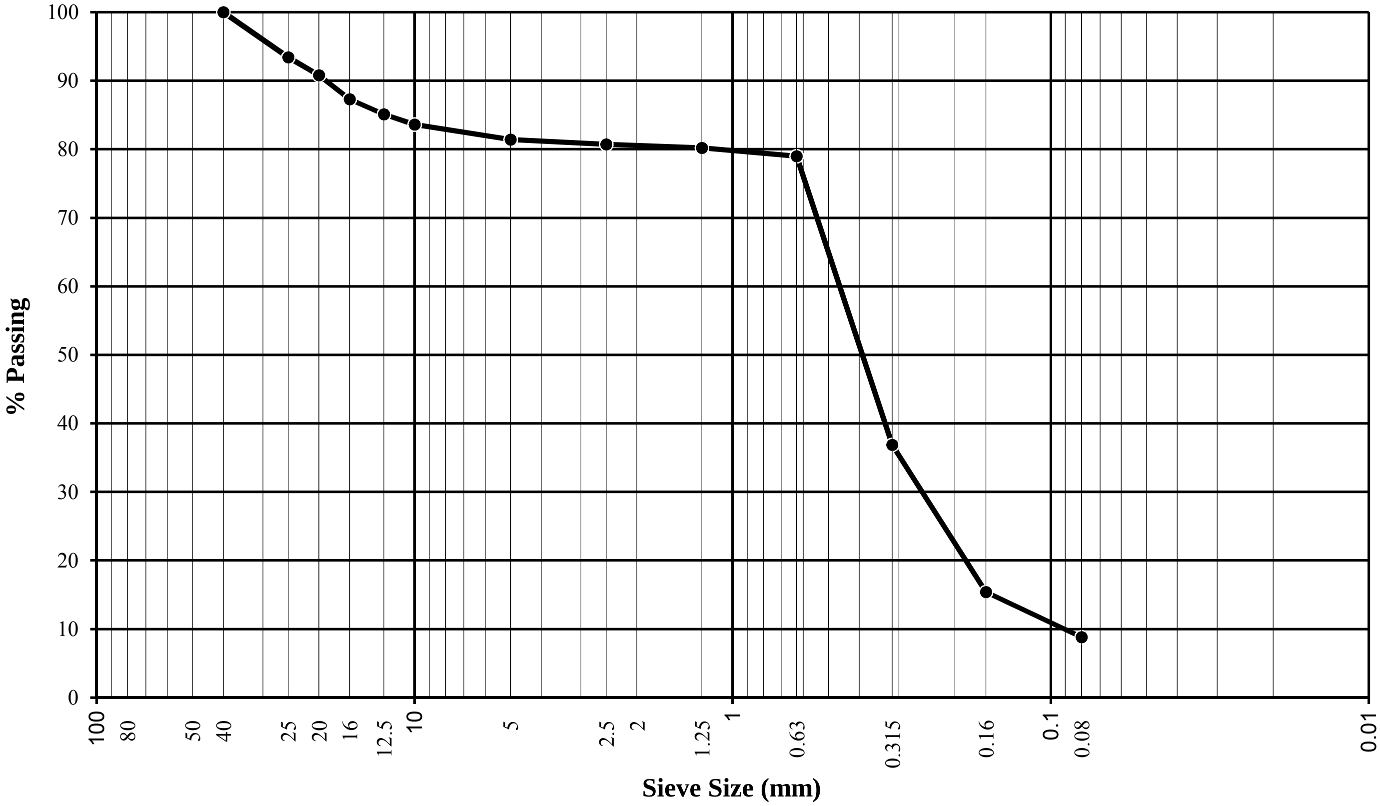
Comments

Gavel	18.6	%
Sand	72.6	%
Silt/Clay	8.8	%

TH 1

Depth 22.2 - 22.6m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80			
50			
40	100.0		
25	93.4		
20	90.8		
16	87.3		
12.5	85.1		
10	83.6		
5	81.4		
2.5	80.7		
1.25	80.2		
0.63	79.0		
0.315	36.9		
0.16	15.4		
0.08	8.8		



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Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 1/17	**By**	AA
Date Received	Aug 1/17	**By**	AA
Date Tested	Aug 5/17	**By**	DK

Aggregate Type Sandy Gravel, trace silt/clay

Aggregate Source

Classification GP
C_C= 3.8
C_U= 91.7

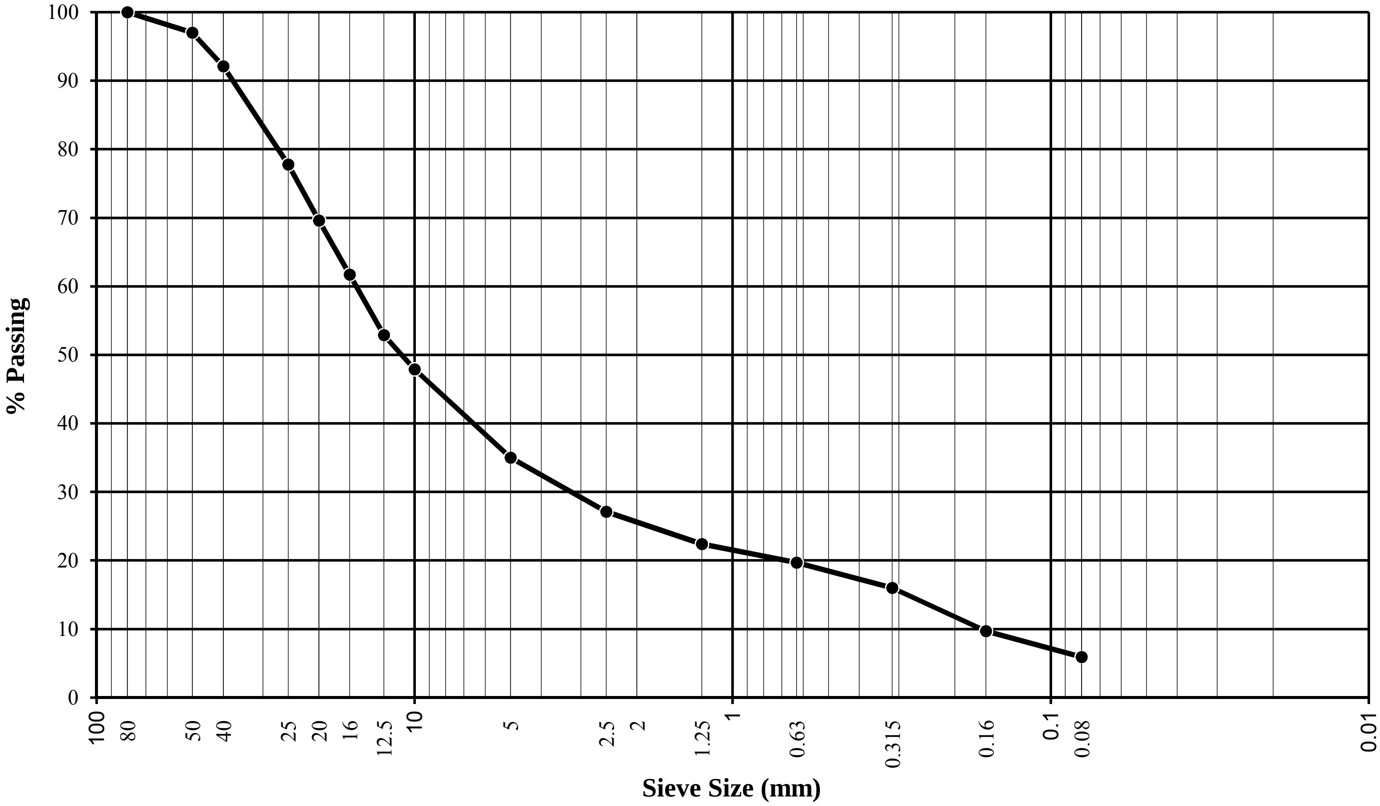
Specification

Comments

Gavel	65.0 %
Sand	29.1 %
Silt/Clay	5.9 %

TH 1
Depth 26 - 27m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	97.0		
40	92.1		
25	77.8		
20	69.6		
16	61.7		
12.5	52.9		
10	47.9		
5	35.0		
2.5	27.1		
1.25	22.4		
0.63	19.7		
0.315	16.0		
0.16	9.7		
0.08	5.9		



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Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	July 31/17	**By**	AA
Date Received	July 31/17	**By**	AA
Date Tested	Aug 14/17	**By**	MTS

Aggregate Type Sandy Gravel, trace silt/clay

Aggregate Source

Classification GW-GM

C_C= 1.1

C_U= 150.1

Specification

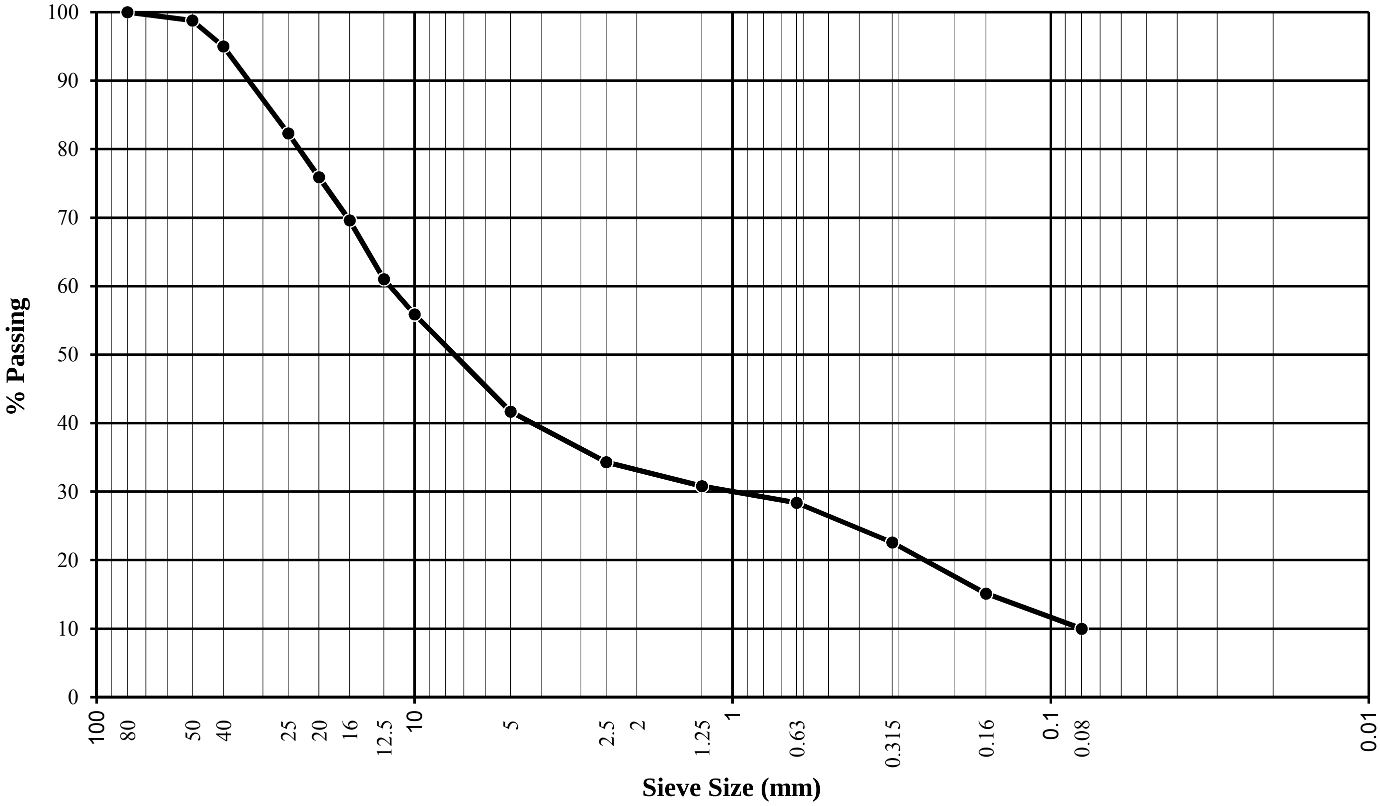
Comments

Gavel	58.3 %
Sand	31.7 %
Silt/Clay	10.0 %

TH 2

Depth 12 - 13m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	98.8		
40	95.0		
25	82.3		
20	75.9		
16	69.6		
12.5	61.0		
10	55.9		
5	41.7		
2.5	34.3		
1.25	30.8		
0.63	28.4		
0.315	22.6		
0.16	15.1		
0.08	10.0		



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Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 1/17	**By**	AA
Date Received	Aug 1/17	**By**	AA
Date Tested	Aug 4/17	**By**	DK

Aggregate Type Gravel, some sand, some silt/clay

Aggregate Source

Classification GM or GC

C_C= 1.4

C_U= 170.0

Specification

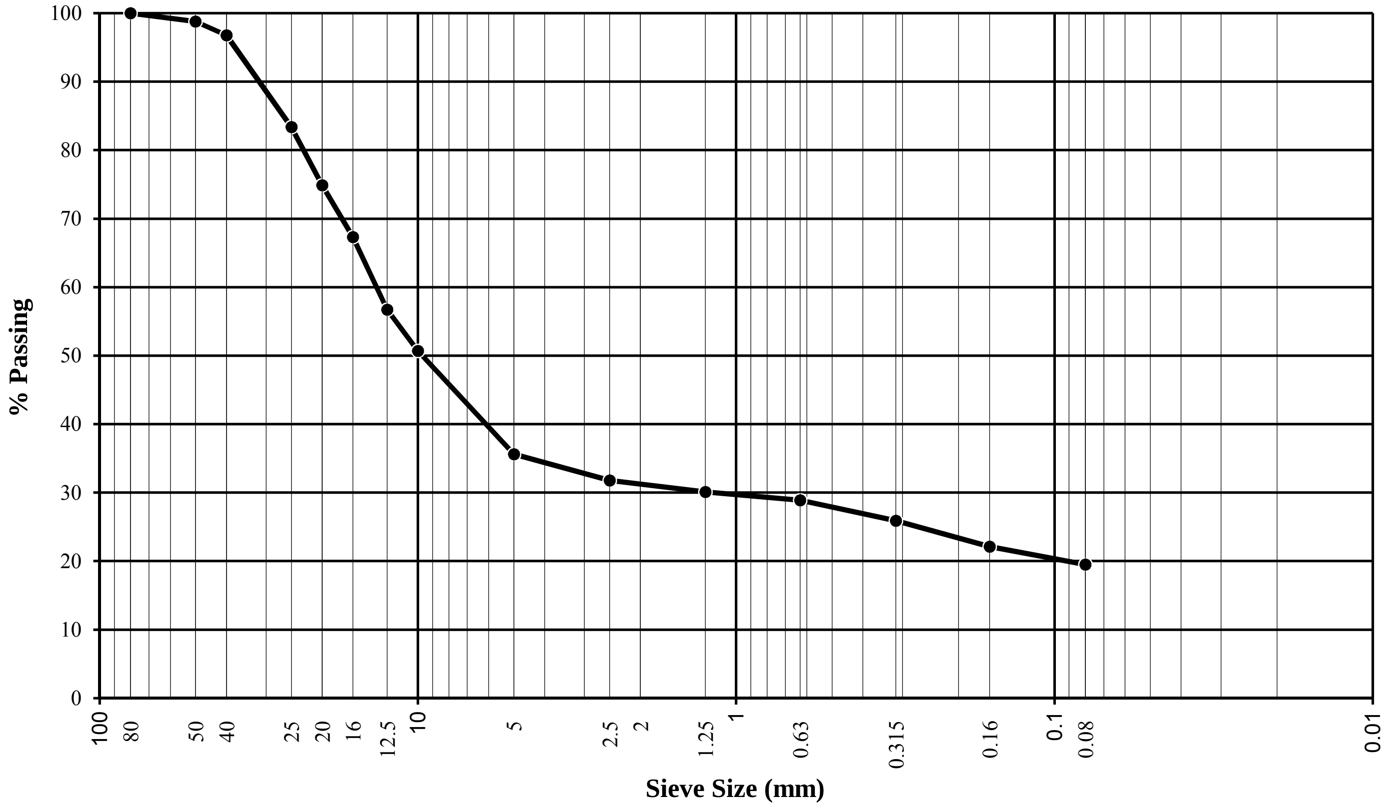
Comments

Gavel	64.4 %
Sand	16.1 %
Silt/Clay	19.5 %

TH 2

Depth 20 - 21m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	98.8		
40	96.8		
25	83.4		
20	74.9		
16	67.3		
12.5	56.7		
10	50.7		
5	35.6		
2.5	31.8		
1.25	30.1		
0.63	28.9		
0.315	25.9		
0.16	22.1		
0.08	19.5		



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Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 1/17	**By**	AA
Date Received	Aug 1/17	**By**	AA
Date Tested	Aug 14/17	**By**	DK

Aggregate Type Sandy Gravel, some silt/clay

Aggregate Source

Classification GM or GC

C_C= 0.1

C_U= 106.7

Specification

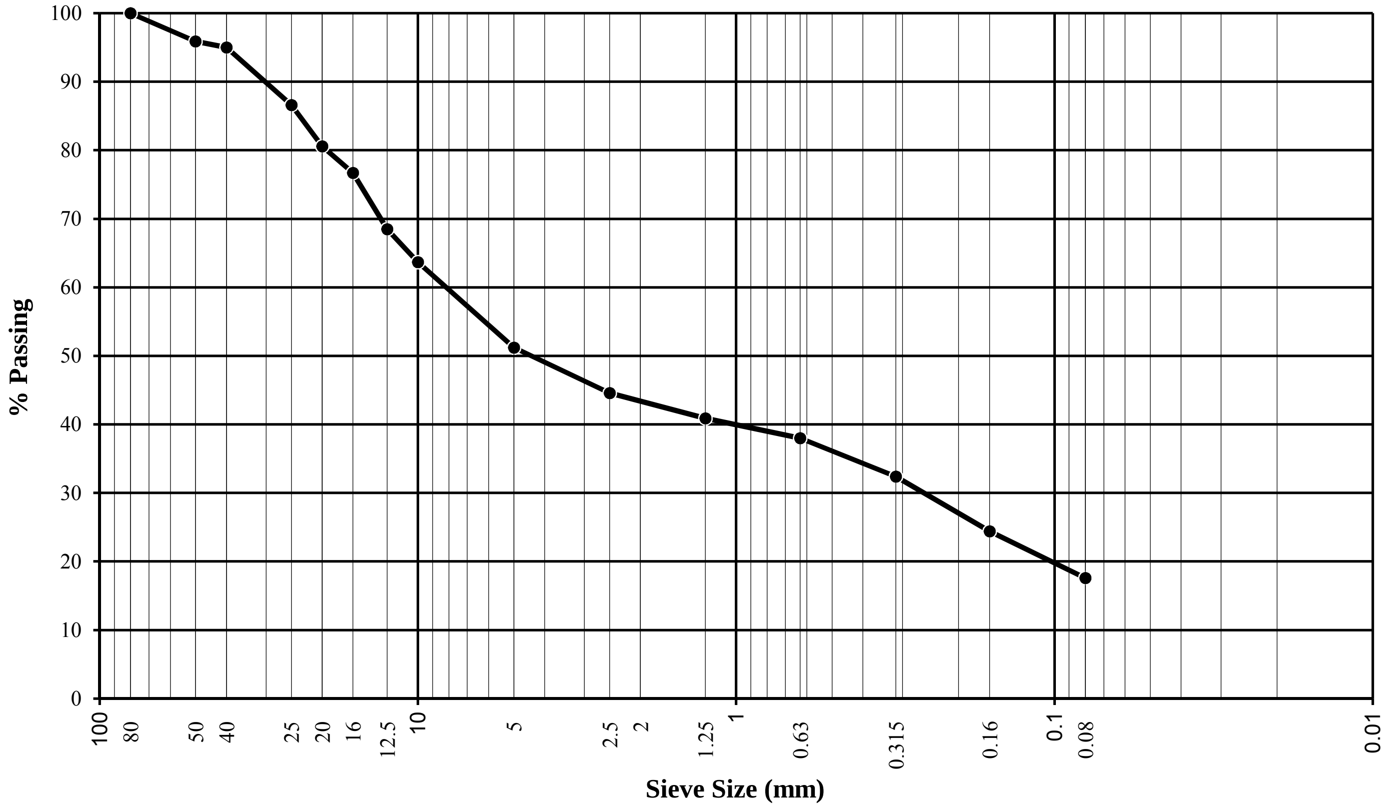
Comments

Gavel	48.8 %
Sand	33.6 %
Silt/Clay	17.6 %

TH 3

Depth 3 - 4m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	95.9		
40	95.0		
25	86.6		
20	80.6		
16	76.7		
12.5	68.5		
10	63.7		
5	51.2		
2.5	44.6		
1.25	40.9		
0.63	38.0		
0.315	32.4		
0.16	24.4		
0.08	17.6		



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Aggregate Analysis Report

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Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 1/17	**By**	AA
Date Received	Aug 1/17	**By**	AA
Date Tested	Aug 2/17	**By**	JKC

Aggregate Type Gravelly Sand, some silt/clay

Aggregate Source

Classification SM or SC

C_C= 0.7

C_U= 4.4

Specification

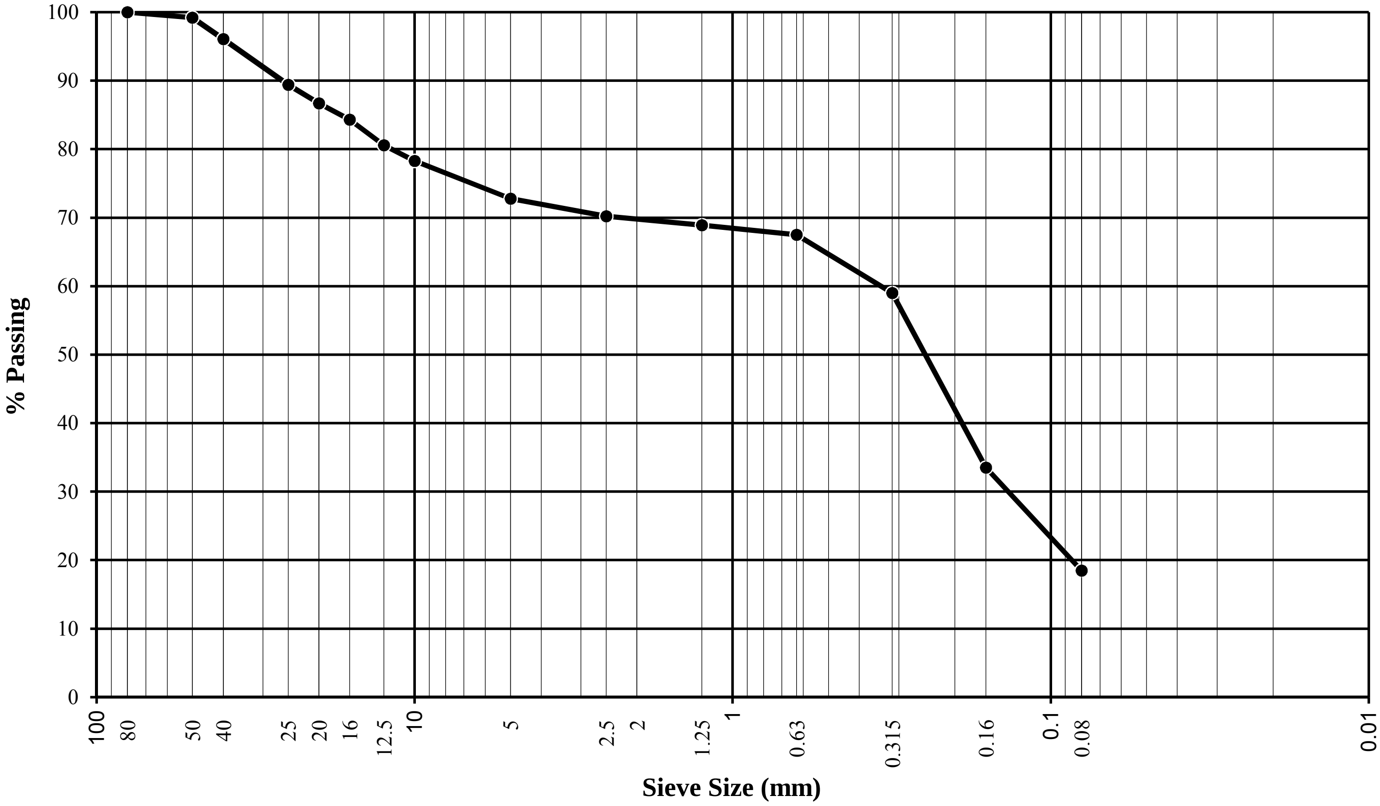
Comments

Gavel	27.2 %
Sand	54.3 %
Silt/Clay	18.5 %

TH 3

Depth 15 - 16m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	99.2		
40	96.1		
25	89.4		
20	86.7		
16	84.3		
12.5	80.6		
10	78.3		
5	72.8		
2.5	70.2		
1.25	68.9		
0.63	67.5		
0.315	59.0		
0.16	33.5		
0.08	18.5		



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Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 1/17	**By**	AA
Date Received	Aug 1/17	**By**	AA
Date Tested	Aug 2/17	**By**	PS

Aggregate Type Sandy Gravel, trace silt/clay

Aggregate Source

Classification GP-GM

C_C= 12.6

C_U= 173.9

Specification

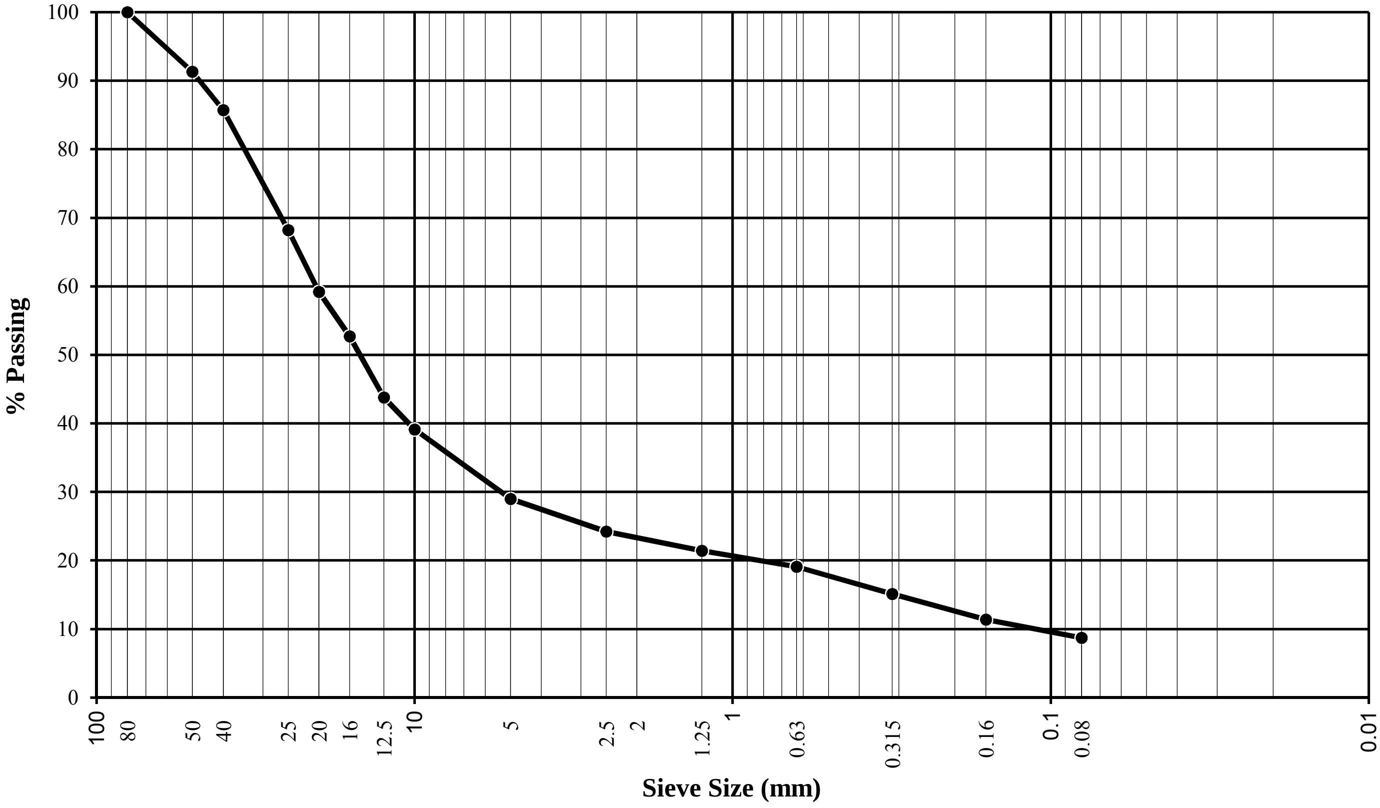
Comments

Gavel	71.0 %
Sand	20.3 %
Silt/Clay	8.7 %

TH 3

Depth 19.5m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	91.3		
40	85.7		
25	68.2		
20	59.2		
16	52.7		
12.5	43.8		
10	39.1		
5	29.0		
2.5	24.2		
1.25	21.4		
0.63	19.1		
0.315	15.1		
0.16	11.4		
0.08	8.7		



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Aggregate Analysis Report
ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No. 099-86-17
Date Sampled Aug 2/17 **By** AA
Date Received Aug 2/17 **By** AA
Date Tested Aug 14/17 **By** BM

Aggregate Type Sandy Gravel, some silt/clay
Aggregate Source

Classification GM or GC
C_C= 0.1
C_U= 120.0

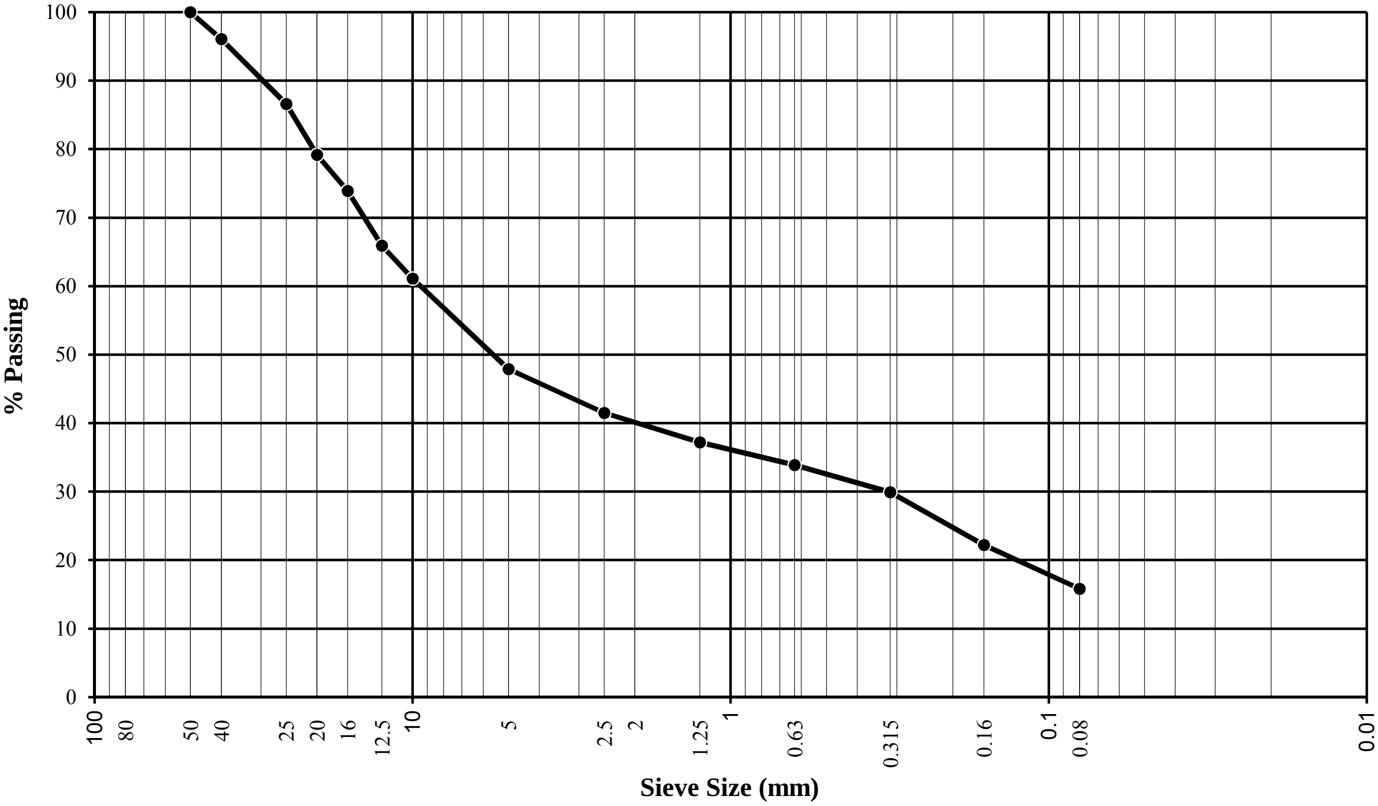
Specification

Comments

Gavel	52.1 %
Sand	32.1 %
Silt/Clay	15.8 %

TH 4
Depth 6 - 7m

Sieve Size (mm)	Percent Passing by Weight	Min.	Max.
200			
150			
100			
80			
50	100.0		
40	96.1		
25	86.6		
20	79.2		
16	73.9		
12.5	65.9		
10	61.1		
5	47.9		
2.5	41.5		
1.25	37.2		
0.63	33.9		
0.315	29.9		
0.16	22.2		
0.08	15.8		



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Aggregate Analysis Report
ASTM C-136

Client	Mountain Ash Limited Partnership	**Job No.**	099-86-17	
		Date Sampled	Aug 2/17	**By** AA
		Date Received	Aug 2/17	**By** AA
Attention	Tige Brady	**Date Tested**	Aug 6/17	**By** DK
Project	Summit Pit Ph 2, Gravel Investigation			

Aggregate Type Gravelly Sand, some silt/clay
Aggregate Source

Classification SM or SC
C_C= 0.9
C_U= 6.3

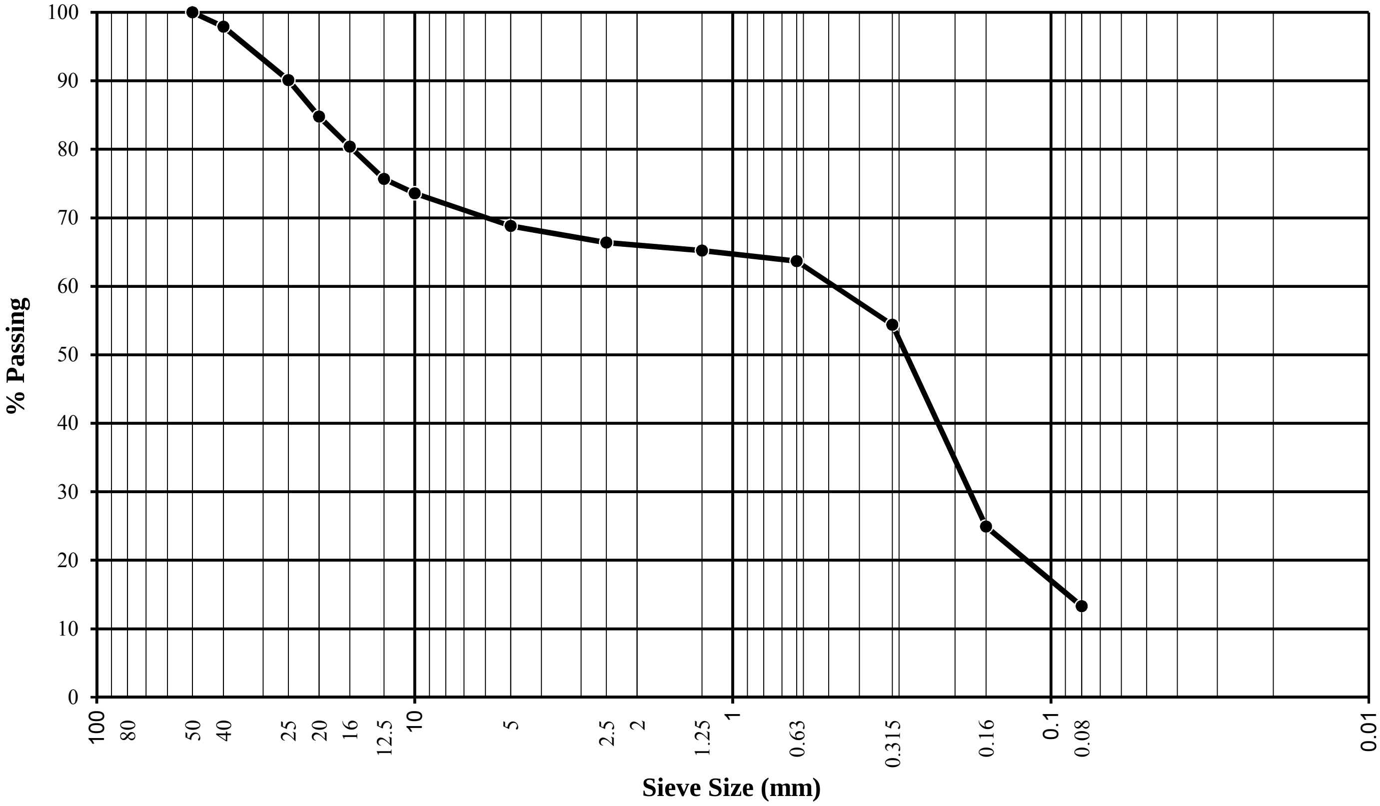
Specification

Comments

Gavel	31.2	%
Sand	55.5	%
Silt/Clay	13.3	%

TH 4
Depth 7 - 7.5m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80			
50	100.0		
40	97.9		
25	90.1		
20	84.8		
16	80.4		
12.5	75.7		
10	73.6		
5	68.8		
2.5	66.4		
1.25	65.2		
0.63	63.7		
0.315	54.4		
0.16	24.9		
0.08	13.3		



7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 2/17	**By**	AA
Date Received	Aug 2/17	**By**	AA
Date Tested	Aug 15/17	**By**	BM

Aggregate Type Sandy Gravel, trace silt/clay
Aggregate Source

Classification GP
C_C= 3.7
C_U= 107.0

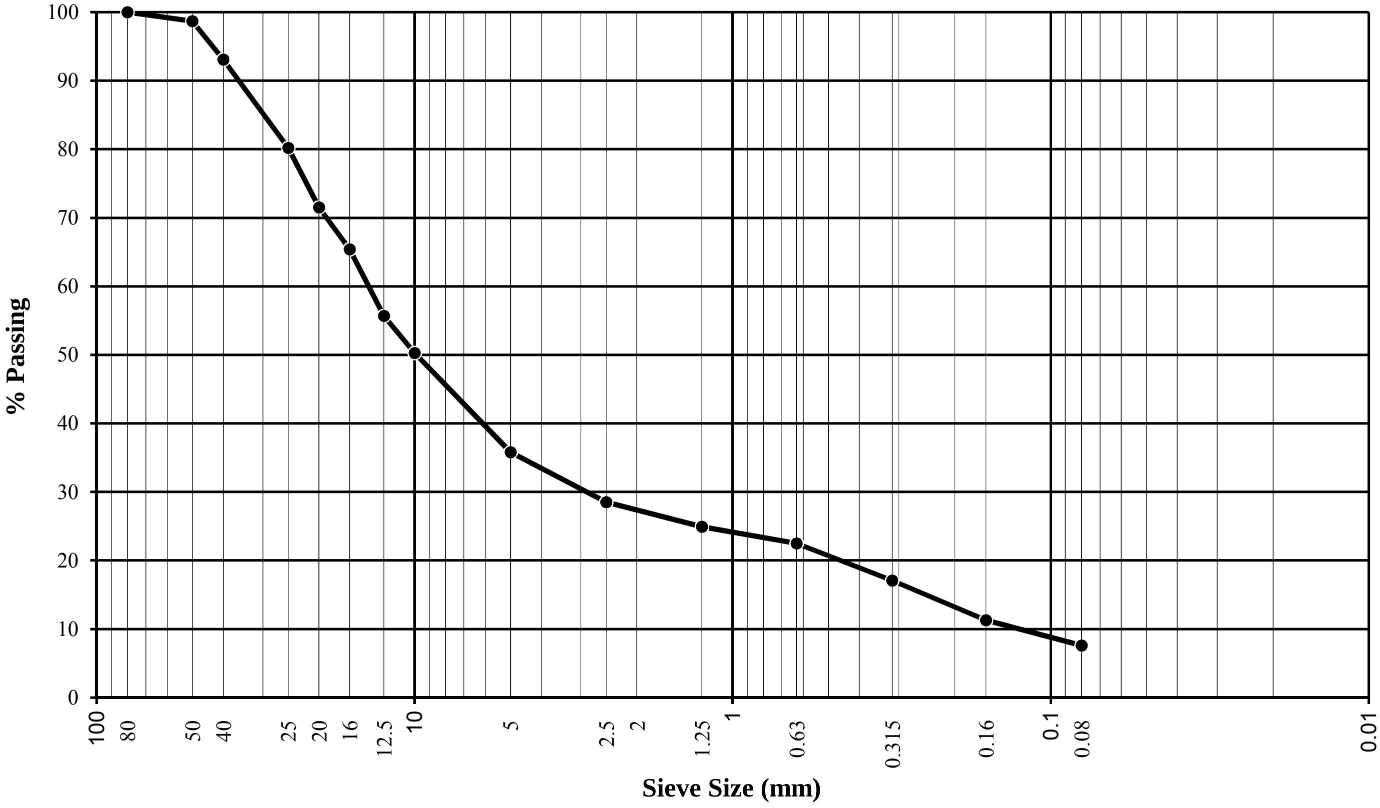
Specification

Comments

Gavel	64.2 %
Sand	28.2 %
Silt/Clay	7.6 %

TH 4
Depth 20 - 20.5m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	98.7		
40	93.1		
25	80.2		
20	71.5		
16	65.4		
12.5	55.7		
10	50.3		
5	35.8		
2.5	28.5		
1.25	24.9		
0.63	22.5		
0.315	17.1		
0.16	11.3		
0.08	7.6		



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Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No. 099-86-17
Date Sampled Aug 2/17 **By** AA
Date Received Aug 2/17 **By** AA
Date Tested Aug 12/17 **By** DK

Aggregate Type Sandy Gravel, trace silt/clay
Aggregate Source

Classification GW
C_C= 2.1
C_U= 89.4

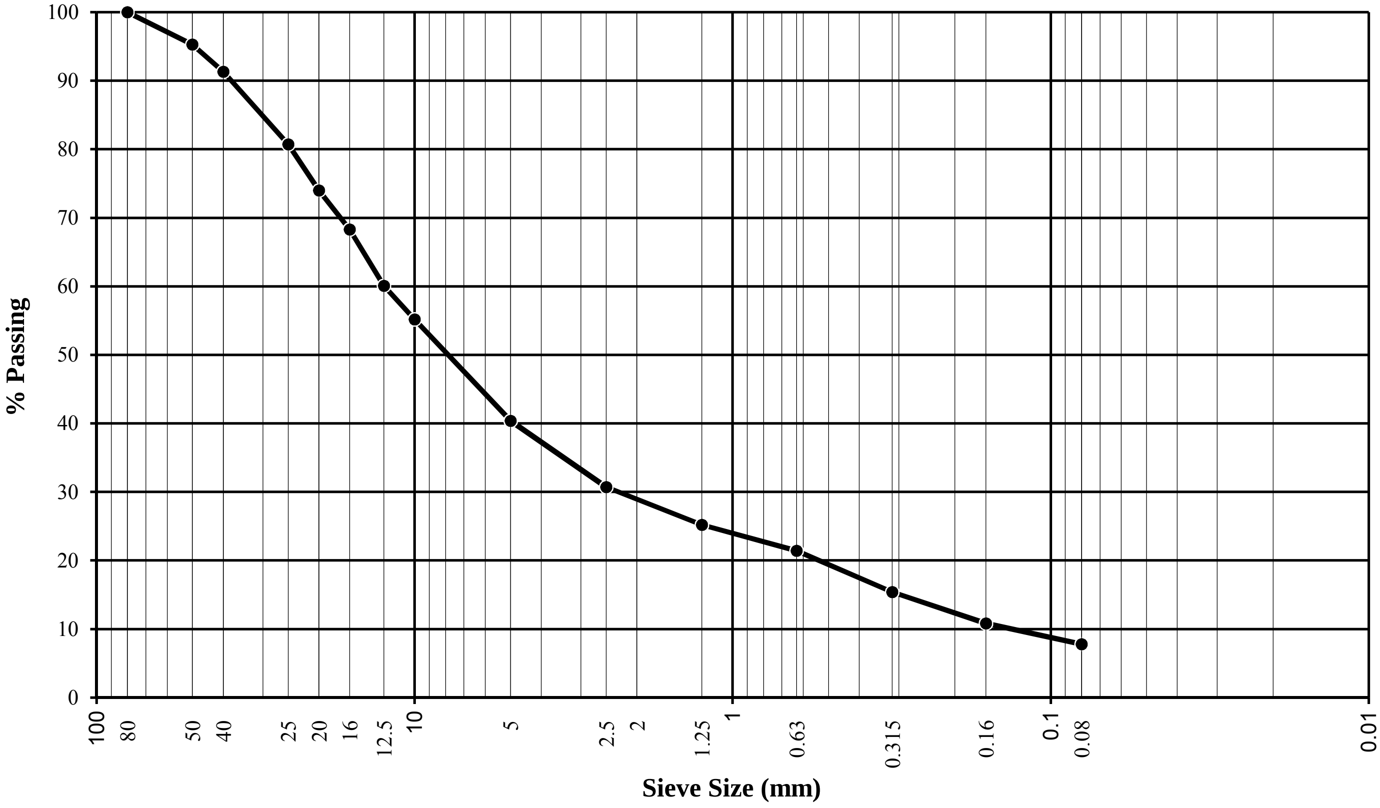
Specification

Comments

Gavel	59.6	%
Sand	32.6	%
Silt/Clay	7.8	%

TH 5
Depth 5 - 6m

Sieve Size	Percent Passing by Weight		
(mm)		Min.	Max.
200			
150			
100			
80	100.0		
50	95.3		
40	91.3		
25	80.7		
20	74.0		
16	68.3		
12.5	60.1		
10	55.2		
5	40.4		
2.5	30.7		
1.25	25.2		
0.63	21.4		
0.315	15.4		
0.16	10.8		
0.08	7.8		



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Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No. 099-86-17

Date Sampled	Aug 3/17	**By**	AA
Date Received	Aug 3/17	**By**	AA
Date Tested	Aug 5/17	**By**	DK

Aggregate Type Gravelly Sand, some silt/clay

Aggregate Source

Classification SM or SC

C_C= 0.9

C_U= 5.5

Specification

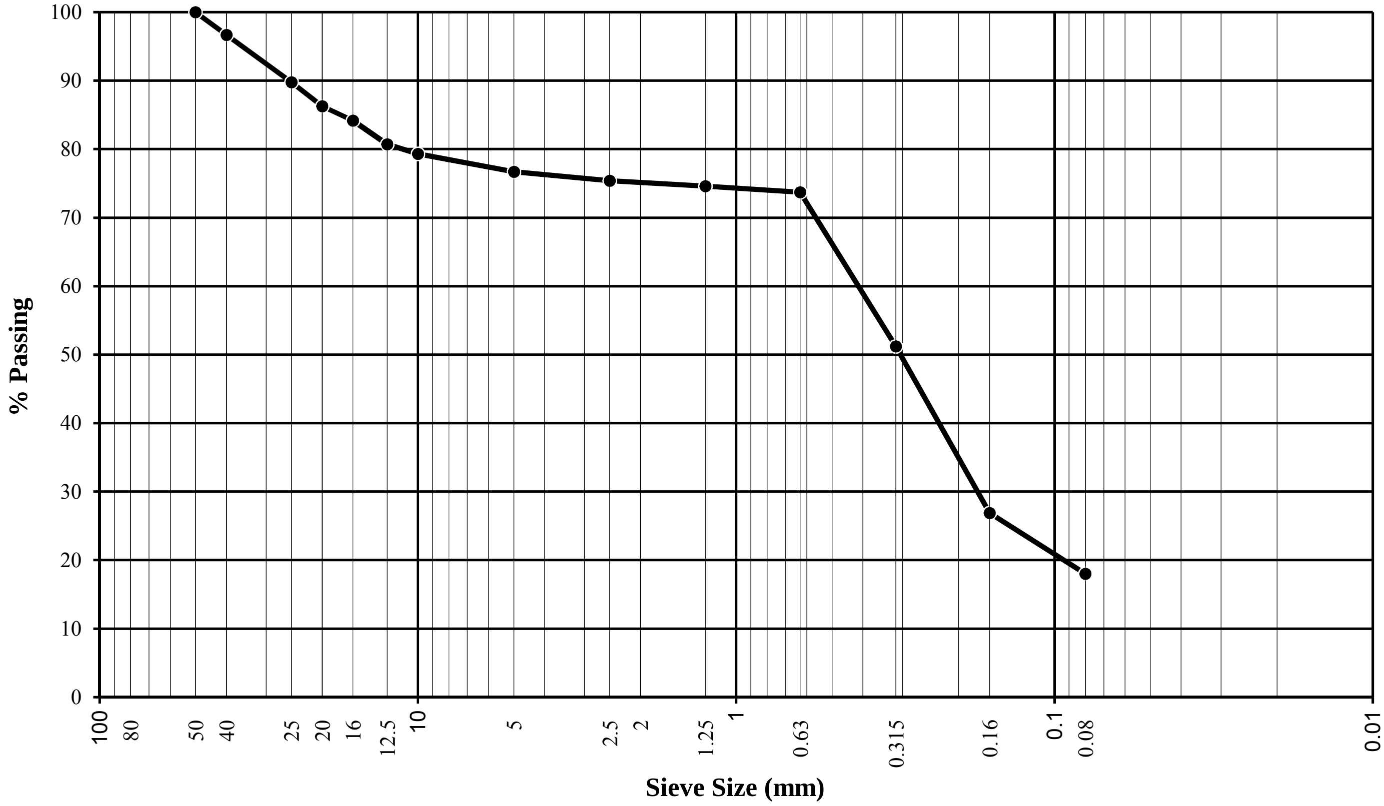
Comments

Gavel	23.3 %
Sand	58.7 %
Silt/Clay	18.0 %

TH 6

Depth 11 - 11.5m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80			
50	100.0		
40	96.7		
25	89.8		
20	86.3		
16	84.2		
12.5	80.7		
10	79.3		
5	76.7		
2.5	75.4		
1.25	74.6		
0.63	73.7		
0.315	51.2		
0.16	26.9		
0.08	18.0		



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Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report
ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 4/17	**By**	JC
Date Received	Aug 4/17	**By**	JC
Date Tested	Aug 6/17	**By**	DK

Aggregate Type Sandy Gravel, some silt/clay
Aggregate Source

Classification GM or GC
C_C= 1.8
C_U= 154.0

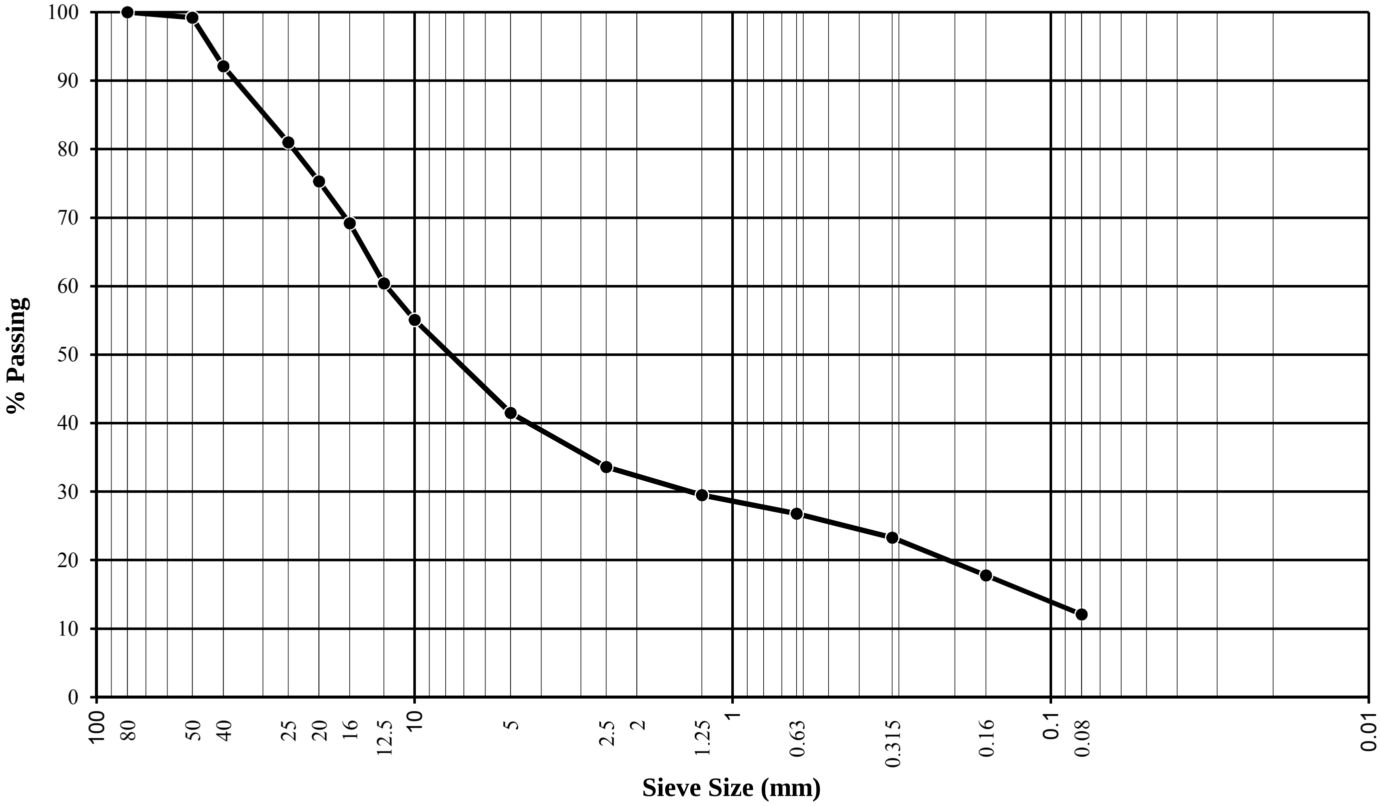
Specification

Comments

Gavel	58.5 %
Sand	29.4 %
Silt/Clay	12.1 %

TH 8
Depth 5 - 6m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	99.2		
40	92.1		
25	81.0		
20	75.3		
16	69.2		
12.5	60.4		
10	55.1		
5	41.5		
2.5	33.6		
1.25	29.5		
0.63	26.8		
0.315	23.3		
0.16	17.8		
0.08	12.1		



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Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report
ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 4/17	**By**	JC
Date Received	Aug 4/17	**By**	JC
Date Tested	Aug 6/17	**By**	CS

Aggregate Type Sandy Gravel, trace silt/clay
Aggregate Source

Classification GW
C_C= 2.0
C_U= 53.7

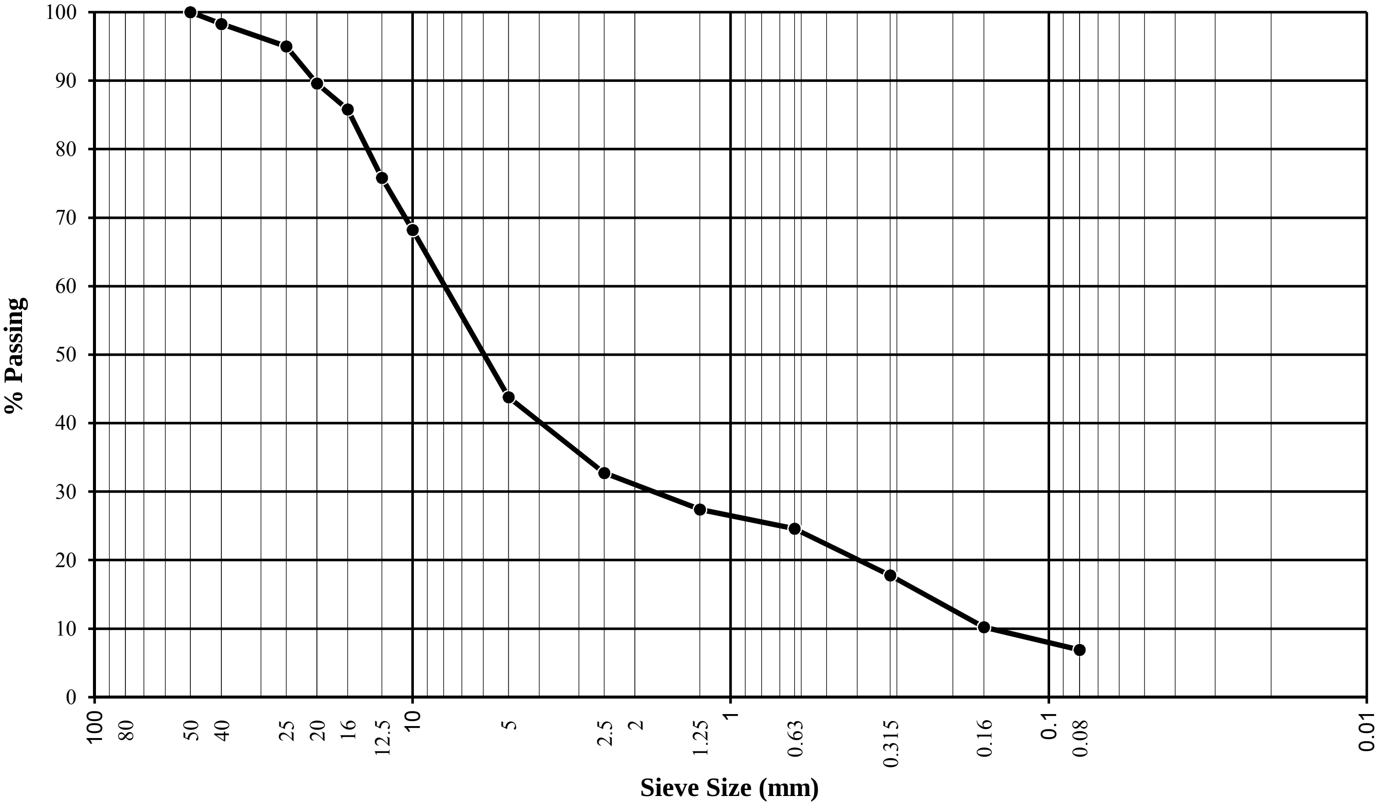
Specification

Comments

Gavel	56.2 %
Sand	36.9 %
Silt/Clay	6.9 %

TH 8
Depth 23 - 23.5m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80			
50	100.0		
40	98.3		
25	95.0		
20	89.6		
16	85.8		
12.5	75.8		
10	68.2		
5	43.8		
2.5	32.7		
1.25	27.4		
0.63	24.6		
0.315	17.8		
0.16	10.2		
0.08	6.9		



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Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 5/17	**By**	AA
Date Received	Aug 5/17	**By**	AA
Date Tested	Aug 15/17	**By**	BM

Aggregate Type Sandy Gravel, trace silt/clay

Aggregate Source

Classification GW-GM

C_C= 1.1

C_U= 120.8

Specification

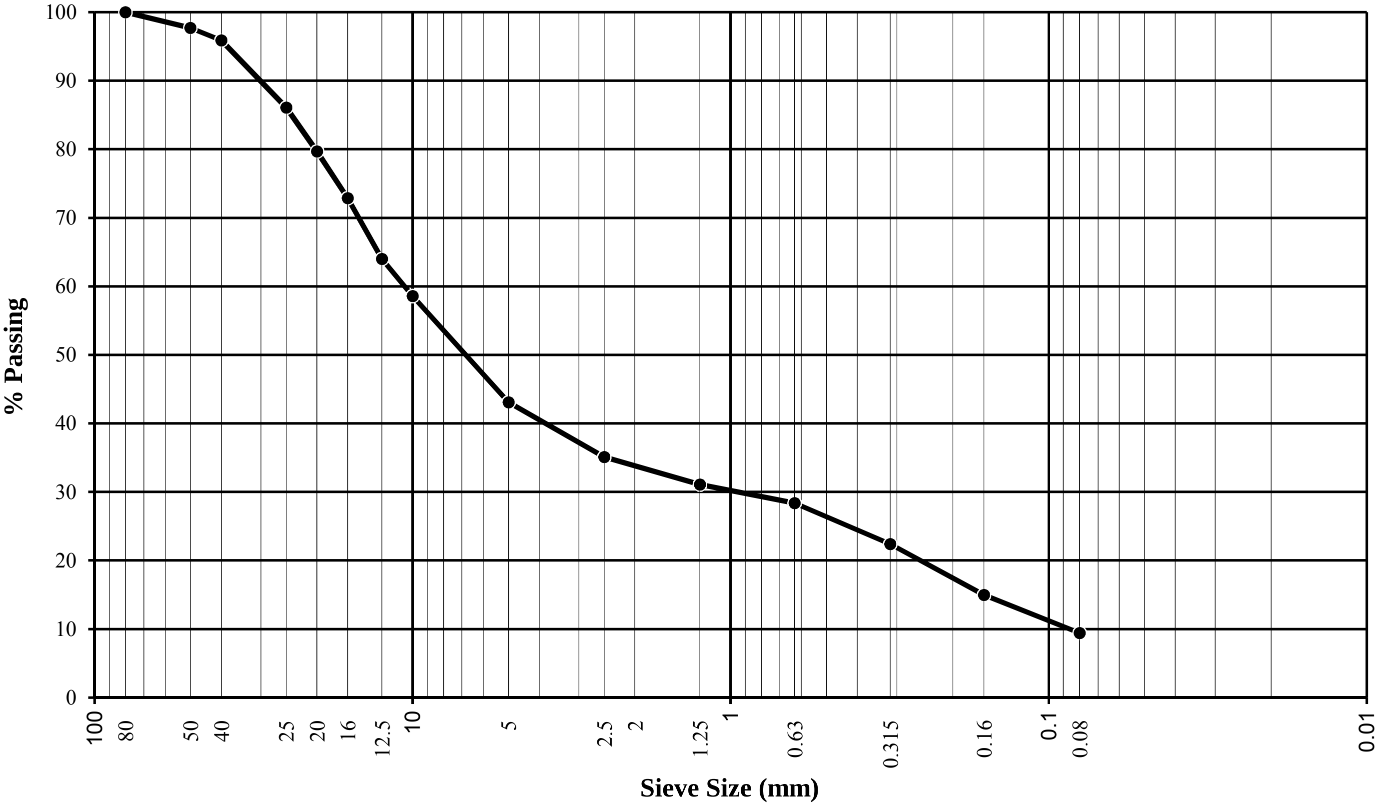
Comments

Gavel	56.9 %
Sand	33.7 %
Silt/Clay	9.4 %

TH 9

Depth 7 - 7.5m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	97.7		
40	95.9		
25	86.1		
20	79.7		
16	72.9		
12.5	64.0		
10	58.6		
5	43.1		
2.5	35.1		
1.25	31.1		
0.63	28.4		
0.315	22.4		
0.16	15.0		
0.08	9.4		



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Calgary, Alberta T2C 2H5
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Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No. 099-86-17
Date Sampled Aug 5/17 **By** AA
Date Received Aug 5/17 **By** AA
Date Tested Aug 14/17 **By** BM

Aggregate Type Sandy Gravel, trace silt/clay
Aggregate Source

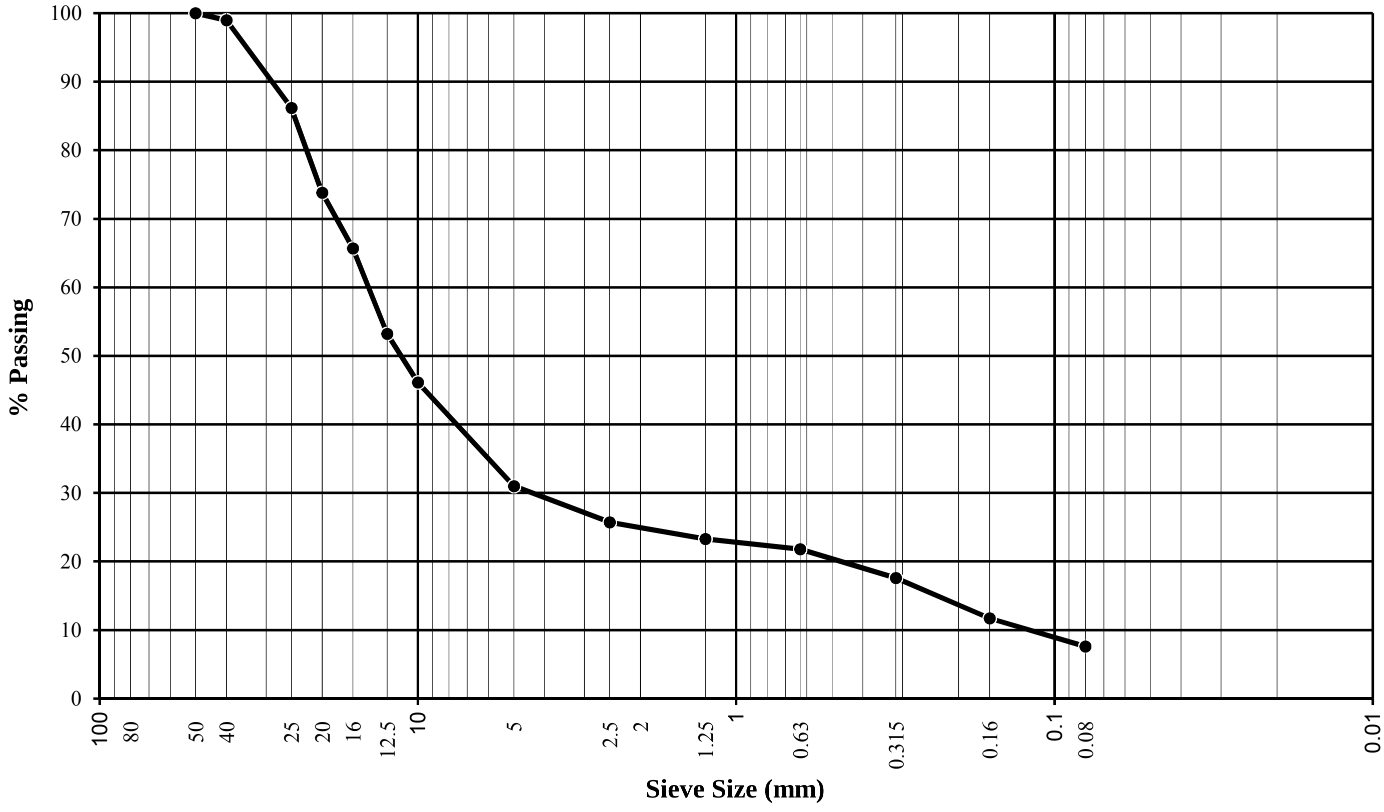
Classification GP
C_C= 10.8
C_U= 113.2

Specification

Comments
Gavel 69.0 %
Sand 23.4 %
Silt/Clay 7.6 %

TH 10
Depth 10 - 10.5m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80			
50	100.0		
40	99.0		
25	86.2		
20	73.8		
16	65.7		
12.5	53.2		
10	46.1		
5	31.0		
2.5	25.7		
1.25	23.3		
0.63	21.8		
0.315	17.6		
0.16	11.7		
0.08	7.6		



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Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No. 099-86-17
Date Sampled Aug 5/17 **By** AA
Date Received Aug 5/17 **By** AA
Date Tested Aug 15/17 **By** BM

Aggregate Type Silty Sand, some gravel/clay
Aggregate Source

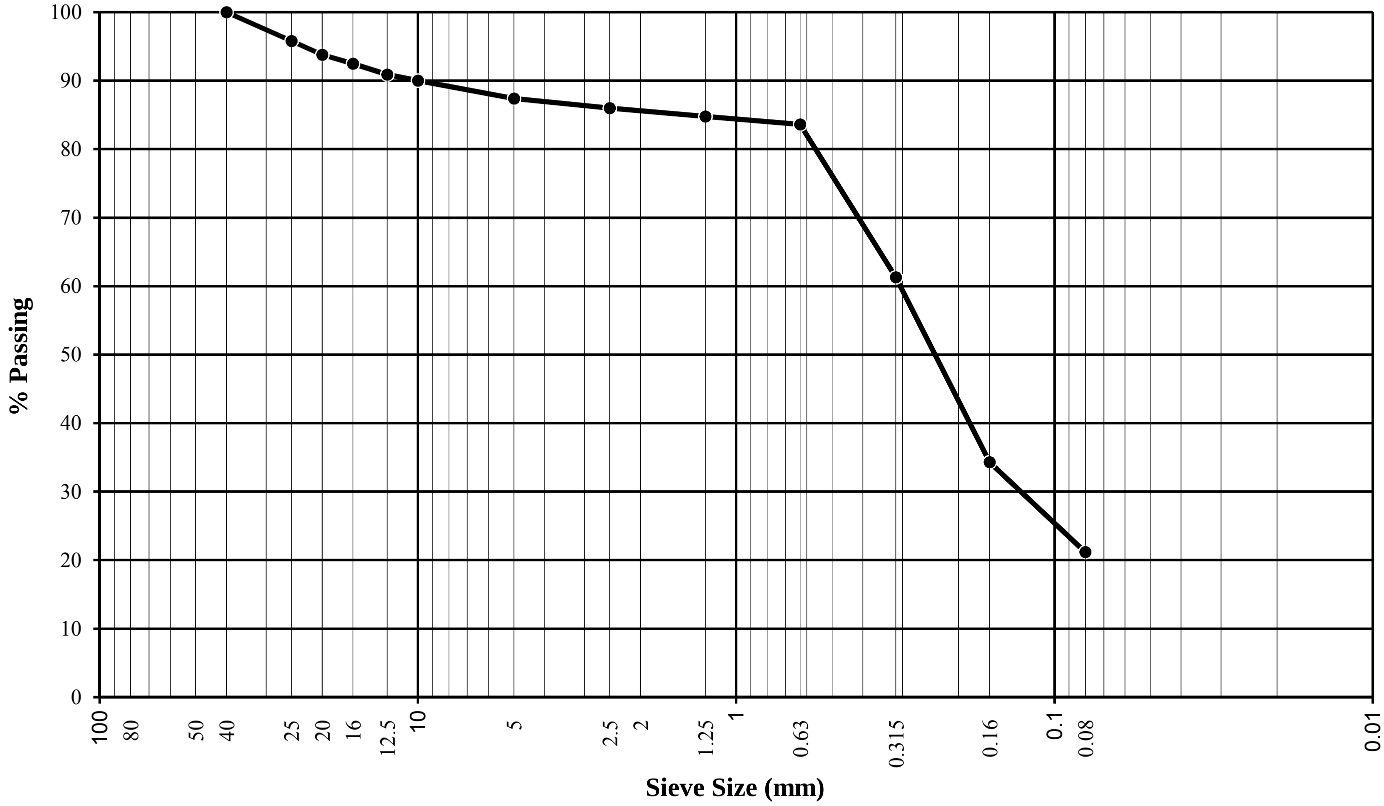
Classification SM or SC
C_C= 0.7
C_U= 3.8

Specification

Comments **Gavel** 12.6 %
Sand 66.2 %
Silt/Clay 21.2 %

TH 10
Depth 17.1 - 17.3m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80			
50			
40	100.0		
25	95.8		
20	93.8		
16	92.5		
12.5	90.9		
10	90.0		
5	87.4		
2.5	86.0		
1.25	84.8		
0.63	83.6		
0.315	61.3		
0.16	34.3		
0.08	21.2		



7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Grain Size Distribution

ASTM D-422

Project Summit Pit Ph 2
Client Mountain Ash Limited Partnership
Almor Job # 099-86-17
Date Recieved July 31/17
Date Tested Aug 7/17

Test Hole # TH1
Depth 9 - 11m
Technician JC

Soil Classification

Gravel	53.1%
Sand	33.9%
Silt	10.5%
Clay	2.5%

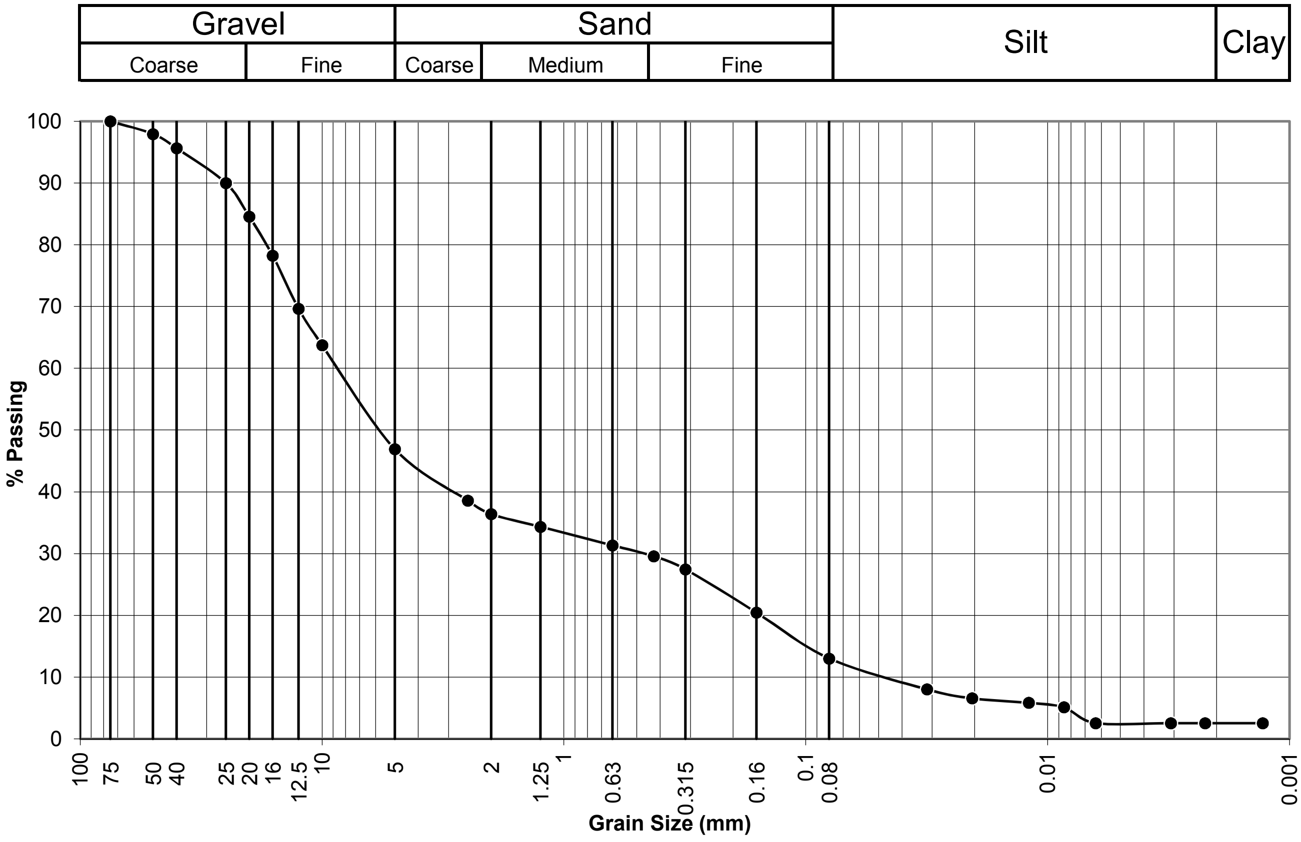
Soil Description Sandy GRAVEL, some silt, trace clay

Soil Properties

Natural Moisture Content		%
Liquid Limit		%
Plastic Limit		%
Plasticity Index		%
Specific Gravity	2.65	

Comments

Sieve Size (mm)	% Passing
150	
100	
80	100.0
50	97.9
40	95.7
25	90.0
20	84.6
10	63.8
5	46.9
2	36.4
0.425	29.6
0.080	13.0
0.005	2.5
0.002	2.5



7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 2/17	**By**	AA
Date Received	Aug 2/17	**By**	AA
Date Tested	Aug 12/17	**By**	BM

Aggregate Type Gravel, some sand, trace silt

Aggregate Source

Classification GP

C_C= 9.0

C_U= 80.6

Specification

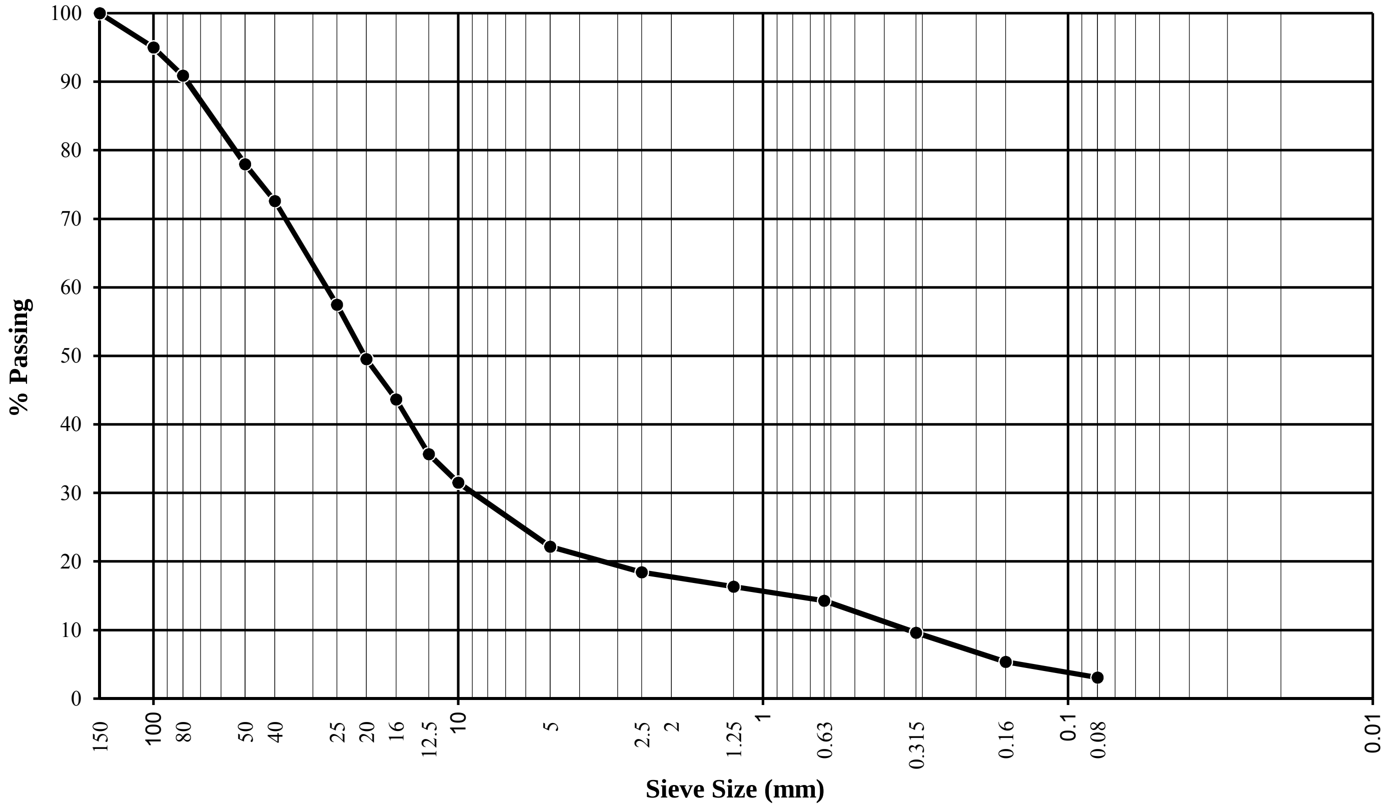
Comments

Gavel	77.8 %
Sand	19.1 %
Silt/Clay	3.1 %

TP 1

Depth 5 - 6m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150	100.0		
100	95.0		
80	90.9		
50	77.9		
40	72.6		
25	57.5		
20	49.5		
16	43.7		
12.5	35.7		
10	31.5		
5	22.2		
2.5	18.4		
1.25	16.3		
0.63	14.3		
0.315	9.6		
0.16	5.3		
0.08	3.1		



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Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No. 099-86-17
Date Sampled Aug 2/17 **By** AA
Date Received Aug 2/17 **By** AA
Date Tested Aug 14/17 **By** MTS

Aggregate Type Gravel, some sand, trace silt
Aggregate Source

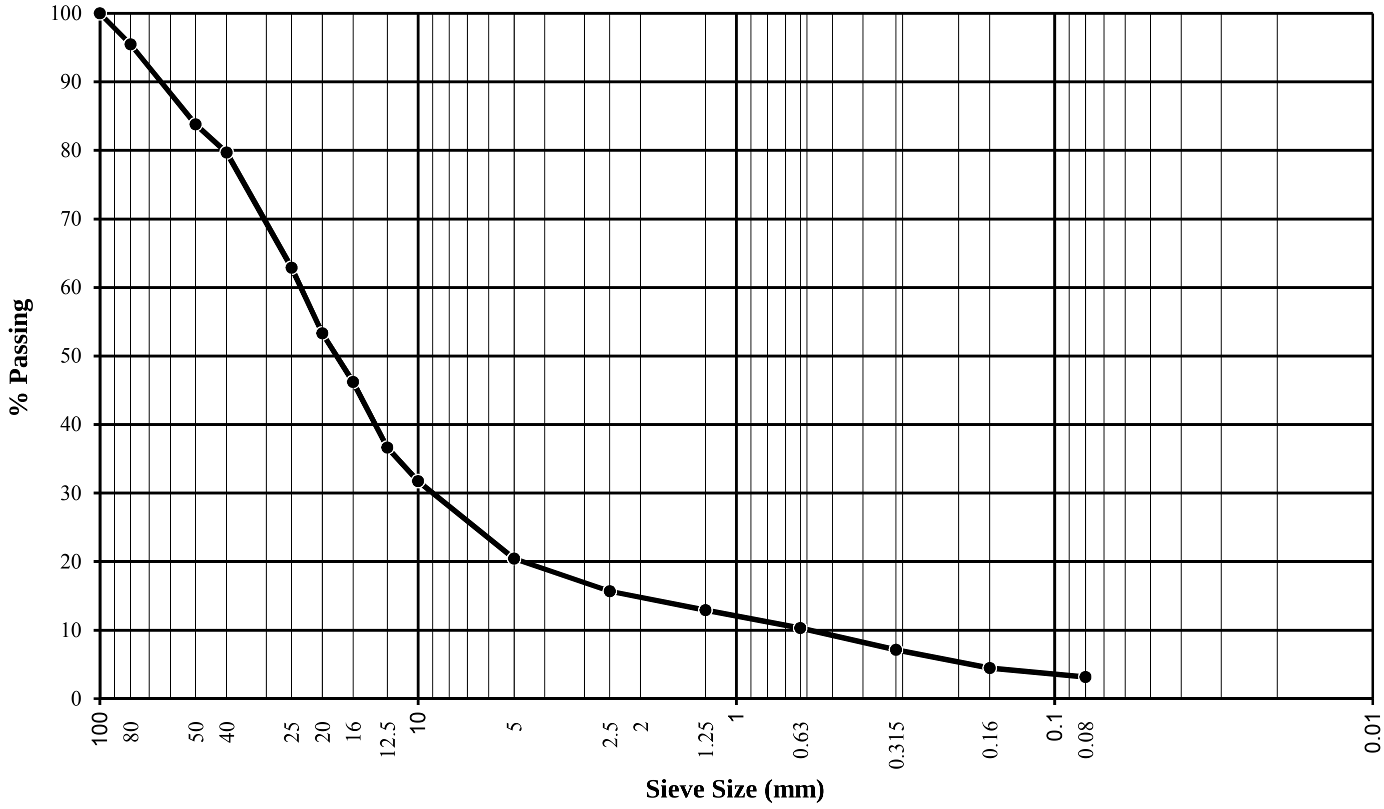
Classification GP
C_C= 6.0
C_U= 39.2

Specification

Comments
Gavel 79.6 %
Sand 17.3 %
Silt/Clay 3.2 %

TP 2
Depth 5 - 6m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100	100.0		
80	95.5		
50	83.8		
40	79.7		
25	62.9		
20	53.3		
16	46.2		
12.5	36.6		
10	31.8		
5	20.4		
2.5	15.7		
1.25	12.9		
0.63	10.3		
0.315	7.1		
0.16	4.5		
0.08	3.2		



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Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project Summit Pit Ph 2, Gravel Investigation

Job No.	099-86-17		
Date Sampled	Aug 2/17	**By**	AA
Date Received	Aug 2/17	**By**	AA
Date Tested	Aug 6/17	**By**	DK

Aggregate Type Gravel, some sand, trace silt

Aggregate Source

Classification GP
C_C= 18.0
C_U= 133.6

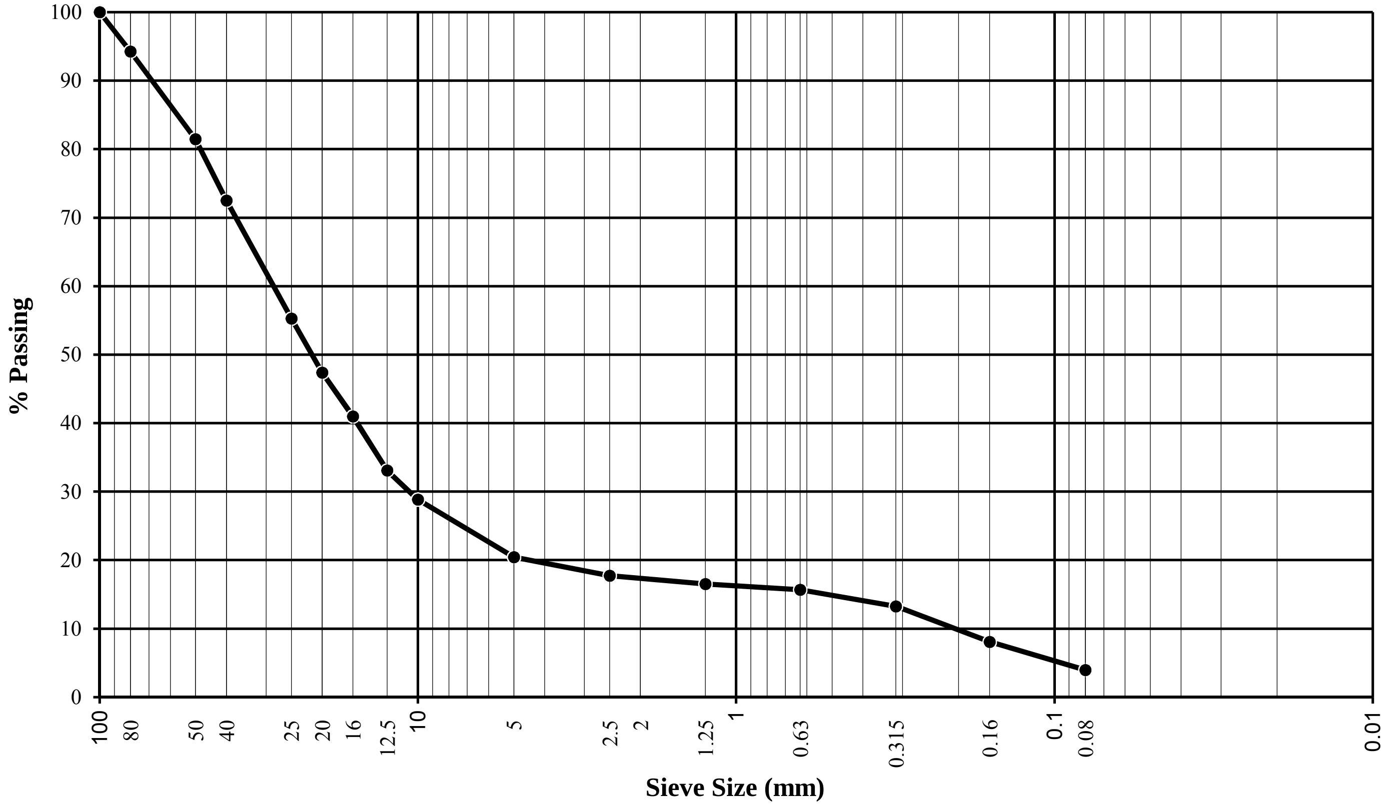
Specification

Comments

Gavel	79.6 %
Sand	16.5 %
Silt/Clay	4.0 %

TP 3
Depth 5.0 - 6.0m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100	100.0		
80	94.3		
50	81.5		
40	72.5		
25	55.3		
20	47.4		
16	41.0		
12.5	33.1		
10	28.8		
5	20.4		
2.5	17.8		
1.25	16.5		
0.63	15.7		
0.315	13.2		
0.16	8.1		
0.08	4.0		



APPENDIX C

GEO Curtis GEO Solutions Inc.

Aug 23, 2017
File: 317-Misc.

Almor Testing Services Ltd.
7505 - 40 Street SE
Calgary, AB T2C 2H5

Email: aalemi@almor.com

Attn: Abdul Alemi

Re: **LA Abrasion Testing (ASTM C - 131)**

Curtis Geo Solutions Inc. tested one (1) sample in accordance with ASTM C-131 Standard Test Method for resistance to degradation of small-size coarse aggregate by abrasion and impact in the Los Angeles machine. The sample was delivered to our office washed, graded (Gradation A) and dried. The sample was run through the test process and the results are tabulated below.

Sample ID	Mass Prior To Test (g)	Mass After Test (g)	Mass Loss Due to Test (g)	Percent Loss (%)
Summit Pit Ph. 2	5002.7	3385.2	1617.5	32.3

We trust that the above is sufficient for your requirements. Should you need further information, please call.

Yours very truly,

Curtis GEO Solutions Inc.

Michael Staple, B.Sc., P.Eng.
Geotechnical Engineer

MS/bd

GEO Curtis GEO Solutions Inc.

Aug 23, 2017
File: 317-Misc.

Almor Testing Services Ltd.
7505 - 40 Street SE
Calgary, AB T2C 2H5

Email: aalemi@almor.com

Attn: Abdul Alemi

Re: **LA Abrasion Testing (ASTM C - 535)**

Curtis Geo Solutions Inc. tested one (1) sample in accordance with ASTM C-535 Standard Test Method for resistance to degradation of Large-size coarse aggregate by abrasion and impact in the Los Angeles machine. The sample was delivered to our office washed, graded (Gradation 1) and dried. The sample was run through the test process and the results are tabulated below.

Sample ID	Mass Prior To Test (g)	Mass After Test (g)	Mass Loss Due to Test (g)	Percent Loss (%)
Summit Pit Ph. 2	10030.1	7735.6	2294.5	22.9

We trust that the above is sufficient for your requirements. Should you need further information, please call.

Yours very truly,

Curtis GEO Solutions Inc.

Michael Staple, B.Sc., P.Eng.
Geotechnical Engineer

MS/bd

APPENDIX D

Gravel/Sand Volume Calculations

As requested, we submit our gravel/sand calculations based on the limited test holes advanced to the depth of bedrock, with a Diesel Hammer Rig.

Per your request, we have combined the data obtained during the 2014 Waterman Gravel Pit Investigation and the data from the Summit Phase 2 Investigation.

Waterman Pit

Test Hole No.	Depth (m)
1	20.4
2	22.8
3	20.6
4	21.9
5	16.8
Average	20.5

Summit Phase 2

Test Hole No.	Depth (m)
1	18.5
2	14.2
3	14.0
4	21.5
5	9.3
6	10.5
7	19.1
8	22.6
9	23.0
10	22.6
Average	17.5

Combined Average = 18.5m

1 acre = ±4046.89 m^2

160 acres = 160 x 4046.89 m^2 = ±647502.4 m^2

Based on the test hole logs (Waterman Pit and Summit Phase 2), total volume of aggregate:

Total volume = Average Depth x Area
= 18.5 m x 647502.4 m^3
= 11,978,794.4 m^3

APPENDIX E

ALMOR
7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Grain Size Distribution

ASTM D-422

Project	Summit Pit Ph 2		**Test Hole #**	TH3
Client	Mountain Ash Limited Partnership		**Depth**	0.2m
Almor Job #	099-86-17		**Technician**	KC
Date Recieved	Aug 1/17			
Date Tested	Aug 4/17			

Soil Classification

Gravel	0.2%
Sand	11.8%
Silt	67.3%
Clay	20.7%

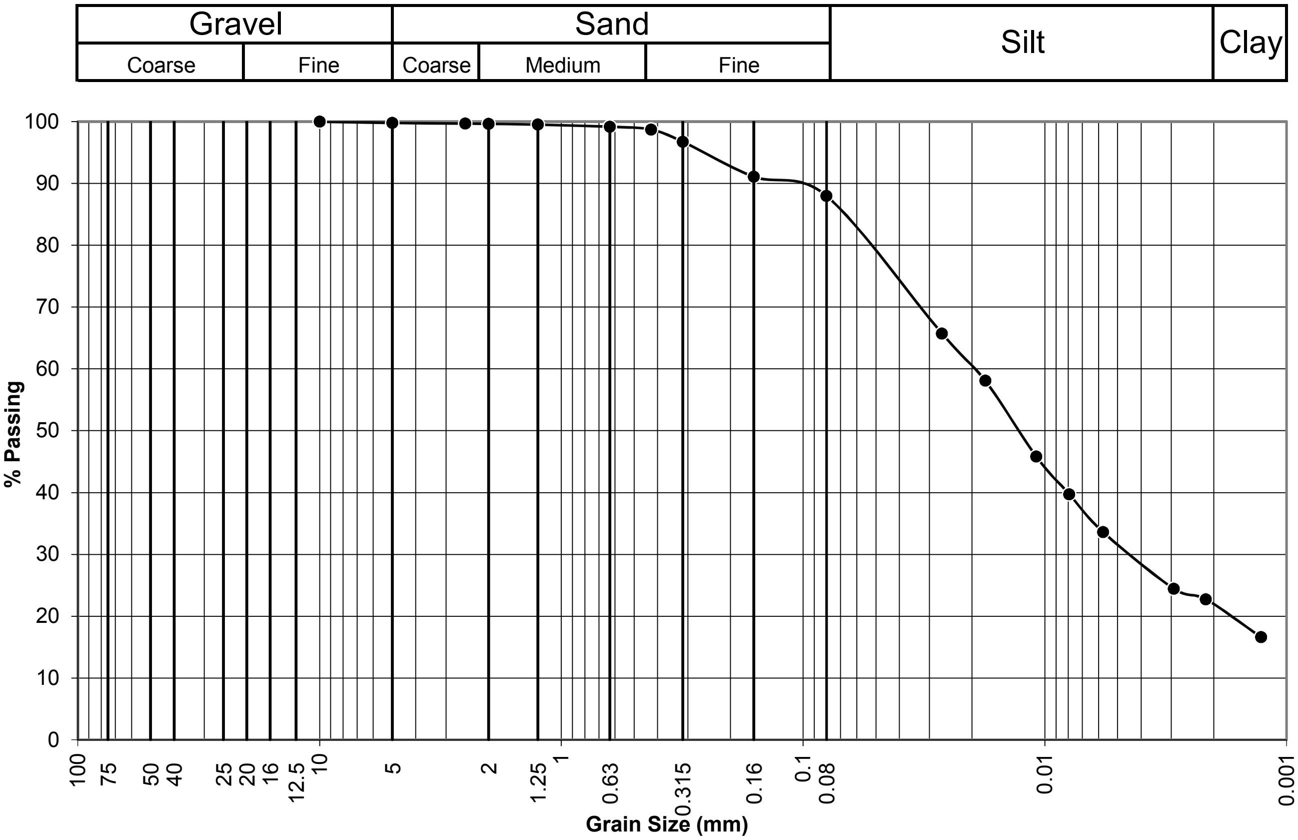
Soil Description Clayey SILT, some Sand, trace Gravel

Soil Properties

Natural Moisture Content	18.7	%
Liquid Limit		%
Plastic Limit		%
Plasticity Index		%
Specific Gravity	2.65	
Organic Content	12.6	%

Comments Topsoil - Grain Size Distribution

Sieve Size (mm)	% Passing
150	
100	
80	
50	
40	
25	
20	
10	100.0
5	99.8
2	99.6
0.425	98.7
0.080	88.0
0.005	31.2
0.002	20.7



ALMOR
7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Atterberg Limits Determination

ASTM D4318

CLIENT Mountain Ash Limited Partnership

DATE Sept 28/17

PROJECT Summit Pit Ph 2

JOB # 099-86-17

TESTHOLE TH1

DEPTH 4.5m

TECH. JKC

SAMPLE ID

DATE REC'D. Aug 1/17

SOIL DESCRIPTION

	LIQUID LIMIT				Wn	PLASTIC LIMIT	
Trial No.	1	2	3			1	2
Number of Blows	34	22	12				
Tare Number	AT-41	AT-42	AT-43		MF-96	AT-44	AT-45
Wet + Tare (g)	34.340	41.740	47.312		210.0	37.664	36.373
Dry + Tare (g)	29.370	34.661	38.440		199.8	35.178	34.125
Tare Weight (g)	15.039	15.213	15.661		3.8	15.278	15.669
Weight Dry Soil (g)	14.331	19.448	22.779		196.0	19.900	18.456
Weight Water (g)	4.970	7.079	8.872		10.2	2.486	2.248
Moisture Content (%)	34.7%	36.4%	38.9%		5.2%	12.5%	12.2%

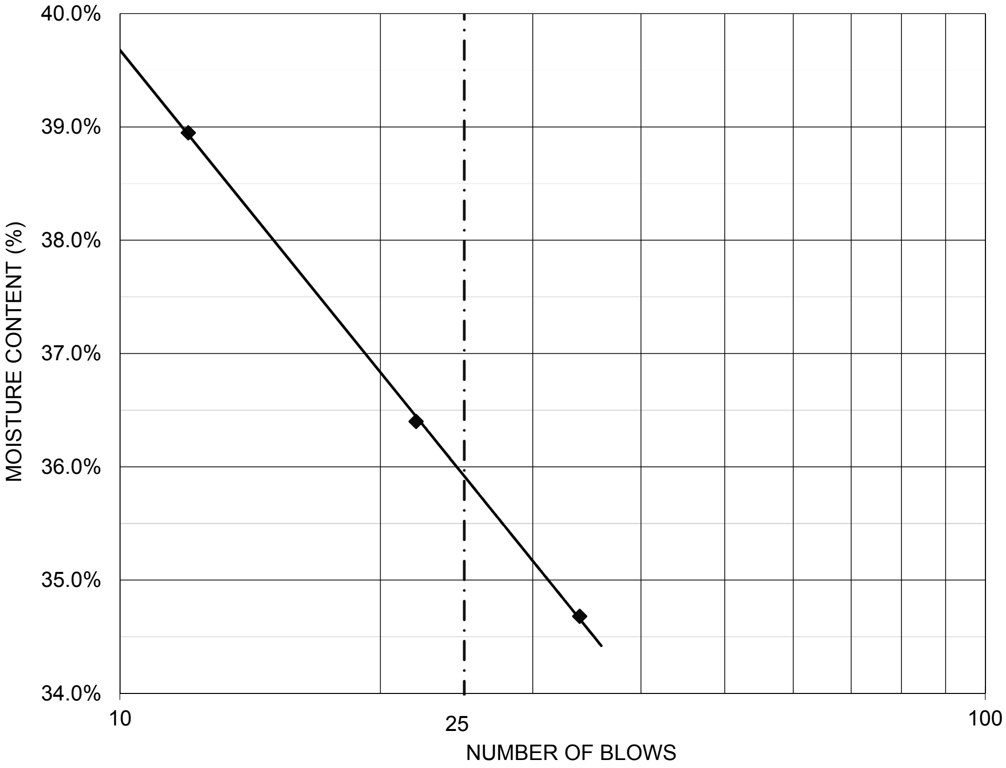
Natural Moisture Content (%) = 5.2

Liquid Limit (L_L) = 36

Plastic Limit (P_L) = 12

Plasticity Index (I_P) = 24

USC Soil Classification = **CI**



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Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Grain Size Distribution

ASTM D-422

Project Summit Pit Ph 2
Client Mountain Ash Limited Partnership
Almor Job # 099-86-17
Date Recieved Aug 1/17
Date Tested Aug 4/17

Test Hole # TH1
Depth 3.0m
Technician KC

Sieve Size (mm)	% Passing
150	
100	
80	
50	
40	100.0
25	90.8
20	88.3
10	83.8
5	79.2
2	74.7
0.425	66.8
0.080	56.9
0.005	34.1
0.002	25.7

Soil Classification

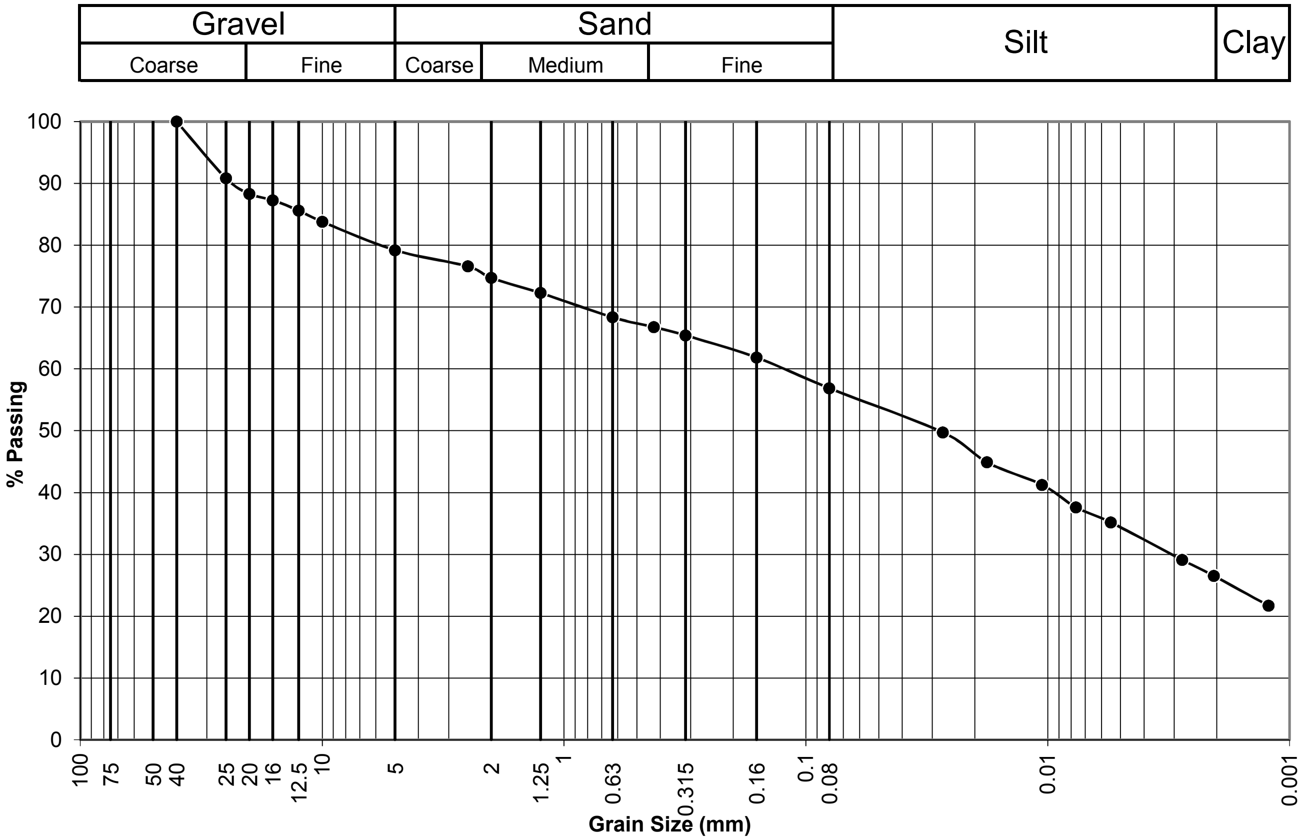
Gravel	20.8%
Sand	22.3%
Silt	31.2%
Clay	25.7%

Soil Description Sandy Clayey SILT, some gravel

Soil Properties

Natural Moisture Content	7.7	%
Liquid Limit		%
Plastic Limit		%
Plasticity Index		%
Specific Gravity	2.65	

Comments Silty Clay Till (Overburden) - Grain Size Distribution



ALMOR TESTING SERVICES LTD.

7505 - 40 STREET S.E., CALGARY, AB T2C 2H5 PHONE (403) 236-8880 · FAX (403) 236-1707

2017 12 28

099-144-17

Mountain Ash Limited Partnership

Attention: Mr. Tige Brady, C.E.T. *(tige.brady@telus.net)*

Re: Gravel Pit Investigation
John Nugter Property
Highway 567 and Range Road 40
Rocky View County, Alberta

Almor Testing Services Ltd. observed and obtained gravel samples, during the advancement of six (6) test holes, at the subject site from August 8 to August 12, 2017. Test holes designated as JN01 through JN06 were advanced mostly to the north and northeast of the SW 1/4, Section 31, Township Road 26, Range Road 3, W5M. The test holes were advanced using a Becker Hammer drill rig, operated by Great West Drilling of Calgary, Alberta. Refer to Figure 1 in Appendix 'A' for the approximate test hole locations.

Test hole depths ranged from a minimum of 7.6m (JN06) to a maximum of 28.6m (JN04). The thickness of the granular deposit in the test holes ranged from a minimum 7.1m (JN03) to a maximum 24.2m (JN04). The mean average thickness of the granular deposit encountered is 20.2m and groundwater seepage was not encountered in the test holes. This value does not include the data from Test Hole JN06, as no gravel was encountered in this test hole.

Samples were obtained for gradation analysis, representative of the granular deposit encountered below the silty clay overburden. Four (4) Gradation Analyses were performed on samples from Test Hole No.'s JN01 through JN04. The Test Hole logs and the results of the Gradation Analyses are attached in Appendix 'B'. The Gradation Analyses of the samples indicated fines contents (material passing the 80 µm sieve size) in the range of 9.8% to 16.4%.

The fines content of the gravel samples obtained using a Becker Hammer drill rig is typically higher, due to the crushing or fracture of the rocks during pounding of the hammer casing into the gravels. A fines content to a maximum of 10% is generally considered desirable for gravels used for structural purposes (roads construction, foundation base, etc.). Aggregates for use in the manufacture of concrete and asphalt products typically have more stringent fines content requirements. In order to estimate the insitu fine content of gravel at the site, two (2) test pits were advanced in close proximity of Test Hole No.'s 2 and 3 and gravel samples were obtained. The Test Pit logs and the results of the Gradation Analyses of the test pit samples are attached in Appendix 'C'. Table 1 compares the fine content of gravel samples obtained using the Becker Hammer drill rig and from the test pits.

.../2

TABLE 1
Fine Content Comparison of Gravel Samples
Becker Hammer Drilling vs Test Pits

TP/TH No.	Depth (m)	Fines Content (%)
TP01	4.5 - 5.25	5.8
JN02	5.5	16.2
TP02	4.5 - 5.25	7.9
JN03	4.9 - 5.5	9.8

Table 1 indicates the fines content of the samples obtained using Becker Hammer drill rig is almost 1.3 to 3 times higher than those obtained from test pits. It is anticipated that the granular material recovered, during a commercial mining operation would yield lower fines contents than what is indicated by the samples recovered, during this investigation using a hammer rig.

Overall, the aggregates and gradation of the gravels at the test hole locations are suitable for producing aggregates required in the construction industry, with some sorting and blending sand seams.

The volume of the gravel has been estimated based on the limited bore holes advanced and is presented in Appendix 'D'.

The overburden in the subject areas consisted of topsoil/browns overlying silty clay till.

The topsoil/browns were encountered in all test hole locations and ranged from 100 to 300mm in thickness.

Below topsoil/browns, silty clay till was encountered in all test hole locations. The thickness of silty clay overburden ranged from 3500mm (JN05) to 7500mm (JN06). The thickness of the overburden at the test hole JN06 location may be more, as drilling was terminated at a depth of 7.5m. The overburden soil was described as silty clay till of low to medium plasticity.

The silty clay and topsoil overburden can be utilized for grading, during the pit rehabilitation stages of the gravel pit.

We trust this meets with your present requirements.

Respectfully submitted,
ALMOR TESTING SERVICES LTD.

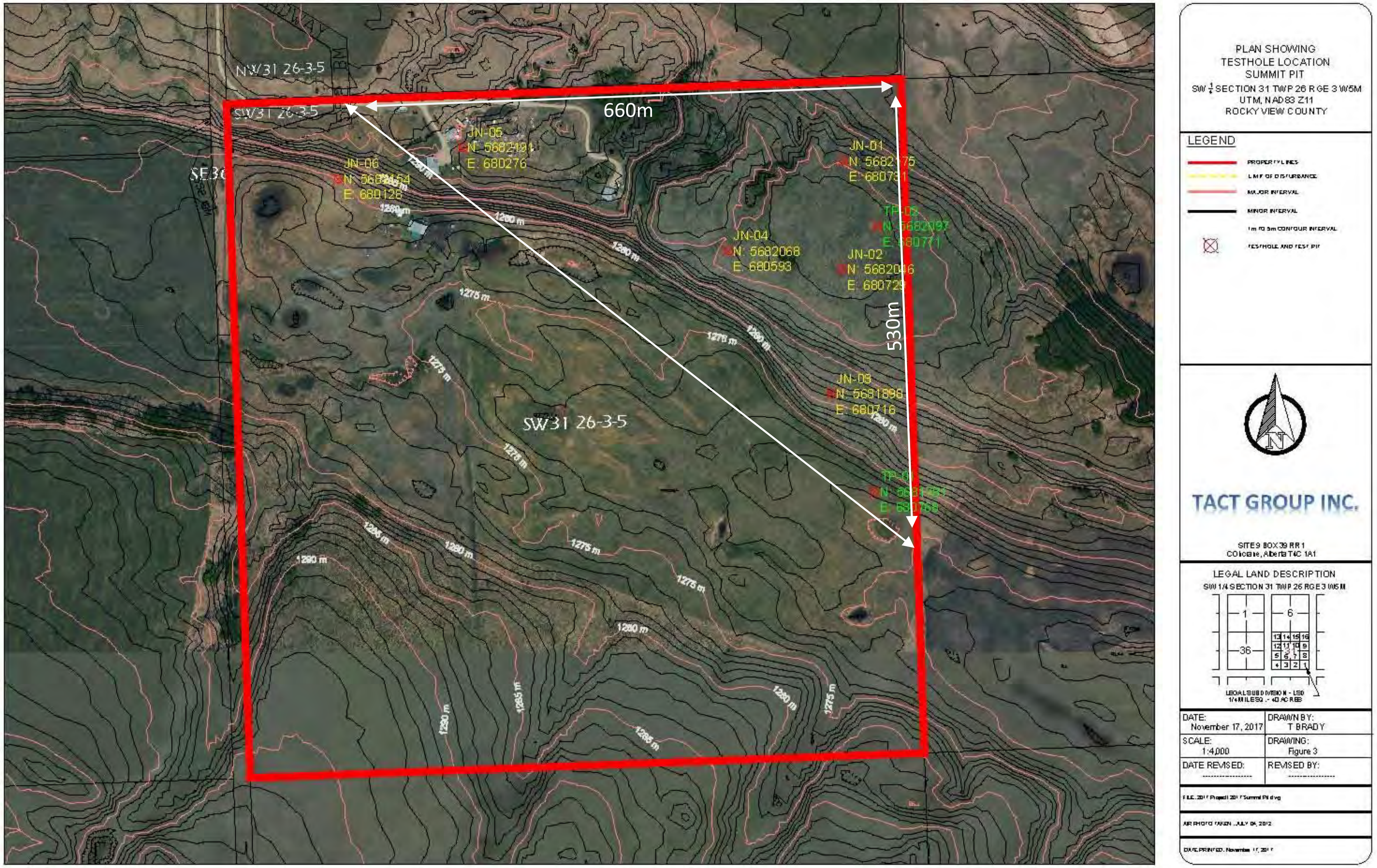
J.B. MONTGOMERY

* APEGA Permit to Practice #P2260

J.B. Montgomery, P.Eng.
AA:ms:A06268

Attachments

APPENDIX A



PLAN SHOWING
TESTHOLE LOCATION
SUMMIT PIT
SW $\frac{1}{4}$ SECTION 31 TWP 26 RGE 3 W5M
UTM, NAD83 Z11
ROCKY VIEW COUNTY

LEGEND

- PROPERTY LINES
- LIMIT OF DISTURBANCE
- MAJOR INTERVAL
- MINOR INTERVAL
- 1m TO 5m CONTOUR INTERVAL
- ☒ TESTHOLE AND TEST PIT

TACT GROUP INC.

SITE 9 BOX 39 RR 1
Cochrane, Alberta T4C 1A1

LEGAL LAND DESCRIPTION
SW 1/4 SECTION 31 TWP 26 RGE 3 W5M

LEGAL SUBDIVISION - LSD
1/4 MILE SQ. - 40 ACRES

DATE: November 17, 2017	DRAWN BY: T BRADY
SCALE: 1:4,000	DRAWING: Figure 3
DATE REVISED: -----------------	REVISED BY: ----------------

FILE: 2017 Project 2017 Summit Pit.dwg

AIR PHOTO TAKEN: JULY 04, 2012

DATE PRINTED: November 17, 2017

Figure 1

APPENDIX B

PROJECT:	GRAVEL PIT ASSESSMENT JOHN NUGTER PROPERTY	PROJECT NO.	
		HOLE NO.	JN01
CLIENT:	MOUNTAIN ASH LIMITED PARTNERSHIP	DRILL TYPE	DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m) | SOIL DESCRIPTION | DEPTH (ft) | SAMPLE TYPE | MOD UNIFIED SOIL CLASS | WATER CONTENT (%) ● PLASTIC LIMIT LIQUID LIMIT 20 40 60 | COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400 | OTHER TESTS

TOPSOIL

Silty CLAY (TILL) stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist

Gravelly SAND compact, trace to some silt, fine grained, poorly graded, olive, damp

Silty GRAVEL compact to dense, some sand to sandy, fine to coarse grained, poorly graded, brown, damp

- occasional medium to high plastic clay lens below 20.0 m

SILTSTONE (BEDROCK)

END OF TEST HOLE AT 26.6m

- no standpipe installed
- test hole dry at completion
- test hole backfilled with soil cuttings

OTHER TESTS:

Gravel 57.1 %
Sand 26.5 %
Silt & Clay 16.4 %

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100 102 104 106

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m^3 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ⧅ BT Pen

GROUNDWATER
Date Measured

COMPLETION DEPTH	27 m	DATE DRILLED	August 8, 2017
LOGGED BY	Kevin Carter	PLATE NO.	11

PROJECT: GRAVEL PIT ASSESSMENT
JOHN NUGTER PROPERTY

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

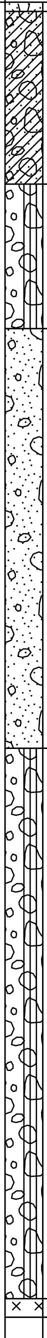
HOLE NO. JN02

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)		SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT LIQUID LIMIT 20 40 60	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS



TOPSOIL

Silty CLAY (TILL) stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist

Sandy GRAVEL compact to dense, trace to some silt, fine to coarse grained, poorly graded, olive, damp

Gravel 47.4 %
Sand 36.4 %
Silt & Clay 16.2 %

Gravelly SAND compact, trace to some silt, fine grained, poorly graded, olive, damp

- some gravel below 15.0 m

Silty GRAVEL compact to dense, some sand to sandy, fine to coarse grained, poorly graded, brown, damp

- occasional medium to high plastic clay lens below 20.5 m

SILTSTONE (BEDROCK)

END OF TEST HOLE AT 27.8m
- no standpipe installed
- test hole dry at completion
- test hole backfilled with soil cuttings

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100 102 104 106

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
Date Measured

COMPLETION DEPTH 28.5 m

DATE DRILLED August 8, 2017

LOGGED BY Kevin Carter

PLATE NO. 12

PROJECT: GRAVEL PIT ASSESSMENT
JOHN NUGTER PROPERTY

PROJECT NO.

HOLE NO. JN03

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT LIQUID LIMIT 20 40 60	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
	TOPSOIL						
1 2 3 4	**Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist	2 4 6 8 10 12 14					
5 6 7 8 9 10 11	**Silty GRAVEL** compact to dense, some sand to sandy, fine to coarse grained, poorly graded, brown, damp - occasional medium to high plastic clay lens below 6.0 m	16 18 20 22 24 26 28 30 32 34 36					Gravel 58.6 % Sand 31.6 % Silt & Clay 9.8 %
12	**MUDSTONE (BEDROCK)**	38 40 42					
13 14	**END OF TEST HOLE AT 12.8m** - no standpipe installed - test hole dry at completion - test hole backfilled with soil cuttings	44 46 48					

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 12.8 m

DATE DRILLED August 10, 2017

LOGGED BY Kevin Carter

PLATE NO. 13

PROJECT: GRAVEL PIT ASSESSMENT
JOHN NUGTER PROPERTY

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

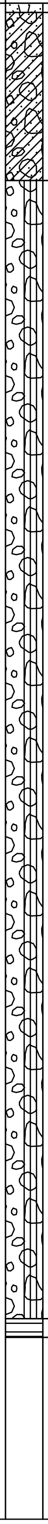
HOLE NO. JN04

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT 20 40 60 LIQUID LIMIT	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
0–4	**TOPSOIL** **Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist						
4–28.6	**Sandy GRAVEL** compact to dense, trace to some silt, fine to coarse grained, poorly graded, brown, damp						Gravel 56.6 % Sand 33.2 % Silt & Clay 10.2 %
24	- occasional medium to high plastic clay lens below 24.0 m - becoming silty						
28.6	**MUDSTONE (BEDROCK)** **END OF TEST HOLE AT 28.6m** - no standpipe installed - test hole dry at completion - test hole backfilled with soil cuttings						



DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

DEPTH (ft): 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100 102 104 106

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
Date Measured

COMPLETION DEPTH 28.8 m

DATE DRILLED August 11, 2017

LOGGED BY Kevin Carter

PLATE NO. 14

PROJECT: GRAVEL PIT ASSESSMENT
JOHN NUGTER PROPERTY

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

HOLE NO. JN05

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)	SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT ├──┤ LIQUID LIMIT 20 40 60	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
0–0.2	**TOPSOIL**						
0.2–3.5	**Silty CLAY (TILL)** stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist						
3.5–7.9	**Sandy GRAVEL** compact to dense, trace to some silt, fine to coarse grained, poorly graded, brown, damp - occasional fine to coarse grained sand lens below 6.8 m						
7.9–10.1	**Gravelly SAND** compact, trace to some silt, fine grained, poorly graded, olive, damp - trace to some gravel below 8.5 m - some gravel below 9.8 m						
10.1–27.6	**Sandy GRAVEL** compact to dense, trace to some silt, fine to coarse grained, poorly graded, brown, damp - occasional medium to high plastic clay lens below 26.0 m						
27.6–28.0	**SILTSTONE (BEDROCK)**						
28.0	**END OF TEST HOLE AT 28.0m** - no standpipe installed - test hole dry at completion - test hole backfilled with soil cuttings						

DEPTH (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32

DEPTH (ft): 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106

ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
▼ Date Measured

COMPLETION DEPTH 28.2 m

DATE DRILLED August 11, 2017

LOGGED BY Kevin Carter

PLATE NO. 15

PROJECT: GRAVEL PIT ASSESSMENT
JOHN NUGTER PROPERTY

CLIENT: MOUNTAIN ASH LIMITED PARTNERSHIP

PROJECT NO.

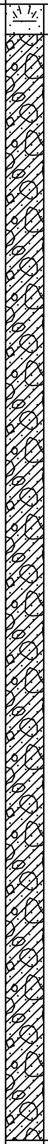
HOLE NO. JN06

DRILL TYPE DIESEL HAMMER RIG

GEODETIC ELEVATION (m)

DATUM

DEPTH (m)		SOIL DESCRIPTION	DEPTH (ft)	SAMPLE TYPE	MOD UNIFIED SOIL CLASS	WATER CONTENT (%) ● PLASTIC LIMIT ├── LIQUID LIMIT 20 40 60	COMPRESSIVE STRENGTH Unconfined ▲ Pocket Pen △ TSF 2 3 4 5 KPa 200 300 400	OTHER TESTS
		TOPSOIL						
		Silty CLAY (TILL) stiff to very stiff, low to medium plastic, trace to some sand, trace gravel, olive, damp to moist						
			2					
1			4					
2			6					
			8					
3			10					
			12					
4			14					
5			16					
			18					
6			20					
			22					
7			24					
		END OF TEST HOLE AT 7.5m - no standpipe installed - test hole dry at completion - test hole backfilled with soil cuttings						
8			26					
			28					
9			30					
			32					



ALMOR TESTING SERVICES LTD.

TEST HOLE LOG

KN/m³ 16 18 20 22
PCF 100 120 140
WET UNIT WEIGHT ○

20 40 60
PENETRATION RESISTANCE ■
☐ SPT ◪ Case
■ Cone ◩ BT Pen

GROUNDWATER
Date Measured

COMPLETION DEPTH 7.5 m

DATE DRILLED August 12, 2017

LOGGED BY Kevin Carter

PLATE NO. 16

7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project John Nugter Property, Gravel Investigation

Job No.	099-144-17		
Date Sampled	Aug 8/17	**By**	KC
Date Received	Aug 8/17	**By**	KC
Date Tested	Aug 16/17	**By**	BM

Aggregate Type Sandy GRAVEL, some silt/clay

Aggregate Source

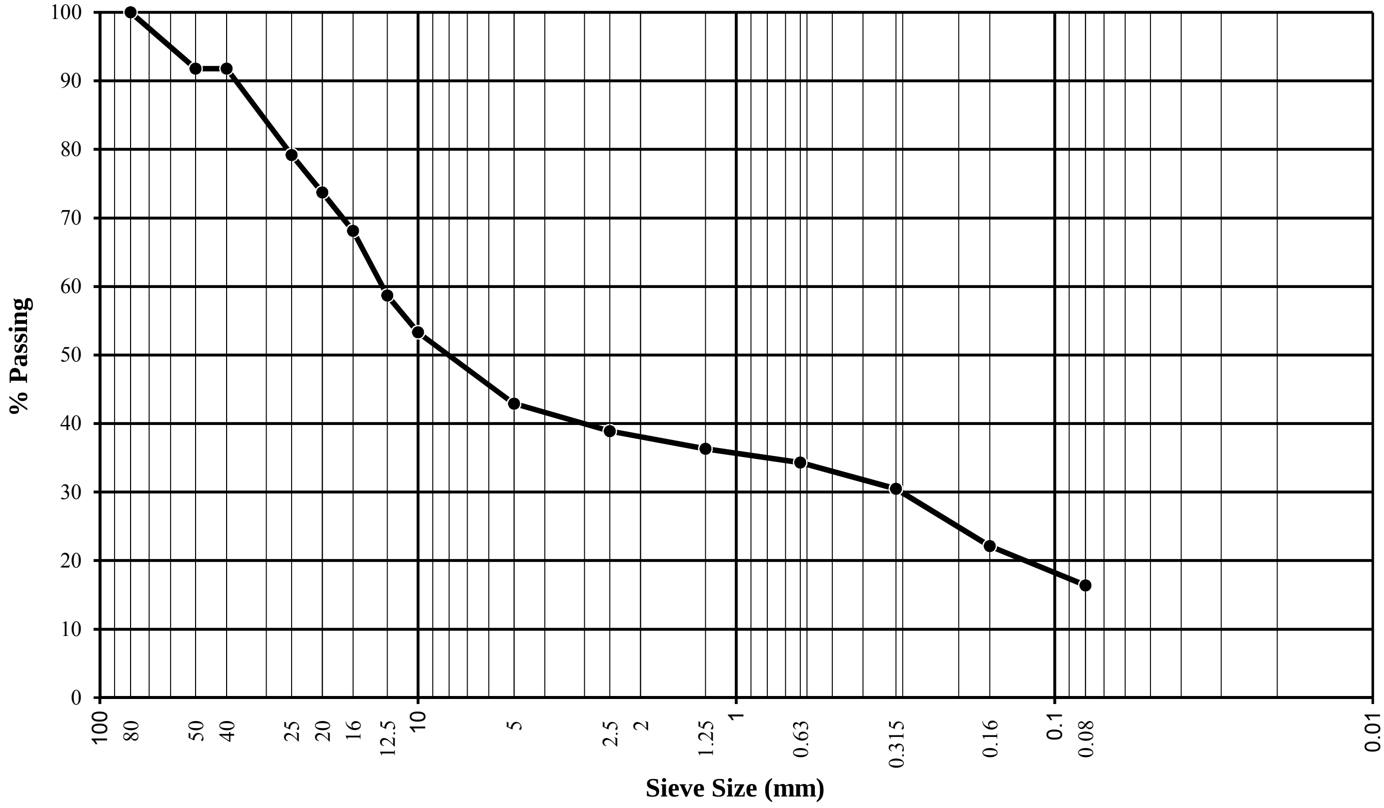
Classification GM or GC
C_C= 0.1
C_U= 162.3

Specification

Comments

Gavel	57.1 %
Sand	26.5 %
Silt/Clay	16.4 %
TH	JN01
Depth	20.5m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	91.8		
40	91.8		
25	79.2		
20	73.7		
16	68.1		
12.5	58.7		
10	53.3		
5	42.9		
2.5	38.9		
1.25	36.3		
0.63	34.3		
0.315	30.5		
0.16	22.1		
0.08	16.4		



7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project John Nugter Property, Gravel Investigation

Job No.	099-144-17		
Date Sampled	Aug 8/17	**By**	KC
Date Received	Aug 8/17	**By**	KC
Date Tested	Aug 16/17	**By**	BM

Aggregate Type Sandy GRAVEL, some silt/clay

Aggregate Source

Sieve Size	Percent Passing by Weight		
(mm)		Min.	Max.
200			
150			
100			
80			
50	100.0		
40	96.6		
25	85.5		
20	80.3		
16	75.6		
12.5	69.0		
10	64.5		
5	52.6		
2.5	45.5		
1.25	41.0		
0.63	37.6		
0.315	32.7		
0.16	24.5		
0.08	16.2		

Classification GM or GC

C_C= 0.1

C_U= 101.3

Specification

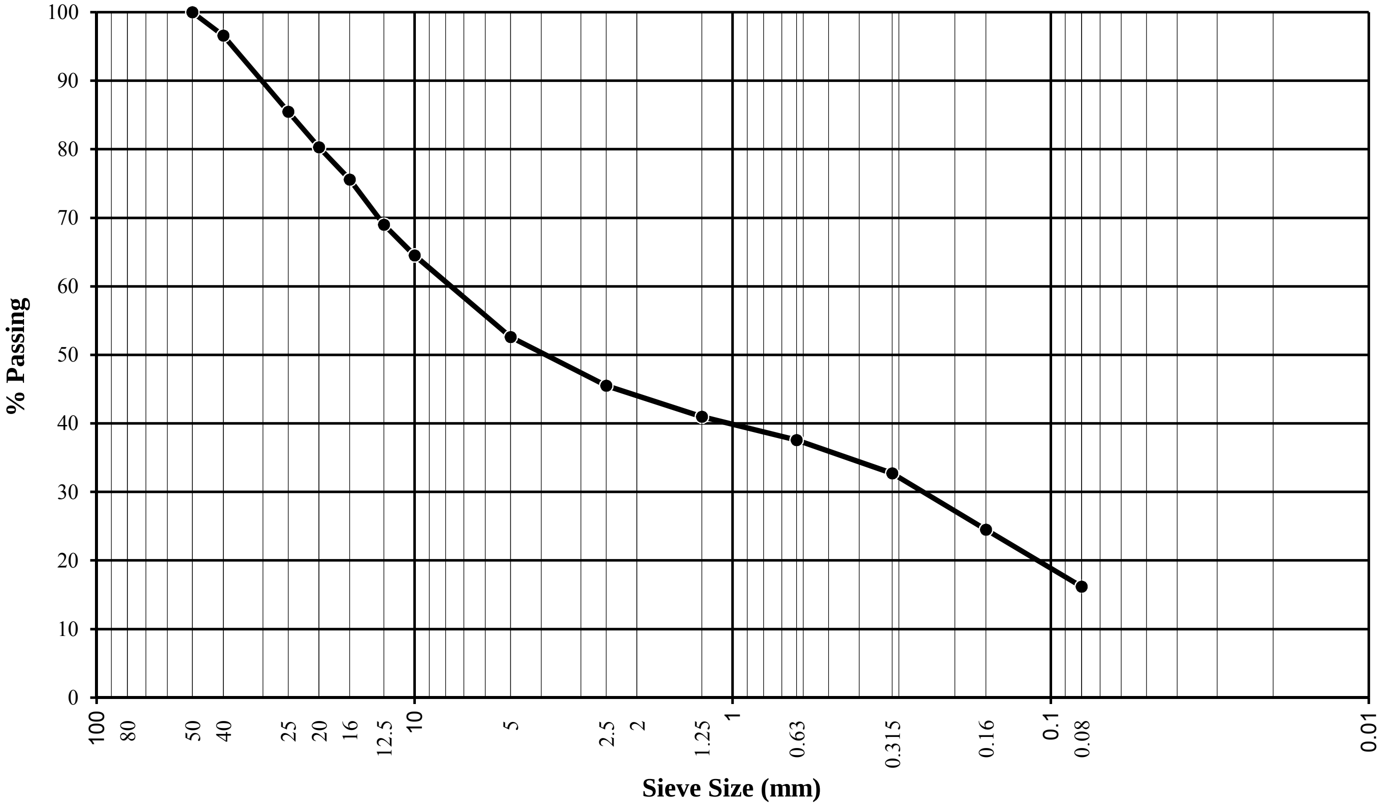
Comments

Gavel	47.4 %
Sand	36.4 %
Silt/Clay	16.2 %

TH JN02

Depth 5.5m

Compare to TP Sample



7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project John Nugter Property, Gravel Investigation

Job No. 099-144-17
Date Sampled Aug 10/17 **By** KC
Date Received Aug 10/17 **By** KC
Date Tested Aug 12/17 **By** BM

Aggregate Type Sandy GRAVEL trace silt/clay
Aggregate Source

Classification GW-GM
C_C= 2.3
C_U= 144.6

Specification

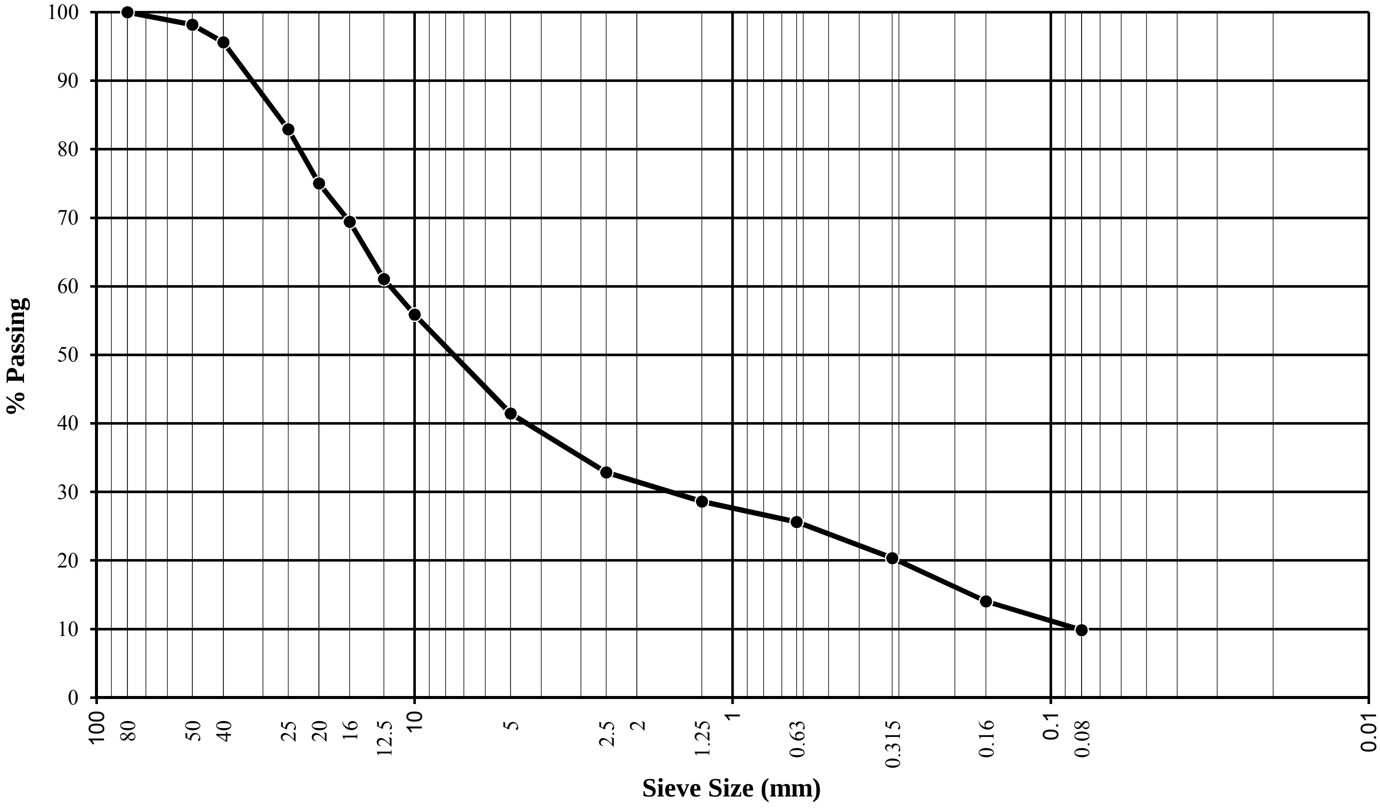
Comments

Gavel	58.6	%
Sand	31.6	%
Silt/Clay	9.8	%

TH JN03
Depth 4.9 to 5.5m

Compare to TP Sample

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	98.2		
40	95.6		
25	82.9		
20	75.0		
16	69.4		
12.5	61.1		
10	55.9		
5	41.4		
2.5	32.8		
1.25	28.6		
0.63	25.6		
0.315	20.4		
0.16	14.0		
0.08	9.8		



ALMOR
7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project John Nugter Property, Gravel Investigation

Job No. 099-144-17
Date Sampled Aug 11/17 **By** KC
Date Received Aug 11/17 **By** KC
Date Tested Aug 12/17 **By** BM

Aggregate Type Sandy GRAVEL some silt/clay
Aggregate Source

Classification GW-GM
C_C= 0.6
C_U= 141.1

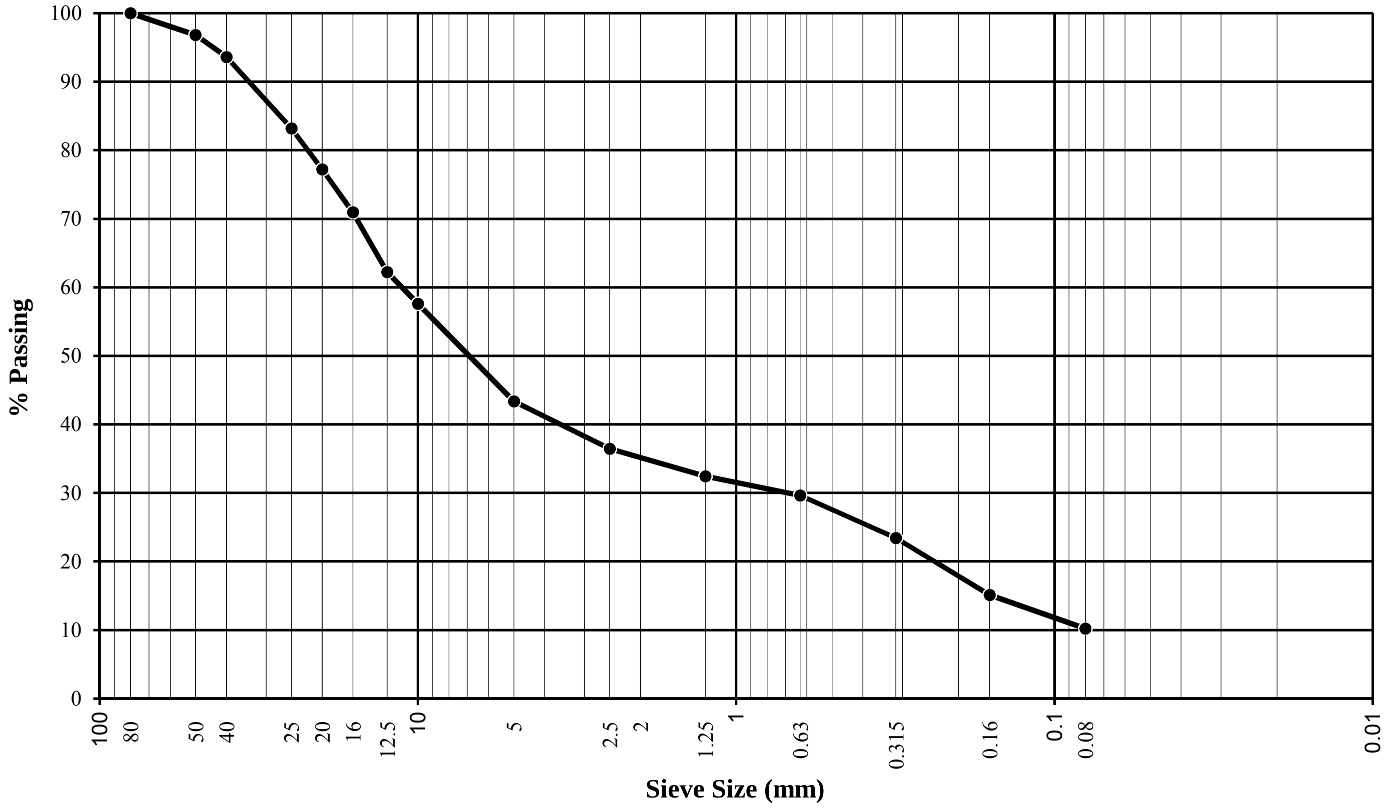
Specification

Comments

Gavel	56.6	%
Sand	33.2	%
Silt/Clay	10.2	%

TH JN04
Depth 18.0m

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100			
80	100.0		
50	96.8		
40	93.6		
25	83.2		
20	77.2		
16	71.0		
12.5	62.2		
10	57.6		
5	43.4		
2.5	36.5		
1.25	32.4		
0.63	29.6		
0.315	23.4		
0.16	15.1		
0.08	10.2		



APPENDIX C

ALMOR

7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project John Nugter Property, Gravel Investigation

Job No.	099-144-17		
Date Sampled	Aug 6/17	**By**	KC
Date Received	Aug 6/17	**By**	KC
Date Tested	Aug 12/17	**By**	BM

Aggregate Type Sandy GRAVEL trace silt/clay

Aggregate Source

Classification GP

C_C= 10.9

C_U= 185.5

Specification

Comments

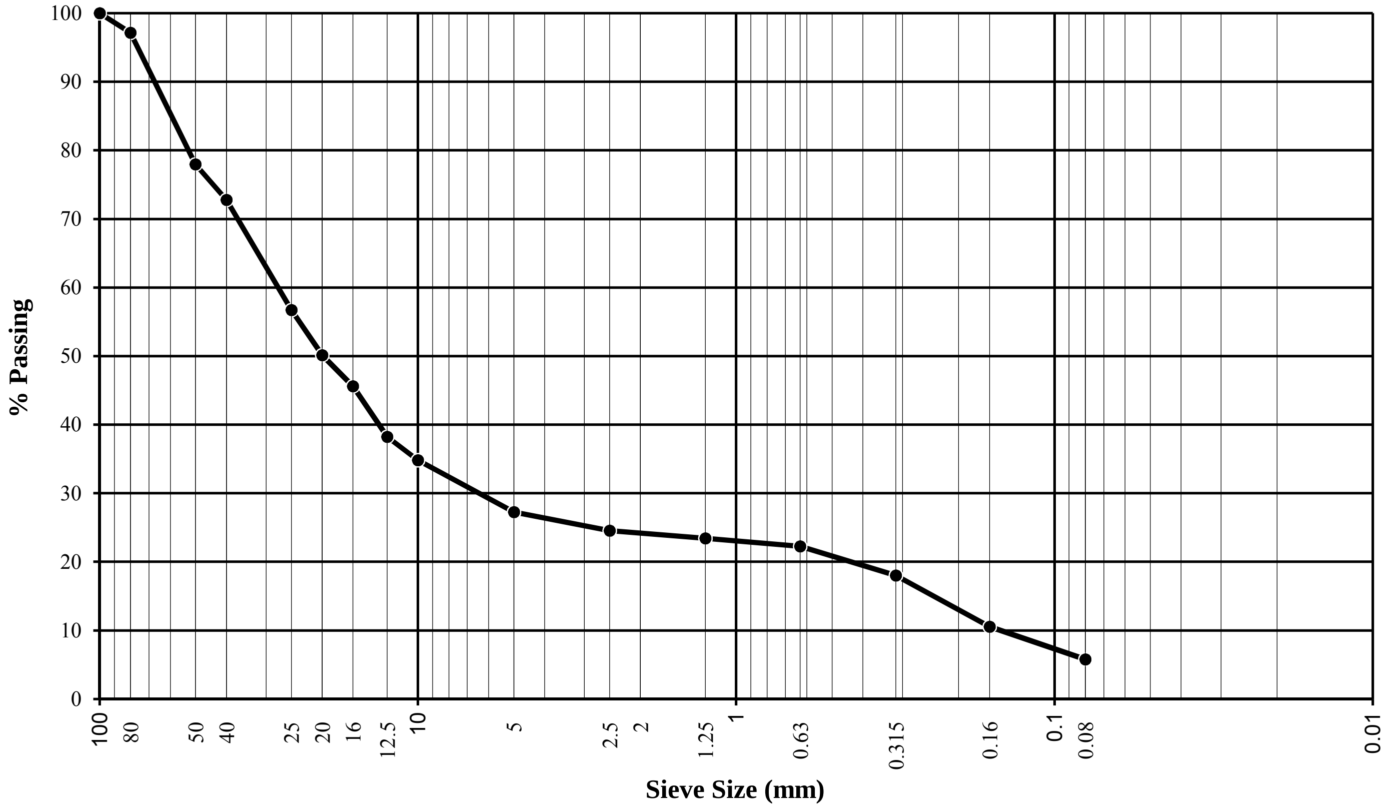
Gavel	72.7	%
Sand	21.5	%
Silt/Clay	5.8	%

TP adj to JN02

Depth 4.5 to 5.25m

Compare to TH JN02 Sample

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100	100.0		
80	97.2		
50	78.0		
40	72.8		
25	56.7		
20	50.1		
16	45.6		
12.5	38.2		
10	34.8		
5	27.3		
2.5	24.5		
1.25	23.4		
0.63	22.3		
0.315	18.0		
0.16	10.5		
0.08	5.8		



7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Mountain Ash Limited Partnership

Attention Tige Brady

Project John Nugter Property, Gravel Investigation

Job No. 099-144-17
Date Sampled Aug 6/17 **By** KC
Date Received Aug 6/17 **By** KC
Date Tested Aug 12/17 **By** BM

Aggregate Type Sandy GRAVEL trace silt/clay
Aggregate Source

Classification GP
C_C= 13.4
C_U= 203.9

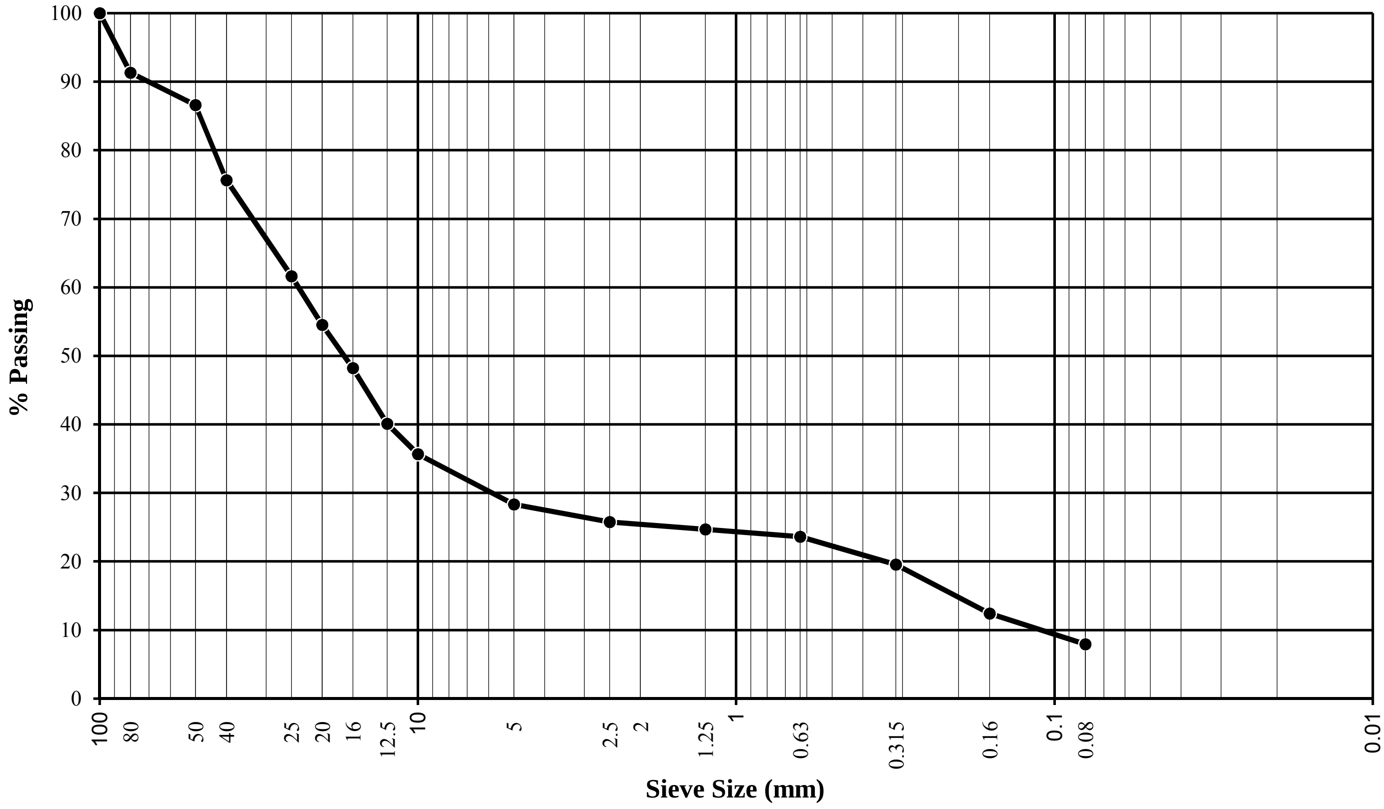
Specification

Comments
Gavel 71.6 %
Sand 20.4 %
Silt/Clay 7.9 %

TP adj to JN03
Depth 4.5 to 5.25m

Compare to TH JN03 Sample

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
200			
150			
100	100.0		
80	91.3		
50	86.6		
40	75.7		
25	61.6		
20	54.5		
16	48.2		
12.5	40.1		
10	35.7		
5	28.4		
2.5	25.8		
1.25	24.7		
0.63	23.6		
0.315	19.6		
0.16	12.4		
0.08	7.9		



APPENDIX D

Estimated Sand/Gravel Volumes

As requested, we submit our sand/gravel calculations for the above noted project, based on the limited test holes advanced to the depth of bedrock, with a Diesel Hammer Rig.

Please refer to the site plan indicating the triangular shaped area used for the sand/gravel volume calculations.

Based on the logs, the thickness of sand/gravel in the test holes are as follows:

JN01 - 22.1m
JN02 - 23.8m
JN03 - 7.1m
JN04 - 24.2m
JN05 - 24.0m

The average depth of sand/gravel is 20.2m

The area of triangle is :

Base of triangle = 660m
Height of triangle = 530m
Total area of triangle = ½ x Base x Height
= ½ x 800m x 490m
= 174,900 m^2

The estimated volume of aggregate is:

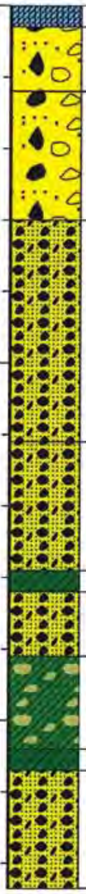
Average Depth x Area = Total Volume (m^3)
20.2m x 174,900 m^2 = 353,2980 m^3

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-06*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,650.0
EASTING: 680,079.0
ELEVATION: 1,294.0
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-26-18*
DATE COMPLETED: *06-26-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4*
EST. WL (m): *21.9m*



Depth (m)	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
0	0.3	topsoil			1	1	0
	0.9	silty till					
	1.8	clay till, stiff			2	2	
5	3.0	sandy gravel, medium to fine sand thin clayey seam @ 5.6m	28.5	16.9	3 4	3 4	5
	1.8	sandy gravel, medium to fine sand	31.6	22	5	5	
	0.3	clay seam, moist	25.5	18.4			
	0.9	silty gravel, fine sand, dry	31.9	12.5	6	6	
10	1.2	gravel, clay, fine sand, moist	28.1	24.7	7	7	10
	0.3	clay seam					
	2.1	gravel, fine to medium sand, silty, poorly graded consolidated thin silt seams.	30.6	19.1	8	8	

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-06*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,650.0
EASTING: 680,079.0
ELEVATION: 1,294.0
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-26-18*
DATE COMPLETED: *06-26-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4*
EST. WL (m): *21.9m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Depth (m)
	🟨	1.8	gravel, fine to medium sand, silty, poorly graded consolidated thin silt seams. 	29.7	17.5	
15	🟩	0.6	gravel, clay, fine sand, moist	33.7	11.4	15
		0.9	lost core, wet, likely saturated			
	🟩	0.6	clay, gravel	21.7	11.7	
	🟨	1.5	gravel, silt, fine sand, cobbles, poorly graded dry	24.3	19.8	
	🟨	1.2	gravel, silt/clay, fine sand, wet	22.4	19.5	
20	🟨	1.8	gravel, silt, fine sand, cobbles, poorly graded dry	18.5	25.8	20
	🟩	3.7	clay with sand and gravel, wet	25.8	17.6	

Sample Run	Picture #
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-06*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,650.0
EASTING: 680,079.0
ELEVATION: 1,294.0
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-26-18*
DATE COMPLETED: *06-26-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4*
EST. WL (m): *21.9m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
25	🟩	2.4	siltstone			17	17	25
						18	18	

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-07*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,664.0
EASTING: 680,393.0
ELEVATION: 1,287.8
TOTAL DEPTH: *19.8m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-26-18*
DATE COMPLETED: *06-26-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *19.8m*
EST. WL (m): *15.2m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
0	🟨	2.1	silty till, unconsolidated, tan			1	1	0
5	🟨	4.0	clay till, very stiff, hard, brown			2 3 4	2 3 4	5
	🟨	3.0	gravel, silty, poorly graded fine sand, some cobble, tan consolidated thin silt seams	37.2	19.3	5 6	5 6	
10	🟩	1.8	gravel, clay, fine sand, brown, wet	21.2	23.2	7	7	10
	🟨	1.2	gravel, silty, poorly graded fine sand, some cobble, tan dry	21.9	24.6	8	8	
	🟩		gravel, silt and clay, clay-rich seams	[illegible]	[illegible]			

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: CALGARY
COUNTY: ROCKY VIEW
PROVINCE: ALBERTA
LOCATION: MOUNTAIN ASH
LOGGED BY: D.B.

BORING ID: MA-18-07
COORD. SYS: WGS84 - UTM ZONE 11N
RIG: B.L. - Track Mounted
NORTHING: 5,682,664.0
EASTING: 680,393.0
ELEVATION: 1,287.8
TOTAL DEPTH: 19.8m

DRILL METHOD: SONIC
DATE STARTED: 06-26-18
DATE COMPLETED: 06-26-18
TYPE SAMPLE: 4.0" CORE
CASED TO: 19.8m
EST. WL (m): 15.2m

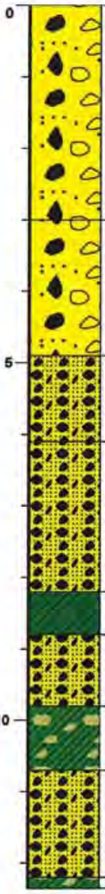
Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
	🟩	1.5	gravel, silt and clay, clay-rich seams wet			9	9	
15	🟨	1.5	gravel, silty, poorly graded fine sand, some cobble - increasing with depth, tan dry, getting wet near the bottom of run	30.3	24.1	10	10	15
	🟨	3.0	gravel, silt and clay, fine sand, medium sand seam (>150mm) @ 16.5m wet	11.7	47.3	11 12	11 12	
	🟩	0.6	siltstone			13	13	
	🟨	0.6	sand and gravel, wet					
	🟩	0.3	siltstone / claystone					

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-08*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,628.0
EASTING: 680,724.0
ELEVATION: 1,292.1
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-28-18*
DATE COMPLETED: *06-28-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *21.3m*



Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
0		3.0	silty till			1 2	1 2	0
		1.8	clay till, stiff, hard			3	3	
5		1.2	sandy gravel, fine to medium sand, moderately graded, brown	44.9	16	4	4	5
		2.1	gravel, fine sand, brown, wet	28.1	35.1	5	5	
		0.6	clay, some gravel	25.9	7.7	6	6	
		0.9	gravel, silt, fine sand, poorly graded, tan to brown dry,	37.9	14.7			
10		0.9	gravel, clay/silt, cobbles, brown wet	30.6	25.5	7	7	10
		1.5	sandy gravel, fine to medium sand, moderately graded, brown dry	48.8	12.3	8	8	
			gravel, clay/silt, cobbles, brown	[illegible]	[illegible]			

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-08*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,628.0
EASTING: 680,724.0
ELEVATION: 1,292.1
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-28-18*
DATE COMPLETED: *06-28-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *21.3m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
	▨	1.2	gravel, clay/silt, cobbles, brown wet			9	9	
15	▦	1.8	gravel, silt, fine sand, consolidated, dry	31	15.5	10	10	15
	▨	1.8	gravel, fine sand, clay, some cobble wet to saturated	27.7	24.6	11	11	
	▦	1.2	gravel, silt, fine sand, poorly graded dry	31.6	19.6	12	12	
	▨	1.2	clayey sand and gravel, cobbles, wet	20.8	23.2	13	13	
20	▦	1.8	gravel, silt, fine sand, some cobble, consolidated, damp	35	23.8	14	14	20
	▦	3.4	gravel, silty, fine sand, saturated	26.4	39.9	15 16	15 16	

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-08*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,628.0
EASTING: 680,724.0
ELEVATION: 1,292.1
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-28-18*
DATE COMPLETED: *06-28-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *21.3m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
25	🟩	2.7	claystone			17	17	25
						18	18	

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-11*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,281.0
EASTING: 680,070.0
ELEVATION: 1,294.0
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-25-18*
DATE COMPLETED: *06-25-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *24.4m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
0	🟩	1.5	dry silt, becoming hard and consolidated			1	1	0
	🟨	2.4	clay till, hard, stiff			2 3	2 3	
5	🟨	2.1	sandy gravel, moderately to poorly graded sand / silt dry	34.1	23.2	4	4	5
	🟨	1.5	gravel, fine sand and silt, cobbles saturated from 6.7m to 7.6m, thin (<100mm) clay lense at bottom	28.2	24.9	5	5	
10	🟨	2.4	sandy gravel, moderately graded, some coarse sand dry	27.6	14.2	6 7	6 7	10
	🟨	0.6	sand, fine to medium, with silt, trace gravel consolidated, dry	1	0			
	🟨	0.9	gravel ,silt, clay seam at 11.6m saturated	42.6	20	8	8	
	🟨	0.6	sandy gravel, moderately graded, some coarse sand damp, use 25-33' as reference sample					
	🟩		clay, with sand and gravel, sticky	35.2	16.1			

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-11*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,281.0
EASTING: 680,070.0
ELEVATION: 1,294.0
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-25-18*
DATE COMPLETED: *06-25-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *24.4m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
	🟩	1.5	clay, with sand and gravel. sticky			9	9	
	🟨	1.5	gravel, silty to sandy, damp at bottom	34.4	18	10	10	
15	🟩	1.8	gravel, higher clay content, damp	27.6	17.6	11	11	15
	🟨	3.0	gravel, sand, silt consolidated	23.3 25.2	24.4 17.6	12 13	12 13	
20	🟨	1.2	gravel, silt, sand, clay seams (<100mm thick)			14	14	20
	🟨	3.0	coarse gravel, some sand, silt, poorly graded consolidated, dry	20.3	22.3	15 16	15 16	
	🟩		gravel, clay, sand	28.6	26.5			

SAND & GRAVEL EXPLORATION LOG

PROPERTY:
PLANT: *CALGARY*
COUNTY: *ROCKY VIEW*
PROVINCE: *ALBERTA*
LOCATION: *MOUNTAIN ASH*
LOGGED BY: *D.B.*

BORING ID: *MA-18-11*
COORD. SYS: *WGS84 - UTM ZONE 11N*
RIG: *B.L. - Track Mounted*
NORTHING: 5,682,281.0
EASTING: 680,070.0
ELEVATION: 1,294.0
TOTAL DEPTH: *27.4m*

DRILL METHOD: *SONIC*
DATE STARTED: *06-25-18*
DATE COMPLETED: *06-25-18*
TYPE SAMPLE: *4.0" CORE*
CASED TO: *27.4m*
EST. WL (m): *24.4m*

Depth (m)	Lithology	Thickness (m)	MATERIAL DESCRIPTION	Gravel %	Oversize	Sample Run	Picture #	Depth (m)
25	▨	1.2	wet			17	17	25
	🟩	1.8	siltstone			18	18	

APPENDIX B
SLR Consulting Ltd – Monitoring Well Construction Logs

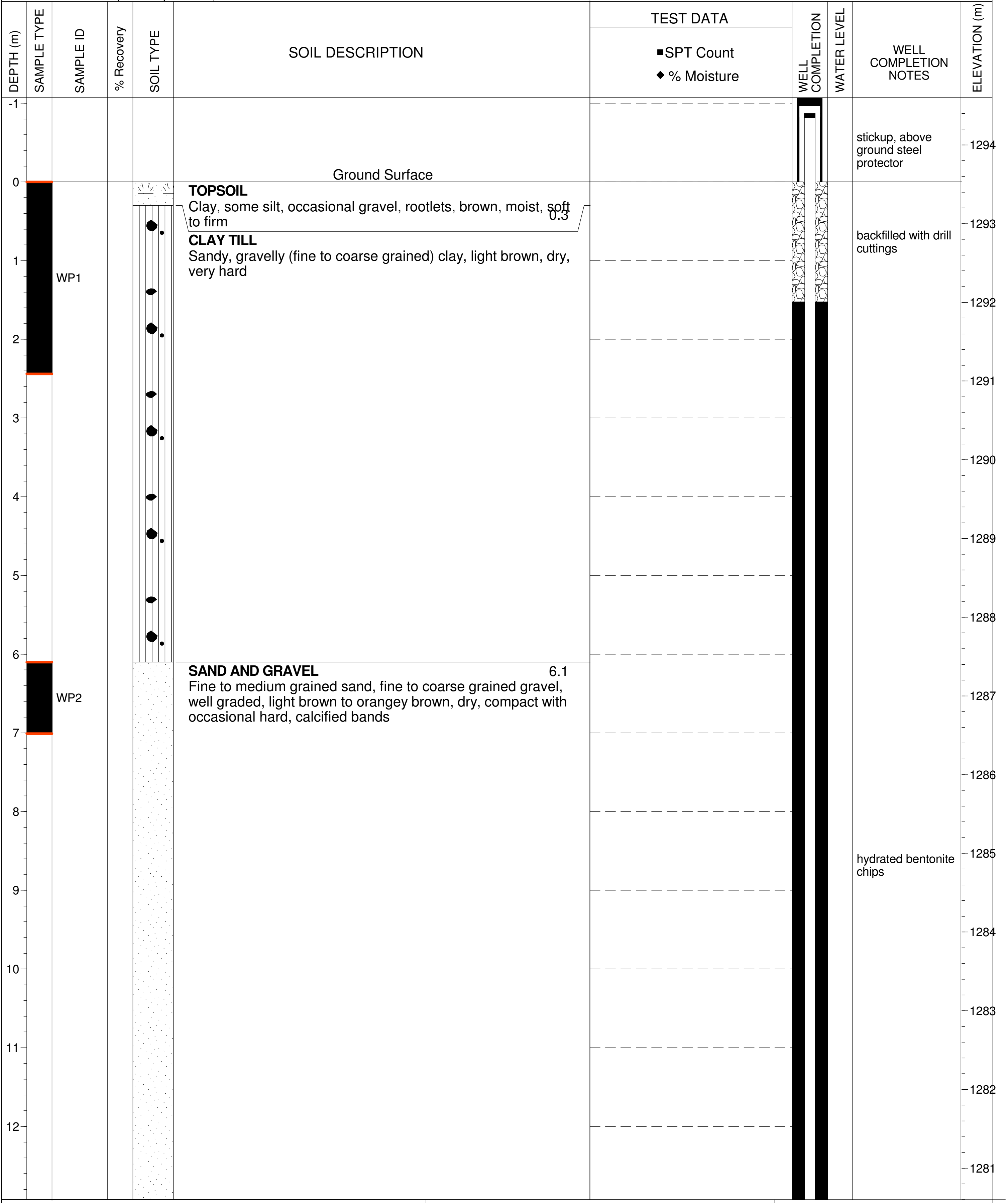
Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-101
SURFACE ELEVATION: 1293.53 m
UTM COORDINATES
5682869 N
680066.4 E



Ground Surface

TOPSOIL
Clay, some silt, occasional gravel, rootlets, brown, moist, soft to firm 0.3

CLAY TILL
Sandy, gravelly (fine to coarse grained) clay, light brown, dry, very hard

SAND AND GRAVEL 6.1
Fine to medium grained sand, fine to coarse grained gravel, well graded, light brown to orangey brown, dry, compact with occasional hard, calcified bands

stickup, above ground steel protector

backfilled with drill cuttings

hydrated bentonite chips

DRILLING METHOD: Becker Hammer

DRILL DATE: 30 September 2014 LOGGED BY: RT

Notes: ■ GRAB SAMPLE

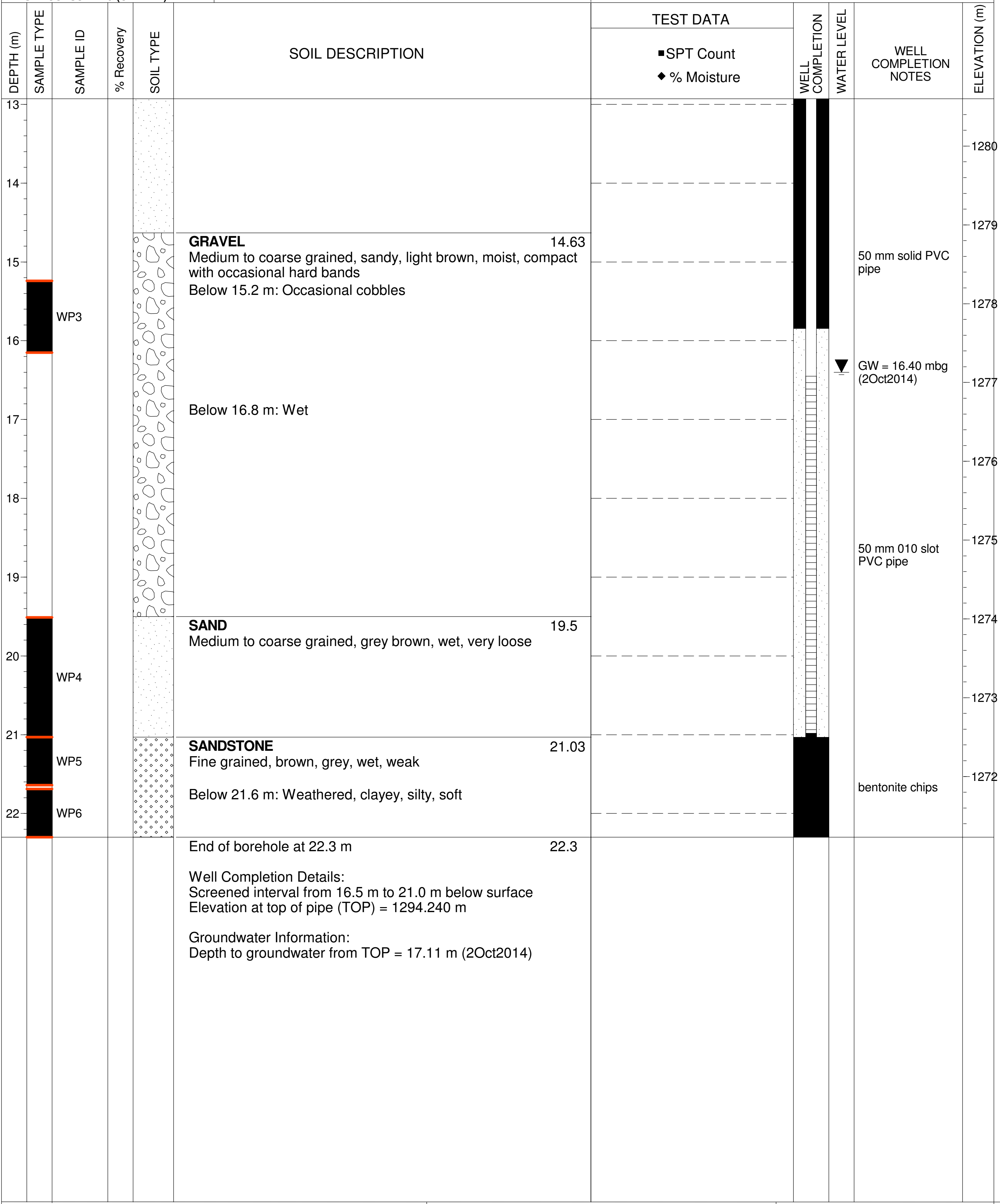
SLR

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-101
SURFACE ELEVATION: 1293.53 m
UTM COORDINATES
5682869 N
680066.4 E



GRAVEL 14.63
Medium to coarse grained, sandy, light brown, moist, compact with occasional hard bands
Below 15.2 m: Occasional cobbles

Below 16.8 m: Wet

SAND 19.5
Medium to coarse grained, grey brown, wet, very loose

SANDSTONE 21.03
Fine grained, brown, grey, wet, weak

Below 21.6 m: Weathered, clayey, silty, soft

End of borehole at 22.3 m 22.3

Well Completion Details:
Screened interval from 16.5 m to 21.0 m below surface
Elevation at top of pipe (TOP) = 1294.240 m

Groundwater Information:
Depth to groundwater from TOP = 17.11 m (2Oct2014)

DRILLING METHOD: Becker Hammer

DRILL DATE: 30 September 2014 LOGGED BY: RT

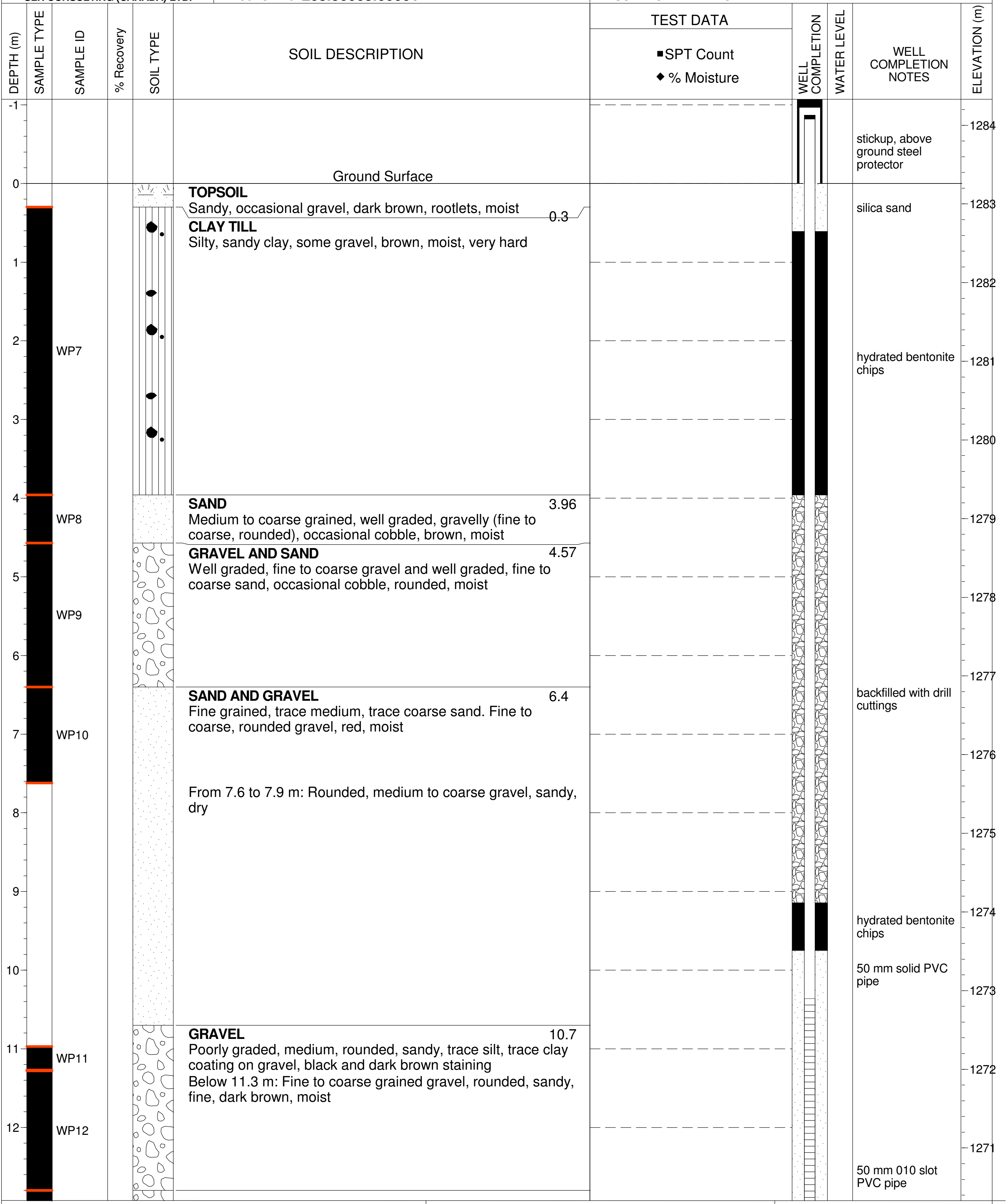
Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-102
SURFACE ELEVATION: 1283.26 m
UTM COORDINATES
5682280 N
680791.6 E



Ground Surface

TOPSOIL
Sandy, occasional gravel, dark brown, rootlets, moist — 0.3

CLAY TILL
Silty, sandy clay, some gravel, brown, moist, very hard

SAND — 3.96
Medium to coarse grained, well graded, gravelly (fine to coarse, rounded), occasional cobble, brown, moist

GRAVEL AND SAND — 4.57
Well graded, fine to coarse gravel and well graded, fine to coarse sand, occasional cobble, rounded, moist

SAND AND GRAVEL — 6.4
Fine grained, trace medium, trace coarse sand. Fine to coarse, rounded gravel, red, moist

From 7.6 to 7.9 m: Rounded, medium to coarse gravel, sandy, dry

GRAVEL — 10.7
Poorly graded, medium, rounded, sandy, trace silt, trace clay coating on gravel, black and dark brown staining
Below 11.3 m: Fine to coarse grained gravel, rounded, sandy, fine, dark brown, moist

WELL COMPLETION NOTES:

stickup, above ground steel protector

silica sand

hydrated bentonite chips

backfilled with drill cuttings

hydrated bentonite chips

50 mm solid PVC pipe

50 mm 010 slot PVC pipe

DRILLING METHOD: Becker Hammer

DRILL DATE: 1 October 2014 LOGGED BY: MH

Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-102
SURFACE ELEVATION: 1283.26 m

UTM COORDINATES
5682280 N
680791.6 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION		TEST DATA ■SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
13	■	WP13			**GRAVEL AND SAND** Fine to medium, trace coarse, rounded gravel. Fine, trace medium, trace coarse sand, occasional cobble, dry Below 13.7 m: Increasing cobble	12.8					1270
14											1269
15	■	WP14			**SANDSTONE** Weak, fine grained, silty, dry	14.93				silica sand	1268
	■	WP15			From 15.5 to 15.8 m: Higher clay and silt					bentonite chips	
16					Becoming more competent below 15.8 m						1267
					End of borehole at 16.5 m Well Completion Details: Screened interval from 10.4 m to 14.9 m below surface Elevation at top of pipe (TOP) = 1284.060 m	16.5					

DRILLING METHOD: Becker Hammer

DRILL DATE: 1 October 2014 LOGGED BY: MH

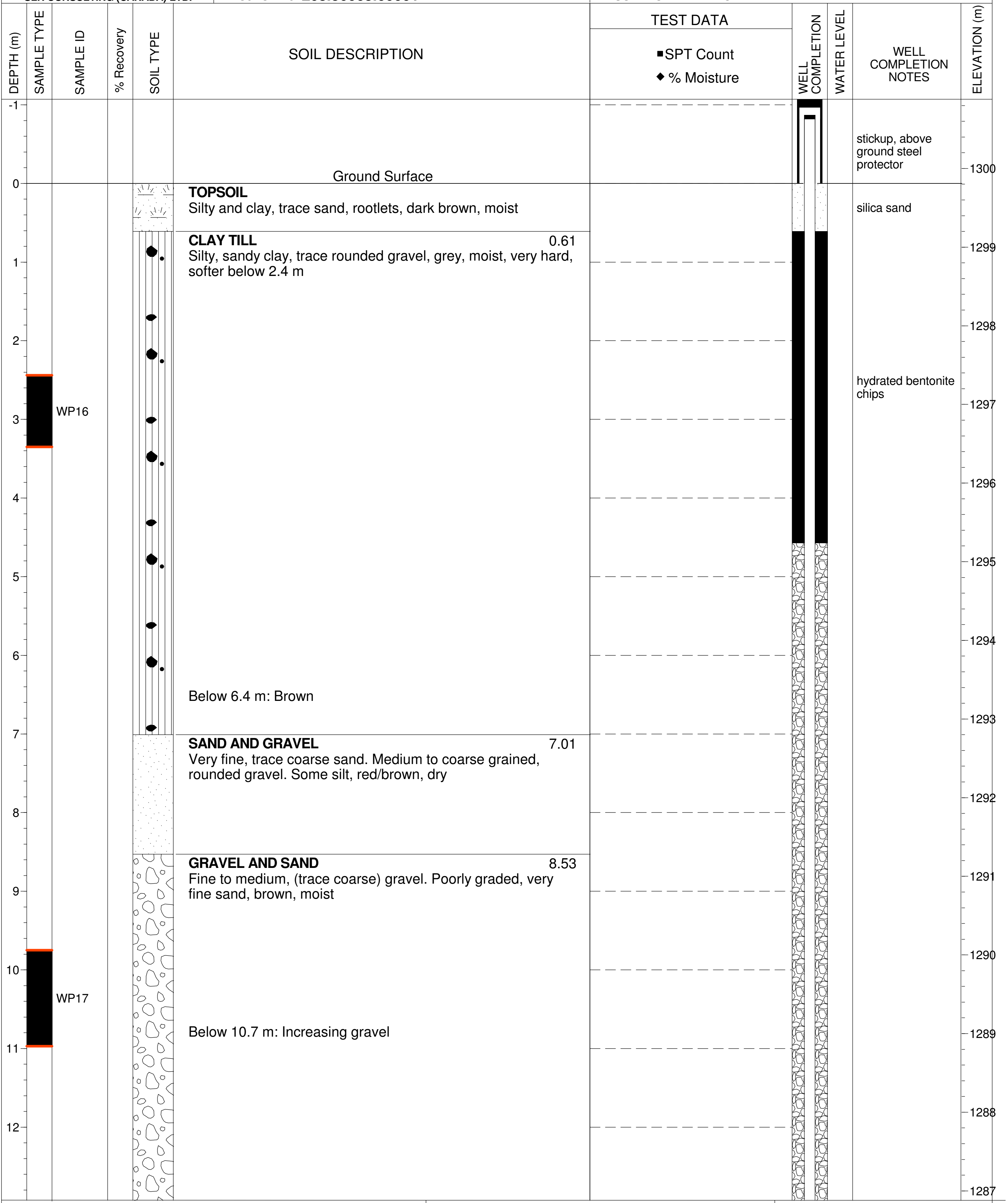
Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-103
SURFACE ELEVATION: 1299.81 m
UTM COORDINATES
5683100 N
680739 E



Ground Surface

TOPSOIL
Silty and clay, trace sand, rootlets, dark brown, moist

CLAY TILL 0.61
Silty, sandy clay, trace rounded gravel, grey, moist, very hard, softer below 2.4 m

Below 6.4 m: Brown

SAND AND GRAVEL 7.01
Very fine, trace coarse sand. Medium to coarse grained, rounded gravel. Some silt, red/brown, dry

GRAVEL AND SAND 8.53
Fine to medium, (trace coarse) gravel. Poorly graded, very fine sand, brown, moist

Below 10.7 m: Increasing gravel

stickup, above ground steel protector

silica sand

hydrated bentonite chips

DRILLING METHOD: Becker Hammer

DRILL DATE: 1 October 2014 LOGGED BY: MH

Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.

CLIENT: **Summit Aggregates Resource**
PROJECT: **Hydrogeological Assessment**
NW 31-026-3 W5M Alberta
PROJECT No. **203.50065.00001**

BOREHOLE LOG

BOREHOLE NO: MW14-103
SURFACE ELEVATION: 1299.81 m
UTM COORDINATES
5683100 N
680739 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
13					Below 12.8 m: Increasing gravel, some cobble				50 mm solid PVC pipe	
										1286
14					Below 14.0 m: Decreasing gravel, no cobble					
										1285
15										
										1284
16										
17					Below 16.8 m: Decreasing gravel					1283
										1282
18	■									
										1281
19		WP18			**SAND AND GRAVEL** 19.2 Poorly graded, very fine sand. Medium with trace fine and trace coarse gravel. Occasional cobble, red/brown, moist					
										1280
20										
										1279
21					Below 21.3 m: Increasing gravel					
										1278
22										
										1277
23					Below 23.2 m: 0.08 m clay lens			▼	GW = 23.49 mbg (2Oct2014)	
										1276
24									50 mm 010 slot PVC pipe	
25	■	WP19			Below 25.3 m: Wet gravel, very angular					1275
										1274
26										
										1273

DRILLING METHOD: Becker Hammer

DRILL DATE: 1 October 2014 LOGGED BY: MH

Notes: ■ GRAB SAMPLE

SLR CONSULTING (CANADA) LTD.	CLIENT: **Summit Aggregates Resource** PROJECT: **Hydrogeological Assessment** **NW 31-026-3 W5M Alberta** PROJECT No. **203.50065.00001**	**BOREHOLE LOG** BOREHOLE NO: MW14-103 SURFACE ELEVATION: 1299.81 m	UTM COORDINATES 5683100 N 680739 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
27									silica sand	
	■	WP20 WP21			**WEATHERED SILTSTONE** 27.4 Clay and silt, some sand, grey with red striations, moist Below 27.7 m: Siltstone, grey, dry 27.7				hydrated bentonite chips	

End of borehole at 27.7 m

Well Completion Details:
Screened interval from 22.6 m to 27.1 m below surface
Elevation at top of pipe (TOP) = 1300.720 m

Groundwater Information:
Depth to groundwater from TOP = 24.40 m (2Oct2014)

DRILLING METHOD: Becker Hammer	Notes: ■ GRAB SAMPLE	
DRILL DATE: 1 October 2014 LOGGED BY: MH		Sheet 3 of 3

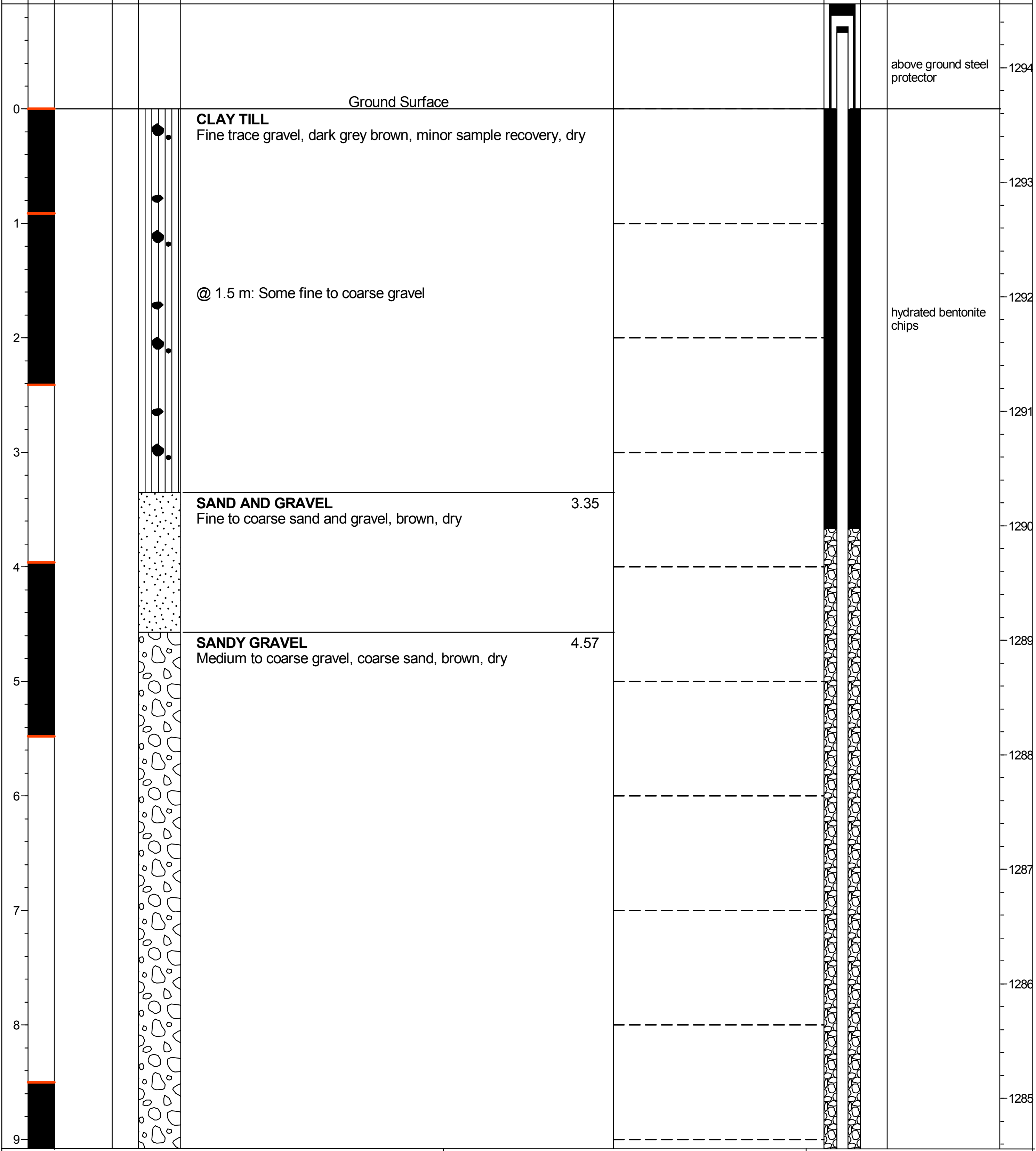
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-108
SURFACE ELEVATION: 1293.64 m
UTM COORDINATES
680386 N
5682182 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)



Ground Surface

CLAY TILL
Fine trace gravel, dark grey brown, minor sample recovery, dry

@ 1.5 m: Some fine to coarse gravel

SAND AND GRAVEL 3.35
Fine to coarse sand and gravel, brown, dry

SANDY GRAVEL 4.57
Medium to coarse gravel, coarse sand, brown, dry

above ground steel protector

hydrated bentonite chips

DRILLING METHOD: Sonic/Odex

DRILL DATE: June 3, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

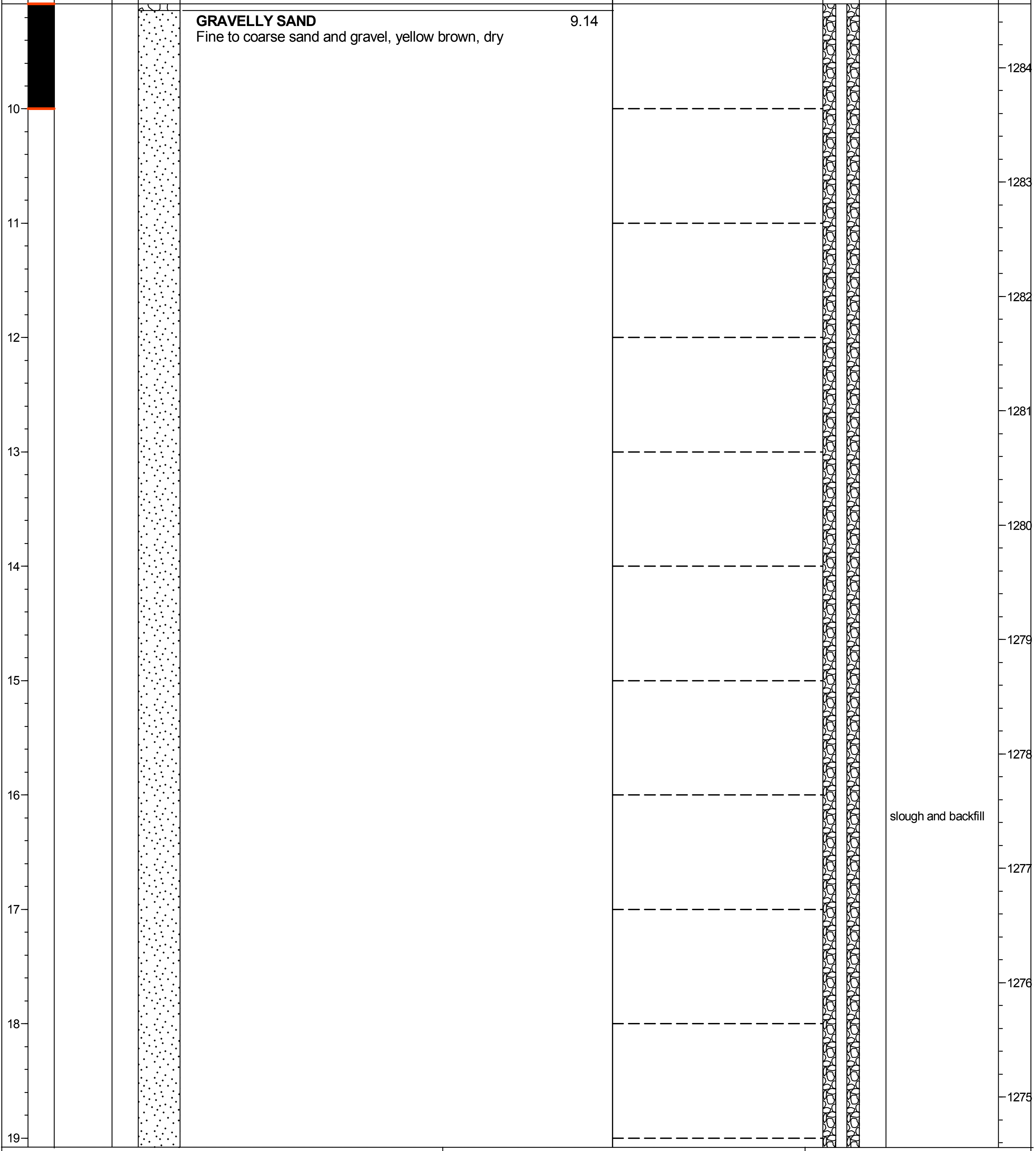
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-108
SURFACE ELEVATION: 1293.64 m
UTM COORDINATES
680386 N
5682182 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)



GRAVELLY SAND 9.14
Fine to coarse sand and gravel, yellow brown, dry

slough and backfill

DRILLING METHOD: Sonic/Odex

DRILL DATE: June 3, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 2 of 4

SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-108
SURFACE ELEVATION: 1293.64 m
UTM COORDINATES
680386 N
5682182 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
					@ 19.2 m: Trace silt present to 20.7 m					
										1274
20										
										1273
21										
										1272
22										
										1271
23										
										1270
24										
										1269
25										
										1268
26										
										1267
					SAND 26.8 Some gravel, brown, fine to coarse sand and gravel, dry					
27										
										1266
28										
										1265
29										

DRILLING METHOD: Sonic/Odex

DRILL DATE: June 3, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

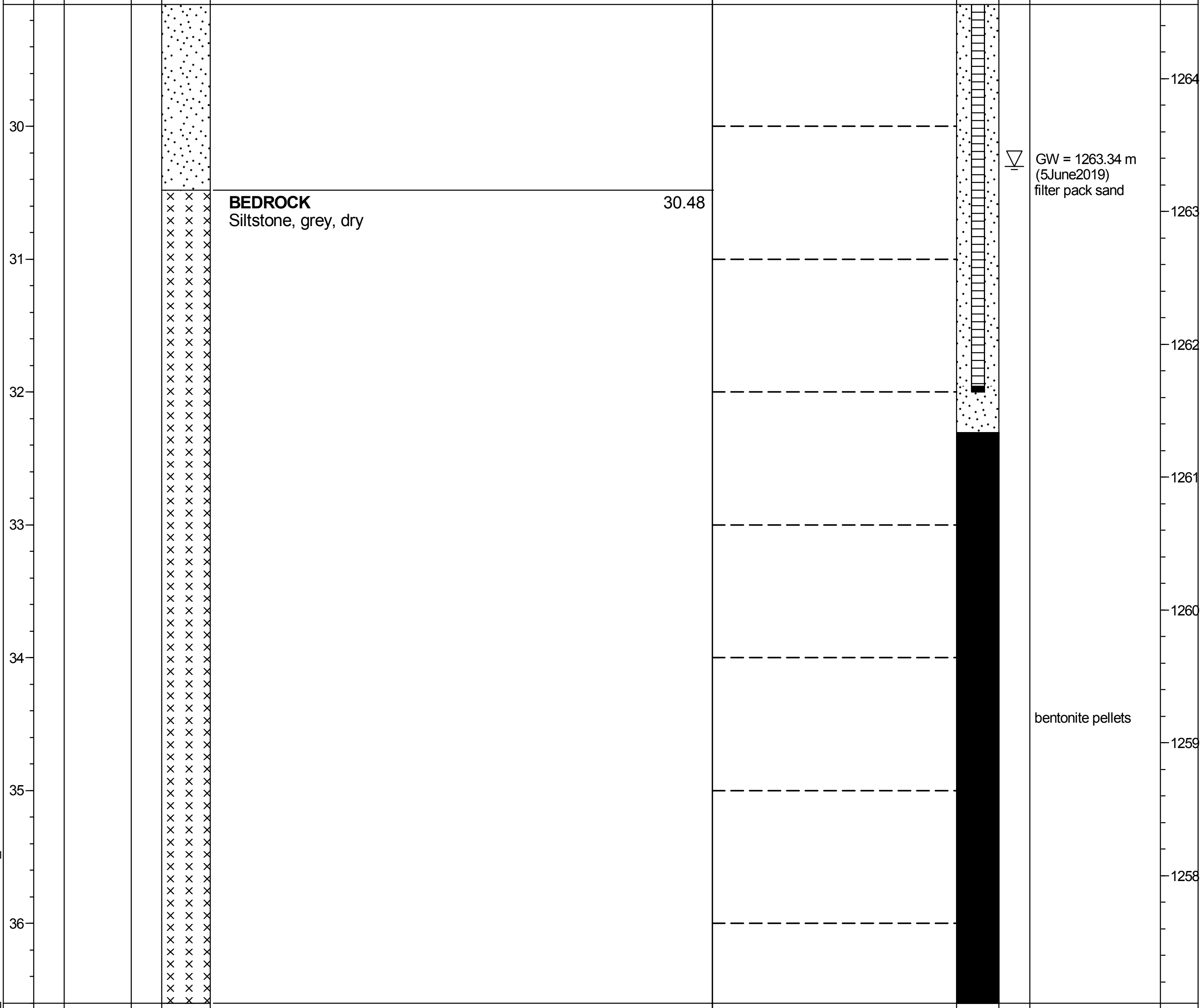
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-108
SURFACE ELEVATION: 1293.64 m
UTM COORDINATES
680386 N
5682182 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)



BEDROCK 30.48
Siltstone, grey, dry

GW = 1263.34 m
(5June2019)
filter pack sand

bentonite pellets

End of borehole at 36.6 m 36.6

DRILLING METHOD: Sonic/Odex

DRILL DATE: June 3, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 4 of 4

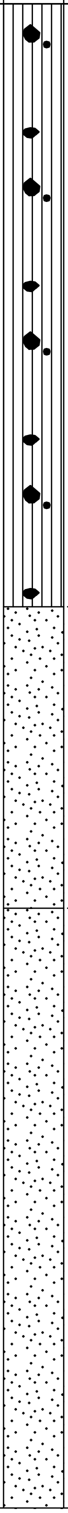
SLR CONSULTING (CANADA) LTD.

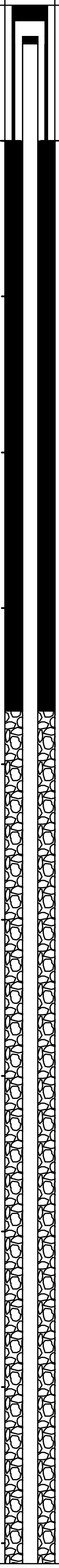
CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-109
SURFACE ELEVATION: 1271.68 m
UTM COORDINATES
5681803 N
680679 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
									above ground steel protector	1272
0					Ground Surface					
0					**CLAY TILL** Trace fine gravel, dark brown, moist					1271
1					@ 1.5 m: Some fine gravel				hydrated bentonite chips	1270
2										1269
3										1268
3.66					**SAND AND GRAVEL** Coarse sand, fine to coarse gravel, grey brown, dry					
4										1267
5										1266
5.49					**GRAVELLY SAND** Fine to coarse gravel and sand, grey brown, dry					
6										1265
7									slough and backfill	1264
8										1263
9										





DRILLING METHOD: ODEX Air Rotary Drilling
DRILL DATE: June 4, 2019
LOGGED BY: NY

Notes:

Sheet 1 of 2

SLR BOREHOLE LOG (MOISTURE) 212.06650.00003_100 SERIES_3-5JUNE2019.GPJ SLR_CAN V5.2 MOISTURE.GDT 12/6/19

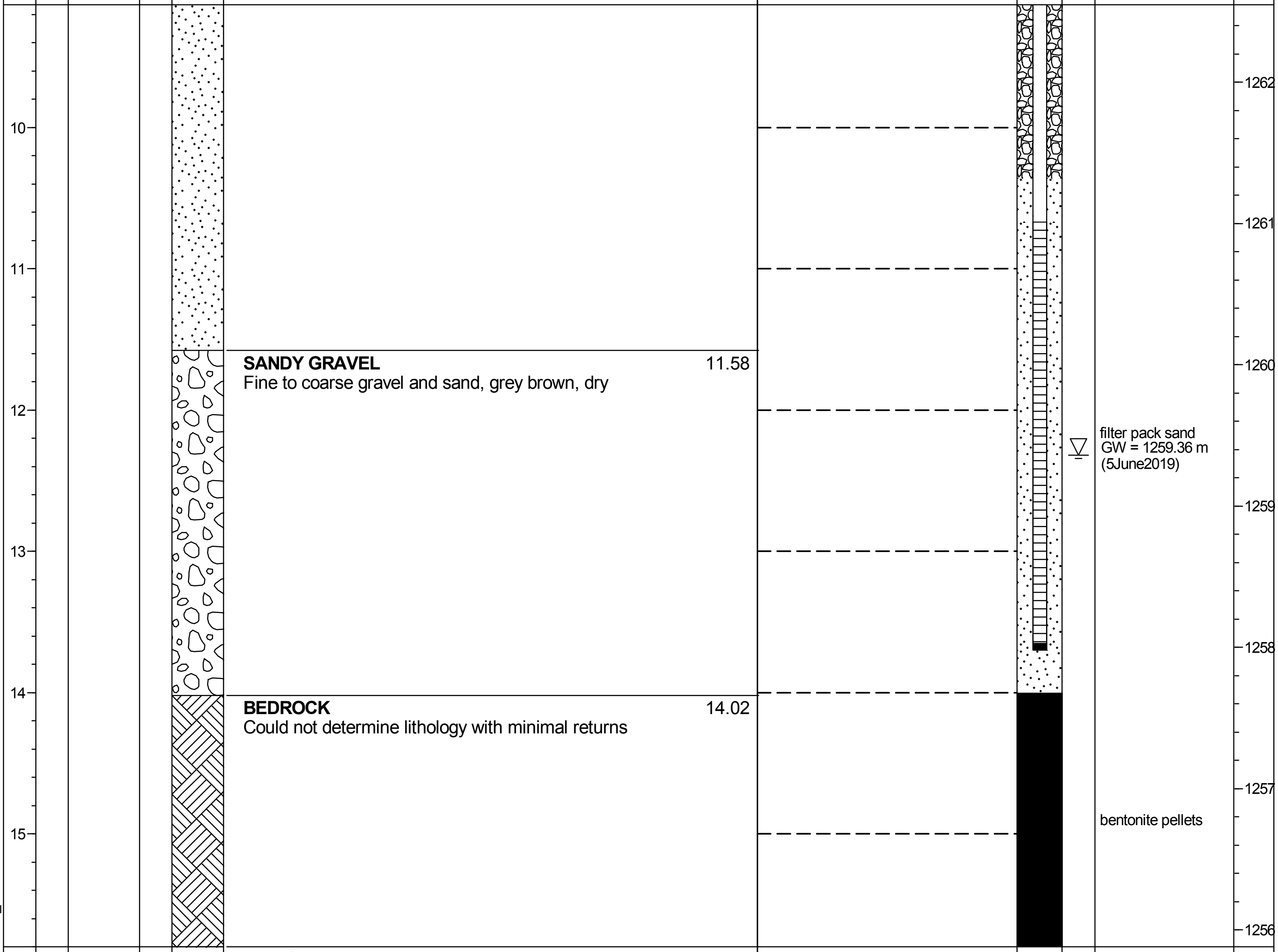
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-109
SURFACE ELEVATION: 1271.68 m
UTM COORDINATES
5681803 N
680679 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION		TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
11.58					**SANDY GRAVEL** Fine to coarse gravel and sand, grey brown, dry	11.58					
									∇	filter pack sand GW = 1259.36 m (5June2019)	
14.02					**BEDROCK** Could not determine lithology with minimal returns	14.02				bentonite pellets	
15.8					End of borehole at 15.8 m	15.8					



Groundwater Information:
Depth to groundwater from TOP = 12.32 m (5June2019)

DRILLING METHOD: ODEX Air Rotary Drilling

DRILL DATE: June 4, 2019 LOGGED BY: NY

Notes:

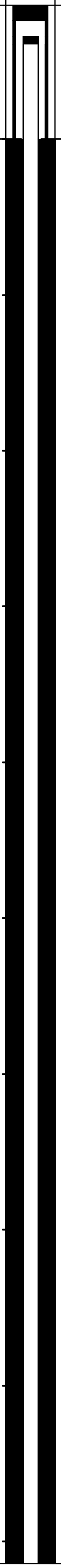
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-110
SURFACE ELEVATION: 1291.14 m
UTM COORDINATES
5682058 N
680788 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
									above ground steel protector	
0					Ground Surface					
					CLAY TILL Trace gravel, dark brown, moist					1291
1										1290
2										1289
3										1288
					SAND AND GRAVEL 3.35 Fine to coarse sand and gravel, yellow brown, dry					
4										1287
					GRAVELLY SAND 4.57 Fine to coarse sand and gravel, reddish brown, dry					
5										1286
					@ 5.5 m: Yellow brown to 11.6 m				hydrated bentonite chips	
6										1285
7										1284
8										1283
9										



DRILLING METHOD: ODEX Air Rotary Drilling

DRILL DATE: June 4, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 1 of 4

SLR

SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-110
SURFACE ELEVATION: 1291.14 m
UTM COORDINATES
5682058 N
680788 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
					@ 9.1 m: Clay layer, dark brown, moist to 10.1 m					
10										1281
11										1280
					GRAVEL AND SAND 11.58 Fine to coarse sand and gravel, yellow brown, dry					
12										1279
13										1278
14										1277
15										1276
16										1275
17										1274
18										1273
19										

DRILLING METHOD: ODEX Air Rotary Drilling

DRILL DATE: June 4, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 2 of 4

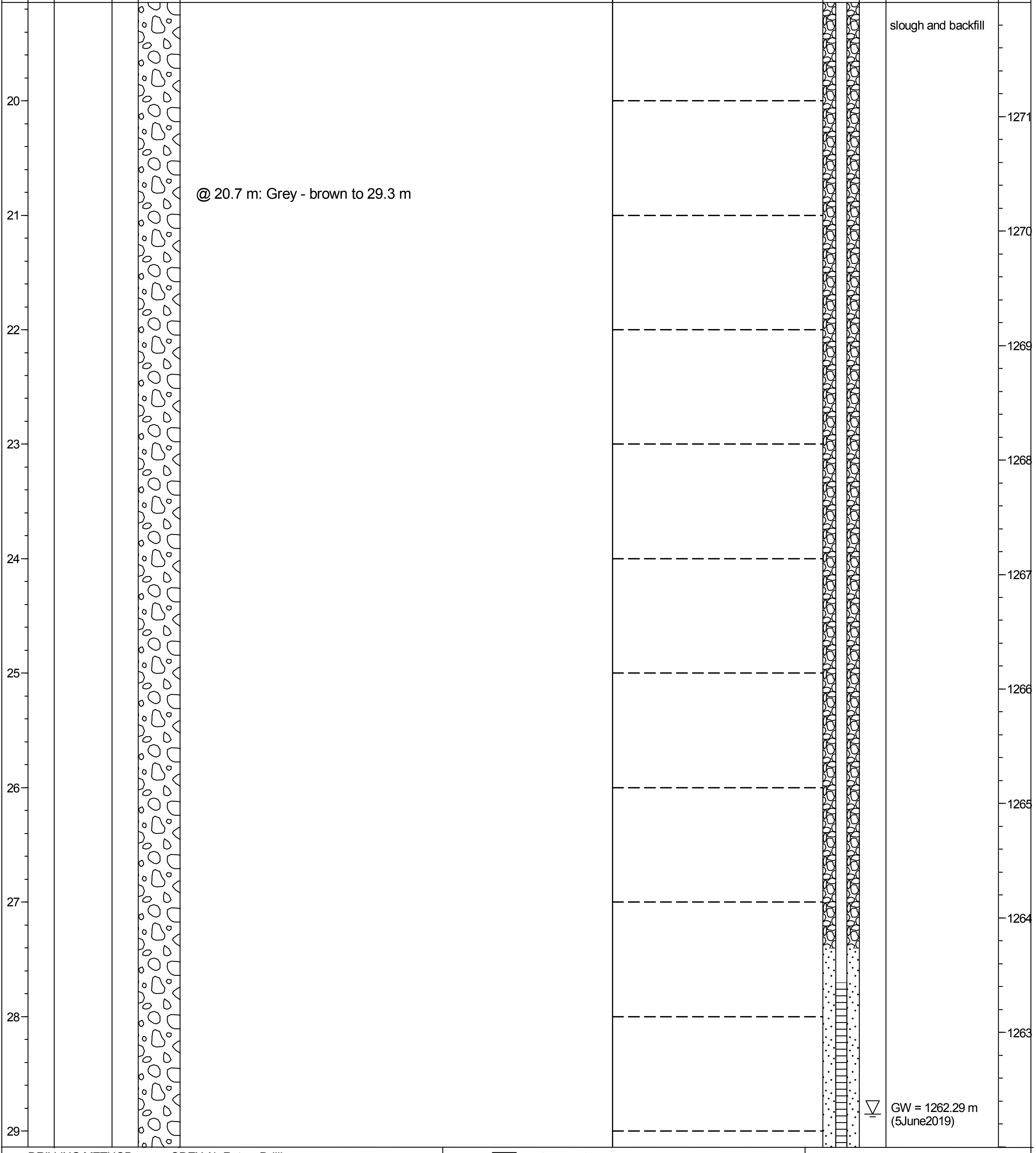
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-110
SURFACE ELEVATION: 1291.14 m
UTM COORDINATES
5682058 N
680788 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION	TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)



@ 20.7 m: Grey - brown to 29.3 m

slough and backfill

GW = 1262.29 m (5June2019)

DRILLING METHOD: ODEX Air Rotary Drilling

DRILL DATE: June 4, 2019

LOGGED BY: NY

Notes: ▬ GRAB SAMPLE

Sheet 3 of 4

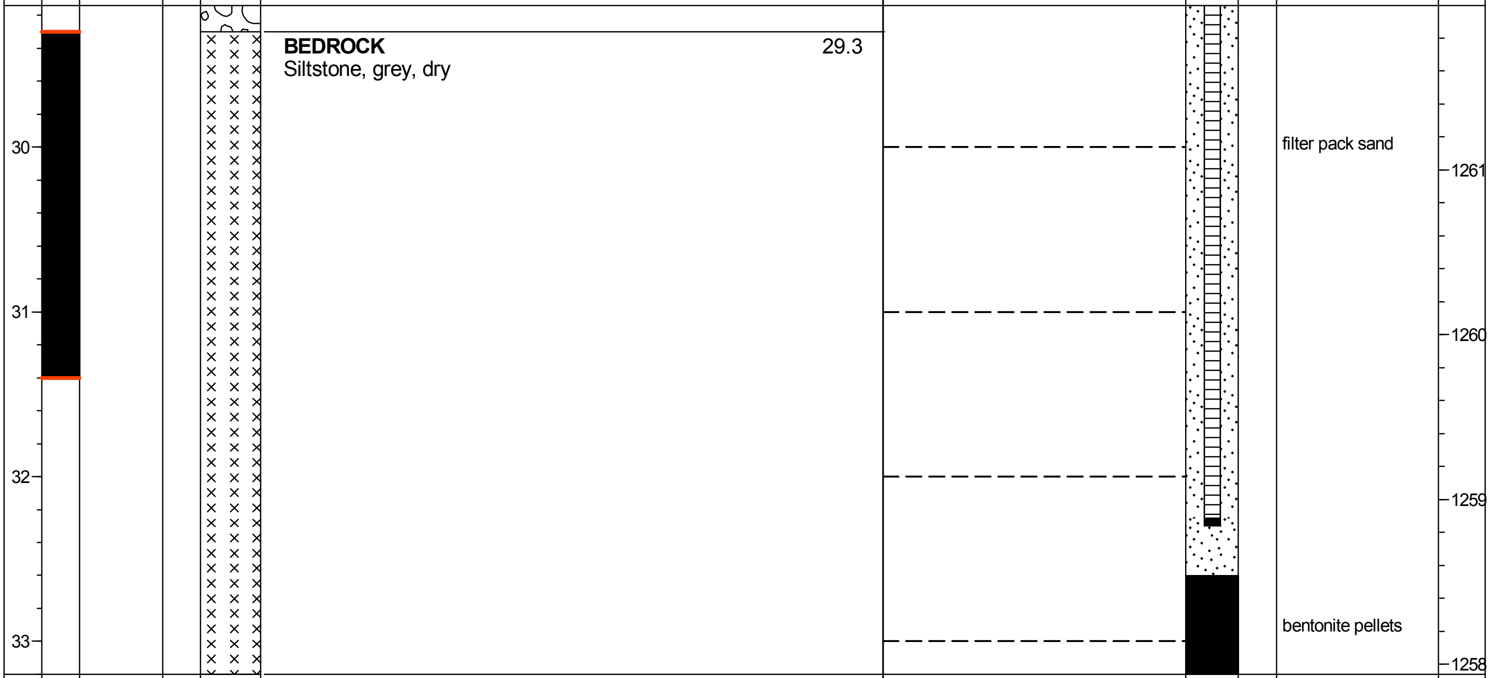
SLR CONSULTING (CANADA) LTD.

CLIENT: **Mountain Ash Limited Partnership**
PROJECT: **Proposed Summit Pit**
NW 31-026-03 W5M Cochrane, AB
PROJECT No. **212.06650.00003**

BOREHOLE LOG

BOREHOLE NO: MW19-110
SURFACE ELEVATION: 1291.14 m
UTM COORDINATES
5682058 N
680788 E

DEPTH (m)	SAMPLE TYPE	SAMPLE ID	% Recovery	SOIL TYPE	SOIL DESCRIPTION		TEST DATA ■ SPT Count ◆ % Moisture	WELL COMPLETION	WATER LEVEL	WELL COMPLETION NOTES	ELEVATION (m)
					BEDROCK Siltstone, grey, dry	29.3				filter pack sand bentonite pellets	
					End of borehole at 33.2 m	33.2					



Groundwater Information:
Depth to groundwater from TOP = 28.85 m (5June2019)

DRILLING METHOD: ODEX Air Rotary Drilling

DRILL DATE: June 4, 2019 LOGGED BY: NY

Notes: ■ GRAB SAMPLE

Sheet 4 of 4

APPENDIX C
Alberta Water Well Records

Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003

Reconnaissance Report

View in Imperial

Export to Excel

Groundwater Wells

Please click the water Well ID to generate the Water Well Drilling Report.

GIC Well ID	LSD	SEC	TWP	RGE	M	DRILLING COMPANY	DATE COMPLETED	DEPTH (m)	TYPE OF WORK	USE	CHM	LT	PT	WELL OWNER	STATIC LEVEL (m)	TEST RATE (L/min)	SC_DIA (cm)
350194	SW	31	26	3	5	LOU'S WATER WELL DRILLING	1990-03-09	35.05	New Well	Domestic		9		DAVIDSON, D.W.	15.24	54.55	14.12
360164	SE	6	27	3	5	AERO DRILLING & CONSULTING LTD.	1991-10-08	73.15	New Well	Domestic		10		BARGETZI, ERNIE	33.53	136.38	14.12
387449	NE	36	26	4	5	PARSONS DRLG	1962-08-10	33.83	New Well	Unknown		9		BRISTOW, C.R.	21.95	72.74	0.00
390998	SE	6	27	3	5	ALBERTA SOUTHERN EXPLORATION DRILLING LTD.	1987-02-11	65.53	New Well	Domestic & Stock		11		STRANGE, R.	45.72	36.37	16.84
390999	SE	6	27	3	5	ALBERTA SOUTHERN EXPLORATION DRILLING LTD.	1987-11-19	73.15	New Well	Stock		15		STRANGE, R.	39.62	45.46	16.84
391000	4	6	27	3	5	DIVERSIFIED DRILLING & EXPLORATION CO.	1984-11-07	40.23	New Well	Domestic & Stock	1	7		CIRCLE J RANCHES	28.96	68.19	13.97
391598	NW	31	26	3	5	PARSONS DRILLING		39.62	New Well	Domestic & Stock				MURRAY, R.J.			17.78
391599	NE	31	26	3	5	KRIEGER DRILLING LTD.		49.38	New Well-Decommissioned	Investigation		14		PARKER, G.L.	0.00		0.00
391600	NE	31	26	3	5	KRIEGER DRILLING LTD.	1981-10-14	27.43	New Well-Decommissioned	Domestic		9		PARKER, G.L.			0.00
395786	NE	31	26	3	5	PARSONS DRILLING	1981-11-19	62.48	New Well	Domestic & Stock		21		PARKER, G.L.	48.77	68.19	17.78
395793	NE	31	26	3	5	UNKNOWN DRILLER		62.48	Chemistry	Domestic				KIRK, S.			0.00
494773	NE	36	26	4	5	ALKEN BASIN DRILLING LTD.	1999-11-16	30.48	New Well	Stock		4	9	GOETJEN, MORRIE	22.25	63.65	13.97
498400	NW	31	26	3	5	MEDICINE VALLEY WATER WELLS	2001-05-14	74.68	New Well	Domestic		14	24	GIBBS, DAVE	10.82	9.09	13.97
1022436	9	36	26	4	5	AARON DRILLING INC.	2014-05-05	30.48	New Well	Investigation		6		LAFARGE CANADA INC			16.81
1475698	16	31	26	3	5	M&M DRILLING CO. LTD.	2003-01-14	39.62	New Well	Domestic		10	24	QUICK WAY FARMS LTD	32.00	45.46	14.13
1475699	15	31	26	3	5	M&M DRILLING CO. LTD.	2003-01-17	53.95	New Well	Domestic		10	24	QUICK WAY FARMS LTD	32.64	24.55	14.13
2095665	SW	6	27	3	5	UNKNOWNDRILLINGCOMP11		25.60	Well Inventory	Domestic & Stock		1		CIRCLE J RANCHES LTD			

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	350194
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1990/03/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
DAVIDSON, D.W.	P.O. BOX 970 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	31	026	03	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.259801 Longitude -114.414277

How Location Obtained

Not Verified

Elevation m

How Elevation Obtained

Not Obtained

Drilling Information

Method of Drilling

Cable Tool

Type of Work

New Well

Proposed Well Use

Domestic

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
6.10		Boulders
10.67		Sand & Gravel
12.19		Sand
15.24		Gravel
18.29		Gray Shale
22.86		Light Green Shale
28.96		Green Shale
32.00		Green Shale
35.05		Green Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1990/03/09	54.55	15.24

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
35.05 m		1990/03/02	1990/03/09

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	35.05

Surface Casing (if applicable)

Steel

Size OD : 14.12 cm

Wall Thickness : 0.478 cm

Bottom at : 15.24 m

Well Casing/Liner

Steel

Size OD : 11.43 cm

Wall Thickness : 0.318 cm

Top at : 13.72 m

Bottom at : 35.05 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
22.86	35.05	0.318		25.40

Perforated by Torch

Annular Seal Driven

Placed from 0.00 m to 15.24 m

Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment

Top Fittings Bottom Fittings

Pack

Type Grain Size

Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

UNKNOWN NA DRILLER

Certification No

1

Company Name

LOU'S WATER WELL DRILLING

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	350194
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1990/03/16

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
DAVIDSON, D.W.	P.O. BOX 970 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.259801 Longitude -114.414277
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level — Measurement in Metric

Test Date	Start Time	Static Water Level
1990/03/09	12:00 AM	15.24 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 54.55 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
LOU'S WATER WELL DRILLING

Copy of Well report provided to owner
Date approval holder signed

Government
of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	360164
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1991/10/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BARGETZI, ERNIE	233 RATCLIFF PLACE SE, CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5		2	9110979	

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274744 Longitude -114.405998
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
9.45		Till & Clay
21.64		Gravel
25.30		Brown Shale
34.75		Gray Shale
39.62		Gray Sandstone
44.20		Gray Shale
51.82		Gray Sandstone
59.74		Gray Shale
66.75		Gray Sandstone
73.15		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 136.38 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1991/10/08	136.38	33.53

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
73.15 m		1991/10/08	1991/10/08

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	73.15

Surface Casing (if applicable)
Steel
Size OD : 14.12 cm
Wall Thickness : 0.620 cm
Bottom at : 24.99 m

Well Casing/Liner
Steel
Size OD : 11.43 cm
Wall Thickness : 0.396 cm
Top at : 18.29 m
Bottom at : 73.15 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
36.58	67.06	0.157		15.24

Perforated by Torch

Annular Seal Drive Shoe
Placed from 0.00 m to 24.99 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
AERO DRILLING & CONSULTING LTD.

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 360164
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1991/10/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BARGETZI, ERNIE	233 RATCLIFF PLACE SE, CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5		2	9110979	

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274744 Longitude -114.405998
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 136.38 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1991/10/08	12:00 AM	33.53 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 136.38 L/min
Depth Withdrawn From 39.62 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
AERO DRILLING & CONSULTING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID 387449
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BRISTOW, C.R.	COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	36	026	04	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267032 Longitude -114.426119
How Location Obtained
Map

Elevation 1292.35 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Cable Tool

Type of Work
New Well

Proposed Well Use
Unknown

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.88		Yellow Clay
21.03		Gravel
23.77		Fine Grained Sand
25.91		Yellow Clay
26.82		Blue Clay
27.13		Hard Shale
28.04		Sand
32.00		Blue Shale & Sandstone Ledges
33.83		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1962/08/10	72.74	21.95

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
33.83 m			1962/08/10

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	33.83

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PARSONS DRLG

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial Export to Excel

GIC Well ID 387449
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
BRISTOW, C.R.	COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	36	026	04	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267032 Longitude -114.426119
How Location Obtained
Map

Elevation 1292.35 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1962/08/10	12:00 AM	21.95 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 72.74 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PARSONS DRLG

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 390998
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1987/03/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STRANGE, R.	P.O. BOX 981 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274744 Longitude -114.405998
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic & Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
7.62		Till
10.36		Gravel
11.58		Silty Clay
17.68		Weathered Shale
27.43		Shale
39.62		Sandstone
48.77		Shale
60.96		Sandstone
62.48		Shale
63.70		Sandstone
65.53		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 27.28 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1987/02/11	36.37	45.72

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
65.53 m		1987/02/10	1987/02/11

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	65.53

Surface Casing (if applicable)
Steel
Size OD : 16.84 cm
Wall Thickness : 0.478 cm
Bottom at : 18.29 m

Well Casing/Liner
Plastic
Size OD : 12.70 cm
Wall Thickness : 0.630 cm
Top at : 16.76 m
Bottom at : 65.53 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
47.24	59.44	0.000		0.10

Perforated by Machine

Annular Seal Driven
Placed from 0.00 m to 11.58 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	390998
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1987/03/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STRANGE, R.	P.O. BOX 981 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274744 Longitude -114.405998
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 27.28 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 62.48 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	Start Time	Static Water Level
1987/02/11	12:00 AM	45.72 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 36.37 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Copy of Well report provided to owner

Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 390999
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1987/12/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STRANGE, R.	P.O. BOX 981 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274744 Longitude -114.405998
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
5.79		Till
8.84		Gravel
9.75		Till
16.76		Yellow Sandstone
20.12		Gray Sandstone
30.48		Shale
36.88		Sandstone
39.62		Shale
40.23		Moist Sandstone
50.29		Shale
51.82		Sandstone
58.22		Shale
64.01		Shale
71.32	Yes	Water Bearing Sandstone
73.15		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 31.82 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1987/11/19	45.46	39.62

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
73.15 m		1987/11/18	1987/11/19

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	73.15

Surface Casing (if applicable)
Steel
Size OD : 16.84 cm
Wall Thickness : 0.478 cm
Bottom at : 11.89 m

Well Casing/Liner
Plastic
Size OD : 12.70 cm
Wall Thickness : 0.630 cm
Top at : 9.14 m
Bottom at : 73.15 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
39.62	73.15	0.157		15.24

Perforated by Other

Annular Seal Driven
Placed from 0.00 m to 9.75 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 390999
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1987/12/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
STRANGE, R.	P.O. BOX 981 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SE	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274744 Longitude -114.405998
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 31.82 L/min
Recommended Pump Intake Depth (From TOC) 60.96 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
WATER OCCURES AT 130-132' @ 1 GPM, 210-234' @ 8-10 GPM.

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
1987/11/19	12:00 AM	39.62 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate 45.46 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALBERTA SOUTHERN EXPLORATION DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	391000
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1984/12/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CIRCLE J RANCHES	RR2, COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	04	06	027	03	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.272936 Longitude -114.420414

How Location Obtained

Map

Elevation m

How Elevation Obtained

Not Obtained

Drilling Information

Method of Drilling
Cable Tool

Type of Work
New Well

Proposed Well Use
Domestic & Stock

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.05		Yellow Clay
7.32		Cemented Gravel
19.51		Gravel
20.12		Cemented Gravel
29.87		Gravel & Boulders
32.92		Brown Shale & Sandstone
40.23	Yes	Brown Water Bearing Sandstone

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1984/11/07	68.19	28.96

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
40.23 m		1984/10/15	1984/11/07

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	40.23

Surface Casing (if applicable)
Steel

Size OD : 13.97 cm

Wall Thickness : 0.620 cm

Bottom at : 31.09 m

Well Casing/Liner
Steel

Size OD : 11.43 cm

Wall Thickness : 0.318 cm

Top at : 0.00 m

Bottom at : 40.23 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
33.53	39.62	0.396		25.40

Perforated by Torch

Annular Seal Driven

Placed from 0.00 m to 1.22 m

Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment

Top Fittings Bottom Fittings

Pack

Type Grain Size

Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
DIVERSIFIED DRILLING & EXPLORATION CO.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial | Export to Excel

GIC Well ID 391000
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1984/12/05

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CIRCLE J RANCHES	RR2, COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	04	06	027	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.272936 Longitude -114.420414
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 0.00 L/min
Recommended Pump Intake Depth (From TOC) 0.00 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD Yes

Additional Comments on Well

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	Start Time	Static Water Level
1984/11/07	12:00 AM	28.96 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer
Removal Rate 68.19 L/min
Depth Withdrawn From 32.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
DIVERSIFIED DRILLING & EXPLORATION CO.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial Export to Excel

GIC Well ID 391598
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MURRAY, R.J.	511 19ST NW, CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.414280
How Location Obtained
Map

Elevation 1290.83 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Domestic & Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
39.62 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	39.62

Surface Casing (if applicable)
Steel
Size OD : 17.78 cm
Wall Thickness : 0.000 cm
Bottom at : 26.82 m

Well Casing/Liner
Steel
Size OD : 12.70 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 39.62 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
31.09	38.10	0.000		0.00

Perforated by

Annular Seal Drive Shoe
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PARSONS DRILLING

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial Export to Excel

GIC Well ID 391598
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
MURRAY, R.J.	511 19ST NW, CALGARY				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.414280
How Location Obtained
Map

Elevation 1290.83 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
PARSONS DRILLING

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial Export to Excel

GIC Well ID 391599
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Map

Elevation 1295.40 m
How Elevation Obtained
Estimated

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Investigation

Type of Work
New Well-Abandoned

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
1.22		Gray Clay
4.27		Brown Clay
6.71		Brown Sandy Clay
11.89		Sandy Gravel
17.07		Medium Grained Gravel
18.90		Fine Grained Gravel
19.20		Sandstone
24.69		Fine Grained Sand
32.92		Fine Grained Gravel
36.27		Shale
36.58		Dark Shale
43.59		Clay & Shale
49.38		Unknown

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1981/10/10		0.00

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
49.38 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	49.38

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Driven
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
KRIEGER DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

GIC Well ID 391599
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Map

Elevation 1295.40 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 0.00 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 0.00 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS MED HARD WATER, NO SPECS FOR SURFACE CASING

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1981/10/10	12:00 AM	0.00 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Air
Removal Rate L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
KRIEGER DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	391600
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1981/11/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.267033 Longitude -114.402748

How Location Obtained

Map

Elevation 1295.40 m

How Elevation Obtained

Estimated

Drilling Information

Method of Drilling

Rotary

Proposed Well Use

Domestic

Type of Work

New Well-Abandoned

Plugged 1981/10/14

Plugged with Unknown

Amount

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
10.06		Sandy Till
17.68		Clay & Shale
20.12		Clay & Gravel
21.03		Shale
22.86		Clay & Silt
24.08		Gray Clay
26.82		Clay & Gravel
27.43		Lost Circulation

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
27.43 m		1981/10/11	1981/10/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	27.43

Surface Casing (if applicable)

Size OD : 0.00 cm

Wall Thickness : 0.000 cm

Bottom at : 0.00 m

Well Casing/Liner

Size OD : 0.00 cm

Wall Thickness : 0.000 cm

Top at : 0.00 m

Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal

Placed from 0.00 m to 0.00 m

Amount

Other Seals

Type	At (m)

Screen Type

Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment

Top Fittings Bottom Fittings

Pack

Type Grain Size

Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

UNKNOWN NA DRILLER

Certification No

1

Company Name

KRIEGER DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 391600
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1981/11/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Map

Elevation 1295.40 m
How Elevation Obtained
Estimated

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
KRIEGER DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 395786
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1982/02/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Map

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Domestic & Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
1.83		Brown Clay & Boulders
3.35		Gray Clay & Boulders
3.96		Boulders
10.97		Brown Clay & Gravel
13.72		Gravel
15.54		Brown Shale
21.64		Gray Hard Shale
23.16		Gray Hard Sandstone
25.30		Gray Shale
26.82		Gray Sandstone
27.74		Gray Shale
28.65		Gray Sandstone
29.26		Gray Soft Sandstone
30.78		Gray Hard Sandstone
34.75		Gray Firm Shale
36.88		Gray Hard Sandstone
43.89		Gray Firm Shale
45.11		Gray Hard Sandstone
54.86		Gray Shale
56.39	Yes	Gray Water Bearing Sandstone
62.48		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 0.00 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1981/11/19	68.19	48.77

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
62.48 m		1981/11/05	1981/11/19

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	62.48

Surface Casing (if applicable)
Steel
Size OD : 17.78 cm
Wall Thickness : 0.587 cm
Bottom at : 13.72 m

Well Casing/Liner
Steel
Size OD : 12.70 cm
Wall Thickness : 0.556 cm
Top at : 0.00 m
Bottom at : 62.48 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
48.16	61.87	0.953		40.64

Perforated by Torch

Annular Seal Drive Shoe
Placed from 0.00 m to 13.72 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount 0.00

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Company Name
PARSONS DRILLING

Certification No
1

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID	395786
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	1982/02/02

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
PARKER, G.L.	P.O. BOX 123 COCHRANE				

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.267033 Longitude -114.402748

How Location Obtained

Map

Elevation m

How Elevation Obtained

Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm

Is Artesian Flow

Is Flow Control Installed

Rate L/min

Describe

Recommended Pump Rate 0.00 L/min

Pump Installed

Depth m

Recommended Pump Intake Depth (From TOC) 60.96 m

Type

Make

H.P.

Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)

Depth m

Well Disinfected Upon Completion

Gas

Depth m

Geophysical Log Taken

Submitted to ESRD

Sample Collected for Potability

Submitted to ESRD

Additional Comments on Well

DRILLER REPORTS WATER QUALITY AS TURBID

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	Start Time	Static Water Level
1981/11/19	12:00 AM	48.77 m

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)

Method of Water Removal

Type Bailer

Removal Rate 68.19 L/min

Depth Withdrawn From 48.77 m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

UNKNOWN NA DRILLER

Certification No

1

Company Name

PARSONS DRILLING

Copy of Well report provided to owner

Date approval holder signed

Government
of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID 395793
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KIRK, S.	P.O. BOX 1295 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic

Type of Work
Chemistry

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
62.48 m			

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	62.48

Surface Casing (if applicable)
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Bottom at : 0.00 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from 0.00 m to 0.00 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial | Export to Excel

GIC Well ID 395793
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
KIRK, S.	P.O. BOX 1295 COCHRANE				T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.402748
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD
Additional Comments on Well

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
UNKNOWN DRILLER

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 494773
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1999/11/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GOETJEN, MORRIE	RR1, AIRDRIE			CANADA	T4B 2A3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	36	26	4	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267032 Longitude -114.426119
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Stock

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.05		Brown Clay
23.16		Coarse Grained Gravel
29.26	Yes	Water Bearing Gravel
30.48		Brown Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 36.37 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
1999/11/16	63.65	22.25

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
30.48 m		1999/11/15	1999/11/16

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	30.48

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.620 cm
Bottom at : 28.04 m

Well Casing/Liner
Size OD : 0.00 cm
Wall Thickness : 0.000 cm
Top at : 0.00 m
Bottom at : 0.00 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Driven & Bentonite
Placed from 0.00 m to 28.04 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALKEN BASIN DRILLING LTD.

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 494773
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 1999/11/25

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GOETJEN, MORRIE	RR1, AIRDRIE			CANADA	T4B 2A3

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NE	36	26	4	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267032 Longitude -114.426119
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 36.37 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 27.43 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas Yes
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 2'.

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
1999/11/16	12:00 AM	22.25 m

Method of Water Removal

Type Air
Removal Rate 63.65 L/min
Depth Withdrawn From 30.48 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
	1:00	26.82
	2:00	24.38
	3:00	23.16
	4:00	22.71
	5:00	22.56
	6:00	22.40
	7:00	22.25
	8:00	22.25
	10:00	22.25

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
ALKEN BASIN DRILLING LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

GIC Well ID 498400
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2001/06/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GIBBS, DAVE	P.O. BOX 1773 SPRUCE VIEW				T0M 1V0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.414280
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Cable Tool

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
4.57		Brown Clay & Rocks
8.23		Gray Sandstone
13.72		Gray Shale
19.51		Gray Sandy Shale
22.86		Gray Shale
24.08		Gray Sandstone
29.87		Gray Shale
30.78		Blue Shale
34.14		Gray Silty Shale
54.56		Gray Shale
57.30		Gray Sandstone
67.67		Gray Shale
71.63		Gray Sandy Shale
74.68		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 9.09 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2001/05/14	9.09	10.82

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
74.68 m		2001/05/07	2001/05/14

Borehole

Diameter (cm)	From (m)	To (m)
0.00	0.00	74.68

Surface Casing (if applicable)
Steel
Size OD : 13.97 cm
Wall Thickness : 0.620 cm
Bottom at : 24.69 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.602 cm
Top at : 19.81 m
Bottom at : 74.68 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
24.69	74.68	0.635		20.32

Perforated by Saw

Annular Seal Driven
Placed from 0.00 m to 24.69 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : 0.00 cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
MEDICINE VALLEY WATER WELLS

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 498400
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2001/06/22

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
GIBBS, DAVE	P.O. BOX 1773 SPRUCE VIEW				T0M 1V0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	NW	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267033 Longitude -114.414280
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 9.09 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 71.63 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
DRILLER REPORTS DISTANCE FROM TOP OF CASING TO GROUND LEVEL: 1'.

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
2001/05/14	12:00 AM	10.82 m

Method of Water Removal

Type Bailer
Removal Rate 9.09 L/min
Depth Withdrawn From 0.00 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
	1:00	54.32
	2:00	53.77
	3:00	53.28
	4:00	52.88
	5:00	52.40
	6:00	52.09
	7:00	51.82
	8:00	51.58
	9:00	51.19
	10:00	50.81
	12:00	50.38
	14:00	50.05
	16:00	49.50
	20:00	48.05
	25:00	46.09
	30:00	44.84
	35:00	43.08
	40:00	41.53
	50:00	39.01
	60:00	36.32
	75:00	33.19
	90:00	30.57
	105:00	28.79
	120:00	26.93

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN NA DRILLER

Certification No
1

Company Name
MEDICINE VALLEY WATER WELLS

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	1022436
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/09/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
LAFARGE CANADA INC	115 QUARRY PARK BLVD	CALGARY	ALBERTA	CANADA	T2C 5G9

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	9	36	26	4	5				

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.265686 Longitude -114.424418

How Location Obtained

Hand held autonomous GPS 20-30m

Elevation m

How Elevation Obtained

Hand held autonomous GPS 20-30m

Drilling Information

Method of Drilling
Rotary - Air

Type of Work
New Well

Proposed Well Use
Investigation

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Topsoil
4.27		Brown Moist Clay
25.30		Gravel
28.35		Moist Gravel
29.26		Sandstone
30.48		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
30.48 m	28.35 m	2014/05/01	2014/05/05

Borehole

Diameter (cm)	From (m)	To (m)
20.02	0.00	25.60
15.56	25.60	30.48

Surface Casing (if applicable)
Steel

Size OD : 16.81 cm

Wall Thickness : 0.478 cm

Bottom at : 25.60 m

Well Casing/Liner

Size OD : cm

Wall Thickness : cm

Top at : m

Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Cement/Grout

Placed from 0.00 m to 25.60 m

Amount 150.00 Gallons

Other Seals

Type	At (m)
Driven	25.60

Screen Type Stainless Steel

Size OD : 14.12 cm

From (m)	To (m)	Slot Size (cm)
26.21	27.43	0.025

Attachment Telescoped

Top Fittings Packer

Bottom Fittings Tail Pipe

Pack

Type Natural

Grain Size

Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHRIS QUINLAN

Certification No
48135A

Company Name
AARON DRILLING INC.

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/09/24

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 1022436
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2014/09/24

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
LAFARGE CANADA INC	115 QUARRY PARK BLVD	CALGARY	ALBERTA	CANADA	T2C 5G9

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	9	36	26	4	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.265686 Longitude -114.424418
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Hand held autonomous GPS 20-30m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 91.44 cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion Yes
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
PUMP TEST PERFORMED BY WATERLINE RESOURCES

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
CITY OF CALGARY	9092.18 L	2014/04/29 8:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well	Certification No
CHRIS QUINLAN	48135A

Company Name	Copy of Well report provided to owner	Date approval holder signed
AARON DRILLING INC.	Yes	2014/09/24

Government
of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 1475698
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
QUICK WAY FARMS LTD	P.O. BOX 1719	BROOKS	AB	CA	T1R 1C5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267444 Longitude -114.400639
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
2.13		Clay
21.03		Clay & Gravel
23.16		Clay
26.82		Gray Shale
28.65		Gray Sandy Shale
31.39		Gray Shale
31.70		Sandstone
33.53		Shale
35.97		Sandstone
39.62		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 36.37 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2003/01/15	45.46	32.00

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
39.62 m		2003/01/10	2003/01/14

Borehole

Diameter (cm)	From (m)	To (m)
22.23	0.00	39.62

Surface Casing (if applicable)
Steel
Size OD : 14.13 cm
Wall Thickness : 0.478 cm
Bottom at : 35.97 m

Well Casing/Liner
Unknown
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
32.00	35.97	0.318		25.40

Perforated by Torch

Annular Seal Driven & Bentonite
Placed from 0.00 m to 31.39 m
Amount
Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
WILLIAM PENROD

Company Name
M&M DRILLING CO. LTD.

Certification No
A000187

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

GIC Well ID 1475698
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
QUICK WAY FARMS LTD	P.O. BOX 1719	BROOKS	AB	CA	T1R 1C5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	16	31	026	03	5				

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267444 Longitude -114.400639
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 60.96 cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate 36.37 L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) 35.05 m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
FIELD TEST HARD WATER TDS 250, GPS # 51.2671333, N-51-16.0-2.8, W-114-24-2.3, -114.40038333, BOREHOLE DIAMETER 8.75" TO 103' & 6.25" TO 130'

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
2003/01/15	12:00 AM	32.00 m

Method of Water Removal

Type Pump
Removal Rate 45.46 L/min
Depth Withdrawn From 35.05 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
32.39	1:00	32.81
32.59	2:00	32.69
32.69	3:00	32.65
32.75	4:00	32.61
32.83	5:00	32.60
32.85	6:00	32.56
32.89	7:00	32.51
32.90	8:00	32.49
32.92	9:00	32.47
32.94	10:00	32.45
32.99	12:00	32.40
33.02	14:00	32.37
33.05	16:00	32.34
33.08	20:00	32.32
33.13	25:00	32.28
33.06	30:00	32.26
33.19	35:00	32.23
33.24	40:00	32.21
33.27	50:00	32.20
33.28	60:00	32.16
33.31	75:00	32.12
33.32	90:00	32.10
33.34	105:00	32.09
33.35	120:00	32.06

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
WILLIAM PENROD

Certification No
A000187

Company Name
M&M DRILLING CO. LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 1475699
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
QUICK WAY FARMS LTD	P.O. BOX 1719	BROOKS	AB	CA	T1R 1C5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	15	31	026	03	5				STOCK WELL

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267556 Longitude -114.405667
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Rotary

Proposed Well Use
Domestic

Type of Work
New Well

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
2.44		Clay & Rocks
27.43		Lost Circulation Gravel
28.96		Shattered Shale
32.92		Brown Sandstone
34.75		Gray Sandstone
45.72		Shale & Sandstone Ledges
47.24	Yes	Water Bearing Sandstone
50.29	Yes	Water Bearing Shale
50.90	Yes	Water Bearing Sandstone
53.95		Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate 27.28 L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)
2003/01/20	24.55	32.64

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
53.95 m		2003/01/15	2003/01/17

Borehole

Diameter (cm)	From (m)	To (m)
22.23	0.00	53.95

Surface Casing (if applicable)
Steel
Size OD : 14.13 cm
Wall Thickness : 0.478 cm
Bottom at : 30.18 m

Well Casing/Liner
Plastic
Size OD : 11.43 cm
Wall Thickness : 0.544 cm
Top at : 23.47 m
Bottom at : 53.95 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)
43.28	50.90	0.635		25.40

Perforated by Saw

Annular Seal Driven & Bentonite
Placed from 0.00 m to 30.18 m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Unknown Grain Size
Amount Unknown

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
WILLIAM PENROD

Company Name
M&M DRILLING CO. LTD.

Certification No
A000187

Copy of Well report provided to owner Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID 1475699
GoA Well Tag No.
Drilling Company Well ID
Date Report Received

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
QUICK WAY FARMS LTD	P.O. BOX 1719	BROOKS	AB	CA	T1R 1C5

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	15	31	026	03	5				STOCK WELL

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.267556 Longitude -114.405667
How Location Obtained
Hand held autonomous GPS 20-30m

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 60.96 cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate 27.28 L/min
Recommended Pump Intake Depth (From TOC) 42.67 m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS) Depth m
Gas Depth m
Well Disinfected Upon Completion
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

FIELD TEST 300 TDS MOD HARD BAILED @ 7 IGM, GPS # 51-16-03.2, W-114-24-20.4, -114.4034, BOREHOLE DIAMETER 8.75" TO 99' & 5.125" 177', 90' - 95' SHATTERED SHALE (LOSS CIRCULATION),

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
2003/01/20	12:00 AM	32.64 m

Method of Water Removal

Type Pump
Removal Rate 24.55 L/min
Depth Withdrawn From 53.34 m

If water removal period was < 2 hours, explain why

Depth to water level

Drawdown (m)	Elapsed Time Minutes:Sec	Recovery (m)
35.07	1:00	36.99
35.73	2:00	36.20
35.83	3:00	36.12
36.01	4:00	36.02
36.22	5:00	35.91
36.37	6:00	35.79
36.49	7:00	35.72
36.62	8:00	35.61
31.24	9:00	35.45
36.86	10:00	35.41
36.96	12:00	35.29
37.11	14:00	35.16
36.91	16:00	35.05
37.40	20:00	34.88
37.58	25:00	34.75
37.76	30:00	34.59
37.90	35:00	34.50
38.01	40:00	34.40
38.28	50:00	34.27
38.43	60:00	34.14
38.71	75:00	34.03
38.91	90:00	33.91
39.09	105:00	33.83
39.24	120:00	33.74

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
WILLIAM PENROD

Certification No
A000187

Company Name
M&M DRILLING CO. LTD.

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

View in Imperial **Export to Excel**

GIC Well ID	1556533
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION HOLE #5

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.258118 Longitude -114.396505

How Location Obtained

Differential corrected handheld GPS 5-10m

Elevation 1270.00 m

How Elevation Obtained

Differential corrected handheld GPS 5-10m

Drilling Information

Method of Drilling
Rotary - Mud

Type of Work
Other

Proposed Well Use
Monitoring

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
0.30		Black Topsoil
6.40		Brown Clay
11.89		Gray Gravel
13.72		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
13.72 m	13.72 m	2014/05/08	2014/05/08

Borehole

Diameter (cm)	From (m)	To (m)
14.29	0.00	13.72

Surface Casing (if applicable)

Size OD : cm

Wall Thickness : cm

Bottom at : m

Well Casing/Liner

Plastic

Size OD : 6.35 cm

Wall Thickness : 0.516 cm

Top at : -0.91 m

Bottom at : 13.72 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Bentonite Chips/Tablets

Placed from 0.91 m to 9.75 m

Amount 300.00 Pounds

Other Seals

Type	At (m)

Screen Type Slotted PVC

Size OD : 6.35 cm

From (m)	To (m)	Slot Size (cm)
10.67	13.72	0.254

Attachment Attached To Casing

Top Fittings Riser Pipe

Bottom Fittings Plug

Pack

Type Sand

Grain Size 10-20

Amount 200.00 Pounds

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Certification No
46340A

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID 1556533
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION HOLE #5

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.258118 Longitude -114.396505
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1270.00 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 91.44 cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion Yes
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
LOCKABLE PROTECTOR PIPE INSTALLED AND CONCRETED INTO THE GROUND.

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
TOWN OF OKOTOKS	1818.44 L	2014/05/08 7:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Certification No
46340A

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government
of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID	1556534
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION WELL #6

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.257155 Longitude -114.394328
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1277.00 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Drilling Information

Method of Drilling
Rotary - Mud

Proposed Well Use
Monitoring

Type of Work
Other

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
5.79		Brown Sandy Clay & Rocks
8.84		Gray Gravel
10.97		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
10.97 m	10.97 m	2014/05/12	2014/05/12

Borehole

Diameter (cm)	From (m)	To (m)
14.29	0.00	10.97

Surface Casing (if applicable)
Size OD : cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Plastic
Size OD : 6.35 cm
Wall Thickness : 0.518 cm
Top at : -0.91 m
Bottom at : 10.97 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Bentonite Chips/Tablets
Placed from 0.91 m to 7.01 m
Amount 200.00 Pounds

Other Seals

Type	At (m)

Screen Type Slotted PVC
Size OD : 6.35 cm

From (m)	To (m)	Slot Size (cm)

Attachment Attached To Casing
Top Fittings Riser Pipe
Bottom Fittings Plug

Pack
Type Sand
Grain Size 10-20
Amount 200.00 Pounds

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Company Name
NIEMANS DRILLING (1980) LTD.

Certification No
46340A

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

GIC Well ID 1556534
GoA Well Tag No.
Drilling Company Well ID
Date Report Received 2014/06/04

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy. The information on this report will be retained in a public database.

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION WELL #6

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.257155 Longitude -114.394328
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1277.00 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 91.44 cm
Is Artesian Flow
Rate L/min
Is Flow Control Installed
Describe

Recommended Pump Rate L/min
Recommended Pump Intake Depth (From TOC) m
Pump Installed
Depth m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Gas
Depth m
Well Disinfected Upon Completion Yes
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well
INSTALLED LOCKABLE PROTECTOR CASING AND CONCRETED INTO THE GROUND.

Yield Test

Taken From Ground Level Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal
Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
TOWN OF OKOTOKS	2727.66 L	2014/05/12 7:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Certification No
46340A

Company Name
NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government
of Alberta ■

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID	1556535
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION WELL #7

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.255906 Longitude -114.392635
How Location Obtained
Differential corrected handheld GPS 5-10m

Elevation 1273.00 m
How Elevation Obtained
Differential corrected handheld GPS 5-10m

Drilling Information

Method of Drilling
Rotary - Mud

Proposed Well Use
Monitoring

Type of Work
Other

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
3.66		Brown Clay & Rocks
11.28		Gray Gravel
12.19		Gray Shale

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
12.19 m	12.19 m	2014/05/13	2014/05/13

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Size OD : cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Plastic
Size OD : 6.35 cm
Wall Thickness : 0.518 cm
Top at : -0.91 m
Bottom at : 12.19 m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal Bentonite Chips/Tablets
Placed from 0.91 m to 8.23 m
Amount 250.00 Pounds

Other Seals

Type	At (m)

Screen Type Plastic
Size OD : 6.35 cm

From (m)	To (m)	Slot Size (cm)
9.14	12.19	0.000

Attachment Attached To Casing
Top Fittings Riser Pipe
Bottom Fittings Plug

Pack
Type Sand
Grain Size 10-20
Amount 200.00 Pounds

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
CHAD NIEMANS

Company Name
NIEMANS DRILLING (1980) LTD.

Certification No
46340A

Copy of Well report provided to owner
Yes

Date approval holder signed
2014/06/04

Government of Alberta

Water Well Drilling Report

View in Imperial **Export to Excel**

GIC Well ID	1556535
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/06/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
SOUTH ROCK LTD	P.O. BOX 460	MEDICINE HAT	ALBERTA	CANADA	T1A 7G2

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	4	32	26	3	5				OBSERVATION WELL #7

Measured from Boundary of

m from

m from

GPS Coordinates in Decimal Degrees (NAD 83)

Latitude 51.255906 Longitude -114.392635

How Location Obtained

Differential corrected handheld GPS 5-10m

Elevation 1273.00 m

How Elevation Obtained

Differential corrected handheld GPS 5-10m

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level 91.44 cm

Is Artesian Flow

Is Flow Control Installed

Rate L/min

Describe

Recommended Pump Rate L/min

Pump Installed

Depth m

Recommended Pump Intake Depth (From TOC) m

Type

Make

H.P.

Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)

Depth m

Well Disinfected Upon Completion Yes

Gas

Depth m

Geophysical Log Taken

Submitted to ESRD

Sample Collected for Potability

Submitted to ESRD

Additional Comments on Well

INSTALLED LOCKABLE PROTECTOR CASING AND CONCRETED INTO THE GROUND.

Yield Test

Taken From Ground Level

Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type

Removal Rate L/min

Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
TOWN OF OKOTOKS	1818.44 L	2014/05/12 7:00 AM

Contractor Certification

Name of Journeyman responsible for drilling/construction of well

CHAD NIEMANS

Certification No

46340A

Company Name

NIEMANS DRILLING (1980) LTD.

Copy of Well report provided to owner

Yes

Date approval holder signed

2014/06/04

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID	2095665
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/12/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CIRCLE J RANCHES LTD	RR 2	COCHRANE	ALBERTA	CANADA	T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	6	27	3	5				M. GILES

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274608 Longitude -114.417737
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Drilling Information

Method of Drilling
Unknown

Proposed Well Use
Domestic & Stock

Type of Work
Well Inventory

Formation Log

Measurement in Metric

Depth from ground level (m)	Water Bearing	Lithology Description
25.60		Old Well

Yield Test Summary

Measurement in Metric

Recommended Pump Rate L/min

Test Date	Water Removal Rate (L/min)	Static Water Level (m)

Well Completion

Measurement in Metric

Total Depth Drilled	Finished Well Depth	Start Date	End Date
25.60 m		1934/06/30	

Borehole

Diameter (cm)	From (m)	To (m)

Surface Casing (if applicable)
Size OD : cm
Wall Thickness : cm
Bottom at : m

Well Casing/Liner
Size OD : cm
Wall Thickness : cm
Top at : m
Bottom at : m

Perforations

From (m)	To (m)	Diameter or Slot Width(cm)	Slot Length(cm)	Hole or Slot Interval(cm)

Perforated by

Annular Seal
Placed from m to m
Amount

Other Seals

Type	At (m)

Screen Type
Size OD : cm

From (m)	To (m)	Slot Size (cm)

Attachment
Top Fittings Bottom Fittings

Pack
Type Grain Size
Amount

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN DRILLER11

Certification No
11

Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner
Date approval holder signed

Government of Alberta

Water Well Drilling Report

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View in Imperial **Export to Excel**

GIC Well ID	2095665
GoA Well Tag No.	
Drilling Company Well ID	
Date Report Received	2014/12/04

Well Identification and Location

Measurement in Metric

Owner Name	Address	Town	Province	Country	Postal Code
CIRCLE J RANCHES LTD	RR 2	COCHRANE	ALBERTA	CANADA	T0L 0W0

Location	1/4 or LSD	SEC	TWP	RGE	W of MER	Lot	Block	Plan	Additional Description
	SW	6	27	3	5				M. GILES

Measured from Boundary of
m from
m from

GPS Coordinates in Decimal Degrees (NAD 83)
Latitude 51.274608 Longitude -114.417737
How Location Obtained
Not Verified

Elevation m
How Elevation Obtained
Not Obtained

Additional Information

Measurement in Metric

Distance From Top of Casing to Ground Level cm
Is Artesian Flow
Is Flow Control Installed
Rate L/min
Describe

Recommended Pump Rate L/min
Pump Installed
Depth m
Recommended Pump Intake Depth (From TOC) m
Type
Make
H.P.
Model (Output Rating)

Did you Encounter Saline Water (>4000 ppm TDS)
Depth m
Well Disinfected Upon Completion
Gas
Depth m
Geophysical Log Taken
Submitted to ESRD
Sample Collected for Potability
Submitted to ESRD

Additional Comments on Well

ORIGINAL WELL REPORT NOT IN GIC. THE FOLLOWING INFORMATION WAS TAKEN FROM DROUGHT EMERGENCY GROUNDWATER TESTING PROGRAM APPLICATION RECEIVED ON DECEMBER 04, 1984. OWNER REPORTS THIS WELL WAS BAILED OUT TO 4 FEET OF WATER, TOOK 1 DAY TO RECOVER, WERE GETTING 1 GPM CONSISTENTLY. OWNER REPORTS THAT WELL WAS CONSTRUCTED IN APPROXIMATELY 1934 AND IS APPROXIMATELY 84 FEET DEEP. ALREADY DRILLED ANOTHER WELL 391000.

Yield Test

Taken From Ground Level
Measurement in Metric

Test Date	Start Time	Static Water Level
		m

Method of Water Removal

Type
Removal Rate L/min
Depth Withdrawn From m

If water removal period was < 2 hours, explain why

Water Diverted for Drilling

Water Source	Amount Taken	Diversion Date & Time
	L	

Contractor Certification

Name of Journeyman responsible for drilling/construction of well
UNKNOWN DRILLER11

Certification No
11

Company Name
UNKNOWNDRILLINGCOMP11

Copy of Well report provided to owner
Date approval holder signed

APPENDIX D
Residential Well Assessment Questionnaires

Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003

Water Well Reconnaissance Survey

SLR

SITE RECONNAISSANCE CHECKLIST

Project Name: WATERMAN AGGREGATE RESOURCE

Project Number: 203-30065.00001 **SLR Staff:** R. TILL

Street Address: [redacted] - NW 31-26-3 W5M - 35181 BIG HILL SPRINGS ROAD

Property Type: Private Residence ☑ Commerical/Industrial ☐ Other

Person/Resident Interviewed: JULIE THORESON, BRUCE WATERMAN

Date of Visit: 29 OCT 2014 **Time:** 10:15

1. Well Owner Information

Name: BRUCE WATERMAN

Street Address:

Contact Number: **Home:** **Business:** **Cell:**

Email Address:

2. Well User/Occupant of the Residence Using the Well

Same as Well Owner ☐

If different from well owner please fill out details below:

Name: JULIE THORESON

Street Address:

Contact Number: **Home:** **Business:** **Cell:**

Email Address:

3. Well Details

Well Location **Lot:** NW 31-26-3 W5M **Concession:** **Township:**

3A. Well Use

Water Use: NO DRINKING, USES BOTTLED WATER

Domestic: ☑ **No. of people using water from the well:** 1

Livestock: ☑ **No. of livestock using water from the well:** 7 HORSES + SHEEP + GOAT

Lawn Watering: ☐ **Acres/area covered:** **Approximate Amount:**

Irrigation: ☐ **Acres/area covered:** **Approximate Amount:**

3A. Well Use Continued

Additional Equipment: Pool: ☐ Jacuzzi/Hot Tub: ☐ Landscape water feature/fountain: ☐

Other: ______

Private waste and water disposal: Type (ex. Speptic tank): SEPTIC TANK

System description: 1000 GAL TANK

Distance to Well 75ft Direction from well (N, S, E, or W) W

Well is Uphill ☐ Downhill ☐ Same Grade ☑ as the waste water system

3B. Well Construction Details

Construction/Installation Date: UNKNOWN PRE-1960 Contractor: ______

Type of Installation: Drilled ☑ Dug ☐ Other: ______

Diameter: 6/8 INCH Well Depth (m): ~ 400ft

Screen? UNKNOWN YES ☐ NO ☐

Screen length (m) ______

Depth to top of screen (m) ______

MOE Record Number: ______

Confirmed ☐ Inferred ☐

Is the well accesible for sampling? YES ☐ NO ☑

If no provide details: WELL HEAD APPROXIMATELY 2m BELOW GROUND LEVEL IN A PIT

Location of measurement (top of pipe (TOP), ground surface): —

SLR staff member collecting the measurement: —

Date of original measurement: — Original/initial water level depth (m)

Subsequent water level measurements

Date						
Depth (m)						
Staff						

3C. Pumping Equipment

Pump Type: Suction-lift ☐ Pumping Capacity ______

Positive-submergence ☐ Age ______

How is the pump lubricated? ______

Depth of intake setting: Original (m) ______ Present (m) 100+ft Pumping Rate (L/s) ______

Storage Tank: Type: CISTERN Capacity: 1000 GAL

Additional Features: Chlorinator ☐ Water softener ☐ Water filter ☐ Filter type: ______

NO TREATMENT

SLR

4. Well History

How long have you owned, operated or lived on this property? 7 YEARS

Have you ever experienced any previous problems with your well? SAND IN WELL

If so, when? ONGOING

What was the cause of the previous problem:

Drought		Pump Failure	
Plugging		Increased usage	
Interference		Contamination	✓

If the problem was contamination, what water quality changes were apparent? (Note any differences in taste, odour, colour or clarity)

SAND IN CISTERN, PIPES ETC

What action was taken to overcome this problem? FLUSHING, + CHLORINATED

What were the effects of this action? CLEARED PROBLEM BUT PROBLEM CAME BACK

Did you ever have your well?

deepend,	YES	☐	NO	☑	
cleaned,	YES	☑	NO	☐	SHOCKED
or a new well	YES	☐	NO	☑	

If so why?

Outline briefly any previous repairs or changes in pumping equipment, and dates

5. Sample Details – TAKEN FROM KITCHEN TAP – (NO TREATMENT ON SITE)

Date: 29/10/14

Sample Collected? YES ☑ NO ☐

Sample Name/Number: WW1

Number of Bottles: 2

Field Analysis

Harness	Iron	Conductivity
pH	Temperature	Other

6. Contact Details

Permission for future monitoring? YES ☑ NO ☐

Well Aware Booklet:

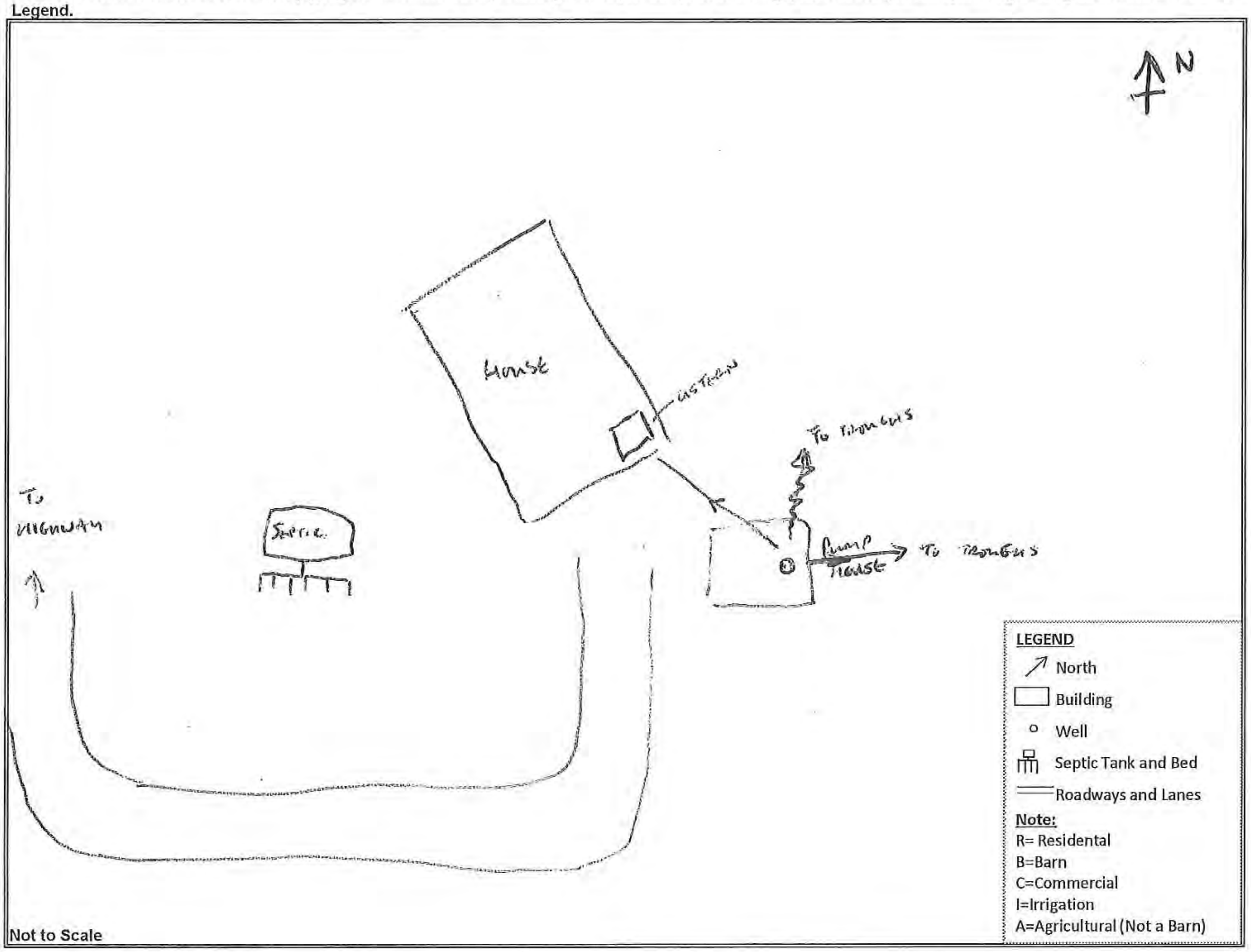
Perferred contact time/method: call/contact ahead ☑ site visit ☐

Contact by: email ☐ phone ☑ perferred contact number:

preferred contact time (evening, weekday, morning, etc.): ANY TIME DURING DAY

7. Well Location Sketch

Notes: shown location of water well(s), septic tanks and beds, laneways/roads, fences, site buildings, north arrow, and any distinguishing site features. Include Legend.



Not to Scale

Well GPS ____________ , ____________ , ____________

8. Site Photograph Log

Number of Photos Taken: ____________

Photograph Number/Name	Description

SLR

Water Well Reconnaissance Survey

SITE RECONNAISSANCE CHECKLIST

Project Name: WATERMAN AGGREGATE RESOURCE

Project Number: 203.50065.00001 **SLR Staff:** R.TILL

Street Address: SE 31-26-3 WSM

Property Type: **Private Residence** ☑ **Commerical/Industrial** ☐ **Other** _____

Person/Resident Interviewed: MRS PARKER

Date of Visit: PHONE CALL 10 DEC 2014 **Time:** 16:30

1. Well Owner Information

Name: MRS PARKER

Street Address: BOX 123 SE 31 26 3 WSM

Contact Number: **Home:** **Business:** **Cell:**

Email Address:

2. Well User/Occupant of the Residence Using the Well

Same as Well Owner ☑

If different from well owner please fill out details below:

Name:

Street Address:

Contact Number: **Home:** **Business:** **Cell:**

Email Address:

3. Well Details

Well Location **Lot:** IN HOUSE **Concession:** SE 31-26-3 WSM **Township:**

3A. Well Use

4 WELLS

Water Use:

Domestic: ☑ **No. of people using water from the well:** 2

Livestock: ☑ **No. of livestock using water from the well:** 100 HEAD CATTLE

Lawn Watering: ☐ **Acres/area covered:** _____ **Approximate Amount:** _____

Irrigation: ☐ **Acres/area covered:** _____ **Approximate Amount:** _____

3 ARTESIAN WELLS

3A. Well Use Continued

Additional Equipment: Pool: ☐ Jacuzzi/Hot Tub: ☐ Landscape water feature/fountain: ☐

Other:

Private waste and water disposal: Type (ex. Spectic tank): SEPTIC TANK

System description:

Distance to Well 100 ft Direction from well (N, S, E, or W) DEPENDS ON WELL

Well is Uphill ☑ Downhill ☐ Same Grade ☐ as the waste water system

3B. Well Construction Details

Construction/Installation Date: 1920's Contractor: OWNER

Type of Installation: Drilled ☐ Dug ☑ Other:

Diameter: 6" or 8" Well Depth (m): 20 - 25 feet

Screen? YES ☑ NO ☐

Screen length (m)

Depth to top of screen (m)

MOE Record Number:

Confirmed ☐ Inferred ☐

Is the well accesible for sampling? YES ☐ NO ☑

If no provide details: IN THE HOUSE

Location of measurement (top of pipe (TOP), ground surface):

SLR staff member collecting the measurement:

Date of original measurement: Original/initial water level depth (m) 3 ARTESIAN - 10 ft BELOW GROUND

Subsequent water level measurements

Date						
Depth (m)						
Staff						

3C. Pumping Equipment

Pump Type: Suction-lift ☐ SUBMERSIBLE Pumping Capacity

Positive-submergence ☐ Age

How is the pump lubricated?

Depth of intake setting: Original (m) Present (m) Pumping Rate (L/s)

Storage Tank: NO Type: Capacity:

Additional Features: NO TREATMENT Chlorinator ☐ Water softener ☐ Water filter ☐ Filter type:

4. Well History

How long have you owned, operated or lived on this property? 1955

Have you ever experienced any previous problems with your well? NO

If so, when?

What was the cause of the previous problem:

Drought / Pump Failure /

Plugging / Increased usage /

Interference / Contamination /

If the problem was contamination, what water quality changes were apparent? (Note any differences in taste, odour, colour or clarity)

What action was taken to overcome this problem?

What were the effects of this action?

Did you ever have your well?

deepend, YES ☐ NO ☑

cleaned, YES ☐ NO ☑

or a new well YES ☐ NO ☑

If so why?

Outline briefly any previous repairs or changes in pumping equipment, and dates 1966/67 Pumps

5. Sample Details

Date:

Sample Collected? YES ☐ NO ☐

Sample Name/Number:

Number of Bottles:

Field Analysis

Harness

Iron

Conductivity

pH

Temperature

Other

6. Contact Details

Permission for future monitoring? YES ☐ NO ☑ – NOT UNTIL AFTER XMAS

Well Aware Booklet:

Perferred contact time/method: call/contact ahead ☐ site visit ☐

Contact by: email ☐ phone ☐ perferred contact number:

preferred contact time (evening, weekday, morning, etc.):

7. Well Location Sketch

Notes: shown location of water well(s), septic tanks and beds, laneways/roads, fences, site buildings, north arrow, and any distinguishing site features. Include Legend.

LEGEND

↗ North

▭ Building

○ Well

╥ Septic Tank and Bed

═ Roadways and Lanes

Note:

R= Residental

B=Barn

C=Commercial

I=Irrigation

A=Agricultural (Not a Barn)

Not to Scale

Well GPS ________________, ________________, ________________

8. Site Photograph Log

Number of Photos Taken: ________________

Photograph Number/Name	**Description**

Water Well Reconnaissance Survey

SITE RECONNAISSANCE CHECKLIST

Project Name: WATERMAN AGGREGATE RESOURCE

Project Number: 203.50065.00001 **SLR Staff:** R. TILL

Street Address: NE 31-26-3 WSM

Property Type: Private Residence ☑ Commerical/Industrial ☐ Other

Person/Resident Interviewed: CALVIN [redacted] RAWN

Date of Visit: 29 OCT 2014 **Time:** 12:00

1. Well Owner Information

Name: CALVIN RAWN

Street Address: AS ABOVE

Contact Number: **Home:** **Business:** **Cell:**

Email Address:

2. Well User/Occupant of the Residence Using the Well

Same as Well Owner ☑

If different from well owner please fill out details below:

Name:

Street Address:

Contact Number: **Home:** **Business:** **Cell:**

Email Address:

3. Well Details

Well Location **Lot:** NE 31-26-3 WSM **Concession:** **Township:**

3A. Well Use

2 WELLS

Water Use:

Domestic:	☑	**No. of people using water from the well:**	5	(WW 2)
Livestock:	☑	**No. of livestock using water from the well:**	40 HORSES	(WW 3)
Lawn Watering:	☐	**Acres/area covered:**	**Approximate Amount:**	
Irrigation:	☐	**Acres/area covered:**	**Approximate Amount:**	

3A. Well Use Continued

Additional Equipment: Pool: ☐ Jacuzzi/Hot Tub: ☐ Landscape water feature/fountain: ☐

Other:

Private waste and water disposal: Type (ex. Spectic tank): SEPTIC TANK

System description:

Distance to Well 2-300 ft Direction from well (N, S, E, or W) EAST

Well is Uphill ☐ Downhill ☐ Same Grade ☑ as the waste water system

3B. Well Construction Details

Construction/Installation Date: Contractor:

Type of Installation: Drilled ☑ Dug ☐ Other:

Diameter: 6 INCH Well Depth (m): HOUSE 177 + BARN 135 ft

Screen? YES ☐ NO ☐

Screen length (m)

Depth to top of screen (m)

MOE Record Number:

Confirmed ☐ Inferred ☐

Is the well accesible for sampling? YES ☑ (WW2) NO ☑ (WW3)

If no provide details: WW3 BLOCKED @ 27.5mbTOP

Location of measurement (top of pipe (TOP), ground surface): TOP

SLR staff member collecting the measurement: ROBERT TILL

Date of original measurement: 29/OCT/2014 Original/initial water level depth (m) 29.65mbTOP (WW2)

Subsequent water level measurements - WW2 - LOGGER INSTALLED

Date						
Depth (m)						
Staff						

3C. Pumping Equipment

Pump Type: Suction-lift ☐ SUBMERSIBLE Pumping Capacity —

Positive-submergence ☐ Age 10 YRS + 5 YRS

How is the pump lubricated?

Depth of intake setting: Original (m) Present (m) WW2 160ft + WW3 125ft Pumping Rate (L/s)

Storage Tank: Type: CISTERN Capacity: WW2 400 GAL (HOUSE) + WW3 750 GAL

Additional Features: Chlorinator ☐ Water softener ☑ HOUSE Water filter ☑ HOUSE Filter type: PARTICULATE

4. Well History

How long have you owned, operated or lived on this property? 10 YRS

Have you ever experienced any previous problems with your well? NO

If so, when?

What was the cause of the previous problem: Drought — Pump Failure — Plugging — Increased usage — Interference — Contamination —

If the problem was contamination, what water quality changes were apparent? (Note any differences in taste, odour, colour or clarity)

N/A

What action was taken to overcome this problem? N/A

What were the effects of this action? N/A

Did you ever have your well?

deepend, YES ☐ NO ☑

cleaned, YES ☐ NO ☑

or a new well YES ☐ NO ☑

If so why?

Outline briefly any previous repairs or changes in pumping equipment, and dates REPLACED HOUSE PUMP

5. Sample Details

WW2 - STANDPIPE AT BACK OF PUMP HOUSE, WW3 - HOSE IN STABLES (NO TREATMENT)

Date: 29 OCT 2014

Sample Collected? YES ☑ NO ☐

Sample Name/Number: WW2 + WW3

Number of Bottles: 2 EACH

Field Analysis

Harness

Iron

Conductivity 577 µS/cm

pH 7.62

Temperature 6.4°C

Other

6. Contact Details

Permission for future monitoring? YES ☑ NO ☐

Well Aware Booklet: —

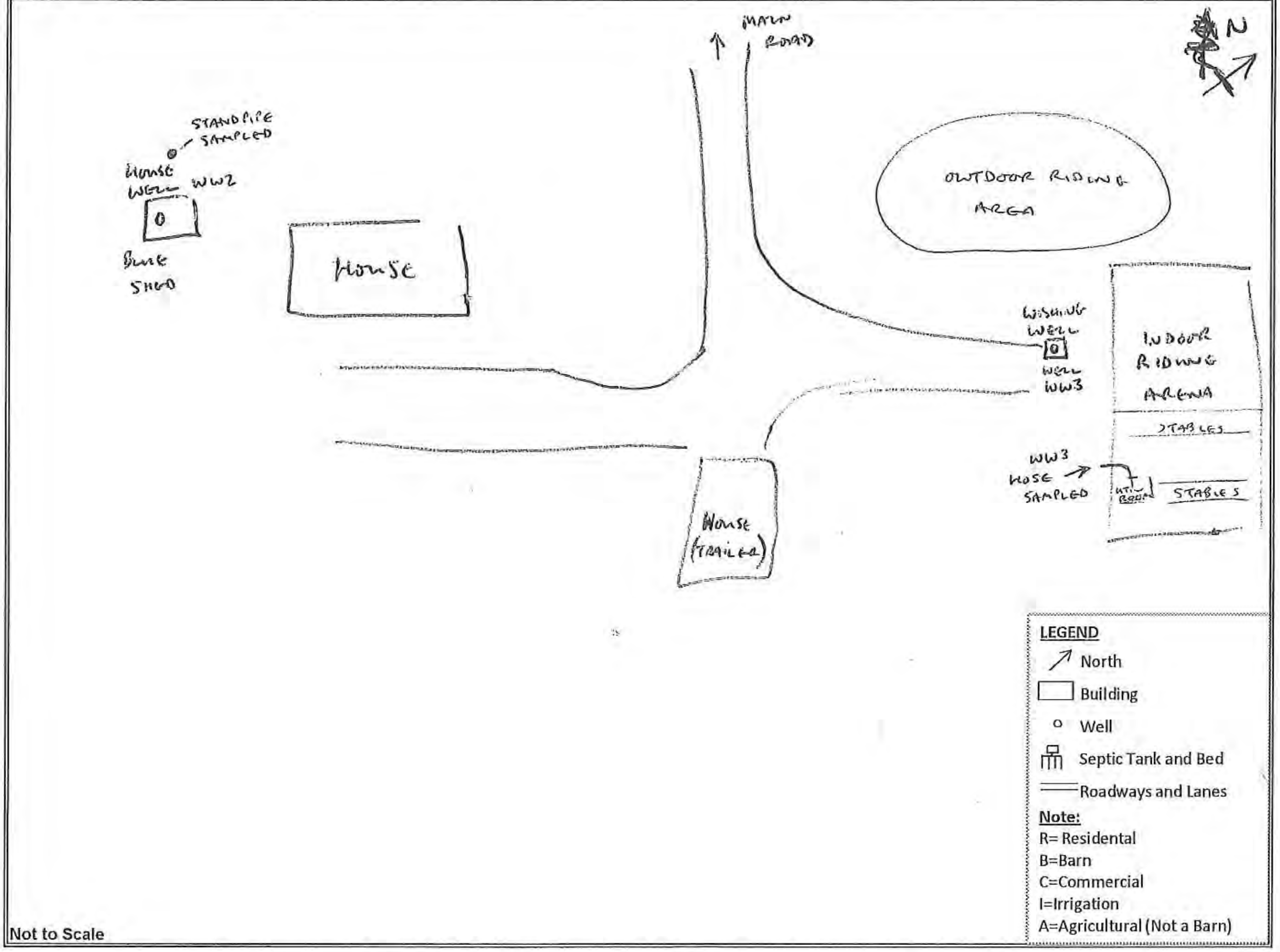
Perferred contact time/method: call/contact ahead ☑ site visit ☐

Contact by: email ☐ phone ☐ perferred contact number: —

preferred contact time (evening, weekday, morning, etc.): DURING DAY - ANY REASONABLE HOUR

7. Well Location Sketch

Notes: shown location of water well(s), septic tanks and beds, laneways/roads, fences, site buildings, north arrow, and any distinguishing site features. Include Legend.



Not to Scale

Well GPS WW2 - 0680992 m , 5682772 m WW3 - 0681169 m , 5682906 m

8. Site Photograph Log

Number of Photos Taken: ____________________

Photograph Number/Name	**Description**

Water Well Reconnaissance Survey

SITE RECONNAISSANCE CHECKLIST

Project Name: WATERMAN AGGREGATE RESOURCE

Project Number: 203.50065.00001 **SLR Staff:** R. TILL

Street Address: SW 31-26-03 WSM

Property Type: Private Residence ☑ Commerical/Industrial ☐ Other

Person/Resident Interviewed: JOHN NUGTER

Date of Visit: 30 OCTOBER 2014 **Time:** 11:20

1. Well Owner Information

Name: JOHN NUGTER

Street Address: AS ABOVE

Contact Number: **Home:** **Business:** **Cell:** [redacted]

Email Address:

2. Well User/Occupant of the Residence Using the Well

Same as Well Owner ☑

If different from well owner please fill out details below:

Name:

Street Address:

Contact Number: **Home:** **Business:** **Cell:**

Email Address:

3. Well Details

Well Location **Lot:** SW.31-26-03 WSM **Concession:** **Township:**

3A. Well Use

Water Use:

Domestic: ☑ No. of people using water from the well: 3

Livestock: ☑ No. of livestock using water from the well: 25 CATTLE, 5 HORSES

Lawn Watering: ☐ Acres/area covered: Approximate Amount:

Irrigation: ☐ Acres/area covered: Approximate Amount:

3A. Well Use Continued

Additional Equipment: Pool: ☐ Jacuzzi/Hot Tub: ☐ Landscape water feature/fountain: ☐

Other: ____________________

Private waste and water disposal: Type (ex. Spectic tank): SEPTIC TANKS (2 TANKS)

System description: 1 TANK FOR HOUSE + 1 FOR RENTAL HOUSE

Distance to Well __________ Direction from well (N, S, E, or W) __________

Well is Uphill ☐ Downhill ☐ Same Grade ☐ as the waste water system

3B. Well Construction Details

Construction/Installation Date: 1990 Contractor: LOU'S WATER WELL DRILLING

Type of Installation: Drilled ☑ Dug ☐ Other: __________

Diameter: __________ Well Depth (~~m~~): 115 ft

Screen? YES ☑ NO ☐

Screen length (m) __________

Depth to top of screen (m) __________

MOE Record Number: 350194

Confirmed ☑ Inferred ☐

Is the well accesible for sampling? YES ☑ NO ☐

If no provide details: __________

Location of measurement (top of pipe (TOP), ground surface): TOP

SLR staff member collecting the measurement: ROBERT TILL

Date of original measurement: 30 OCTOBER 2014 Original/initial water level depth (m) 11.734 mbTOC

Subsequent water level measurements

Date						
Depth (m)						
Staff						

3C. Pumping Equipment

Pump Type: Suction-lift ☐ Positive-submergence ☐ SUBMERSIBLE

Pumping Capacity 30 GAL/MIN

Age 2006

How is the pump lubricated? __________

Depth of intake setting: Original (m) __________ Present (m) 100ft ? Pumping Rate (L/s) __________

Storage Tank: Type: N/A Capacity: __________

Additional Features: Chlorinator ☐ Water softener ☐ Water filter ☐ Filter type: __________

NO TREATMENT

4. Well History

How long have you owned, operated or lived on this property? 17 YEARS

Have you ever experienced any previous problems with your well? NO

If so, when?

What was the cause of the previous problem:

Drought ______ Pump Failure ______

Plugging ______ Increased usage ______

Interference ______ Contamination ______

If the problem was contamination, what water quality changes were apparent? (Note any differences in taste, odour, colour or clarity)

What action was taken to overcome this problem?

What were the effects of this action?

Did you ever have your well?

deepend, YES ☐ NO ☑

cleaned, YES ☐ NO ☑

or a new well YES ☐ NO ☑

If so why?

Outline briefly any previous repairs or changes in pumping equipment, and dates CHANGED PUMP 2006

5. Sample Details

Date: 30 OCT 2014

Sample Collected? YES ☑ NO ☐

Sample Name/Number: WW4

Number of Bottles: 2

Field Analysis

Harness ______

Iron ______

Conductivity 606 µS/cm

pH 5.44 ?

Temperature 5.1°C

Other ______

6. Contact Details

Permission for future monitoring? YES ☑ NO ☐

Well Aware Booklet:

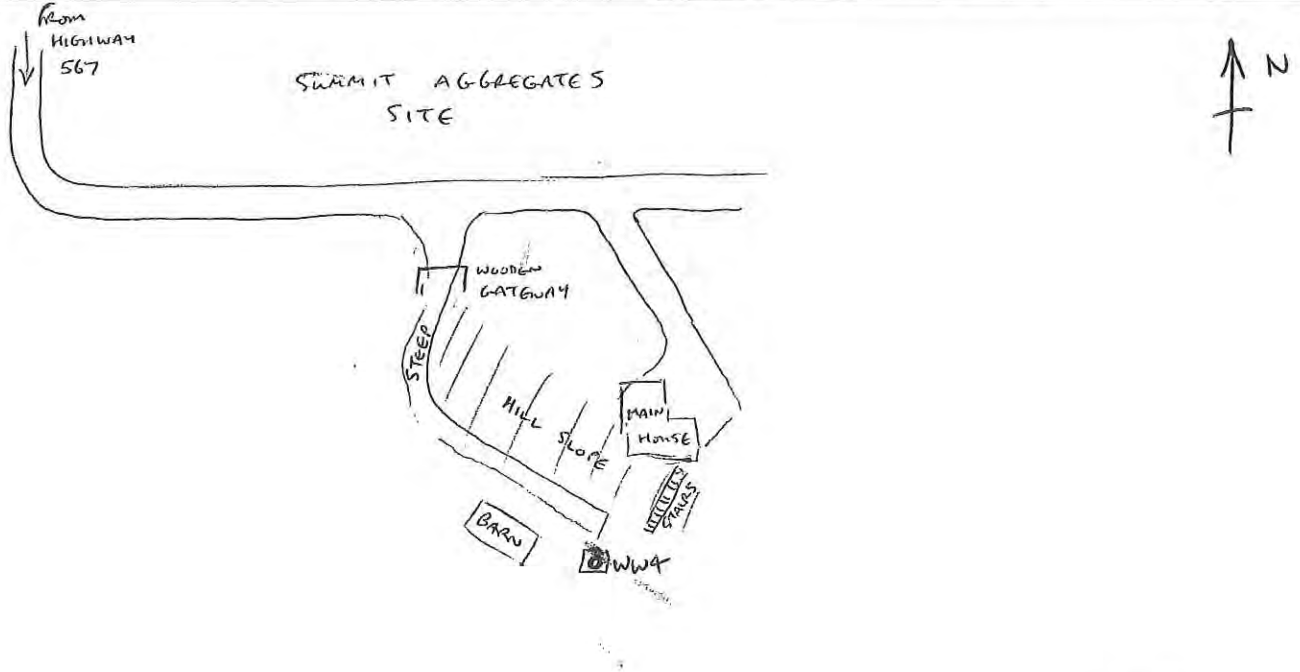
Perferred contact time/method: call/contact ahead ☑ site visit ☐

Contact by: email ☐ phone ☑ perferred contact number:

preferred contact time (evening, weekday, morning, etc.):

7. Well Location Sketch

Notes: shown location of water well(s), septic tanks and beds, laneways/roads, fences, site buildings, north arrow, and any distinguishing site features. Include Legend.



LEGEND

↗ North

▭ Building

o Well

Septic Tank and Bed

═ Roadways and Lanes

Note:
R= Residental
B=Barn
C=Commercial
I=Irrigation
A=Agricultural (Not a Barn)

Not to Scale

Well GPS 0680258 . 5682090 .

8. Site Photograph Log

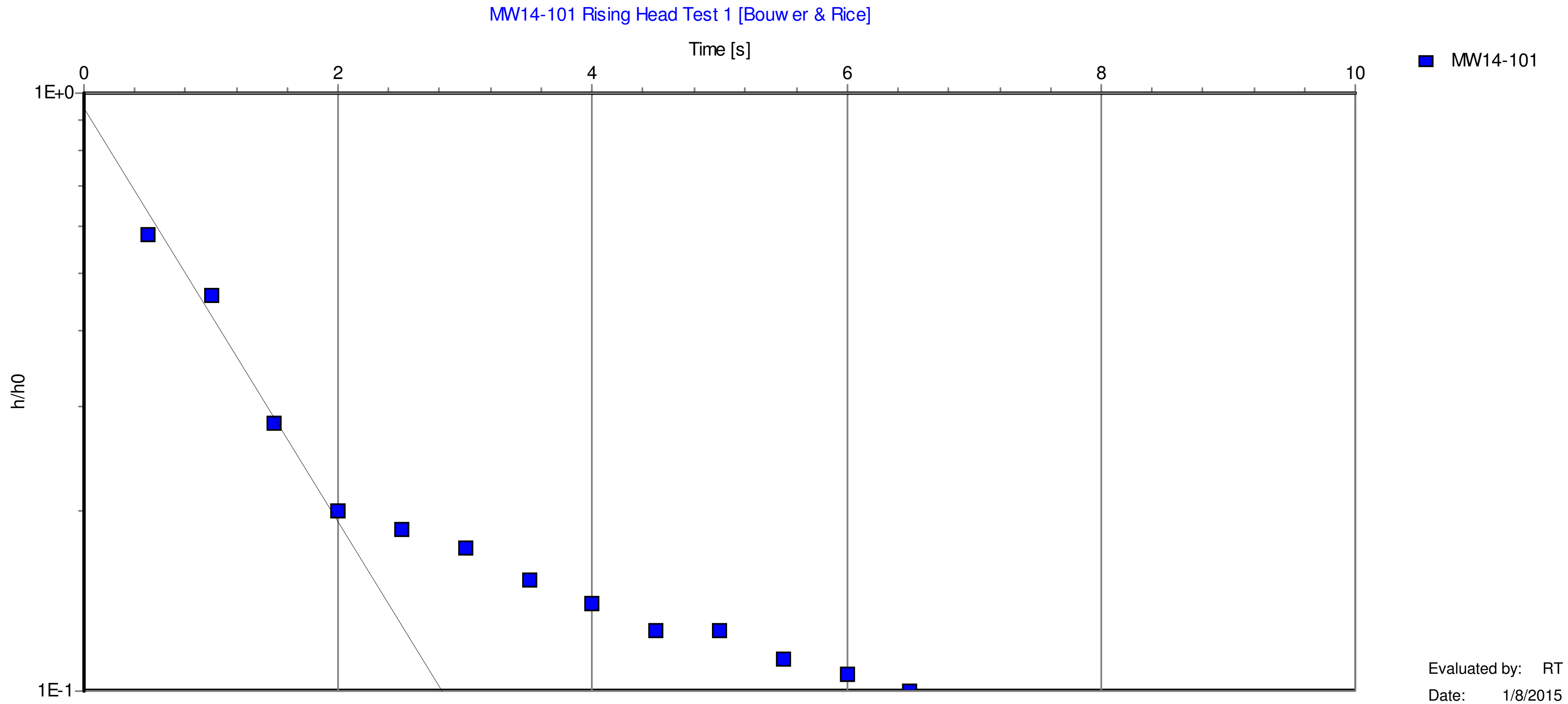
Number of Photos Taken: ____________

Photograph Number/Name	Description

APPENDIX E
Hydraulic Conductivity Test Analysis

Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003

Analysis Report	**Slug Test:** **MW14-101 Rising Head Test 1**
Project: Summit Aggregate Resource	**Analysis Method:** **Bouwer & Rice**
Number: 203.50065.00001	Comments:
Client: Summit Aggregates	Saturated screen length = 4.5 [m] Max. Head Change = 0.45 [m] R (eff) not used in analysis



Evaluated by: RT
Date: 1/8/2015

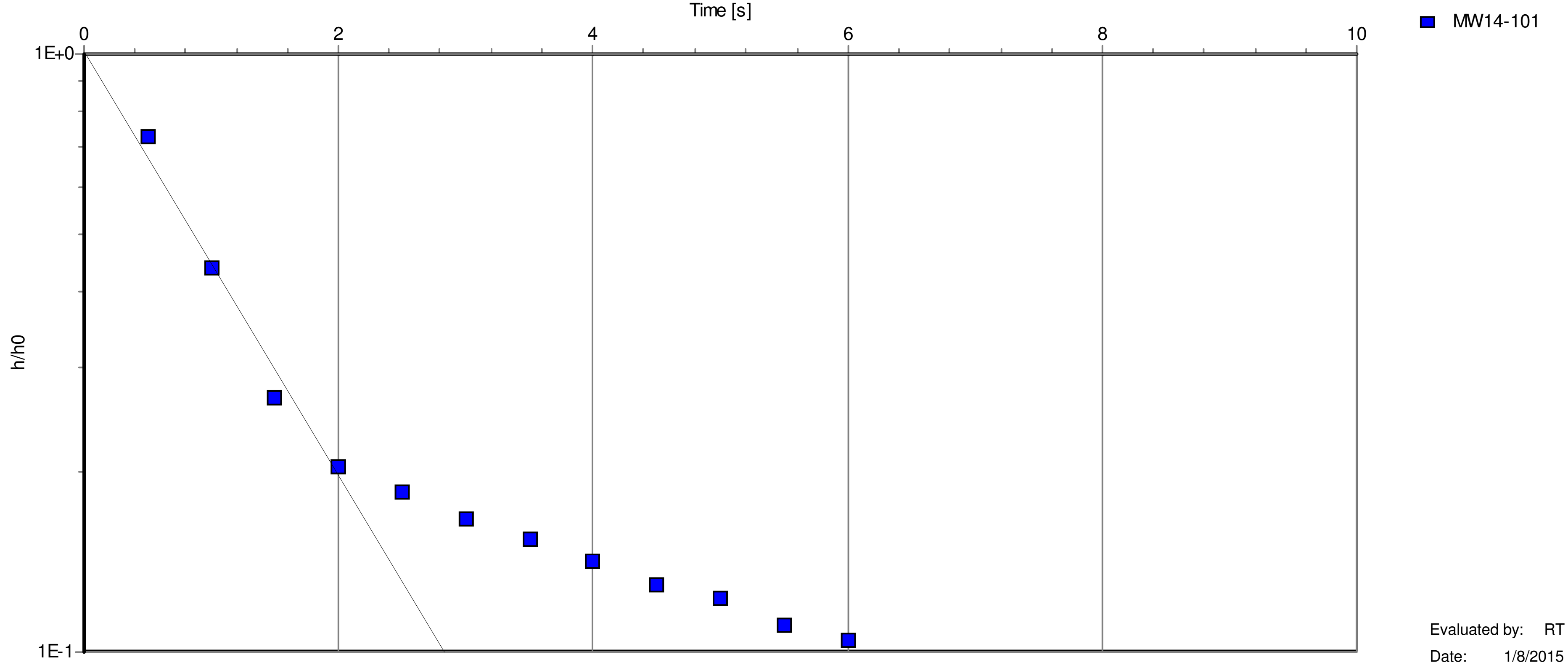
Analysis results: Conductivity: 1.85E-4 [m/s]

Test parameters:

Test Well:	MW14-101	r(eff):	0.044 [m]
Screen radius:	0.0254 [m]	Aquifer thickness:	5.325 [m]
Screen length:	4.5 [m]	Boring radius:	0.0762 [m]

	Analysis Report	**Slug Test:** **MW14-101 Rising Head Test 2**
	Project: Summit Aggregate Resource	**Analysis Method:** **Bouwer & Rice**
	Number: 203.50065.00001	Comments: Saturated screen length = 4.5 [m] Max. Head Change = 0.49 [m] R (eff) not used in analysis
	Client: Summit Aggregates	

MW14-101 Rising Head Test 2 [Bouwer & Rice]

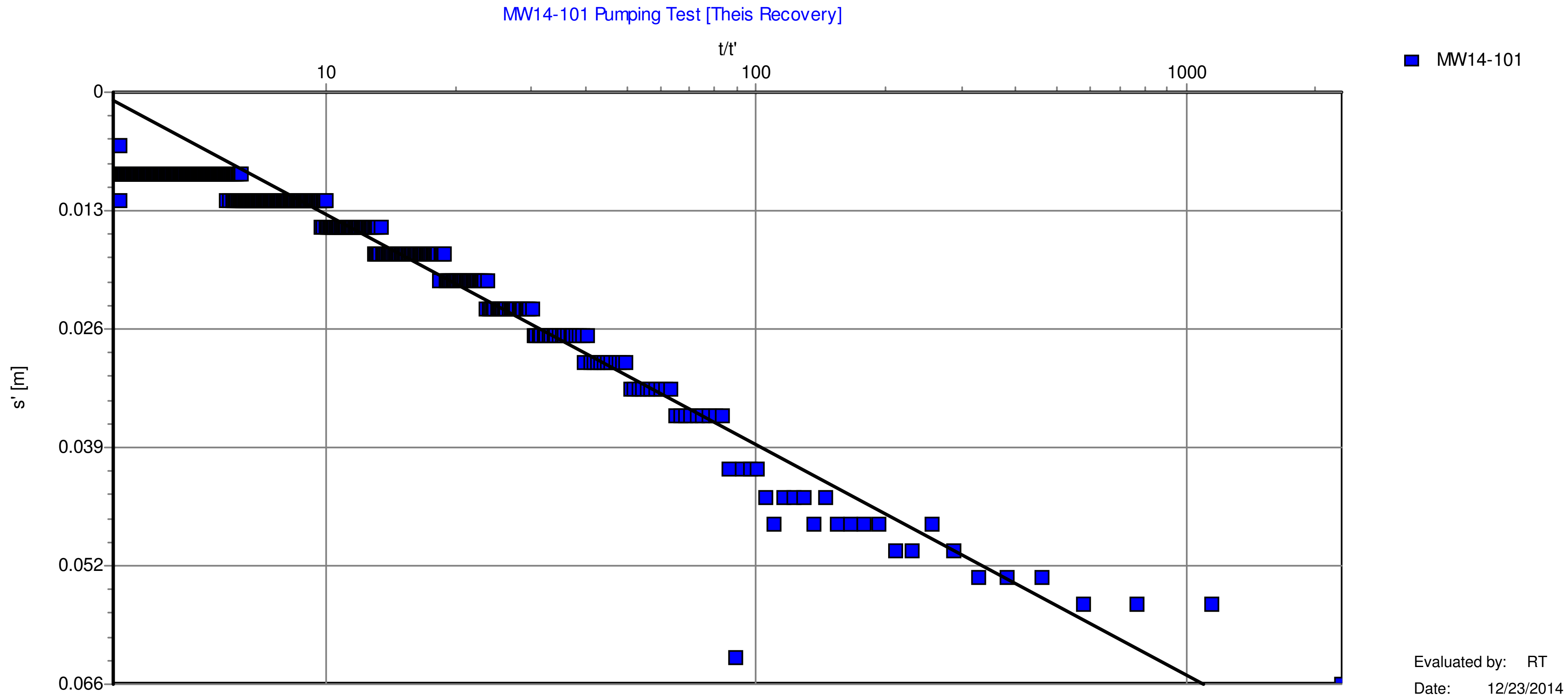


Evaluated by: RT
Date: 1/8/2015

Analysis results: Conductivity: 1.91E-4 [m/s]

Test parameters:	Test Well:	MW14-101	r(eff):	0.044 [m]
	Screen radius:	0.0254 [m]	Aquifer thickness:	5.325 [m]
	Screen length:	4.5 [m]	Boring radius:	0.0762 [m]

SLR	**Analysis Report**	**Pumping Test:** **MW14-101 Yield Test**
	Project: Summit Aggregate Resource	**Analysis Method:** **Theis Recovery**
	Number: 203.50065.00001	Comments:
	Client: Summit Aggregates	Saturated screen length = 4.50 [m] Max. Head Change = 0.09 [m] R (eff) not used in analysis



Evaluated by: RT
Date: 12/23/2014

Analysis results:	Transmissivity:	5.75E-4 [m²/s]	Conductivity:	1.08E-4 [m/s]

Test parameters:	Pumping Well:	MW14-101	Pumping Time	1148 [s]
	Screen radius:	0.0254 [m]	Aquifer thickness:	5.325 [m]
	Screen length:	4.5 [m]	Boring radius:	0.0762 [m]
			Discharge Rate:	8E-5 [m³/s]

Analysis Report

Project: Summit Aggregate Resource

Number: 203.50065.00001

Client: Summit Aggregates

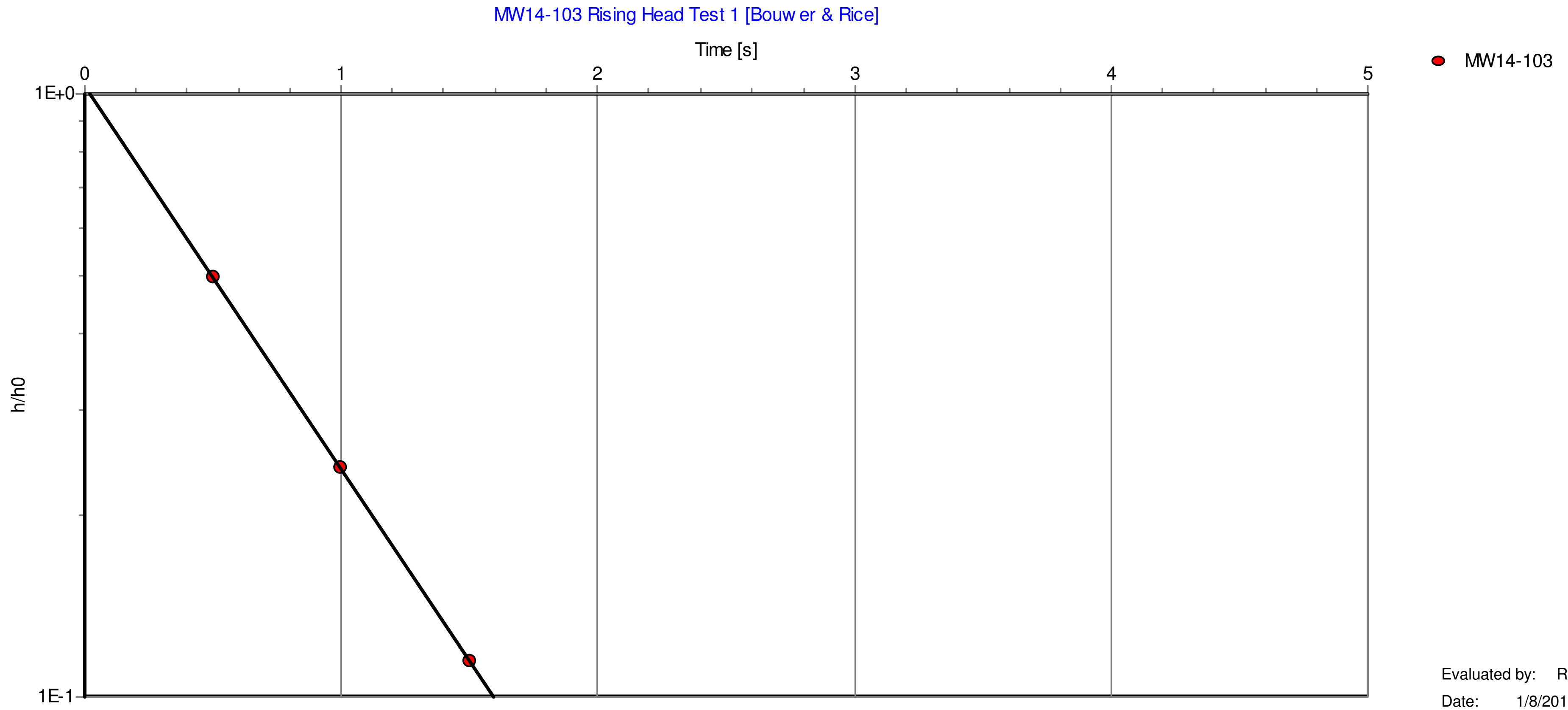
Slug Test: **MW14-103 Rising Head Test 1**

Analysis Method: **Bouwer & Rice**

Comments:

Saturated screen length = 4.36 [m] Max. Head Change = 0.58 [m]

R (eff) not used in analysis



Evaluated by: RT

Date: 1/8/2015

Analysis results: Conductivity: 3.28E-4 [m/s]

Test parameters:

Test Well: MW14-103

Screen radius: 0.0254 [m]

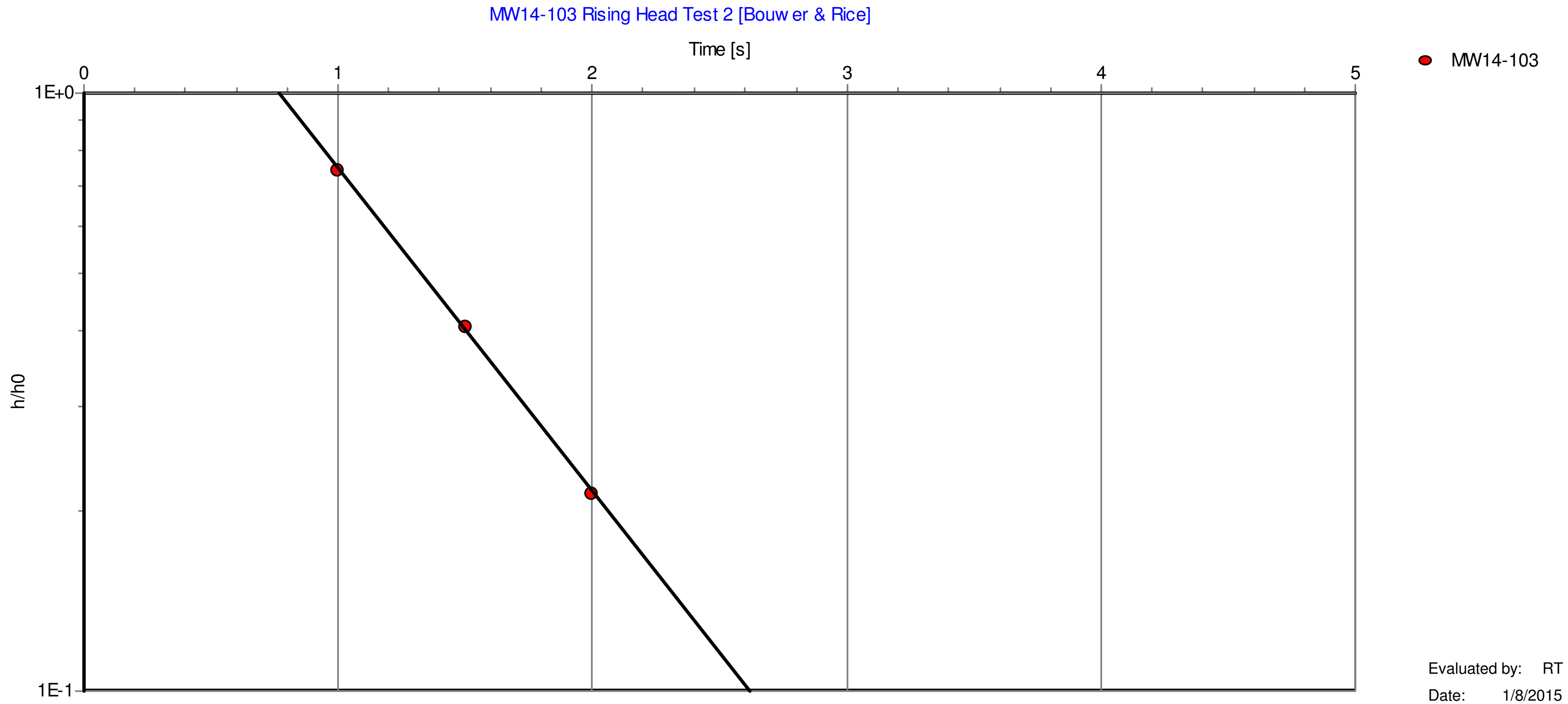
Screen length: 4.5 [m]

r(eff): 0.044 [m]

Aquifer thickness: 4.357 [m]

Boring radius: 0.0762 [m]

	Analysis Report	**Slug Test:** **MW14-103 Rising Head Test 2**
	Project: Summit Aggregate Resource	**Analysis Method:** **Bouwer & Rice**
	Number: 203.50065.00001	Comments:
	Client: Summit Aggregates	Saturated screen length = 4.36 [m] Max. Head Change = 0.65 [m] R (eff) not used in analysis

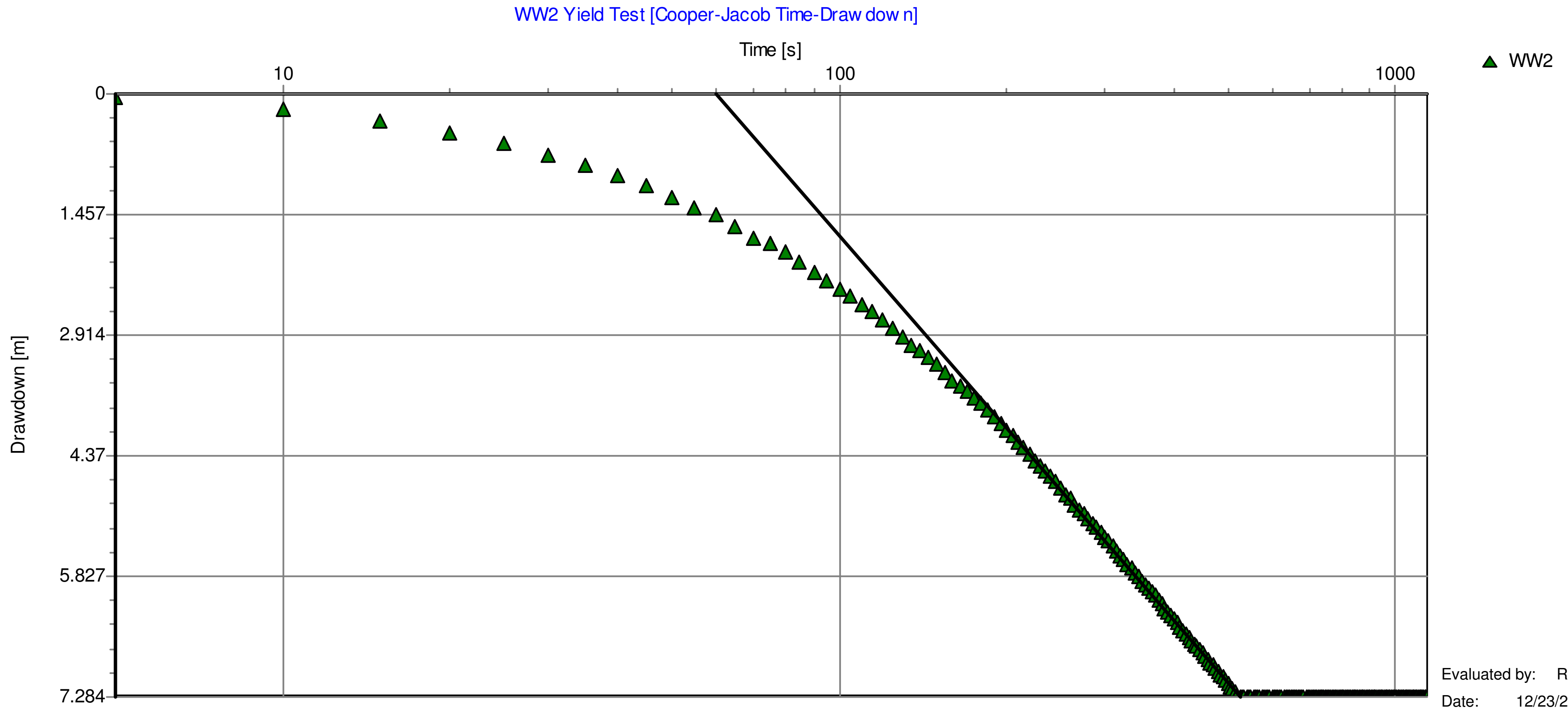


Evaluated by: RT
Date: 1/8/2015

Analysis results: Conductivity: 2.79E-4 [m/s]

Test parameters:	Test Well:	MW14-103	r(eff):	0.044 [m]
	Screen radius:	0.0254 [m]	Aquifer thickness:	4.357 [m]
	Screen length:	4.5 [m]	Boring radius:	0.0762 [m]

Analysis Report	**Pumping Test:** **WW2 Yield Test**
Project: Summit Aggregate Resource	**Analysis Method:** **Cooper-Jacob Time-Drawdown**
Number: 203.50065.00001	Comments:
Client: Summit Aggregates	Saturated screen length = 7.62 [m] Max. Head Change = >7 [m] R (eff) not used in analysis



Evaluated by: RT
Date: 12/23/2014

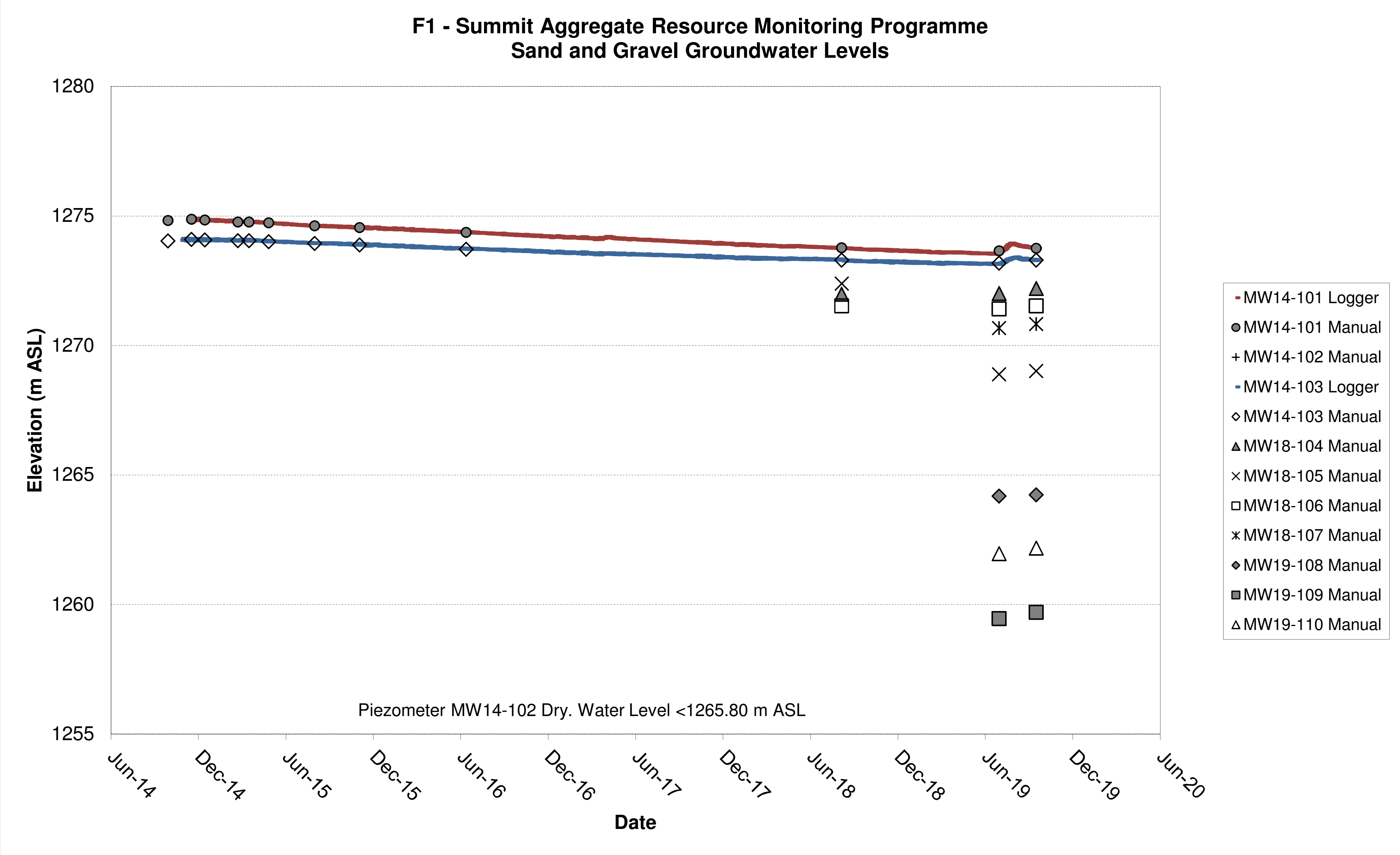
Analysis results: Transmissivity: 4.63E-6 [m²/s] Conductivity: 2.18E-7 [m/s]

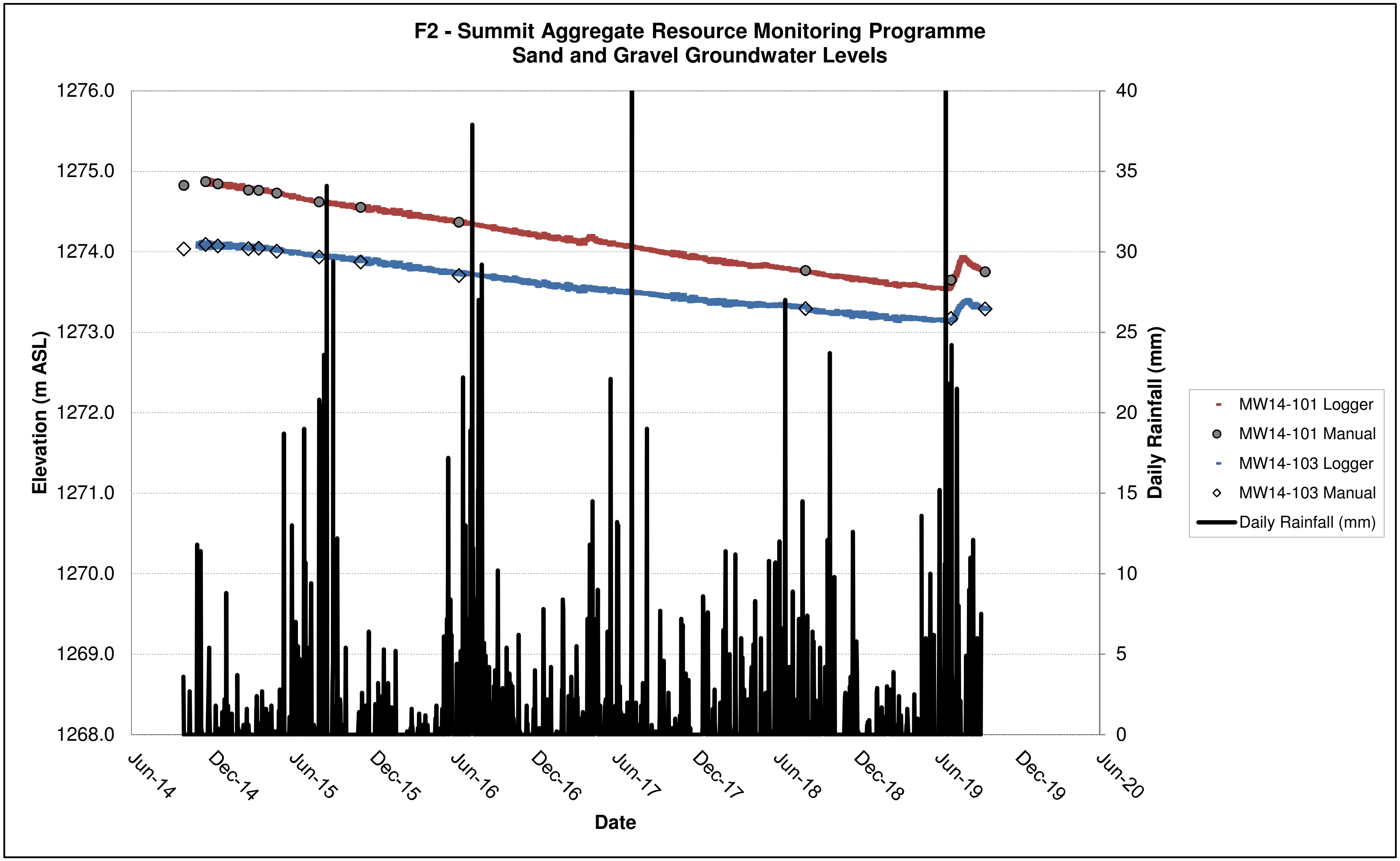
Test parameters:

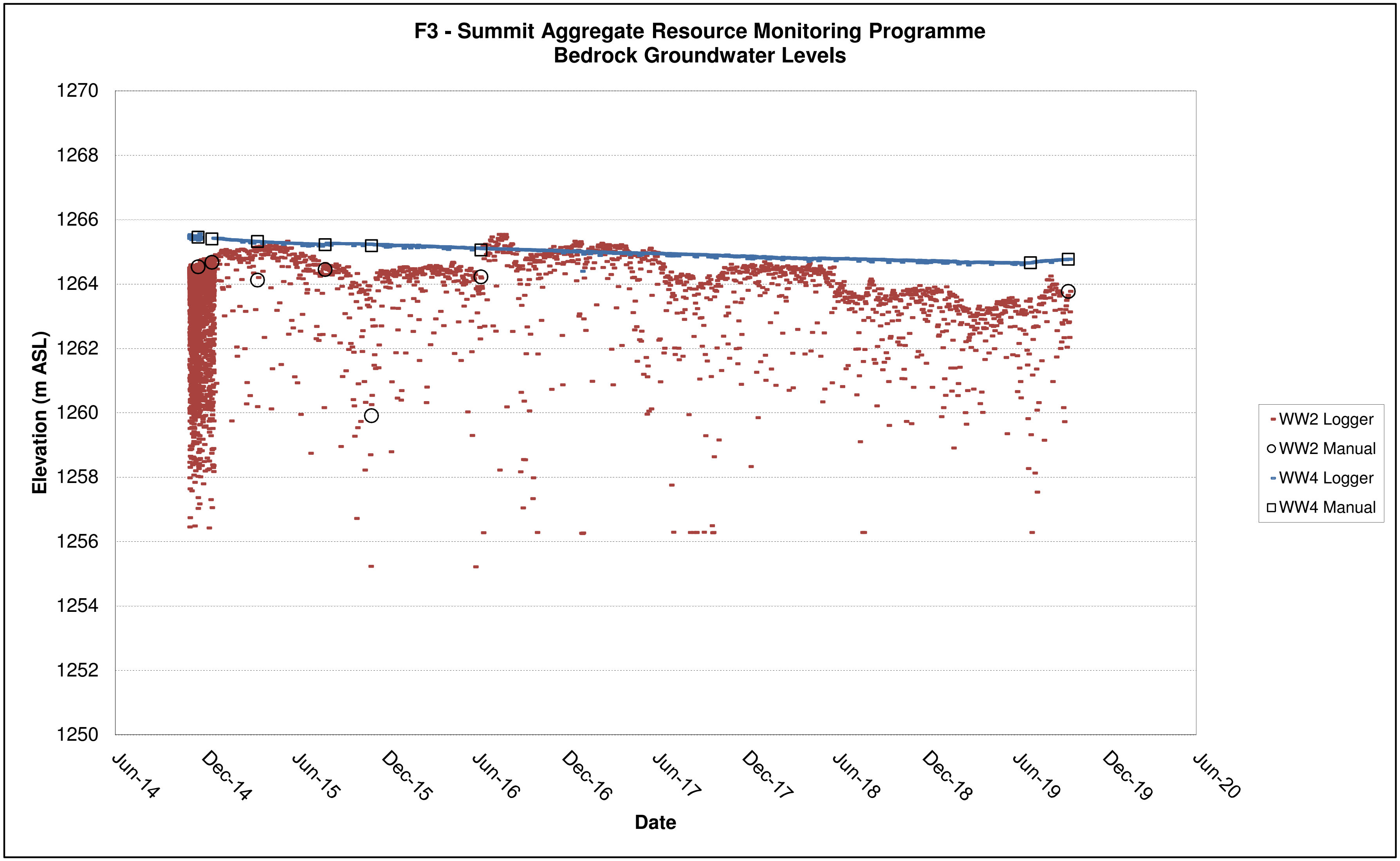
Pumping Well:	WW2		
Screen radius:	0.051 [m]	Aquifer thickness:	21.25 [m]
Screen length:	7.62 [m]	Boring radius:	0.111 [m]
		Discharge Rate:	0.000196 [m³/s]

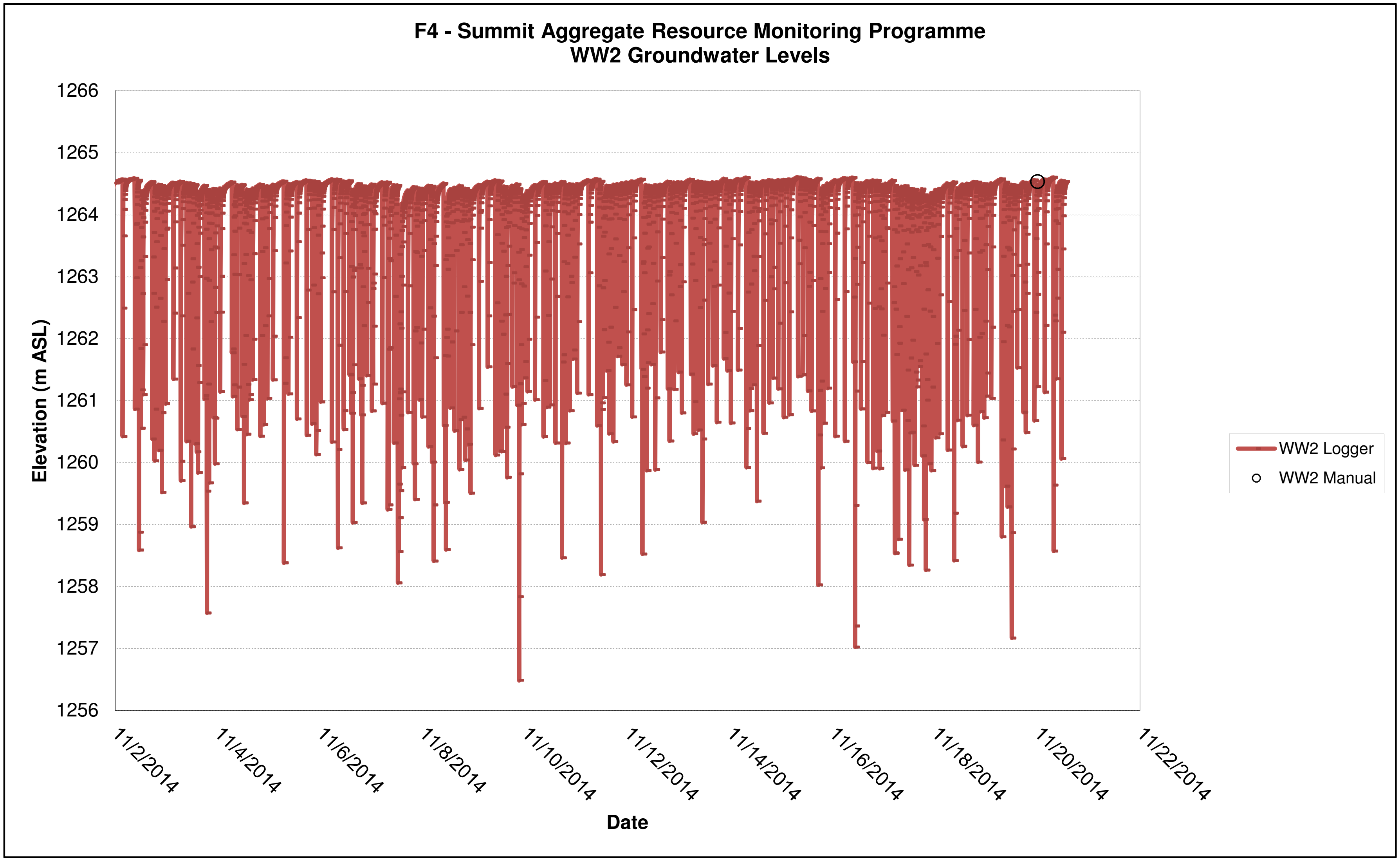
APPENDIX F
Groundwater Elevation Data

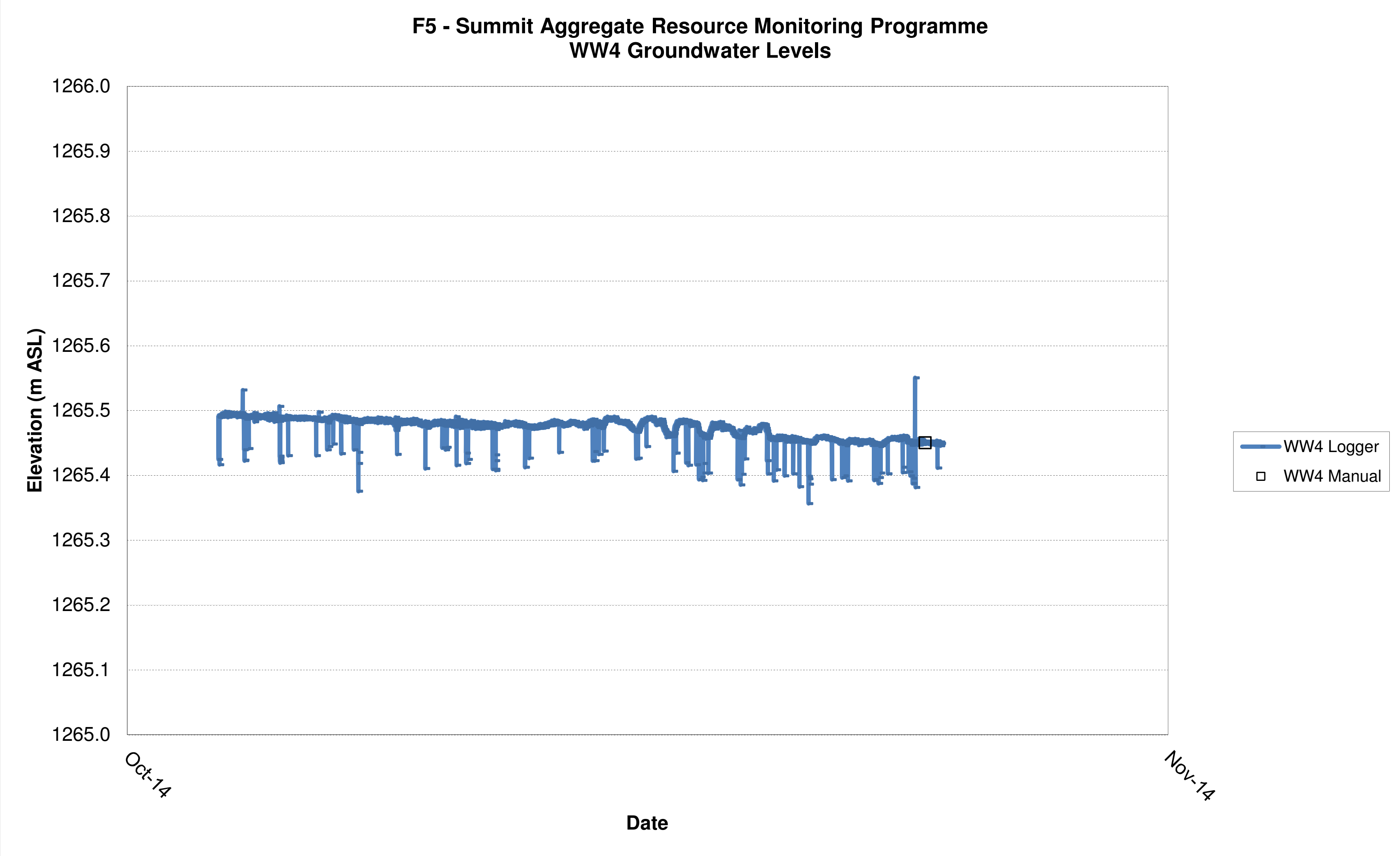
Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003


F1 - Summit Aggregate Resource Monitoring Programme
Sand and Gravel Groundwater Levels
Elevation (m ASL)
1280
1275
1270
1265
1260
1255
Date
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Piezometer MW14-102 Dry. Water Level <1265.80 m ASL
MW14-101 Logger
MW14-101 Manual
MW14-102 Manual
MW14-103 Logger
MW14-103 Manual
MW18-104 Manual
MW18-105 Manual
MW18-106 Manual
MW18-107 Manual
MW19-108 Manual
MW19-109 Manual
MW19-110 Manual


F2 - Summit Aggregate Resource Monitoring Programme
Sand and Gravel Groundwater Levels
Elevation (m ASL)
1276.0
1275.0
1274.0
1273.0
1272.0
1271.0
1270.0
1269.0
1268.0
Daily Rainfall (mm)
40
35
30
25
20
15
10
5
0
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
Date
MW14-101 Logger
MW14-101 Manual
MW14-103 Logger
MW14-103 Manual
Daily Rainfall (mm)


F3 - Summit Aggregate Resource Monitoring Programme
Bedrock Groundwater Levels
Elevation (m ASL)
1270
1268
1266
1264
1262
1260
1258
1256
1254
1252
1250
Date
Jun-14
Dec-14
Jun-15
Dec-15
Jun-16
Dec-16
Jun-17
Dec-17
Jun-18
Dec-18
Jun-19
Dec-19
Jun-20
WW2 Logger
WW2 Manual
WW4 Logger
WW4 Manual


F4 - Summit Aggregate Resource Monitoring Programme
WW2 Groundwater Levels
Elevation (m ASL)
1266
1265
1264
1263
1262
1261
1260
1259
1258
1257
1256
11/2/2014
11/4/2014
11/6/2014
11/8/2014
11/10/2014
11/12/2014
11/14/2014
11/16/2014
11/18/2014
11/20/2014
11/22/2014
Date
WW2 Logger
WW2 Manual


F5 - Summit Aggregate Resource Monitoring Programme
WW4 Groundwater Levels
Elevation (m ASL)
1266.0
1265.9
1265.8
1265.7
1265.6
1265.5
1265.4
1265.3
1265.2
1265.1
1265.0
Oct-14
Nov-14
Date
WW4 Logger
WW4 Manual

APPENDIX G
Laboratory Analytical Reports

Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003

333 50th Ave. S.E.
Calgary, AB, T2G 2B3
Phone (403) 297-0868
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KaizenLAB

ANALYTICAL REPORT

Client: SLR Consulting (Canada) Ltd.
6940 Roper Rd NW
Edmonton, AB T6B 3H9

Attention: Robert Till

KaizenLAB JOB #:	**167115**
DATE RECEIVED:	30-Oct-2014
DATE REPORTED:	05-Nov-2014
PROJECT ID:	203.50065.00001
LOCATION:	Summit Aggregates

KaizenLAB Sample # 167115_001 **Sample ID:** WW1
Date Sampled 29-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	552		
pH		8.1	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	318	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	0.2	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	<0.00040	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	300.7		
Bicarbonate (as HCO3)	mg/L	366.6		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	70.3		
Dissolved Magnesium	mg/L	35.1		
Dissolved Potassium	mg/L	3.3		
Dissolved Sodium	mg/L	7.2	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	320.3		
Anions in Water				
Chloride	mg/L	4.29	250.00 (AO)	Acceptable
Fluoride	mg/L	0.12	1.50 (MAC)	Pass
Nitrate-N	mg/L	1.67	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.05	1.00 (AO)	Acceptable
Nitrite-N + Nitrate-N	mg/L	1.67		

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167115_001 **Sample ID:** WW1
Date Sampled 29-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Phosphate	mg/L	<0.10		
Sulphate	mg/L	6.95	500.00 (AO)	Acceptable
Total Metals including Mercury				
Total Mercury	mg/L	<0.00010		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	0.0068	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	0.00088	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000126	0.0100 (MAC)	Pass
Total Barium	mg/L	0.282	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	0.022	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000013	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.0317	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.015	0.30 (AO)	Acceptable
Total Lead	mg/L	0.00127	0.0100 (MAC)	Pass
Total Manganese	mg/L	<0.0010	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00148		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	0.00084	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.433		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.106		
Total Uranium	mg/L	0.001299	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	<0.020	5.000 (AO)	Acceptable

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

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*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167115_002 **Sample ID:** WW2
Date Sampled 29-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	566		
pH		8.0	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	328	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	0.2	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	0.00300	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	312.2		
Bicarbonate (as HCO3)	mg/L	380.6		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	63.6		
Dissolved Magnesium	mg/L	37.3		
Dissolved Potassium	mg/L	2.8		
Dissolved Sodium	mg/L	13.8	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	312.2		
Anions in Water				
Chloride	mg/L	1.38	250.00 (AO)	Acceptable
Fluoride	mg/L	0.14	1.50 (MAC)	Pass
Nitrate-N	mg/L	0.78	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.05	1.00 (AO)	Acceptable
Nitrite-N + Nitrate-N	mg/L	0.78		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	15.82	500.00 (AO)	Acceptable

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167115_002 **Sample ID:** WW2
Date Sampled 29-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00010		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	<0.0050	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	0.00059	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000165	0.0100 (MAC)	Pass
Total Barium	mg/L	0.128	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	0.032	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000016	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.0022	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.018	0.30 (AO)	Acceptable
Total Lead	mg/L	<0.00030	0.0100 (MAC)	Pass
Total Manganese	mg/L	0.0040	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00222		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	0.00112	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.488		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.0971		
Total Uranium	mg/L	0.001023	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	0.024	5.000 (AO)	Acceptable

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

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*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167115_003 **Sample ID:** WW3
Date Sampled 29-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	607		
pH		7.9	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	349	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	0.2	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	<0.00040	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	321.2		
Bicarbonate (as HCO3)	mg/L	391.6		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	73.2		
Dissolved Magnesium	mg/L	39.9		
Dissolved Potassium	mg/L	3.1		
Dissolved Sodium	mg/L	7.8	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	346.9		
Anions in Water				
Chloride	mg/L	10.31	250.00 (AO)	Acceptable
Fluoride	mg/L	0.14	1.50 (MAC)	Pass
Nitrate-N	mg/L	1.87	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.05	1.00 (AO)	Acceptable
Nitrite-N + Nitrate-N	mg/L	1.87		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	10.33	500.00 (AO)	Acceptable

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167115_003 **Sample ID:** WW3
Date Sampled 29-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00010		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	0.0061	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000143	0.0100 (MAC)	Pass
Total Barium	mg/L	0.221	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000040	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.125	1.0000 (AO)	Acceptable
Total Iron	mg/L	<0.010	0.30 (AO)	Acceptable
Total Lead	mg/L	0.00302	0.0100 (MAC)	Pass
Total Manganese	mg/L	0.0014	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00113		
Total Nickel	mg/L	0.00174		
Total Selenium	mg/L	0.00070	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.421		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.109		
Total Uranium	mg/L	0.001744	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	0.205	5.000 (AO)	Acceptable

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167115_004 **Sample ID:** WW4
Date Sampled 30-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	596		
pH		8.0	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	339	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	0.6	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	<0.00040	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	304.9		
Bicarbonate (as HCO3)	mg/L	371.8		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	75.3		
Dissolved Magnesium	mg/L	35.2		
Dissolved Potassium	mg/L	3.1		
Dissolved Sodium	mg/L	7.1	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	333.1		
Anions in Water				
Chloride	mg/L	10.86	250.00 (AO)	Acceptable
Fluoride	mg/L	0.15	1.50 (MAC)	Pass
Nitrate-N	mg/L	3.02	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.05	1.00 (AO)	Acceptable
Nitrite-N + Nitrate-N	mg/L	3.02		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	7.66	500.00 (AO)	Acceptable

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167115_004 **Sample ID:** WW4
Date Sampled 30-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00010		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	<0.0050	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000192	0.0100 (MAC)	Pass
Total Barium	mg/L	0.385	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000008	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.0017	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.017	0.30 (AO)	Acceptable
Total Lead	mg/L	<0.00030	0.0100 (MAC)	Pass
Total Manganese	mg/L	<0.0010	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00076		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	0.00180	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.425		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.114		
Total Uranium	mg/L	0.001785	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	0.029	5.000 (AO)	Acceptable

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167115_005 **Sample ID:** BHS1
Date Sampled 30-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	588		
pH		8.2	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	342	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	0.8	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	<0.00040	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	308.5		
Bicarbonate (as HCO3)	mg/L	376.1		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	74.1		
Dissolved Magnesium	mg/L	36.7		
Dissolved Potassium	mg/L	3.4		
Dissolved Sodium	mg/L	7.8	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	336.0		
Anions in Water				
Chloride	mg/L	9.60	250.00 (AO)	Acceptable
Fluoride	mg/L	0.14	1.50 (MAC)	Pass
Nitrate-N	mg/L	2.83	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.05	1.00 (AO)	Acceptable
Nitrite-N + Nitrate-N	mg/L	2.83		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	9.36	500.00 (AO)	Acceptable

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167115_005 **Sample ID:** BHS1
Date Sampled 30-Oct-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00010		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	0.0182	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000153	0.0100 (MAC)	Pass
Total Barium	mg/L	0.304	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	0.024	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000032	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	<0.0010	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.027	0.30 (AO)	Acceptable
Total Lead	mg/L	<0.00030	0.0100 (MAC)	Pass
Total Manganese	mg/L	0.0019	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00141		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	0.00218	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.443		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	0.0083		
Total Titanium	mg/L	0.115		
Total Uranium	mg/L	0.001953	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	<0.020	5.000 (AO)	Acceptable

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

Test Methodologies

Alkalinity in Water: Modified from APHA 2320B
Anions in Water: Modified from APHA 4110B
Cations in Water: Modified from APHA 3030B and APHA 3120B
Dissolved Metals in Water: Modified from APHA 3030B and APHA 3125B
Electrical Conductivity in Water: Modified from APHA 2510B
pH in Water: Modified from APHA 4500-H+ B
Total Dissolved Solids (calculated): Modified from APHA 1030E
Total Mercury in Water: Modified from EPA 200.2 and EPA 1631
Total Metals in Water: Modified from EPA 200.2 and APHA 3125B
True Colour in Water: Modified from APHA 2120C
Turbidity in Water: Modified from APHA 2130B

Final Review by:

Natalia Klink
Client Service Representative / Project Coordinator

Note: The results in this report relate only to the items tested. Information is available for any items in 5.10.2 of ISO/IEC 17025 that cannot be put on a test report.

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KaizenLAB

ANALYTICAL REPORT

Client: SLR Consulting (Canada) Ltd.
6940 Roper Rd NW
Edmonton, AB T6B 3H9

Attention: Robert Till

KaizenLAB JOB #:	**167823**
DATE RECEIVED:	21-Nov-2014
DATE REPORTED:	27-Nov-2014
PROJECT ID:	203,50065,00001
LOCATION:	Summit Aggregates

KaizenLAB Sample # 167823_001 **Sample ID:** MW 14-101
Date Sampled 20-Nov-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	596		
pH		7.9	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	337	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	9.6	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0400	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	<0.00400	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	313.6		
Bicarbonate (as HCO3)	mg/L	382.3		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	76.1		
Dissolved Magnesium	mg/L	33.7		
Dissolved Potassium	mg/L	4.8		
Dissolved Sodium	mg/L	6.0	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	328.6		
Anions in Water				
Chloride	mg/L	10.54	250.00 (AO)	Acceptable
Fluoride	mg/L	0.13	1.50 (MAC)	Pass
Nitrate-N	mg/L	1.19	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.05	1.00 (AO)	Acceptable
Nitrite-N + Nitrate-N	mg/L	1.19		

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167823_001 **Sample ID:** MW 14-101

Date Sampled 20-Nov-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Phosphate	mg/L	<0.10		
Sulphate	mg/L	8.88	500.00 (AO)	Acceptable
Total Metals including Mercury				
Total Mercury	mg/L	<0.00010		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	0.164	0.10 (OG) see notes	Unacceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000350	0.0100 (MAC)	Pass
Total Barium	mg/L	0.424	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000016	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	<0.0010	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.28	0.30 (AO)	Acceptable
Total Lead	mg/L	0.00031	0.0100 (MAC)	Pass
Total Manganese	mg/L	0.0164	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00080		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	<0.00060	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.384		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	0.0182		
Total Titanium	mg/L	0.122		
Total Uranium	mg/L	0.001697	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	<0.020	5.000 (AO)	Acceptable

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

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*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167823_002 **Sample ID:** MW 14-103
Date Sampled 20-Nov-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	610		
pH		7.8	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	354	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	680	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0400	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	<0.00400	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	311.5		
Bicarbonate (as HCO3)	mg/L	379.8		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	74.7		
Dissolved Magnesium	mg/L	33.4		
Dissolved Potassium	mg/L	4.3		
Dissolved Sodium	mg/L	8.8	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	324.1		
Anions in Water				
Chloride	mg/L	7.83	250.00 (AO)	Acceptable
Fluoride	mg/L	0.13	1.50 (MAC)	Pass
Nitrate-N	mg/L	5.22	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.05	1.00 (AO)	Acceptable
Nitrite-N + Nitrate-N	mg/L	5.22		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	11.90	500.00 (AO)	Acceptable

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 167823_002 **Sample ID:** MW 14-103
Date Sampled 20-Nov-2014

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00010		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	5.57	0.10 (OG) see notes	Unacceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.007858	0.0100 (MAC)	Pass
Total Barium	mg/L	0.700	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000290	0.0050 (MAC)	Pass
Total Chromium	mg/L	0.0076	0.050 (MAC)	Pass
Total Cobalt	mg/L	0.00445		
Total Copper	mg/L	0.0093	1.0000 (AO)	Acceptable
Total Iron	mg/L	12	0.30 (AO)	Unacceptable
Total Lead	mg/L	0.00464	0.0100 (MAC)	Pass
Total Manganese	mg/L	0.928	0.0500 (AO)	Unacceptable
Total Molybdenum	mg/L	0.00184		
Total Nickel	mg/L	0.01196		
Total Selenium	mg/L	0.00112	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.423		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.236		
Total Uranium	mg/L	0.002014	0.020000 (MAC)	Pass
Total Vanadium	mg/L	0.01145		
Total Zinc	mg/L	0.033	5.000 (AO)	Acceptable

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

Test Methodologies

Alkalinity in Water: Modified from APHA 2320B
Anions in Water: Modified from APHA 4110B
Cations in Water: Modified from APHA 3030B and APHA 3120B
Dissolved Metals in Water: Modified from APHA 3030B and APHA 3125B
Electrical Conductivity in Water: Modified from APHA 2510B
pH in Water: Modified from APHA 4500-H+ B
Total Dissolved Solids (calculated): Modified from APHA 1030E
Total Mercury in Water: Modified from EPA 200.2 and EPA 1631
Total Metals in Water: Modified from EPA 200.2 and APHA 3125B
True Colour in Water: Modified from APHA 2120C
Turbidity in Water: Modified from APHA 2130B

Final Review by: ______________________

Joel Sababan
Client Services Administrator

Note: The results in this report relate only to the items tested. Information is available for any items in 5.10.2 of ISO/IEC 17025 that cannot be put on a test report.

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KaizenLAB

ANALYTICAL REPORT

Client: SLR Consulting (Canada) Ltd.
6940 Roper Rd NW
Edmonton, AB T6B 3H9

Attention: Robert Till

KaizenLAB JOB #:	**173114**
DATE RECEIVED:	04-Aug-2015
DATE REPORTED:	06-Aug-2015
PROJECT ID:	203-50065-00003
LOCATION:	Summit

KaizenLAB Sample # 173114_001 **Sample ID:** MW14-103
Date Sampled 4-Aug-2015

Parameter Description	**Units**	**Result**	**Guideline Limits***	**Comment**
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	611		
pH		8.0	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	333	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	8.00	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	0.00069	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	307.7		
Bicarbonate (as HCO3)	mg/L	375.1		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	73.3		
Dissolved Magnesium	mg/L	32.6		
Dissolved Potassium	mg/L	3.9		
Dissolved Sodium	mg/L	7.9	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	317.0		
Anions in Water				
Chloride	mg/L	8.81	250.00 (AO)	Acceptable
Fluoride	mg/L	0.14	1.50 (MAC)	Pass
Nitrate-N	mg/L	1.801	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.005	1.00 (MAC)	Pass
Nitrite-N + Nitrate-N	mg/L	1.801		

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_001 **Sample ID:** MW14-103
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Phosphate	mg/L	<0.10		
Sulphate	mg/L	10.56	500.00 (AO)	Acceptable
Total Metals including Mercury				
Total Mercury	mg/L	<0.00020		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	0.109	0.10 (OG) see notes	Unacceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000336	0.0100 (MAC)	Pass
Total Barium	mg/L	0.332	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	<0.000005	0.0050 (MAC)	Pass
Total Chromium	mg/L	0.0016	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.0013	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.22	0.30 (AO)	Acceptable
Total Lead	mg/L	<0.00030	0.0100 (MAC)	Pass
Total Manganese	mg/L	0.0144	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00086		
Total Nickel	mg/L	0.00051		
Total Selenium	mg/L	0.00087	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.377		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.118		
Total Uranium	mg/L	0.001563	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	<0.020	5.000 (AO)	Acceptable
Total Coliforms and E. coli				
E. Coli	MPN/100mL	<1	0 (MAC)	Pass
Total Coliforms	MPN/100mL	<1	0 (MAC)	Pass

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_002 **Sample ID:** WW1
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	570		
pH		8.0	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	310	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	0.31	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	<0.00040	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	294.9		
Bicarbonate (as HCO3)	mg/L	359.6		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	68.2		
Dissolved Magnesium	mg/L	31.8		
Dissolved Potassium	mg/L	3.2		
Dissolved Sodium	mg/L	7.0	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	301.4		
Anions in Water				
Chloride	mg/L	4.49	250.00 (AO)	Acceptable
Fluoride	mg/L	0.14	1.50 (MAC)	Pass
Nitrate-N	mg/L	1.658	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.005	1.00 (MAC)	Pass
Nitrite-N + Nitrate-N	mg/L	1.658		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	7.51	500.00 (AO)	Acceptable

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*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_002 **Sample ID:** WW1
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00020		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	0.0110	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000132	0.0100 (MAC)	Pass
Total Barium	mg/L	0.284	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	<0.000005	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.0130	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.014	0.30 (AO)	Acceptable
Total Lead	mg/L	0.00048	0.0100 (MAC)	Pass
Total Manganese	mg/L	<0.0010	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00147		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	<0.00060	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.450		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.105		
Total Uranium	mg/L	0.001241	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	<0.020	5.000 (AO)	Acceptable
Total Coliforms and E. coli				
E. Coli	MPN/100mL	<1	0 (MAC)	Pass
Total Coliforms	MPN/100mL	<1	0 (MAC)	Pass

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

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*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_003 **Sample ID:** WW2
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	585		
pH		8.1	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	317	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	1.23	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	0.00275	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	307.6		
Bicarbonate (as HCO3)	mg/L	375.1		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	63.4		
Dissolved Magnesium	mg/L	35.0		
Dissolved Potassium	mg/L	2.6		
Dissolved Sodium	mg/L	9.3	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	302.4		
Anions in Water				
Chloride	mg/L	1.93	250.00 (AO)	Acceptable
Fluoride	mg/L	0.15	1.50 (MAC)	Pass
Nitrate-N	mg/L	1.054	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.005	1.00 (MAC)	Pass
Nitrite-N + Nitrate-N	mg/L	1.054		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	12.85	500.00 (AO)	Acceptable

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_003 **Sample ID:** WW2
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00020		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	<0.0050	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000205	0.0100 (MAC)	Pass
Total Barium	mg/L	0.142	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000024	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.0016	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.040	0.30 (AO)	Acceptable
Total Lead	mg/L	<0.00030	0.0100 (MAC)	Pass
Total Manganese	mg/L	0.0042	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00193		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	0.00105	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.454		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.103		
Total Uranium	mg/L	0.001214	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	<0.020	5.000 (AO)	Acceptable
Total Coliforms and E. coli				
E. Coli	MPN/100mL	<1	0 (MAC)	Pass
Total Coliforms	MPN/100mL	<1	0 (MAC)	Pass

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_004 **Sample ID:** WW3
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	604		
pH		8.0	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	330	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	0.25	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	<0.00040	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	309.8		
Bicarbonate (as HCO3)	mg/L	377.7		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	69.7		
Dissolved Magnesium	mg/L	35.5		
Dissolved Potassium	mg/L	3.0		
Dissolved Sodium	mg/L	7.6	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	320.4		
Anions in Water				
Chloride	mg/L	5.88	250.00 (AO)	Acceptable
Fluoride	mg/L	0.14	1.50 (MAC)	Pass
Nitrate-N	mg/L	1.889	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.005	1.00 (MAC)	Pass
Nitrite-N + Nitrate-N	mg/L	1.889		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	11.09	500.00 (AO)	Acceptable

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_004 **Sample ID:** WW3

Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00020		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	<0.0050	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000121	0.0100 (MAC)	Pass
Total Barium	mg/L	0.225	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000024	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.0057	1.0000 (AO)	Acceptable
Total Iron	mg/L	<0.010	0.30 (AO)	Acceptable
Total Lead	mg/L	<0.00030	0.0100 (MAC)	Pass
Total Manganese	mg/L	<0.0010	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00104		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	0.00085	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.418		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.111		
Total Uranium	mg/L	0.001688	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	<0.020	5.000 (AO)	Acceptable
Total Coliforms and E. coli				
E. Coli	MPN/100mL	<1	0 (MAC)	Pass
Total Coliforms	MPN/100mL	<1	0 (MAC)	Pass

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_005 **Sample ID:** WW4
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	608		
pH		8.0	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	328	500 (AO)	Acceptable
True Colour	TCU	<3	15 (AO)	Acceptable
Turbidity	NTU	0.23	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	<0.00040	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	299.6		
Bicarbonate (as HCO3)	mg/L	365.2		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	72.0		
Dissolved Magnesium	mg/L	31.5		
Dissolved Potassium	mg/L	2.9		
Dissolved Sodium	mg/L	6.5	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	309.4		
Anions in Water				
Chloride	mg/L	10.95	250.00 (AO)	Acceptable
Fluoride	mg/L	0.14	1.50 (MAC)	Pass
Nitrate-N	mg/L	3.314	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.005	1.00 (MAC)	Pass
Nitrite-N + Nitrate-N	mg/L	3.314		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	6.77	500.00 (AO)	Acceptable

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_005 **Sample ID:** WW4
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00020		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	<0.0050	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000194	0.0100 (MAC)	Pass
Total Barium	mg/L	0.391	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	<0.000005	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.0018	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.044	0.30 (AO)	Acceptable
Total Lead	mg/L	<0.00030	0.0100 (MAC)	Pass
Total Manganese	mg/L	<0.0010	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00066		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	0.00096	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.421		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.114		
Total Uranium	mg/L	0.001672	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	0.031	5.000 (AO)	Acceptable
Total Coliforms and E. coli				
E. Coli	MPN/100mL	<1	0 (MAC)	Pass
Total Coliforms	MPN/100mL	<1	0 (MAC)	Pass

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_006 **Sample ID:** BHS1
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Routine Water Potability Analysis (Potability pkg #2)				
Electrical Conductivity (EC)	uS/cm	606		
pH		8.2	6.5-8.5 (AO)	Acceptable
Total Dissolved Solids (calculated)	mg/L	334	500 (AO)	Acceptable
True Colour	TCU	3	15 (AO)	Acceptable
Turbidity	NTU	1.07	0.1/0.3/1.0 see notes	See notes
Dissolved Metals in Water by ICP-MS				
Dissolved Iron	mg/L	<0.0040	0.3000 (AO)	Acceptable
Dissolved Manganese	mg/L	0.00069	0.0500 (AO)	Acceptable
Alkalinity parameters of water				
Alkalinity (phenolphthalein, as CaCO3)	mg/L	<2.0		
Alkalinity (total, as CaCO3)	mg/L	304.3		
Bicarbonate (as HCO3)	mg/L	371.0		
Carbonate (as CO3)	mg/L	<1.5		
Hydroxide (as OH)	mg/L	<0.5		
Cations in Water				
Dissolved Calcium	mg/L	72.0		
Dissolved Magnesium	mg/L	33.3		
Dissolved Potassium	mg/L	3.3		
Dissolved Sodium	mg/L	7.5	200.00 (AO)	Acceptable
Hardness (calculated, as CaCO3)	mg/L	317.0		
Anions in Water				
Chloride	mg/L	10.12	250.00 (AO)	Acceptable
Fluoride	mg/L	0.15	1.50 (MAC)	Pass
Nitrate-N	mg/L	3.037	10.00 (MAC)	Pass
Nitrite-N	mg/L	<0.005	1.00 (MAC)	Pass
Nitrite-N + Nitrate-N	mg/L	3.037		
Phosphate	mg/L	<0.10		
Sulphate	mg/L	8.36	500.00 (AO)	Acceptable

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

KaizenLAB Sample # 173114_006 **Sample ID:** BHS1
Date Sampled 4-Aug-2015

Parameter Description	Units	Result	Guideline Limits*	Comment
Total Metals including Mercury				
Total Mercury	mg/L	<0.00020		
Total Metals in Water by ICP-MS				
Total Aluminum	mg/L	0.0144	0.10 (OG) see notes	Acceptable
Total Antimony	mg/L	<0.00050	0.0060 (MAC)	Pass
Total Arsenic	mg/L	0.000146	0.0100 (MAC)	Pass
Total Barium	mg/L	0.313	1.0000 (MAC)	Pass
Total Beryllium	mg/L	<0.0010		
Total Boron	mg/L	<0.020	5.00 (MAC)	Pass
Total Cadmium	mg/L	0.000008	0.0050 (MAC)	Pass
Total Chromium	mg/L	<0.0010	0.050 (MAC)	Pass
Total Cobalt	mg/L	<0.00020		
Total Copper	mg/L	0.0010	1.0000 (AO)	Acceptable
Total Iron	mg/L	0.019	0.30 (AO)	Acceptable
Total Lead	mg/L	<0.00030	0.0100 (MAC)	Pass
Total Manganese	mg/L	0.0012	0.0500 (AO)	Acceptable
Total Molybdenum	mg/L	0.00089		
Total Nickel	mg/L	<0.00050		
Total Selenium	mg/L	0.00130	0.0100 (MAC)	Pass
Total Silver	mg/L	<0.000070		
Total Strontium	mg/L	0.450		
Total Thallium	mg/L	<0.00020		
Total Tin	mg/L	<0.0070		
Total Titanium	mg/L	0.117		
Total Uranium	mg/L	0.001875	0.020000 (MAC)	Pass
Total Vanadium	mg/L	<0.00060		
Total Zinc	mg/L	<0.020	5.000 (AO)	Acceptable
Total Coliforms and E. coli				
E. Coli	MPN/100mL	1733	0 (MAC)	Fail
Total Coliforms	MPN/100mL	2420	0 (MAC)	Fail

Notes:

- Aluminum: This Operational Guideline applies only to drinking water treatment plants using aluminum-based coagulants: conventional systems - 0.1 mg/L, other systems - 0.2 mg/L
- Turbidity: Based on slow sand or diatomaceous earth filtration (0.1 NTU) / membrane filtration (0.3 NTU) / conventional treatment (1.0 NTU). No limits apply for well water not under the influence of surface water. For further details and additional guidance restriction, see Guidelines for Canadian Drinking Water Quality (GCDWQ 2008).

*CDWQG = Canadian Drinking Water Quality Guidelines, Health Canada 2008: MAC = Maximum Acceptable Concentration (affects health), AO = Aesthetic Objective (does not affect health but affects color, taste, etc.), OG = Operational Guidance

Test Methodologies

Alkalinity in Water: Modified from APHA 2320B
Anions in Water: Modified from APHA 4110B
Cations in Water: Modified from APHA 3030B and APHA 3120B
Dissolved Metals in Water: Modified from APHA 3030B and APHA 3125B
E. coli in Water: Modified from Method 9223 B. Enzyme Substrate Test. Standard Methods for the Examination of Water and Wastewater, 22nd ed. 2012
Electrical Conductivity in Water: Modified from APHA 2510B
pH of Water: Modified from APHA 4500-H+ B
Total Coliforms in Water: Modified from Method 9223 B. Enzyme Substrate Test. Standard Methods for the Examination of Water and Wastewater, 22nd
Total Dissolved Solids (calculated): Modified from APHA 1030E
Total Mercury in Water: Modified from EPA 200.2 and EPA 1631
Total Metals in Water: Modified from EPA 200.2 and APHA 3125B
True Colour in Water: Modified from APHA 2120C
Turbidity in Water: Modified from APHA 2130B

Final Review by:

Enyo Sewordor
Client Service Representative / Project Coordinator

Your P.O. #: EDM4886
Your Project #: 212.06550.00003
Site Location: MOUNTAIN ASH
Your C.O.C. #: M083946

Attention: ROBERT TILL

SLR CONSULTING (CANADA) LTD
6940 ROPER ROAD
EDMONTON, AB
CANADA T6B 3H9

Report Date: 2019/07/25
Report #: R2757540
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: B953759
Received: 2019/07/05, 07:00

Sample Matrix: Water
Samples Received: 5

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity @25C (pp, total), CO3,HCO3,OH	4	N/A	2019/07/08	AB SOP-00005	SM 23 2320 B m
Alkalinity @25C (pp, total), CO3,HCO3,OH	1	N/A	2019/07/10	AB SOP-00005	SM 23 2320 B m
Cadmium - low level CCME - Dissolved	5	N/A	2019/07/24		Auto Calc
Cadmium - low level CCME (Total)	5	N/A	2019/07/11		Auto Calc
Chloride by Automated Colourimetry	5	N/A	2019/07/10	AB SOP-00020	SM 23-4500-Cl-E m
Total Coliforms and E.Coli	5	2019/07/05	2019/07/06	AB SOP-00089	SM 23 9223 A,B m
Conductivity @25C	4	N/A	2019/07/08	AB SOP-00005	SM 23 2510 B m
Conductivity @25C	1	N/A	2019/07/10	AB SOP-00005	SM 23 2510 B m
Hardness	5	N/A	2019/07/10		Auto Calc
Mercury - Low Level (Total)	1	2019/07/11	2019/07/11	CAL SOP-00007	EPA 1631 RE 20460 m
Mercury - Low Level (Total)	4	2019/07/11	2019/07/12	CAL SOP-00007	EPA 1631 RE 20460 m
Elements by ICP-Dissolved-Lab Filtered (1)	5	N/A	2019/07/09	AB SOP-00042	EPA 6010d R5 m
Elements by ICP - Total	5	2019/07/10	2019/07/10	AB SOP-00014 / AB SOP-00042	EPA 6010d R4 m
Elements by ICPMS-Dissolved-Lab Filtered (2)	3	N/A	2019/07/23	AB SOP-00043	EPA 6020b R2 m
Elements by ICPMS-Dissolved-Lab Filtered (2)	2	N/A	2019/07/24	AB SOP-00043	EPA 6020b R2 m
Elements by ICPMS - Total	4	2019/07/10	2019/07/10	AB SOP-00014 / AB SOP-00043	EPA 6020b R2 m
Elements by ICPMS - Total	1	2019/07/10	2019/07/11	AB SOP-00014 / AB SOP-00043	EPA 6020b R2 m
Ion Balance	5	N/A	2019/07/06		Auto Calc
Sum of cations, anions	5	N/A	2019/07/10		Auto Calc
Nitrate and Nitrite	5	N/A	2019/07/11		Auto Calc
Nitrate + Nitrite-N (calculated)	5	N/A	2019/07/11		Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	5	N/A	2019/07/07	AB SOP-00023	SM 23 4110 B m
pH @25°C (3)	4	N/A	2019/07/08	AB SOP-00005	SM 23 4500-H+B m
pH @25°C (3)	1	N/A	2019/07/10	AB SOP-00005	SM 23 4500-H+B m
Sulphate by Automated Colourimetry	5	N/A	2019/07/10	AB SOP-00018	SM 23 4500-SO4 E m
Total Dissolved Solids (Calculated)	5	N/A	2019/07/10		Auto Calc
Turbidity	5	N/A	2019/07/06	CAL SOP-00081	SM 23 2130 B m

Remarks:

Your P.O. #: EDM4886
Your Project #: 212.06550.00003
Site Location: MOUNTAIN ASH
Your C.O.C. #: M083946

Attention: ROBERT TILL

SLR CONSULTING (CANADA) LTD
6940 ROPER ROAD
EDMONTON, AB
CANADA T6B 3H9

Report Date: 2019/07/25
Report #: R2757540
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BV LABS JOB #: B953759
Received: 2019/07/05, 07:00

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) Dissolved > Total Imbalance: When applicable, Dissolved and Total results were reviewed and data quality meets acceptable levels unless otherwise noted.
(2) Samples were filtered and preserved at the lab. Values may not reflect concentrations at the time of sampling. Dissolved > Total Imbalance: When applicable, Dissolved and Total results were reviewed and data quality meets acceptable levels unless otherwise noted.
(3) The CCME method requires pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the CCME holding time. Bureau Veritas Laboratories endeavours to analyze samples as soon as possible after receipt.

Encryption Key

Jenelle Feller
Jenelle Feller
Key Account Specialist
25 Jul 2019 16:32:26

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Jenelle Feller, Key Account Specialist
Email: JFeller@bvlabs.com
Phone# (403)735-2264
==

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 2

ROUTINE WATER -LAB FILTERED (WATER)

BV Labs ID		WA5520		WA5521		WA5522		WA5523		
Sampling Date		2019/07/04 09:55		2019/07/04 10:55		2019/07/04 11:55		2019/07/04 13:55		
COC Number		M083946		M083946		M083946		M083946		
	UNITS	**MW18-105**	**QC Batch**	**MW19-108**	**RDL**	**MW18-104**	**RDL**	**MW18-106**	**RDL**	**QC Batch**
Calculated Parameters										
Anion Sum	meq/L	5.9	9493590	7.3	N/A	6.2	N/A	6.6	N/A	9493590
Cation Sum	meq/L	6.4	9493590	7.0	N/A	6.3	N/A	6.7	N/A	9493590
Hardness (CaCO3)	mg/L	300	9493521	320	0.50	280	0.50	310	0.50	9493521
Ion Balance (% Difference)	%	4.0	9493527	2.3	N/A	0.59	N/A	0.98	N/A	9493527
Dissolved Nitrate (NO3)	mg/L	12	9493534	11	0.044	4.3	0.044	10	0.044	9493534
Nitrate plus Nitrite (N)	mg/L	2.6	9493540	2.5	0.014	1.1	0.014	2.3	0.014	9493540
Dissolved Nitrite (NO2)	mg/L	<0.033	9493534	0.16	0.033	0.32	0.033	<0.033	0.033	9493534
Calculated Total Dissolved Solids	mg/L	300	9493550	350	1.0	310	1.7	320	1.0	9493550
Misc. Inorganics										
Conductivity	uS/cm	560	9498908	610	2.0	570	2.0	590	2.0	9497188
pH	pH	8.05	9498906	7.91	N/A	7.91	N/A	7.87	N/A	9497187
Anions										
Alkalinity (PP as CaCO3)	mg/L	<1.0	9498897	<1.0	1.0	<1.0	1.0	<1.0	1.0	9497185
Alkalinity (Total as CaCO3)	mg/L	260	9498897	320	1.0	260	1.0	300	1.0	9497185
Bicarbonate (HCO3)	mg/L	320	9498897	390	1.0	310	1.0	360	1.0	9497185
Carbonate (CO3)	mg/L	<1.0	9498897	<1.0	1.0	<1.0	1.0	<1.0	1.0	9497185
Hydroxide (OH)	mg/L	<1.0	9498897	<1.0	1.0	<1.0	1.0	<1.0	1.0	9497185
Dissolved Sulphate (SO4)	mg/L	5.8	9501390	17	1.0	9.2	1.0	7.6	1.0	9501390
Dissolved Chloride (Cl)	mg/L	13	9501388	14	1.0	29	1.0	9.3	1.0	9501388
Nutrients										
Dissolved Nitrite (N)	mg/L	<0.010	9495539	0.048	0.010	0.098	0.010	<0.010	0.010	9495539
Dissolved Nitrate (N)	mg/L	2.6	9495539	2.4	0.010	0.97	0.010	2.3	0.010	9495539
Lab Filtered Elements										
Dissolved Aluminum (Al)	mg/L	<0.040	9497648	<0.040	0.040	<0.040	0.040	<0.040	0.040	9497648
Dissolved Barium (Ba)	mg/L	0.34	9497648	0.24	0.010	0.45	0.010	0.32	0.010	9497648
Dissolved Boron (B)	mg/L	<0.020	9497648	<0.020	0.020	0.031	0.020	<0.020	0.020	9497648
Dissolved Calcium (Ca)	mg/L	69	9497648	74	0.30	63	0.30	73	0.30	9497648
Dissolved Chromium (Cr)	mg/L	<0.010	9497648	<0.010	0.010	<0.010	0.010	<0.010	0.010	9497648
Dissolved Iron (Fe)	mg/L	0.16	9497648	0.16	0.060	0.18	0.060	0.16	0.060	9497648
Dissolved Lithium (Li)	mg/L	<0.020	9497648	<0.020	0.020	<0.020	0.020	<0.020	0.020	9497648

RDL = Reportable Detection Limit
N/A = Not Applicable

ROUTINE WATER -LAB FILTERED (WATER)

BV Labs ID		WA5520		WA5521		WA5522		WA5523		
Sampling Date		2019/07/04 09:55		2019/07/04 10:55		2019/07/04 11:55		2019/07/04 13:55		
COC Number		M083946		M083946		M083946		M083946		
	UNITS	**MW18-105**	**QC Batch**	**MW19-108**	**RDL**	**MW18-104**	**RDL**	**MW18-106**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	32	9497648	32	0.20	30	0.20	31	0.20	9497648
Dissolved Manganese (Mn)	mg/L	<0.0040	9497648	0.064	0.0040	0.40	0.0040	0.018	0.0040	9497648
Dissolved Phosphorus (P)	mg/L	<0.10	9497648	<0.10	0.10	0.21	0.10	<0.10	0.10	9497648
Dissolved Potassium (K)	mg/L	2.9	9497648	3.4	0.30	4.1	0.30	3.3	0.30	9497648
Dissolved Silicon (Si)	mg/L	4.7	9497648	4.8	0.10	3.8	0.10	4.6	0.10	9497648
Dissolved Sodium (Na)	mg/L	5.7	9497648	12	0.50	13	0.50	9.0	0.50	9497648
Dissolved Strontium (Sr)	mg/L	0.44	9497648	0.46	0.020	0.41	0.020	0.44	0.020	9497648
Dissolved Sulphur (S)	mg/L	1.6	9497648	4.5	0.20	2.6	0.20	2.1	0.20	9497648
RDL = Reportable Detection Limit										

ROUTINE WATER -LAB FILTERED (WATER)

BV Labs ID		WA5524		
Sampling Date		2019/07/04 14:55		
COC Number		M083946		
	UNITS	**MW18-107**	**RDL**	**QC Batch**
Calculated Parameters				
Anion Sum	meq/L	6.6	N/A	9493590
Cation Sum	meq/L	6.5	N/A	9493590
Hardness (CaCO3)	mg/L	310	0.50	9493521
Ion Balance (% Difference)	%	0.68	N/A	9493527
Dissolved Nitrate (NO3)	mg/L	8.9	0.044	9493534
Nitrate plus Nitrite (N)	mg/L	2.1	0.014	9493540
Dissolved Nitrite (NO2)	mg/L	0.11	0.033	9493534
Calculated Total Dissolved Solids	mg/L	320	1.0	9493550
Misc. Inorganics				
Conductivity	uS/cm	580	2.0	9497188
pH	pH	7.80	N/A	9497187
Anions				
Alkalinity (PP as CaCO3)	mg/L	<1.0	1.0	9497185
Alkalinity (Total as CaCO3)	mg/L	300	1.0	9497185
Bicarbonate (HCO3)	mg/L	370	1.0	9497185
Carbonate (CO3)	mg/L	<1.0	1.0	9497185
Hydroxide (OH)	mg/L	<1.0	1.0	9497185
Dissolved Sulphate (SO4)	mg/L	6.6	1.0	9501390
Dissolved Chloride (Cl)	mg/L	10	1.0	9501388
Nutrients				
Dissolved Nitrite (N)	mg/L	0.034	0.010	9495539
Dissolved Nitrate (N)	mg/L	2.0	0.010	9495539
Lab Filtered Elements				
Dissolved Aluminum (Al)	mg/L	<0.040	0.040	9497648
Dissolved Barium (Ba)	mg/L	0.34	0.010	9497648
Dissolved Boron (B)	mg/L	0.029	0.020	9497648
Dissolved Calcium (Ca)	mg/L	71	0.30	9497648
Dissolved Chromium (Cr)	mg/L	<0.010	0.010	9497648
Dissolved Iron (Fe)	mg/L	0.15	0.060	9497648
Dissolved Lithium (Li)	mg/L	<0.020	0.020	9497648

RDL = Reportable Detection Limit
N/A = Not Applicable

ROUTINE WATER -LAB FILTERED (WATER)

BV Labs ID		WA5524		
Sampling Date		2019/07/04 14:55		
COC Number		M083946		
	UNITS	**MW18-107**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	32	0.20	9497648
Dissolved Manganese (Mn)	mg/L	0.039	0.0040	9497648
Dissolved Phosphorus (P)	mg/L	<0.10	0.10	9497648
Dissolved Potassium (K)	mg/L	3.0	0.30	9497648
Dissolved Silicon (Si)	mg/L	4.8	0.10	9497648
Dissolved Sodium (Na)	mg/L	6.6	0.50	9497648
Dissolved Strontium (Sr)	mg/L	0.46	0.020	9497648
Dissolved Sulphur (S)	mg/L	2.0	0.20	9497648
RDL = Reportable Detection Limit				

REG. METALS (CCME/AT1) – DISS. LAB FILT.

BV Labs ID		WA5520	WA5521	WA5522	WA5523		WA5524		
Sampling Date		2019/07/04 09:55	2019/07/04 10:55	2019/07/04 11:55	2019/07/04 13:55		2019/07/04 14:55		
COC Number		M083946	M083946	M083946	M083946		M083946		
	UNITS	**MW18-105**	**MW19-108**	**MW18-104**	**MW18-106**	**QC Batch**	**MW18-107**	**RDL**	**QC Batch**
Low Level Elements									
Dissolved Cadmium (Cd)	ug/L	<0.020	<0.020	0.039	<0.020	9512961	<0.020	0.020	9513604
Lab Filtered Elements									
Dissolved Aluminum (Al)	mg/L	<0.0030	0.0051	0.0051	0.0034	9519537	0.0033	0.0030	9519537
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	0.0013	<0.00060	9519537	<0.00060	0.00060	9519537
Dissolved Arsenic (As)	mg/L	<0.00020	0.00022	0.00080	<0.00020	9519537	0.00023	0.00020	9519537
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	9519537	<0.0010	0.0010	9519537
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	9519537	<0.0010	0.0010	9519537
Dissolved Cobalt (Co)	mg/L	<0.00030	0.00039	0.0012	<0.00030	9519537	<0.00030	0.00030	9519537
Dissolved Copper (Cu)	mg/L	0.00030	<0.00020	0.0025	0.00072	9519537	<0.00020	0.00020	9519537
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	9519537	<0.00020	0.00020	9519537
Dissolved Molybdenum (Mo)	mg/L	0.00096	0.0029	0.012	0.0012	9519537	0.00095	0.00020	9519537
Dissolved Nickel (Ni)	mg/L	<0.00050	0.0023	0.0024	<0.00050	9519537	<0.00050	0.00050	9519537
Dissolved Selenium (Se)	mg/L	0.00043	0.00074	0.00024	0.00067	9519537	0.00081	0.00020	9519537
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	9519537	<0.00010	0.00010	9519537
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	9519537	<0.00020	0.00020	9519537
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	9519537	0.0012	0.0010	9519537
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	9519537	<0.0010	0.0010	9519537
Dissolved Uranium (U)	mg/L	0.0018	0.0027	0.0015	0.0020	9519537	0.0017	0.00010	9519537
Dissolved Vanadium (V)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	9519537	<0.0010	0.0010	9519537
Dissolved Zinc (Zn)	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	9519537	<0.0030	0.0030	9519537
RDL = Reportable Detection Limit									

REG. METALS (CCME/AT1) – DISS. LAB FILT.

BV Labs ID		WA5524		
Sampling Date		2019/07/04 14:55		
COC Number		M083946		
	UNITS	**MW18-107 Lab-Dup**	**RDL**	**QC Batch**
Lab Filtered Elements				
Dissolved Aluminum (Al)	mg/L	0.0036	0.0030	9519537
Dissolved Antimony (Sb)	mg/L	<0.00060	0.00060	9519537
Dissolved Arsenic (As)	mg/L	<0.00020	0.00020	9519537
Dissolved Beryllium (Be)	mg/L	<0.0010	0.0010	9519537
Dissolved Chromium (Cr)	mg/L	<0.0010	0.0010	9519537
Dissolved Cobalt (Co)	mg/L	<0.00030	0.00030	9519537
Dissolved Copper (Cu)	mg/L	<0.00020	0.00020	9519537
Dissolved Lead (Pb)	mg/L	<0.00020	0.00020	9519537
Dissolved Molybdenum (Mo)	mg/L	0.00090	0.00020	9519537
Dissolved Nickel (Ni)	mg/L	<0.00050	0.00050	9519537
Dissolved Selenium (Se)	mg/L	0.00079	0.00020	9519537
Dissolved Silver (Ag)	mg/L	<0.00010	0.00010	9519537
Dissolved Thallium (Tl)	mg/L	<0.00020	0.00020	9519537
Dissolved Tin (Sn)	mg/L	<0.0010	0.0010	9519537
Dissolved Titanium (Ti)	mg/L	<0.0010	0.0010	9519537
Dissolved Uranium (U)	mg/L	0.0018	0.00010	9519537
Dissolved Vanadium (V)	mg/L	<0.0010	0.0010	9519537
Dissolved Zinc (Zn)	mg/L	<0.0030	0.0030	9519537

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

REGULATED METALS (CCME/AT1) - TOTAL

BV Labs ID		WA5520		WA5521	WA5522	WA5523	WA5524		
Sampling Date		2019/07/04 09:55		2019/07/04 10:55	2019/07/04 11:55	2019/07/04 13:55	2019/07/04 14:55		
COC Number		M083946		M083946	M083946	M083946	M083946		
	UNITS	**MW18-105**	**RDL**	**MW19-108**	**MW18-104**	**MW18-106**	**MW18-107**	**RDL**	**QC Batch**
Low Level Elements									
Total Cadmium (Cd)	ug/L	5.5	0.020	0.95	0.36	0.95	0.33	0.020	9493589
Elements									
Total Aluminum (Al)	mg/L	5.4	0.0030	15	3.7	13	7.0	0.0030	9500624
Total Antimony (Sb)	mg/L	0.0060	0.00060	0.0022	0.0049	0.0048	0.00079	0.00060	9500624
Total Arsenic (As)	mg/L	0.0056	0.00020	0.0086	0.0044	0.017	0.0076	0.00020	9500624
Total Barium (Ba)	mg/L	2.8	0.010	1.1	0.61	1.1	0.79	0.010	9500611
Total Beryllium (Be)	mg/L	0.0014	0.0010	0.0012	<0.0010	<0.0010	<0.0010	0.0010	9500624
Total Boron (B)	mg/L	0.021	0.020	0.029	0.025	<0.020	<0.020	0.020	9500611
Total Calcium (Ca)	mg/L	720 (1)	1.5	170	90	350	170	0.30	9500611
Total Chromium (Cr)	mg/L	0.0046	0.0010	0.038	0.018	0.081	0.025	0.0010	9500624
Total Cobalt (Co)	mg/L	0.035	0.00030	0.011	0.0071	0.015	0.0051	0.00030	9500624
Total Copper (Cu)	mg/L	0.11	0.00020	0.038	0.064	0.11	0.018	0.00020	9500624
Total Iron (Fe)	mg/L	49	0.060	29	7.6	37	17	0.060	9500611
Total Lead (Pb)	mg/L	0.025	0.00020	0.024	0.0049	0.019	0.0075	0.00020	9500624
Total Lithium (Li)	mg/L	0.033	0.020	0.025	<0.020	0.021	<0.020	0.020	9500611
Total Magnesium (Mg)	mg/L	77	0.20	50	35	78	58	0.20	9500611
Total Manganese (Mn)	mg/L	2.9	0.0040	0.74	0.62	1.9	0.60	0.0040	9500611
Total Molybdenum (Mo)	mg/L	0.0014	0.00020	0.0065	0.015	0.0050	0.0021	0.00020	9500624
Total Nickel (Ni)	mg/L	0.015	0.00050	0.047	0.020	0.036	0.014	0.00050	9500624
Total Phosphorus (P)	mg/L	1.6	0.10	1.0	0.76	1.2	0.61	0.10	9500611
Total Potassium (K)	mg/L	6.6	0.30	5.6	4.6	5.0	3.6	0.30	9500611
Total Selenium (Se)	mg/L	0.00093	0.00020	0.0013	0.00049	0.0011	0.00094	0.00020	9500624
Total Silicon (Si)	mg/L	41	0.10	27	9.9	23	12	0.10	9500611
Total Silver (Ag)	mg/L	<0.00010	0.00010	0.00030	0.00044	0.0017	0.00010	0.00010	9500624
Total Sodium (Na)	mg/L	5.6	0.50	12	12	8.1	6.1	0.50	9500611
Total Strontium (Sr)	mg/L	1.4	0.020	0.57	0.41	0.58	0.51	0.020	9500611
Total Sulphur (S)	mg/L	2.3	0.20	5.7	3.2	2.5	2.2	0.20	9500611
Total Thallium (Tl)	mg/L	0.00023	0.00020	0.00028	<0.00020	0.00020	<0.00020	0.00020	9500624
Total Tin (Sn)	mg/L	<0.0010	0.0010	0.0037	0.0052	0.0014	<0.0010	0.0010	9500624
Total Titanium (Ti)	mg/L	0.0092	0.0010	0.098	0.030	0.092	0.13	0.0010	9500624

RDL = Reportable Detection Limit

(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

REGULATED METALS (CCME/AT1) - TOTAL

BV Labs ID		WA5520		WA5521	WA5522	WA5523	WA5524		
Sampling Date		2019/07/04 09:55		2019/07/04 10:55	2019/07/04 11:55	2019/07/04 13:55	2019/07/04 14:55		
COC Number		M083946		M083946	M083946	M083946	M083946		
	UNITS	**MW18-105**	**RDL**	**MW19-108**	**MW18-104**	**MW18-106**	**MW18-107**	**RDL**	**QC Batch**
Total Uranium (U)	mg/L	0.012	0.00010	0.0047	0.0019	0.0030	0.0027	0.00010	9500624
Total Vanadium (V)	mg/L	0.0053	0.0010	0.036	0.011	0.033	0.018	0.0010	9500624
Total Zinc (Zn)	mg/L	0.19	0.0030	0.15	0.072	0.13	0.037	0.0030	9500624

RDL = Reportable Detection Limit

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WA5520		WA5521	WA5522	WA5523		WA5524		
Sampling Date		2019/07/04 09:55		2019/07/04 10:55	2019/07/04 11:55	2019/07/04 13:55		2019/07/04 14:55		
COC Number		M083946		M083946	M083946	M083946		M083946		
	UNITS	**MW18-105**	**RDL**	**MW19-108**	**MW18-104**	**MW18-106**	**RDL**	**MW18-107**	**RDL**	**QC Batch**
Microbiological Param.										
E.Coli DST	MPN/100mL	<100 (1)	100	<10 (1)	10 (1)	<10 (1)	10	<1.0	1.0	9493707
Total Coliforms DST	MPN/100mL	<100 (1)	100	<10 (1)	>24000 (1)	1100 (1)	10	>2400	1.0	9493707
Physical Properties										
Turbidity	NTU	>4000 (2)	0.10	670	130	3100	0.10	53	0.10	9495349

RDL = Reportable Detection Limit

(1) Detection limit raised due to matrix interference.

(2) Sample contained sediment

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

BV Labs ID		WA5520		WA5521		WA5522		WA5523		WA5524		
Sampling Date		2019/07/04 09:55		2019/07/04 10:55		2019/07/04 11:55		2019/07/04 13:55		2019/07/04 14:55		
COC Number		M083946		M083946		M083946		M083946		M083946		
	UNITS	**MW18-105**	**RDL**	**MW19-108**	**RDL**	**MW18-104**	**RDL**	**MW18-106**	**RDL**	**MW18-107**	**RDL**	**QC Batch**
Low Level Elements												
Total Mercury (Hg)	ug/L	1.3 (1)	0.20	0.067 (1)	0.020	0.030 (1)	0.0060	0.32 (1)	0.20	0.048 (1)	0.0060	9502664

RDL = Reportable Detection Limit

(1) Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly.

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.7°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9493707	GK1	Method Blank	E.Coli DST	2019/07/06	<1.0		mpn/100mL	
			Total Coliforms DST	2019/07/06	<1.0		mpn/100mL	
9493707	GK1	RPD	E.Coli DST	2019/07/06	170		%	N/A
			Total Coliforms DST	2019/07/06	33		%	N/A
9495349	EH2	Spiked Blank	Turbidity	2019/07/06		100	%	80 - 120
9495349	EH2	Method Blank	Turbidity	2019/07/06	<0.10		NTU	
9495349	EH2	RPD	Turbidity	2019/07/06	3.9		%	20
9495539	KD9	Matrix Spike	Dissolved Nitrite (N)	2019/07/07		100	%	80 - 120
			Dissolved Nitrate (N)	2019/07/07		99	%	80 - 120
9495539	KD9	Spiked Blank	Dissolved Nitrite (N)	2019/07/07		100	%	80 - 120
			Dissolved Nitrate (N)	2019/07/07		100	%	80 - 120
9495539	KD9	Method Blank	Dissolved Nitrite (N)	2019/07/07	<0.010		mg/L	
			Dissolved Nitrate (N)	2019/07/07	<0.010		mg/L	
9495539	KD9	RPD	Dissolved Nitrite (N)	2019/07/07	NC		%	20
			Dissolved Nitrate (N)	2019/07/07	0.63		%	20
9497185	IK0	Spiked Blank	Alkalinity (Total as CaCO3)	2019/07/08		105	%	80 - 120
9497185	IK0	Method Blank	Alkalinity (PP as CaCO3)	2019/07/08	<1.0		mg/L	
			Alkalinity (Total as CaCO3)	2019/07/08	<1.0		mg/L	
			Bicarbonate (HCO3)	2019/07/08	0.0.0, RDL=1.0		mg/L	
			Carbonate (CO3)	2019/07/08	<1.0		mg/L	
			Hydroxide (OH)	2019/07/08	<1.0		mg/L	
9497185	IK0	RPD	Alkalinity (PP as CaCO3)	2019/07/08	NC		%	20
			Alkalinity (Total as CaCO3)	2019/07/08	1.7		%	20
			Bicarbonate (HCO3)	2019/07/08	1.7		%	20
			Carbonate (CO3)	2019/07/08	NC		%	20
			Hydroxide (OH)	2019/07/08	NC		%	20
9497187	IK0	Spiked Blank	pH	2019/07/08		100	%	97 - 103
9497187	IK0	RPD	pH	2019/07/08	0.052		%	N/A
9497188	IK0	Spiked Blank	Conductivity	2019/07/08		99	%	90 - 110
9497188	IK0	Method Blank	Conductivity	2019/07/08	<2.0		uS/cm	
9497188	IK0	RPD	Conductivity	2019/07/08	0.31		%	10
9497648	MAP	Matrix Spike	Dissolved Aluminum (Al)	2019/07/09		93	%	80 - 120
			Dissolved Barium (Ba)	2019/07/09		92	%	80 - 120
			Dissolved Boron (B)	2019/07/09		94	%	80 - 120
			Dissolved Calcium (Ca)	2019/07/09		NC	%	80 - 120
			Dissolved Chromium (Cr)	2019/07/09		92	%	80 - 120
			Dissolved Iron (Fe)	2019/07/09		94	%	80 - 120
			Dissolved Lithium (Li)	2019/07/09		94	%	80 - 120
			Dissolved Magnesium (Mg)	2019/07/09		87	%	80 - 120
			Dissolved Manganese (Mn)	2019/07/09		94	%	80 - 120
			Dissolved Phosphorus (P)	2019/07/09		96	%	80 - 120
			Dissolved Potassium (K)	2019/07/09		91	%	80 - 120
			Dissolved Silicon (Si)	2019/07/09		92	%	80 - 120
			Dissolved Sodium (Na)	2019/07/09		80	%	80 - 120
			Dissolved Strontium (Sr)	2019/07/09		86	%	80 - 120
			Dissolved Sulphur (S)	2019/07/09		102	%	80 - 120
9497648	MAP	Spiked Blank	Dissolved Aluminum (Al)	2019/07/09		96	%	80 - 120
			Dissolved Barium (Ba)	2019/07/09		97	%	80 - 120
			Dissolved Boron (B)	2019/07/09		97	%	80 - 120
			Dissolved Calcium (Ca)	2019/07/09		98	%	80 - 120
			Dissolved Chromium (Cr)	2019/07/09		98	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Iron (Fe)	2019/07/09		105	%	80 - 120
			Dissolved Lithium (Li)	2019/07/09		96	%	80 - 120
			Dissolved Magnesium (Mg)	2019/07/09		96	%	80 - 120
			Dissolved Manganese (Mn)	2019/07/09		100	%	80 - 120
			Dissolved Phosphorus (P)	2019/07/09		95	%	80 - 120
			Dissolved Potassium (K)	2019/07/09		93	%	80 - 120
			Dissolved Silicon (Si)	2019/07/09		98	%	80 - 120
			Dissolved Sodium (Na)	2019/07/09		96	%	80 - 120
			Dissolved Strontium (Sr)	2019/07/09		98	%	80 - 120
			Dissolved Sulphur (S)	2019/07/09		97	%	80 - 120
9497648	MAP	Method Blank	Dissolved Aluminum (Al)	2019/07/09	<0.040		mg/L	
			Dissolved Barium (Ba)	2019/07/09	<0.010		mg/L	
			Dissolved Boron (B)	2019/07/09	<0.020		mg/L	
			Dissolved Calcium (Ca)	2019/07/09	<0.30		mg/L	
			Dissolved Chromium (Cr)	2019/07/09	<0.010		mg/L	
			Dissolved Iron (Fe)	2019/07/09	<0.060		mg/L	
			Dissolved Lithium (Li)	2019/07/09	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2019/07/09	<0.20		mg/L	
			Dissolved Manganese (Mn)	2019/07/09	<0.0040		mg/L	
			Dissolved Phosphorus (P)	2019/07/09	<0.10		mg/L	
			Dissolved Potassium (K)	2019/07/09	<0.30		mg/L	
			Dissolved Silicon (Si)	2019/07/09	<0.10		mg/L	
			Dissolved Sodium (Na)	2019/07/09	<0.50		mg/L	
			Dissolved Strontium (Sr)	2019/07/09	<0.020		mg/L	
			Dissolved Sulphur (S)	2019/07/09	<0.20		mg/L	
9497648	MAP	RPD	Dissolved Calcium (Ca)	2019/07/09	0.75		%	20
			Dissolved Iron (Fe)	2019/07/09	NC		%	20
			Dissolved Magnesium (Mg)	2019/07/09	0.57		%	20
			Dissolved Manganese (Mn)	2019/07/09	NC		%	20
			Dissolved Potassium (K)	2019/07/09	1.1		%	20
			Dissolved Sodium (Na)	2019/07/09	0.69		%	20
9498897	IK0	Spiked Blank	Alkalinity (Total as CaCO3)	2019/07/09		92	%	80 - 120
9498897	IK0	Method Blank	Alkalinity (PP as CaCO3)	2019/07/09	<1.0		mg/L	
			Alkalinity (Total as CaCO3)	2019/07/09	<1.0		mg/L	
			Bicarbonate (HCO3)	2019/07/09	<1.0		mg/L	
			Carbonate (CO3)	2019/07/09	<1.0		mg/L	
			Hydroxide (OH)	2019/07/09	<1.0		mg/L	
9498897	IK0	RPD	Alkalinity (PP as CaCO3)	2019/07/09	NC		%	20
			Alkalinity (Total as CaCO3)	2019/07/09	2.2		%	20
			Bicarbonate (HCO3)	2019/07/09	2.2		%	20
			Carbonate (CO3)	2019/07/09	NC		%	20
			Hydroxide (OH)	2019/07/09	NC		%	20
9498906	IK0	Spiked Blank	pH	2019/07/09		101	%	97 - 103
9498906	IK0	RPD	pH	2019/07/09	0.053		%	N/A
9498908	IK0	Spiked Blank	Conductivity	2019/07/09		102	%	90 - 110
9498908	IK0	Method Blank	Conductivity	2019/07/09	<2.0		uS/cm	
9498908	IK0	RPD	Conductivity	2019/07/09	1.1		%	10
9500611	ALX	Matrix Spike	Total Barium (Ba)	2019/07/10		96	%	80 - 120
			Total Boron (B)	2019/07/10		97	%	80 - 120
			Total Calcium (Ca)	2019/07/10		NC	%	80 - 120
			Total Iron (Fe)	2019/07/10		101	%	80 - 120
			Total Lithium (Li)	2019/07/10		95	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Magnesium (Mg)	2019/07/10		95	%	80 - 120
			Total Manganese (Mn)	2019/07/10		94	%	80 - 120
			Total Phosphorus (P)	2019/07/10		95	%	80 - 120
			Total Potassium (K)	2019/07/10		94	%	80 - 120
			Total Silicon (Si)	2019/07/10		99	%	80 - 120
			Total Sodium (Na)	2019/07/10		NC	%	80 - 120
			Total Strontium (Sr)	2019/07/10		94	%	80 - 120
			Total Sulphur (S)	2019/07/10		95	%	80 - 120
9500611	ALX	Spiked Blank	Total Barium (Ba)	2019/07/10		96	%	80 - 120
			Total Boron (B)	2019/07/10		96	%	80 - 120
			Total Calcium (Ca)	2019/07/10		95	%	80 - 120
			Total Iron (Fe)	2019/07/10		103	%	80 - 120
			Total Lithium (Li)	2019/07/10		94	%	80 - 120
			Total Magnesium (Mg)	2019/07/10		96	%	80 - 120
			Total Manganese (Mn)	2019/07/10		97	%	80 - 120
			Total Phosphorus (P)	2019/07/10		94	%	80 - 120
			Total Potassium (K)	2019/07/10		92	%	80 - 120
			Total Silicon (Si)	2019/07/10		98	%	80 - 120
			Total Sodium (Na)	2019/07/10		95	%	80 - 120
			Total Strontium (Sr)	2019/07/10		95	%	80 - 120
			Total Sulphur (S)	2019/07/10		96	%	80 - 120
9500611	ALX	Method Blank	Total Barium (Ba)	2019/07/10	<0.010		mg/L	
			Total Boron (B)	2019/07/10	<0.020		mg/L	
			Total Calcium (Ca)	2019/07/10	<0.30		mg/L	
			Total Iron (Fe)	2019/07/10	<0.060		mg/L	
			Total Lithium (Li)	2019/07/10	<0.020		mg/L	
			Total Magnesium (Mg)	2019/07/10	<0.20		mg/L	
			Total Manganese (Mn)	2019/07/10	<0.0040		mg/L	
			Total Phosphorus (P)	2019/07/10	<0.10		mg/L	
			Total Potassium (K)	2019/07/10	<0.30		mg/L	
			Total Silicon (Si)	2019/07/10	<0.10		mg/L	
			Total Sodium (Na)	2019/07/10	<0.50		mg/L	
			Total Strontium (Sr)	2019/07/10	<0.020		mg/L	
			Total Sulphur (S)	2019/07/10	<0.20		mg/L	
9500611	ALX	RPD	Total Barium (Ba)	2019/07/10	0.68		%	20
			Total Boron (B)	2019/07/10	1.0		%	20
			Total Calcium (Ca)	2019/07/10	0.17		%	20
			Total Iron (Fe)	2019/07/10	3.0		%	20
			Total Lithium (Li)	2019/07/10	0		%	20
			Total Magnesium (Mg)	2019/07/10	0.46		%	20
			Total Manganese (Mn)	2019/07/10	NC		%	20
			Total Phosphorus (P)	2019/07/10	NC		%	20
			Total Potassium (K)	2019/07/10	0.63		%	20
			Total Silicon (Si)	2019/07/10	0.92		%	20
			Total Sodium (Na)	2019/07/10	0.55		%	20
			Total Strontium (Sr)	2019/07/10	0.38		%	20
			Total Sulphur (S)	2019/07/10	0.37		%	20
9500624	LQ1	Matrix Spike	Total Aluminum (Al)	2019/07/10		97	%	80 - 120
			Total Antimony (Sb)	2019/07/10		105	%	80 - 120
			Total Arsenic (As)	2019/07/10		94	%	80 - 120
			Total Beryllium (Be)	2019/07/10		97	%	80 - 120
			Total Chromium (Cr)	2019/07/10		99	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Cobalt (Co)	2019/07/10		97	%	80 - 120
			Total Copper (Cu)	2019/07/10		109	%	80 - 120
			Total Lead (Pb)	2019/07/10		102	%	80 - 120
			Total Molybdenum (Mo)	2019/07/10		104	%	80 - 120
			Total Nickel (Ni)	2019/07/10		96	%	80 - 120
			Total Selenium (Se)	2019/07/10		97	%	80 - 120
			Total Silver (Ag)	2019/07/10		100	%	80 - 120
			Total Thallium (Tl)	2019/07/10		99	%	80 - 120
			Total Tin (Sn)	2019/07/10		99	%	80 - 120
			Total Titanium (Ti)	2019/07/10		101	%	80 - 120
			Total Uranium (U)	2019/07/10		98	%	80 - 120
			Total Vanadium (V)	2019/07/10		99	%	80 - 120
			Total Zinc (Zn)	2019/07/10		NC	%	80 - 120
9500624	LQ1	Spiked Blank	Total Aluminum (Al)	2019/07/10		99	%	80 - 120
			Total Antimony (Sb)	2019/07/10		105	%	80 - 120
			Total Arsenic (As)	2019/07/10		95	%	80 - 120
			Total Beryllium (Be)	2019/07/10		94	%	80 - 120
			Total Chromium (Cr)	2019/07/10		100	%	80 - 120
			Total Cobalt (Co)	2019/07/10		98	%	80 - 120
			Total Copper (Cu)	2019/07/10		98	%	80 - 120
			Total Lead (Pb)	2019/07/10		97	%	80 - 120
			Total Molybdenum (Mo)	2019/07/10		100	%	80 - 120
			Total Nickel (Ni)	2019/07/10		97	%	80 - 120
			Total Selenium (Se)	2019/07/10		95	%	80 - 120
			Total Silver (Ag)	2019/07/10		100	%	80 - 120
			Total Thallium (Tl)	2019/07/10		100	%	80 - 120
			Total Tin (Sn)	2019/07/10		98	%	80 - 120
			Total Titanium (Ti)	2019/07/10		99	%	80 - 120
			Total Uranium (U)	2019/07/10		93	%	80 - 120
			Total Vanadium (V)	2019/07/10		99	%	80 - 120
			Total Zinc (Zn)	2019/07/10		96	%	80 - 120
9500624	LQ1	Method Blank	Total Aluminum (Al)	2019/07/10	<0.0030		mg/L	
			Total Antimony (Sb)	2019/07/10	<0.00060		mg/L	
			Total Arsenic (As)	2019/07/10	<0.00020		mg/L	
			Total Beryllium (Be)	2019/07/10	<0.0010		mg/L	
			Total Chromium (Cr)	2019/07/10	<0.0010		mg/L	
			Total Cobalt (Co)	2019/07/10	<0.00030		mg/L	
			Total Copper (Cu)	2019/07/10	<0.00020		mg/L	
			Total Lead (Pb)	2019/07/10	<0.00020		mg/L	
			Total Molybdenum (Mo)	2019/07/10	<0.00020		mg/L	
			Total Nickel (Ni)	2019/07/10	<0.00050		mg/L	
			Total Selenium (Se)	2019/07/10	<0.00020		mg/L	
			Total Silver (Ag)	2019/07/10	<0.00010		mg/L	
			Total Thallium (Tl)	2019/07/10	<0.00020		mg/L	
			Total Tin (Sn)	2019/07/10	<0.0010		mg/L	
			Total Titanium (Ti)	2019/07/10	<0.0010		mg/L	
			Total Uranium (U)	2019/07/10	<0.00010		mg/L	
			Total Vanadium (V)	2019/07/10	<0.0010		mg/L	
			Total Zinc (Zn)	2019/07/10	<0.0030		mg/L	
9500624	LQ1	RPD	Total Aluminum (Al)	2019/07/10	5.2		%	20
			Total Antimony (Sb)	2019/07/10	NC		%	20
			Total Arsenic (As)	2019/07/10	NC		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Beryllium (Be)	2019/07/10	NC		%	20
			Total Chromium (Cr)	2019/07/10	7.9		%	20
			Total Cobalt (Co)	2019/07/10	NC		%	20
			Total Copper (Cu)	2019/07/10	7.8		%	20
			Total Lead (Pb)	2019/07/10	NC		%	20
			Total Molybdenum (Mo)	2019/07/10	1.8		%	20
			Total Nickel (Ni)	2019/07/10	12		%	20
			Total Selenium (Se)	2019/07/10	1.9		%	20
			Total Silver (Ag)	2019/07/10	NC		%	20
			Total Thallium (Tl)	2019/07/10	NC		%	20
			Total Tin (Sn)	2019/07/10	NC		%	20
			Total Titanium (Ti)	2019/07/10	NC		%	20
			Total Uranium (U)	2019/07/10	4.8		%	20
			Total Vanadium (V)	2019/07/10	NC		%	20
			Total Zinc (Zn)	2019/07/10	NC		%	20
9501388	ZI	Matrix Spike	Dissolved Chloride (Cl)	2019/07/10		NC	%	80 - 120
9501388	ZI	Spiked Blank	Dissolved Chloride (Cl)	2019/07/10		106	%	80 - 120
9501388	ZI	Method Blank	Dissolved Chloride (Cl)	2019/07/10	<1.0		mg/L	
9501388	ZI	RPD	Dissolved Chloride (Cl)	2019/07/10	1.2		%	20
9501390	ZI	Matrix Spike	Dissolved Sulphate (SO4)	2019/07/10		NC	%	80 - 120
9501390	ZI	Spiked Blank	Dissolved Sulphate (SO4)	2019/07/10		103	%	80 - 120
9501390	ZI	Method Blank	Dissolved Sulphate (SO4)	2019/07/10	<1.0		mg/L	
9501390	ZI	RPD	Dissolved Sulphate (SO4)	2019/07/10	0.13		%	20
9502664	RK3	Matrix Spike	Total Mercury (Hg)	2019/07/11		95	%	80 - 120
9502664	RK3	Spiked Blank	Total Mercury (Hg)	2019/07/11		91	%	80 - 120
9502664	RK3	Method Blank	Total Mercury (Hg)	2019/07/11	<0.0020		ug/L	
9502664	RK3	RPD	Total Mercury (Hg)	2019/07/11	NC		%	20
9519537	ANE	Matrix Spike [WA5524-01]	Dissolved Aluminum (Al)	2019/07/23		110	%	80 - 120
			Dissolved Antimony (Sb)	2019/07/23		99	%	80 - 120
			Dissolved Arsenic (As)	2019/07/23		98	%	80 - 120
			Dissolved Beryllium (Be)	2019/07/23		102	%	80 - 120
			Dissolved Chromium (Cr)	2019/07/23		95	%	80 - 120
			Dissolved Cobalt (Co)	2019/07/23		94	%	80 - 120
			Dissolved Copper (Cu)	2019/07/23		93	%	80 - 120
			Dissolved Lead (Pb)	2019/07/23		92	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/07/23		98	%	80 - 120
			Dissolved Nickel (Ni)	2019/07/23		94	%	80 - 120
			Dissolved Selenium (Se)	2019/07/23		108	%	80 - 120
			Dissolved Silver (Ag)	2019/07/23		94	%	80 - 120
			Dissolved Thallium (Tl)	2019/07/23		96	%	80 - 120
			Dissolved Tin (Sn)	2019/07/23		75 (1)	%	80 - 120
			Dissolved Titanium (Ti)	2019/07/23		84	%	80 - 120
			Dissolved Uranium (U)	2019/07/23		104	%	80 - 120
			Dissolved Vanadium (V)	2019/07/23		98	%	80 - 120
			Dissolved Zinc (Zn)	2019/07/23		94	%	80 - 120
9519537	ANE	Spiked Blank	Dissolved Aluminum (Al)	2019/07/23		106	%	80 - 120
			Dissolved Antimony (Sb)	2019/07/23		100	%	80 - 120
			Dissolved Arsenic (As)	2019/07/23		99	%	80 - 120
			Dissolved Beryllium (Be)	2019/07/23		100	%	80 - 120
			Dissolved Chromium (Cr)	2019/07/23		98	%	80 - 120
			Dissolved Cobalt (Co)	2019/07/23		97	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Copper (Cu)	2019/07/23		99	%	80 - 120
			Dissolved Lead (Pb)	2019/07/23		94	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/07/23		96	%	80 - 120
			Dissolved Nickel (Ni)	2019/07/23		97	%	80 - 120
			Dissolved Selenium (Se)	2019/07/23		107	%	80 - 120
			Dissolved Silver (Ag)	2019/07/23		94	%	80 - 120
			Dissolved Thallium (Tl)	2019/07/23		97	%	80 - 120
			Dissolved Tin (Sn)	2019/07/23		81	%	80 - 120
			Dissolved Titanium (Ti)	2019/07/23		88	%	80 - 120
			Dissolved Uranium (U)	2019/07/23		100	%	80 - 120
			Dissolved Vanadium (V)	2019/07/23		99	%	80 - 120
			Dissolved Zinc (Zn)	2019/07/23		94	%	80 - 120
9519537	ANE	Method Blank	Dissolved Aluminum (Al)	2019/07/23	<0.0030		mg/L	
			Dissolved Antimony (Sb)	2019/07/23	<0.00060		mg/L	
			Dissolved Arsenic (As)	2019/07/23	<0.00020		mg/L	
			Dissolved Beryllium (Be)	2019/07/23	<0.0010		mg/L	
			Dissolved Chromium (Cr)	2019/07/23	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2019/07/23	<0.00030		mg/L	
			Dissolved Copper (Cu)	2019/07/23	<0.00020		mg/L	
			Dissolved Lead (Pb)	2019/07/23	<0.00020		mg/L	
			Dissolved Molybdenum (Mo)	2019/07/23	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2019/07/23	<0.00050		mg/L	
			Dissolved Selenium (Se)	2019/07/23	<0.00020		mg/L	
			Dissolved Silver (Ag)	2019/07/23	<0.00010		mg/L	
			Dissolved Thallium (Tl)	2019/07/23	<0.00020		mg/L	
			Dissolved Tin (Sn)	2019/07/23	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2019/07/23	<0.0010		mg/L	
			Dissolved Uranium (U)	2019/07/23	<0.00010		mg/L	
			Dissolved Vanadium (V)	2019/07/23	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2019/07/23	<0.0030		mg/L	
9519537	ANE	RPD [WA5524-01]	Dissolved Aluminum (Al)	2019/07/23	9.8		%	20
			Dissolved Antimony (Sb)	2019/07/23	NC		%	20
			Dissolved Arsenic (As)	2019/07/23	12		%	20
			Dissolved Beryllium (Be)	2019/07/23	NC		%	20
			Dissolved Chromium (Cr)	2019/07/23	NC		%	20
			Dissolved Cobalt (Co)	2019/07/23	NC		%	20
			Dissolved Copper (Cu)	2019/07/23	NC		%	20
			Dissolved Lead (Pb)	2019/07/23	NC		%	20
			Dissolved Molybdenum (Mo)	2019/07/23	5.2		%	20
			Dissolved Nickel (Ni)	2019/07/23	NC		%	20
			Dissolved Selenium (Se)	2019/07/23	2.0		%	20
			Dissolved Silver (Ag)	2019/07/23	NC		%	20
			Dissolved Thallium (Tl)	2019/07/23	NC		%	20
			Dissolved Tin (Sn)	2019/07/23	16		%	20
			Dissolved Titanium (Ti)	2019/07/23	NC		%	20
			Dissolved Uranium (U)	2019/07/23	4.6		%	20
			Dissolved Vanadium (V)	2019/07/23	NC		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Zinc (Zn)	2019/07/23	NC		%	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Ghayasuddin Khan, M.Sc., P.Chem., QP, Scientific Specialist, Inorganics

Peng Liang

Harry (Peng) Liang, Senior Analyst

Maxxam
A Bureau Veritas Group Company

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Edmonton: 9331-48 St. T6B 2R4. Toll Free (800) 386-7247
maxxam.ca

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CHAIN OF CUSTODY RECORD

M 083946

Page 1 of 1

Invoice Information	Report Information (if differs from invoice)	Project Information	Turnaround Time (TAT) Required
Company: SLR Consulting Ltd.	Company: Summit Aggregates.	Quotation #:	☒ 5 - 7 Days Regular (Most analyses)
Contact Name: Robert Till	Contact Name:	P.O. #/ AFE#: ~~[illegible]~~ EDM4886	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 6940 Roper Road, Edmonton AB, T6B 3H9	Address:		Rush TAT (Surcharges will be applied)
		Project #: 212-06550.00003	☐ Same Day ☐ 2 Days
Phone:	Phone:	Site Location: Mountain Ash	☐ 1 Day ☐ 3-4 Days
Email: rtill@slrconsulting.com	Email: rtill@slrconsulting.com	Site #:	Date Required:
Copies: ~~[illegible]~~ nyari@slrconsulting.com	Copies: nyari@slrconsulting.com	Sampled By: Noushin Yari	Rush Confirmation #:

Laboratory Use Only

	YES	NO	Cooler ID			
Seal Present	✓		Temp	3	0	8
Seal Intact	✓					
Cooling Media	—					
	YES	NO	Cooler ID			
Seal Present			Temp			
Seal Intact						
Cooling Media						
	YES	NO	Cooler ID			
Seal Present			Temp			
Seal Intact						
Cooling Media						

Depot Reception

Analysis Requested

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	# of containers	BTEX F1 ☐ VOC ☐	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals Tot ☐ ☒ Diss	Mercury Total ☐ ☒ Dissolved	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	Turbidity	~~[illegible]~~	Total Coliforms & E. Coli							HOLD - DO NOT ANALYZE	Special Instructions
1	MW18-105		2019/07/04	9:55 AM	Ground water	6				X	X	X					X		X								→silty
2	MW19-108		↓	10:55 AM	↓	6				X	X	X					X		X								→silty
3	MW18-104			11:55 AM		6				X	X	X					X		X								
4	MW18-106			1:55 pm		6				X	X	X					X		X								→silty
5	MW18-107			2:55 PM		6				X	X	X					X		X								
6																											
7																											
8																											
9																											
10																											

Regulatory Criteria

- ☒ AT1
- ☐ CCME
- ☐ Drinking Water
- ☐ D50 (Drilling Waste)
- ☐ Saskatchewan
- ☐ Other:

Special Instructions

Metals preserved not field filtered. Too wet in field and could not label the bottles w/ marker or Pen. Labels on bags.

Please indicate Filtered, Preserved or Both (F, P, F/P)

Relinquished by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Received by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)
/ Noushin Yari	2019/07/05	06:45 AM		2019/07/05	07:00

05-Jul-19 07:00
Jenelle Feller
B953759
JEM INS-0239

AB FCD-00331/7

Your P.O. #: EDM4886
Your Project #: 212.06550.00003
Site Location: MOUNTAIN ASH
PO # EDM3288
Your C.O.C. #: M083948

Attention: ROBERT TILL
SLR CONSULTING (CANADA) LTD
6940 ROPER ROAD
EDMONTON, AB
CANADA T6B 3H9

Report Date: 2019/07/12
Report #: R2751511
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B953951
Received: 2019/07/05, 12:20

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity @25C (pp, total), CO3,HCO3,OH	2	N/A	2019/07/10	AB SOP-00005	SM 23 2320 B m
Cadmium - low level CCME (Total)	2	N/A	2019/07/11		Auto Calc
Chloride by Automated Colourimetry	2	N/A	2019/07/10	AB SOP-00020	SM 23-4500-Cl-E m
Total Coliforms and E.Coli	2	2019/07/05	2019/07/06	AB SOP-00089	SM 23 9223 A,B m
Conductivity @25C	2	N/A	2019/07/10	AB SOP-00005	SM 23 2510 B m
Hardness	2	N/A	2019/07/11		Auto Calc
Mercury (Total) by CV	1	2019/07/10	2019/07/10	CAL SOP-00007	EPA 1631 RE 20460 m
Mercury (Total) by CV	1	2019/07/10	2019/07/11	CAL SOP-00007	EPA 1631 RE 20460 m
Elements by ICP-Dissolved-Lab Filtered (1)	2	N/A	2019/07/09	AB SOP-00042	EPA 6010d R5 m
Elements by ICP - Total	2	2019/07/10	2019/07/10	AB SOP-00014 / AB SOP-00042	EPA 6010d R4 m
Elements by ICPMS - Total	2	2019/07/10	2019/07/10	AB SOP-00014 / AB SOP-00043	EPA 6020b R2 m
Ion Balance	2	N/A	2019/07/06		Auto Calc
Sum of cations, anions	2	N/A	2019/07/11		Auto Calc
Nitrate and Nitrite	2	N/A	2019/07/10		Auto Calc
Nitrate + Nitrite-N (calculated)	2	N/A	2019/07/10		Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	2	N/A	2019/07/07	AB SOP-00023	SM 23 4110 B m
pH @25°C (2)	2	N/A	2019/07/10	AB SOP-00005	SM 23 4500-H+B m
Sulphate by Automated Colourimetry	2	N/A	2019/07/10	AB SOP-00018	SM 23 4500-SO4 E m
Total Dissolved Solids (Calculated)	2	N/A	2019/07/11		Auto Calc
Turbidity	2	N/A	2019/07/06	CAL SOP-00081	SM 23 2130 B m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Your P.O. #: EDM4886
Your Project #: 212.06550.00003
Site Location: MOUNTAIN ASH
PO # EDM3288
Your C.O.C. #: M083948

Attention: ROBERT TILL
SLR CONSULTING (CANADA) LTD
6940 ROPER ROAD
EDMONTON, AB
CANADA T6B 3H9

Report Date: 2019/07/12
Report #: R2751511
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B953951
Received: 2019/07/05, 12:20

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) Dissolved > Total Imbalance: When applicable, Dissolved and Total results were reviewed and data quality meets acceptable levels unless otherwise noted.
(2) The CCME method requires pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the CCME holding time. Bureau Veritas Laboratories endeavours to analyze samples as soon as possible after receipt.

Encryption Key Jenelle Feller

```
Jenelle Feller
Key Account Specialist
12 Jul 2019 17:52:06
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Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Jenelle Feller, Key Account Specialist
Email: JFeller@bvlabs.com
Phone# (403)735-2264
==
BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

ROUTINE WATER -LAB FILTERED (WATER)

BV Labs ID		WA6549	WA6550		
Sampling Date		2019/07/05	2019/07/05		
COC Number		M083948	M083948		
	UNITS	**MW19-109**	**WW4**	**RDL**	**QC Batch**
Calculated Parameters					
Anion Sum	meq/L	6.9	6.3	N/A	9493590
Cation Sum	meq/L	7.9	7.3	N/A	9493590
Hardness (CaCO3)	mg/L	350	340	0.50	9494037
Ion Balance (% Difference)	%	6.2	7.6	N/A	9493527
Dissolved Nitrate (NO3)	mg/L	7.4	14	0.044	9493534
Nitrate plus Nitrite (N)	mg/L	1.7	3.2	0.014	9493540
Dissolved Nitrite (NO2)	mg/L	0.22	<0.033	0.033	9493534
Calculated Total Dissolved Solids	mg/L	360	330	1.0	9493550
Misc. Inorganics					
Conductivity	uS/cm	660	600	2.0	9498940
pH	pH	8.19	8.13	N/A	9498939
Anions					
Alkalinity (PP as CaCO3)	mg/L	<1.0	<1.0	1.0	9498938
Alkalinity (Total as CaCO3)	mg/L	290	280	1.0	9498938
Bicarbonate (HCO3)	mg/L	350	340	1.0	9498938
Carbonate (CO3)	mg/L	<1.0	<1.0	1.0	9498938
Hydroxide (OH)	mg/L	<1.0	<1.0	1.0	9498938
Dissolved Sulphate (SO4)	mg/L	26	5.9	1.0	9501583
Dissolved Chloride (Cl)	mg/L	18	12	1.0	9501576
Nutrients					
Dissolved Nitrite (N)	mg/L	0.065	<0.010	0.010	9495902
Dissolved Nitrate (N)	mg/L	1.7	3.2	0.010	9495902
Lab Filtered Elements					
Dissolved Calcium (Ca)	mg/L	77	80	0.30	9499250
Dissolved Iron (Fe)	mg/L	0.15	0.16	0.060	9499250
Dissolved Magnesium (Mg)	mg/L	37	35	0.20	9499250
Dissolved Manganese (Mn)	mg/L	0.42	<0.0040	0.0040	9499250
Dissolved Potassium (K)	mg/L	6.3	3.0	0.30	9499250
Dissolved Sodium (Na)	mg/L	18	7.7	0.50	9499250

RDL = Reportable Detection Limit
N/A = Not Applicable

REGULATED METALS (CCME/AT1) - TOTAL

BV Labs ID		WA6549		WA6550		
Sampling Date		2019/07/05		2019/07/05		
COC Number		M083948		M083948		
	UNITS	**MW19-109**	**RDL**	**WW4**	**RDL**	**QC Batch**
Low Level Elements						
Total Cadmium (Cd)	ug/L	10	0.020	<0.020	0.020	9494032
Elements						
Total Aluminum (Al)	mg/L	95	0.0030	0.0041	0.0030	9500624
Total Antimony (Sb)	mg/L	0.0034	0.00060	<0.00060	0.00060	9500624
Total Arsenic (As)	mg/L	0.071	0.00020	0.00032	0.00020	9500624
Total Barium (Ba)	mg/L	7.2 (1)	0.050	0.36	0.010	9500611
Total Beryllium (Be)	mg/L	0.0083	0.0010	<0.0010	0.0010	9500624
Total Boron (B)	mg/L	0.087	0.020	<0.020	0.020	9500611
Total Calcium (Ca)	mg/L	1500 (1)	1.5	68	0.30	9500611
Total Chromium (Cr)	mg/L	0.19	0.0010	0.0012	0.0010	9500624
Total Cobalt (Co)	mg/L	0.12	0.00030	<0.00030	0.00030	9500624
Total Copper (Cu)	mg/L	0.29	0.00020	0.034	0.00020	9500624
Total Iron (Fe)	mg/L	190	0.060	0.30	0.060	9500611
Total Lead (Pb)	mg/L	0.15	0.00020	0.011	0.00020	9500624
Total Lithium (Li)	mg/L	0.18	0.020	<0.020	0.020	9500611
Total Magnesium (Mg)	mg/L	210	0.20	30	0.20	9500611
Total Manganese (Mn)	mg/L	8.9	0.0040	<0.0040	0.0040	9500611
Total Molybdenum (Mo)	mg/L	0.023	0.00020	0.00065	0.00020	9500624
Total Nickel (Ni)	mg/L	0.41	0.00050	<0.00050	0.00050	9500624
Total Phosphorus (P)	mg/L	8.1	0.10	<0.10	0.10	9500611
Total Potassium (K)	mg/L	20	0.30	2.3	0.30	9500611
Total Selenium (Se)	mg/L	0.00059	0.00020	0.00093	0.00020	9500624
Total Silicon (Si)	mg/L	110 (1)	0.50	4.7	0.10	9500611
Total Silver (Ag)	mg/L	0.0025	0.00010	0.00012	0.00010	9500624
Total Sodium (Na)	mg/L	18	0.50	5.7	0.50	9500611
Total Strontium (Sr)	mg/L	2.4	0.020	0.39	0.020	9500611
Total Sulphur (S)	mg/L	11	0.20	1.7	0.20	9500611
Total Thallium (Tl)	mg/L	0.0026	0.00020	<0.00020	0.00020	9500624
Total Tin (Sn)	mg/L	0.0047	0.0010	<0.0010	0.0010	9500624
Total Titanium (Ti)	mg/L	0.23	0.0010	<0.0010	0.0010	9500624

RDL = Reportable Detection Limit
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

REGULATED METALS (CCME/AT1) - TOTAL

BV Labs ID		WA6549		WA6550		
Sampling Date		2019/07/05		2019/07/05		
COC Number		M083948		M083948		
	UNITS	**MW19-109**	**RDL**	**WW4**	**RDL**	**QC Batch**
Total Uranium (U)	mg/L	0.016	0.00010	0.0021	0.00010	9500624
Total Vanadium (V)	mg/L	0.22	0.0010	<0.0010	0.0010	9500624
Total Zinc (Zn)	mg/L	1.2	0.0030	0.99	0.0030	9500624
RDL = Reportable Detection Limit						

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WA6549		WA6550		
Sampling Date		2019/07/05		2019/07/05		
COC Number		M083948		M083948		
	UNITS	**MW19-109**	**RDL**	**WW4**	**RDL**	**QC Batch**
Microbiological Param.						
E.Coli DST	MPN/100mL	100	100	<1.0	1.0	9494183
Total Coliforms DST	MPN/100mL	120000	100	11	1.0	9494183
Physical Properties						
Turbidity	NTU	>4000 (1)	0.10	0.66	0.10	9495457

RDL = Reportable Detection Limit
(1) Sample contained sediment

MERCURY BY COLD VAPOR (WATER)

BV Labs ID		WA6549		WA6550		
Sampling Date		2019/07/05		2019/07/05		
COC Number		M083948		M083948		
	UNITS	**MW19-109**	**RDL**	**WW4**	**RDL**	**QC Batch**
Elements						
Total Mercury (Hg)	ug/L	2.08 (1)	0.20	<0.0020	0.0020	9500789

RDL = Reportable Detection Limit

(1) Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly.

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	7.0°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9494183	GK1	Method Blank	E.Coli DST	2019/07/06	<1.0		mpn/100mL	
			Total Coliforms DST	2019/07/06	<1.0		mpn/100mL	
9494183	GK1	RPD	E.Coli DST	2019/07/06	NC		%	N/A
			Total Coliforms DST	2019/07/06	NC		%	N/A
9495457	EH2	Spiked Blank	Turbidity	2019/07/06		100	%	80 - 120
9495457	EH2	Method Blank	Turbidity	2019/07/06	<0.10		NTU	
9495457	EH2	RPD [WA6550-02]	Turbidity	2019/07/06	5.9		%	20
9495902	KD9	Matrix Spike	Dissolved Nitrite (N)	2019/07/07		99	%	80 - 120
			Dissolved Nitrate (N)	2019/07/07		100	%	80 - 120
9495902	KD9	Spiked Blank	Dissolved Nitrite (N)	2019/07/07		99	%	80 - 120
			Dissolved Nitrate (N)	2019/07/07		100	%	80 - 120
9495902	KD9	Method Blank	Dissolved Nitrite (N)	2019/07/07	<0.010		mg/L	
			Dissolved Nitrate (N)	2019/07/07	<0.010		mg/L	
9495902	KD9	RPD	Dissolved Nitrite (N)	2019/07/07	NC		%	20
			Dissolved Nitrate (N)	2019/07/07	NC		%	20
9498938	IK0	Spiked Blank	Alkalinity (Total as CaCO3)	2019/07/10		92	%	80 - 120
9498938	IK0	Method Blank	Alkalinity (PP as CaCO3)	2019/07/10	<1.0		mg/L	
			Alkalinity (Total as CaCO3)	2019/07/10	<1.0		mg/L	
			Bicarbonate (HCO3)	2019/07/10	<1.0		mg/L	
			Carbonate (CO3)	2019/07/10	<1.0		mg/L	
			Hydroxide (OH)	2019/07/10	<1.0		mg/L	
9498938	IK0	RPD	Alkalinity (PP as CaCO3)	2019/07/10	NC		%	20
			Alkalinity (Total as CaCO3)	2019/07/10	1.7		%	20
			Bicarbonate (HCO3)	2019/07/10	1.7		%	20
			Carbonate (CO3)	2019/07/10	NC		%	20
			Hydroxide (OH)	2019/07/10	NC		%	20
9498939	IK0	Spiked Blank	pH	2019/07/10		101	%	97 - 103
9498939	IK0	RPD	pH	2019/07/10	0.36		%	N/A
9498940	IK0	Spiked Blank	Conductivity	2019/07/10		102	%	90 - 110
9498940	IK0	Method Blank	Conductivity	2019/07/10	<2.0		uS/cm	
9498940	IK0	RPD	Conductivity	2019/07/10	0.61		%	10
9499250	ALX	Matrix Spike	Dissolved Calcium (Ca)	2019/07/09		97	%	80 - 120
			Dissolved Iron (Fe)	2019/07/09		101	%	80 - 120
			Dissolved Magnesium (Mg)	2019/07/09		98	%	80 - 120
			Dissolved Manganese (Mn)	2019/07/09		101	%	80 - 120
			Dissolved Potassium (K)	2019/07/09		102	%	80 - 120
			Dissolved Sodium (Na)	2019/07/09		NC	%	80 - 120
9499250	ALX	Spiked Blank	Dissolved Calcium (Ca)	2019/07/09		100	%	80 - 120
			Dissolved Iron (Fe)	2019/07/09		105	%	80 - 120
			Dissolved Magnesium (Mg)	2019/07/09		104	%	80 - 120
			Dissolved Manganese (Mn)	2019/07/09		102	%	80 - 120
			Dissolved Potassium (K)	2019/07/09		103	%	80 - 120
			Dissolved Sodium (Na)	2019/07/09		105	%	80 - 120
9499250	ALX	Method Blank	Dissolved Calcium (Ca)	2019/07/09	<0.30		mg/L	
			Dissolved Iron (Fe)	2019/07/09	<0.060		mg/L	
			Dissolved Magnesium (Mg)	2019/07/09	<0.20		mg/L	
			Dissolved Manganese (Mn)	2019/07/09	<0.0040		mg/L	
			Dissolved Potassium (K)	2019/07/09	<0.30		mg/L	
			Dissolved Sodium (Na)	2019/07/09	0.77, RDL=0.50 (1)		mg/L	
9499250	ALX	RPD	Dissolved Calcium (Ca)	2019/07/09	2.2		%	20
			Dissolved Iron (Fe)	2019/07/09	0.079		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Magnesium (Mg)	2019/07/09	2.2		%	20
			Dissolved Manganese (Mn)	2019/07/09	NC		%	20
			Dissolved Potassium (K)	2019/07/09	0.075		%	20
			Dissolved Sodium (Na)	2019/07/09	1.6		%	20
9500611	ALX	Matrix Spike	Total Barium (Ba)	2019/07/10		96	%	80 - 120
			Total Boron (B)	2019/07/10		97	%	80 - 120
			Total Calcium (Ca)	2019/07/10		NC	%	80 - 120
			Total Iron (Fe)	2019/07/10		101	%	80 - 120
			Total Lithium (Li)	2019/07/10		95	%	80 - 120
			Total Magnesium (Mg)	2019/07/10		95	%	80 - 120
			Total Manganese (Mn)	2019/07/10		94	%	80 - 120
			Total Phosphorus (P)	2019/07/10		95	%	80 - 120
			Total Potassium (K)	2019/07/10		94	%	80 - 120
			Total Silicon (Si)	2019/07/10		99	%	80 - 120
			Total Sodium (Na)	2019/07/10		NC	%	80 - 120
			Total Strontium (Sr)	2019/07/10		94	%	80 - 120
			Total Sulphur (S)	2019/07/10		95	%	80 - 120
9500611	ALX	Spiked Blank	Total Barium (Ba)	2019/07/10		96	%	80 - 120
			Total Boron (B)	2019/07/10		96	%	80 - 120
			Total Calcium (Ca)	2019/07/10		95	%	80 - 120
			Total Iron (Fe)	2019/07/10		103	%	80 - 120
			Total Lithium (Li)	2019/07/10		94	%	80 - 120
			Total Magnesium (Mg)	2019/07/10		96	%	80 - 120
			Total Manganese (Mn)	2019/07/10		97	%	80 - 120
			Total Phosphorus (P)	2019/07/10		94	%	80 - 120
			Total Potassium (K)	2019/07/10		92	%	80 - 120
			Total Silicon (Si)	2019/07/10		98	%	80 - 120
			Total Sodium (Na)	2019/07/10		95	%	80 - 120
			Total Strontium (Sr)	2019/07/10		95	%	80 - 120
			Total Sulphur (S)	2019/07/10		96	%	80 - 120
9500611	ALX	Method Blank	Total Barium (Ba)	2019/07/10	<0.010		mg/L	
			Total Boron (B)	2019/07/10	<0.020		mg/L	
			Total Calcium (Ca)	2019/07/10	<0.30		mg/L	
			Total Iron (Fe)	2019/07/10	<0.060		mg/L	
			Total Lithium (Li)	2019/07/10	<0.020		mg/L	
			Total Magnesium (Mg)	2019/07/10	<0.20		mg/L	
			Total Manganese (Mn)	2019/07/10	<0.0040		mg/L	
			Total Phosphorus (P)	2019/07/10	<0.10		mg/L	
			Total Potassium (K)	2019/07/10	<0.30		mg/L	
			Total Silicon (Si)	2019/07/10	<0.10		mg/L	
			Total Sodium (Na)	2019/07/10	<0.50		mg/L	
			Total Strontium (Sr)	2019/07/10	<0.020		mg/L	
			Total Sulphur (S)	2019/07/10	<0.20		mg/L	
9500611	ALX	RPD	Total Barium (Ba)	2019/07/10	0.68		%	20
			Total Boron (B)	2019/07/10	1.0		%	20
			Total Calcium (Ca)	2019/07/10	0.17		%	20
			Total Iron (Fe)	2019/07/10	3.0		%	20
			Total Lithium (Li)	2019/07/10	0		%	20
			Total Magnesium (Mg)	2019/07/10	0.46		%	20
			Total Manganese (Mn)	2019/07/10	NC		%	20
			Total Phosphorus (P)	2019/07/10	NC		%	20
			Total Potassium (K)	2019/07/10	0.63		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Silicon (Si)	2019/07/10	0.92		%	20
			Total Sodium (Na)	2019/07/10	0.55		%	20
			Total Strontium (Sr)	2019/07/10	0.38		%	20
			Total Sulphur (S)	2019/07/10	0.37		%	20
9500624	LQ1	Matrix Spike [WA6550-04]	Total Aluminum (Al)	2019/07/10		97	%	80 - 120
			Total Antimony (Sb)	2019/07/10		105	%	80 - 120
			Total Arsenic (As)	2019/07/10		94	%	80 - 120
			Total Beryllium (Be)	2019/07/10		97	%	80 - 120
			Total Chromium (Cr)	2019/07/10		99	%	80 - 120
			Total Cobalt (Co)	2019/07/10		97	%	80 - 120
			Total Copper (Cu)	2019/07/10		109	%	80 - 120
			Total Lead (Pb)	2019/07/10		102	%	80 - 120
			Total Molybdenum (Mo)	2019/07/10		104	%	80 - 120
			Total Nickel (Ni)	2019/07/10		96	%	80 - 120
			Total Selenium (Se)	2019/07/10		97	%	80 - 120
			Total Silver (Ag)	2019/07/10		100	%	80 - 120
			Total Thallium (Tl)	2019/07/10		99	%	80 - 120
			Total Tin (Sn)	2019/07/10		99	%	80 - 120
			Total Titanium (Ti)	2019/07/10		101	%	80 - 120
			Total Uranium (U)	2019/07/10		98	%	80 - 120
			Total Vanadium (V)	2019/07/10		99	%	80 - 120
			Total Zinc (Zn)	2019/07/10		NC	%	80 - 120
9500624	LQ1	Spiked Blank	Total Aluminum (Al)	2019/07/10		99	%	80 - 120
			Total Antimony (Sb)	2019/07/10		105	%	80 - 120
			Total Arsenic (As)	2019/07/10		95	%	80 - 120
			Total Beryllium (Be)	2019/07/10		94	%	80 - 120
			Total Chromium (Cr)	2019/07/10		100	%	80 - 120
			Total Cobalt (Co)	2019/07/10		98	%	80 - 120
			Total Copper (Cu)	2019/07/10		98	%	80 - 120
			Total Lead (Pb)	2019/07/10		97	%	80 - 120
			Total Molybdenum (Mo)	2019/07/10		100	%	80 - 120
			Total Nickel (Ni)	2019/07/10		97	%	80 - 120
			Total Selenium (Se)	2019/07/10		95	%	80 - 120
			Total Silver (Ag)	2019/07/10		100	%	80 - 120
			Total Thallium (Tl)	2019/07/10		100	%	80 - 120
			Total Tin (Sn)	2019/07/10		98	%	80 - 120
			Total Titanium (Ti)	2019/07/10		99	%	80 - 120
			Total Uranium (U)	2019/07/10		93	%	80 - 120
			Total Vanadium (V)	2019/07/10		99	%	80 - 120
			Total Zinc (Zn)	2019/07/10		96	%	80 - 120
9500624	LQ1	Method Blank	Total Aluminum (Al)	2019/07/10	<0.0030		mg/L	
			Total Antimony (Sb)	2019/07/10	<0.00060		mg/L	
			Total Arsenic (As)	2019/07/10	<0.00020		mg/L	
			Total Beryllium (Be)	2019/07/10	<0.0010		mg/L	
			Total Chromium (Cr)	2019/07/10	<0.0010		mg/L	
			Total Cobalt (Co)	2019/07/10	<0.00030		mg/L	
			Total Copper (Cu)	2019/07/10	<0.00020		mg/L	
			Total Lead (Pb)	2019/07/10	<0.00020		mg/L	
			Total Molybdenum (Mo)	2019/07/10	<0.00020		mg/L	
			Total Nickel (Ni)	2019/07/10	<0.00050		mg/L	
			Total Selenium (Se)	2019/07/10	<0.00020		mg/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Silver (Ag)	2019/07/10	<0.00010		mg/L	
			Total Thallium (Tl)	2019/07/10	<0.00020		mg/L	
			Total Tin (Sn)	2019/07/10	<0.0010		mg/L	
			Total Titanium (Ti)	2019/07/10	<0.0010		mg/L	
			Total Uranium (U)	2019/07/10	<0.00010		mg/L	
			Total Vanadium (V)	2019/07/10	<0.0010		mg/L	
			Total Zinc (Zn)	2019/07/10	<0.0030		mg/L	
9500624	LQ1	RPD	Total Aluminum (Al)	2019/07/10	5.2		%	20
			Total Antimony (Sb)	2019/07/10	NC		%	20
			Total Arsenic (As)	2019/07/10	NC		%	20
			Total Beryllium (Be)	2019/07/10	NC		%	20
			Total Chromium (Cr)	2019/07/10	7.9		%	20
			Total Cobalt (Co)	2019/07/10	NC		%	20
			Total Copper (Cu)	2019/07/10	7.8		%	20
			Total Lead (Pb)	2019/07/10	NC		%	20
			Total Molybdenum (Mo)	2019/07/10	1.8		%	20
			Total Nickel (Ni)	2019/07/10	12		%	20
			Total Selenium (Se)	2019/07/10	1.9		%	20
			Total Silver (Ag)	2019/07/10	NC		%	20
			Total Thallium (Tl)	2019/07/10	NC		%	20
			Total Tin (Sn)	2019/07/10	NC		%	20
			Total Titanium (Ti)	2019/07/10	NC		%	20
			Total Uranium (U)	2019/07/10	4.8		%	20
			Total Vanadium (V)	2019/07/10	NC		%	20
			Total Zinc (Zn)	2019/07/10	NC		%	20
9500789	RK3	Matrix Spike	Total Mercury (Hg)	2019/07/10		101	%	80 - 120
9500789	RK3	Spiked Blank	Total Mercury (Hg)	2019/07/10		113	%	80 - 120
9500789	RK3	Method Blank	Total Mercury (Hg)	2019/07/10	<0.0020		ug/L	
9500789	RK3	RPD	Total Mercury (Hg)	2019/07/10	NC		%	20
9501576	STI	Matrix Spike	Dissolved Chloride (Cl)	2019/07/10		NC	%	80 - 120
9501576	STI	Spiked Blank	Dissolved Chloride (Cl)	2019/07/10		106	%	80 - 120
9501576	STI	Method Blank	Dissolved Chloride (Cl)	2019/07/10	<1.0		mg/L	
9501576	STI	RPD	Dissolved Chloride (Cl)	2019/07/10	0.52		%	20
9501583	STI	Matrix Spike	Dissolved Sulphate (SO4)	2019/07/10		NC	%	80 - 120
9501583	STI	Spiked Blank	Dissolved Sulphate (SO4)	2019/07/10		102	%	80 - 120
9501583	STI	Method Blank	Dissolved Sulphate (SO4)	2019/07/10	<1.0		mg/L	
9501583	STI	RPD	Dissolved Sulphate (SO4)	2019/07/10	1.4		%	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Method blank above criteria. Data inspected. All data < RDL or greater than 10x Method Blank.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Ghayasuddin Khan, M.Sc., P.Chem., QP, Scientific Specialist, Inorganics

Peng Liang

Harry (Peng) Liang, Senior Analyst

Maxxam
A Bureau Veritas Group Company

Calgary: 4000 19th St. NE, T2E 6P8. Toll Free (800) 386-7247
Edmonton: 9331-48 St. T6B 2R4. Toll Free (800) 386-7247
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CHAIN OF CUSTODY RECORD

M 083948

Page 1 of 1

Invoice Information	Report Information (if differs from invoice)	Project Information	Turnaround Time (TAT) Required
Company: SLR Consulting Ltd.	Company: Summit Aggregate	Quotation #:	☒ 5 - 7 Days Regular (Most analyses)
Contact Name: Robert Till	Contact Name:	P.O. #/ AFE#: EDM 4886	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS
Address: 6940 Roper Road, Edmonton, T6B 3H9	Address:	Project #: 212-06550-00003	Rush TAT (Surcharges will be applied) ☐ Same Day ☐ 2 Days ☐ 1 Day ☐ 3-4 Days
Phone:	Phone:	Site Location: Mountain Ash	
Email: rtill@slrconsulting.com	Email: rtill@slrconsulting.com	Site #:	Date Required:
Copies: nyari@slrconsulting.com	Copies: nyari@slrconsulting.com	Sampled By: NY	Rush Confirmation #:

Laboratory Use Only

	YES	NO	Cooler ID			
Seal Present	✓		Temp	6	9	6
Seal Intact	✓					
Cooling Media	✓					
	YES	NO	Cooler ID			
Seal Present			Temp			
Seal Intact						
Cooling Media						
	YES	NO	Cooler ID			
Seal Present			Temp			
Seal Intact						
Cooling Media						

Depot Reception

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix
1	~~MW19-110~~		~~2019/07/05~~		~~Ground water~~
2	MW19-109				
3	WW4				
4	~~WW2~~				
5	~~BHS1~~				~~Stream water~~
6					
7					
8					
9					
10					

Please indicate Filtered, Preserved or Both (F, P, F/P)

Analysis Requested

	# of containers	BTEX F1 ☐ VOC ☐	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals ☐ Tot ☒ Diss	Mercury ☐ Total ☒ Dissolved	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	Turbidity	~~[illegible]~~	Total Coliforms + E. Coli							HOLD - DO NOT ANALYZE
1	~~6~~				~~X~~	~~X~~	~~X~~					~~X~~		~~X~~							
2	6				X	X	X					X		X							
3	6				X	X	X					X		X							
4	~~6~~				~~X~~	~~X~~	~~X~~					~~X~~		~~X~~							
5	~~6~~				~~X~~	~~X~~	~~X~~					~~X~~		~~X~~							
6																					
7																					
8																					
9																					
10																					

Regulatory Criteria

☒ AT1
☐ CCME
☐ Drinking Water
☐ D50 (Drilling Waste)
☐ Saskatchewan
☐ Other:

Special Instructions

→ silty

Metals preserved not filtered.

Rainy conditions could not write on labels. Paper in each bag indicate samples

Relinquished by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Received by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Maxxam Job #
/ Noushin Yari	2019/07/05		Jenine McIntyre JENINE MCINTYRE	2019/07/05	12:20	05-Jul-19 12:20 Jenelle Feller B953951

Unless otherwise agreed to in writing, work submitted on this Chain of Custody is subject to Maxxam's standard Terms and Conditions. Signing of this Chain of Custody document is acknowledgment and acceptance of our terms which are available for viewing at www.maxxam

AB FCD-00331/7

KK7 INS-0170

Your P.O. #: EDM4886
PO # EDM3288
Your C.O.C. #: M083881

Attention: ROBERT TILL
SLR CONSULTING (CANADA) LTD
6940 ROPER ROAD
EDMONTON, AB
CANADA T6B 3H9

Report Date: 2019/07/18
Report #: R2753966
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B955649
Received: 2019/07/10, 20:35

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity @25C (pp, total), CO3,HCO3,OH	3	N/A	2019/07/16	AB SOP-00005	SM 23 2320 B m
Cadmium - low level CCME - Dissolved	3	N/A	2019/07/12		Auto Calc
Cadmium - low level CCME (Total)	3	N/A	2019/07/15		Auto Calc
Chloride/Sulphate by Auto Colourimetry	3	N/A	2019/07/16	AB SOP-00020 / AB SOP-00018	SM23-4500-Cl/SO4-E m
Total Coliforms and E.Coli	3	2019/07/11	2019/07/12	AB SOP-00089	SM 23 9223 A,B m
Conductivity @25C	3	N/A	2019/07/16	AB SOP-00005	SM 23 2510 B m
Hardness	3	N/A	2019/07/12		Auto Calc
Mercury (Total) by CV	2	2019/07/16	2019/07/16	CAL SOP-00007	EPA 1631 RE 20460 m
Mercury (Total) by CV	1	2019/07/16	2019/07/17	CAL SOP-00007	EPA 1631 RE 20460 m
Elements by ICP-Dissolved-Lab Filtered (1)	3	N/A	2019/07/12	AB SOP-00042	EPA 6010d R5 m
Elements by ICP - Total	3	2019/07/13	2019/07/16	AB SOP-00014 / AB SOP-00042	EPA 6010d R4 m
Elements by ICPMS-Dissolved-Lab Filtered (2)	3	N/A	2019/07/12	AB SOP-00043	EPA 6020b R2 m
Elements by ICPMS - Total	3	2019/07/13	2019/07/14	AB SOP-00014 / AB SOP-00043	EPA 6020b R2 m
Ion Balance	3	N/A	2019/07/12		Auto Calc
Sum of cations, anions	3	N/A	2019/07/12		Auto Calc
Nitrate and Nitrite	3	N/A	2019/07/12		Auto Calc
Nitrate + Nitrite-N (calculated)	3	N/A	2019/07/12		Auto Calc
Nitrogen (Nitrite - Nitrate) by IC	2	N/A	2019/07/11	AB SOP-00023	SM 23 4110 B m
Nitrogen (Nitrite - Nitrate) by IC	1	N/A	2019/07/12	AB SOP-00023	SM 23 4110 B m
pH @25°C (3)	3	N/A	2019/07/16	AB SOP-00005	SM 23 4500-H+B m
Total Dissolved Solids (Calculated)	3	N/A	2019/07/17		Auto Calc
Turbidity	3	N/A	2019/07/13	CAL SOP-00081	SM 23 2130 B m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless

Your P.O. #: EDM4886
PO # EDM3288
Your C.O.C. #: M083881

Attention: ROBERT TILL

SLR CONSULTING (CANADA) LTD
6940 ROPER ROAD
EDMONTON, AB
CANADA T6B 3H9

Report Date: 2019/07/18
Report #: R2753966
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B955649
Received: 2019/07/10, 20:35

indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) Dissolved > Total Imbalance: When applicable, Dissolved and Total results were reviewed and data quality meets acceptable levels unless otherwise noted.
(2) Samples were filtered and preserved at the lab. Values may not reflect concentrations at the time of sampling. Dissolved > Total Imbalance: When applicable, Dissolved and Total results were reviewed and data quality meets acceptable levels unless otherwise noted.
(3) The CCME method requires pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the CCME holding time. Bureau Veritas Laboratories endeavours to analyze samples as soon as possible after receipt.

Encryption Key

Jenelle Feller

Jenelle Feller
Key Account Specialist
18 Jul 2019 17:04:14

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Jenelle Feller, Key Account Specialist
Email: JFeller@bvlabs.com
Phone# (403)735-2264
==
BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 2

ROUTINE + DISS. REG. METALS – LAB FILT (WATER)

BV Labs ID		WB5701		WB5702	WB5703		
Sampling Date		2019/07/10 13:45		2019/07/10 14:52	2019/07/10 16:48		
COC Number		M083881		M083881	M083881		
	UNITS	**BHS1**	**QC Batch**	**WW2**	**MW19-110**	**RDL**	**QC Batch**
Calculated Parameters							
Anion Sum	meq/L	4.3	9502278	6.2	6.0	N/A	9502278
Cation Sum	meq/L	4.4	9502278	6.1	5.9	N/A	9502278
Hardness (CaCO3)	mg/L	200	9502270	260	280	0.50	9502270
Ion Balance (% Difference)	%	0.87	9502276	1.3	0.91	N/A	9502276
Dissolved Nitrate (NO3)	mg/L	6.3	9502284	1.6	8.6	0.044	9502284
Nitrate plus Nitrite (N)	mg/L	1.4	9502287	0.37	1.9	0.014	9502287
Dissolved Nitrite (NO2)	mg/L	<0.033	9502284	<0.033	<0.033	0.033	9502284
Calculated Total Dissolved Solids	mg/L	210	9502288	300	290	1.0	9502288
Misc. Inorganics							
Conductivity	uS/cm	420	9508468	580	560	2.0	9508468
pH	pH	8.07	9508466	7.95	7.82	N/A	9508466
Low Level Elements							
Dissolved Cadmium (Cd)	ug/L	0.025	9502398	0.036	0.032	0.020	9502398
Anions							
Alkalinity (PP as CaCO3)	mg/L	<1.0	9508465	<1.0	<1.0	1.0	9508465
Alkalinity (Total as CaCO3)	mg/L	190	9508465	290	270	1.0	9508465
Bicarbonate (HCO3)	mg/L	240	9508465	350	330	1.0	9508465
Carbonate (CO3)	mg/L	<1.0	9508465	<1.0	<1.0	1.0	9508465
Hydroxide (OH)	mg/L	<1.0	9508465	<1.0	<1.0	1.0	9508465
Dissolved Chloride (Cl)	mg/L	8.2	9509749	2.0	8.4	1.0	9509749
Dissolved Sulphate (SO4)	mg/L	4.7	9509749	20	8.1	1.0	9509749
Nutrients							
Dissolved Nitrite (N)	mg/L	<0.010	9503263	<0.010	<0.010	0.010	9503263
Dissolved Nitrate (N)	mg/L	1.4	9503263	0.37	1.9	0.010	9503263
Lab Filtered Elements							
Dissolved Aluminum (Al)	mg/L	0.12	9504202	<0.0030	0.0078	0.0030	9504202
Dissolved Antimony (Sb)	mg/L	<0.00060	9504202	<0.00060	<0.00060	0.00060	9504202
Dissolved Arsenic (As)	mg/L	0.00044	9504202	<0.00020	0.00023	0.00020	9504202
Dissolved Barium (Ba)	mg/L	0.19	9503452	0.097	0.25	0.010	9503452
Dissolved Beryllium (Be)	mg/L	<0.0010	9504202	<0.0010	<0.0010	0.0010	9504202
Dissolved Boron (B)	mg/L	<0.020	9503452	0.023	<0.020	0.020	9503452
Dissolved Calcium (Ca)	mg/L	48	9503452	55	62	0.30	9503452

RDL = Reportable Detection Limit
N/A = Not Applicable

ROUTINE + DISS. REG. METALS – LAB FILT (WATER)

BV Labs ID		WB5701		WB5702	WB5703		
Sampling Date		2019/07/10 13:45		2019/07/10 14:52	2019/07/10 16:48		
COC Number		M083881		M083881	M083881		
	UNITS	**BHS1**	**QC Batch**	**WW2**	**MW19-110**	**RDL**	**QC Batch**
Dissolved Chromium (Cr)	mg/L	<0.0010	9504202	<0.0010	<0.0010	0.0010	9504202
Dissolved Cobalt (Co)	mg/L	<0.00030	9504202	<0.00030	<0.00030	0.00030	9504202
Dissolved Copper (Cu)	mg/L	0.00095	9504202	0.0026	0.00032	0.00020	9504202
Dissolved Iron (Fe)	mg/L	0.10	9503452	<0.060	<0.060	0.060	9503452
Dissolved Lead (Pb)	mg/L	<0.00020	9504202	<0.00020	<0.00020	0.00020	9504202
Dissolved Lithium (Li)	mg/L	<0.020	9503452	<0.020	<0.020	0.020	9503452
Dissolved Magnesium (Mg)	mg/L	20	9503452	30	30	0.20	9503452
Dissolved Manganese (Mn)	mg/L	<0.0040	9503452	0.0096	0.042	0.0040	9503452
Dissolved Molybdenum (Mo)	mg/L	0.00098	9507484	0.0020	0.0021	0.00020	9504202
Dissolved Nickel (Ni)	mg/L	0.00085	9504202	0.00054	0.0015	0.00050	9504202
Dissolved Phosphorus (P)	mg/L	<0.10	9503452	<0.10	<0.10	0.10	9503452
Dissolved Potassium (K)	mg/L	4.8	9503452	2.0	2.7	0.30	9503452
Dissolved Selenium (Se)	mg/L	0.00058	9504202	0.00045	0.00067	0.00020	9504202
Dissolved Silicon (Si)	mg/L	6.4	9503452	4.0	4.4	0.10	9503452
Dissolved Silver (Ag)	mg/L	<0.00010	9504202	<0.00010	<0.00010	0.00010	9504202
Dissolved Sodium (Na)	mg/L	5.0	9503452	17	6.0	0.50	9503452
Dissolved Strontium (Sr)	mg/L	0.27	9503452	0.56	0.41	0.020	9503452
Dissolved Sulphur (S)	mg/L	1.8	9503452	5.3	2.2	0.20	9503452
Dissolved Thallium (Tl)	mg/L	<0.00020	9504202	<0.00020	<0.00020	0.00020	9504202
Dissolved Tin (Sn)	mg/L	<0.0010	9504202	<0.0010	<0.0010	0.0010	9504202
Dissolved Titanium (Ti)	mg/L	0.0038	9504202	<0.0010	0.0012	0.0010	9504202
Dissolved Uranium (U)	mg/L	0.0011	9504202	0.00081	0.0024	0.00010	9504202
Dissolved Vanadium (V)	mg/L	<0.0010	9504202	<0.0010	<0.0010	0.0010	9504202
Dissolved Zinc (Zn)	mg/L	<0.0030	9504202	0.043	0.0032	0.0030	9504202
RDL = Reportable Detection Limit							

REGULATED METALS (CCME/AT1) - TOTAL

BV Labs ID		WB5701	WB5702		WB5703		
Sampling Date		2019/07/10 13:45	2019/07/10 14:52		2019/07/10 16:48		
COC Number		M083881	M083881		M083881		
	UNITS	**BHS1**	**WW2**	**RDL**	**MW19-110**	**RDL**	**QC Batch**
Low Level Elements							
Total Cadmium (Cd)	ug/L	0.034	0.029	0.020	4.2	0.020	9502399
Elements							
Total Aluminum (Al)	mg/L	0.30	0.0060	0.0030	10	0.0030	9505482
Total Antimony (Sb)	mg/L	<0.00060	<0.00060	0.00060	<0.00060	0.00060	9505482
Total Arsenic (As)	mg/L	0.00061	<0.00020	0.00020	0.0084	0.00020	9505482
Total Barium (Ba)	mg/L	0.21	0.11	0.010	2.2	0.010	9505479
Total Beryllium (Be)	mg/L	<0.0010	<0.0010	0.0010	0.0019	0.0010	9505482
Total Boron (B)	mg/L	<0.020	0.023	0.020	<0.020	0.020	9505479
Total Calcium (Ca)	mg/L	50	59	0.30	600 (1)	1.5	9505479
Total Chromium (Cr)	mg/L	0.0010	<0.0010	0.0010	0.019	0.0010	9505482
Total Cobalt (Co)	mg/L	<0.00030	<0.00030	0.00030	0.030	0.00030	9505482
Total Copper (Cu)	mg/L	0.0013	0.0045	0.00020	0.032	0.00020	9505482
Total Iron (Fe)	mg/L	0.25	<0.060	0.060	10	0.060	9505479
Total Lead (Pb)	mg/L	<0.00020	0.00054	0.00020	0.019	0.00020	9505482
Total Lithium (Li)	mg/L	<0.020	0.023	0.020	<0.020	0.020	9505479
Total Magnesium (Mg)	mg/L	21	33	0.20	130	0.20	9505479
Total Manganese (Mn)	mg/L	<0.0040	0.012	0.0040	7.3	0.0040	9505479
Total Molybdenum (Mo)	mg/L	0.00038	0.0014	0.00020	0.0015	0.00020	9505482
Total Nickel (Ni)	mg/L	0.00088	0.00060	0.00050	0.065	0.00050	9505482
Total Phosphorus (P)	mg/L	<0.10	<0.10	0.10	2.5	0.10	9505479
Total Potassium (K)	mg/L	5.4	2.3	0.30	4.7	0.30	9505479
Total Selenium (Se)	mg/L	0.00068	0.00052	0.00020	0.00096	0.00020	9505482
Total Silicon (Si)	mg/L	7.5	4.6	0.10	15	0.10	9505479
Total Silver (Ag)	mg/L	<0.00010	<0.00010	0.00010	<0.00010	0.00010	9505482
Total Sodium (Na)	mg/L	5.3	20	0.50	6.9	0.50	9505479
Total Strontium (Sr)	mg/L	0.27	0.58	0.020	1.1	0.020	9505479
Total Sulphur (S)	mg/L	1.8	6.1	0.20	2.5	0.20	9505479
Total Thallium (Tl)	mg/L	<0.00020	<0.00020	0.00020	0.00024	0.00020	9505482
Total Tin (Sn)	mg/L	<0.0010	<0.0010	0.0010	<0.0010	0.0010	9505482
Total Titanium (Ti)	mg/L	0.0068	<0.0010	0.0010	0.17	0.0010	9505482
Total Uranium (U)	mg/L	0.0013	0.00091	0.00010	0.0060	0.00010	9505482
Total Vanadium (V)	mg/L	0.0015	<0.0010	0.0010	0.025	0.0010	9505482

RDL = Reportable Detection Limit

(1) Detection limits raised due to dilution to bring analyte within the calibrated range.

REGULATED METALS (CCME/AT1) - TOTAL

BV Labs ID		WB5701	WB5702		WB5703		
Sampling Date		2019/07/10 13:45	2019/07/10 14:52		2019/07/10 16:48		
COC Number		M083881	M083881		M083881		
	UNITS	**BHS1**	**WW2**	**RDL**	**MW19-110**	**RDL**	**QC Batch**
Total Zinc (Zn)	mg/L	<0.0030	0.046	0.0030	0.14	0.0030	9505482
RDL = Reportable Detection Limit							

RESULTS OF CHEMICAL ANALYSES OF WATER

BV Labs ID		WB5701	WB5702		WB5703		
Sampling Date		2019/07/10 13:45	2019/07/10 14:52		2019/07/10 16:48		
COC Number		M083881	M083881		M083881		
	UNITS	**BHS1**	**WW2**	**RDL**	**MW19-110**	**RDL**	**QC Batch**
Microbiological Param.							
E.Coli DST	MPN/100mL	1600	<1.0	1.0	63 (1)	10	9502759
Total Coliforms DST	MPN/100mL	>2400	1.0	1.0	180 (1)	10	9502759
Physical Properties							
Turbidity	NTU	5.1	0.31	0.10	<0.10	0.10	9505873

RDL = Reportable Detection Limit

(1) Detection limit raised due to matrix interference.

MERCURY BY COLD VAPOR (WATER)

BV Labs ID		WB5701	WB5702		WB5703		
Sampling Date		2019/07/10 13:45	2019/07/10 14:52		2019/07/10 16:48		
COC Number		M083881	M083881		M083881		
	UNITS	**BHS1**	**WW2**	**RDL**	**MW19-110**	**RDL**	**QC Batch**
Elements							
Total Mercury (Hg)	ug/L	0.0025	<0.0020	0.0020	0.257 (1)	0.020	9509199

RDL = Reportable Detection Limit

(1) Due to the sample matrix, sample required dilution. Detection limit was adjusted accordingly.

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	5.0°C

RESULTS OF CHEMICAL ANALYSES OF WATER Comments

Method Blank Total Coliforms and E.Coli: Method Blank exceeds normal acceptance limits due to possible lab contamination.

Sample WB5701, Elements by ICPMS-Dissolved-Lab Filtered: Test repeated.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9502759	AP1	Method Blank	E.Coli DST	2019/07/12	1.0, RDL=1.0		mpn/100mL	
			Total Coliforms DST	2019/07/12	1.0, RDL=1.0		mpn/100mL	
9502759	AP1	RPD [WB5702-03]	E.Coli DST	2019/07/12	NC		%	N/A
			Total Coliforms DST	2019/07/12	0		%	N/A
9503263	PR6	Matrix Spike [WB5701-01]	Dissolved Nitrite (N)	2019/07/11		104	%	80 - 120
			Dissolved Nitrate (N)	2019/07/11		103	%	80 - 120
9503263	PR6	Spiked Blank	Dissolved Nitrite (N)	2019/07/11		102	%	80 - 120
			Dissolved Nitrate (N)	2019/07/11		103	%	80 - 120
9503263	PR6	Method Blank	Dissolved Nitrite (N)	2019/07/11	<0.010		mg/L	
			Dissolved Nitrate (N)	2019/07/11	<0.010		mg/L	
9503263	PR6	RPD [WB5701-01]	Dissolved Nitrite (N)	2019/07/11	NC		%	20
			Dissolved Nitrate (N)	2019/07/11	0.16		%	20
9503452	MAP	Matrix Spike	Dissolved Barium (Ba)	2019/07/12		95	%	80 - 120
			Dissolved Boron (B)	2019/07/12		102	%	80 - 120
			Dissolved Calcium (Ca)	2019/07/12		104	%	80 - 120
			Dissolved Iron (Fe)	2019/07/12		99	%	80 - 120
			Dissolved Lithium (Li)	2019/07/12		93	%	80 - 120
			Dissolved Magnesium (Mg)	2019/07/12		103	%	80 - 120
			Dissolved Manganese (Mn)	2019/07/12		107	%	80 - 120
			Dissolved Phosphorus (P)	2019/07/12		104	%	80 - 120
			Dissolved Potassium (K)	2019/07/12		98	%	80 - 120
			Dissolved Silicon (Si)	2019/07/12		99	%	80 - 120
			Dissolved Sodium (Na)	2019/07/12		99	%	80 - 120
			Dissolved Strontium (Sr)	2019/07/12		100	%	80 - 120
			Dissolved Sulphur (S)	2019/07/12		102	%	80 - 120
9503452	MAP	Spiked Blank	Dissolved Barium (Ba)	2019/07/12		89	%	80 - 120
			Dissolved Boron (B)	2019/07/12		95	%	80 - 120
			Dissolved Calcium (Ca)	2019/07/12		94	%	80 - 120
			Dissolved Iron (Fe)	2019/07/12		94	%	80 - 120
			Dissolved Lithium (Li)	2019/07/12		86	%	80 - 120
			Dissolved Magnesium (Mg)	2019/07/12		97	%	80 - 120
			Dissolved Manganese (Mn)	2019/07/12		99	%	80 - 120
			Dissolved Phosphorus (P)	2019/07/12		93	%	80 - 120
			Dissolved Potassium (K)	2019/07/12		90	%	80 - 120
			Dissolved Silicon (Si)	2019/07/12		91	%	80 - 120
			Dissolved Sodium (Na)	2019/07/12		92	%	80 - 120
			Dissolved Strontium (Sr)	2019/07/12		94	%	80 - 120
			Dissolved Sulphur (S)	2019/07/12		94	%	80 - 120
9503452	MAP	Method Blank	Dissolved Barium (Ba)	2019/07/12	<0.010		mg/L	
			Dissolved Boron (B)	2019/07/12	<0.020		mg/L	
			Dissolved Calcium (Ca)	2019/07/12	<0.30		mg/L	
			Dissolved Iron (Fe)	2019/07/12	<0.060		mg/L	
			Dissolved Lithium (Li)	2019/07/12	<0.020		mg/L	
			Dissolved Magnesium (Mg)	2019/07/12	<0.20		mg/L	
			Dissolved Manganese (Mn)	2019/07/12	<0.0040		mg/L	
			Dissolved Phosphorus (P)	2019/07/12	<0.10		mg/L	
			Dissolved Potassium (K)	2019/07/12	<0.30		mg/L	
			Dissolved Silicon (Si)	2019/07/12	<0.10		mg/L	
			Dissolved Sodium (Na)	2019/07/12	<0.50		mg/L	
			Dissolved Strontium (Sr)	2019/07/12	<0.020		mg/L	
			Dissolved Sulphur (S)	2019/07/12	<0.20		mg/L	
9503452	MAP	RPD	Dissolved Barium (Ba)	2019/07/12	0.76		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Boron (B)	2019/07/12	2.7		%	20
			Dissolved Calcium (Ca)	2019/07/12	0.72		%	20
			Dissolved Iron (Fe)	2019/07/12	20		%	20
			Dissolved Lithium (Li)	2019/07/12	NC		%	20
			Dissolved Magnesium (Mg)	2019/07/12	0.45		%	20
			Dissolved Manganese (Mn)	2019/07/12	NC		%	20
			Dissolved Phosphorus (P)	2019/07/12	NC		%	20
			Dissolved Potassium (K)	2019/07/12	5.0		%	20
			Dissolved Silicon (Si)	2019/07/12	0.94		%	20
			Dissolved Sodium (Na)	2019/07/12	0.29		%	20
			Dissolved Strontium (Sr)	2019/07/12	0.46		%	20
			Dissolved Sulphur (S)	2019/07/12	0.089		%	20
9504202	HC7	Matrix Spike	Dissolved Aluminum (Al)	2019/07/12		90	%	80 - 120
			Dissolved Antimony (Sb)	2019/07/12		97	%	80 - 120
			Dissolved Arsenic (As)	2019/07/12		94	%	80 - 120
			Dissolved Beryllium (Be)	2019/07/12		90	%	80 - 120
			Dissolved Chromium (Cr)	2019/07/12		97	%	80 - 120
			Dissolved Cobalt (Co)	2019/07/12		95	%	80 - 120
			Dissolved Copper (Cu)	2019/07/12		96	%	80 - 120
			Dissolved Lead (Pb)	2019/07/12		90	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/07/12		98	%	80 - 120
			Dissolved Nickel (Ni)	2019/07/12		93	%	80 - 120
			Dissolved Selenium (Se)	2019/07/12		99	%	80 - 120
			Dissolved Silver (Ag)	2019/07/12		89	%	80 - 120
			Dissolved Thallium (Tl)	2019/07/12		90	%	80 - 120
			Dissolved Tin (Sn)	2019/07/12		94	%	80 - 120
			Dissolved Titanium (Ti)	2019/07/12		98	%	80 - 120
			Dissolved Uranium (U)	2019/07/12		97	%	80 - 120
			Dissolved Vanadium (V)	2019/07/12		97	%	80 - 120
			Dissolved Zinc (Zn)	2019/07/12		104	%	80 - 120
9504202	HC7	Spiked Blank	Dissolved Aluminum (Al)	2019/07/12		99	%	80 - 120
			Dissolved Antimony (Sb)	2019/07/12		105	%	80 - 120
			Dissolved Arsenic (As)	2019/07/12		100	%	80 - 120
			Dissolved Beryllium (Be)	2019/07/12		95	%	80 - 120
			Dissolved Chromium (Cr)	2019/07/12		99	%	80 - 120
			Dissolved Cobalt (Co)	2019/07/12		101	%	80 - 120
			Dissolved Copper (Cu)	2019/07/12		102	%	80 - 120
			Dissolved Lead (Pb)	2019/07/12		97	%	80 - 120
			Dissolved Molybdenum (Mo)	2019/07/12		101	%	80 - 120
			Dissolved Nickel (Ni)	2019/07/12		101	%	80 - 120
			Dissolved Selenium (Se)	2019/07/12		99	%	80 - 120
			Dissolved Silver (Ag)	2019/07/12		98	%	80 - 120
			Dissolved Thallium (Tl)	2019/07/12		99	%	80 - 120
			Dissolved Tin (Sn)	2019/07/12		96	%	80 - 120
			Dissolved Titanium (Ti)	2019/07/12		102	%	80 - 120
			Dissolved Uranium (U)	2019/07/12		101	%	80 - 120
			Dissolved Vanadium (V)	2019/07/12		103	%	80 - 120
			Dissolved Zinc (Zn)	2019/07/12		104	%	80 - 120
9504202	HC7	Method Blank	Dissolved Aluminum (Al)	2019/07/12	<0.0030		mg/L	
			Dissolved Antimony (Sb)	2019/07/12	<0.00060		mg/L	
			Dissolved Arsenic (As)	2019/07/12	<0.00020		mg/L	
			Dissolved Beryllium (Be)	2019/07/12	<0.0010		mg/L	
			Dissolved Chromium (Cr)	2019/07/12	<0.0010		mg/L	
			Dissolved Cobalt (Co)	2019/07/12	<0.00030		mg/L	
			Dissolved Copper (Cu)	2019/07/12	<0.00020		mg/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Lead (Pb)	2019/07/12	<0.00020		mg/L	
			Dissolved Molybdenum (Mo)	2019/07/12	<0.00020		mg/L	
			Dissolved Nickel (Ni)	2019/07/12	<0.00050		mg/L	
			Dissolved Selenium (Se)	2019/07/12	<0.00020		mg/L	
			Dissolved Silver (Ag)	2019/07/12	<0.00010		mg/L	
			Dissolved Thallium (Tl)	2019/07/12	<0.00020		mg/L	
			Dissolved Tin (Sn)	2019/07/12	<0.0010		mg/L	
			Dissolved Titanium (Ti)	2019/07/12	<0.0010		mg/L	
			Dissolved Uranium (U)	2019/07/12	<0.00010		mg/L	
			Dissolved Vanadium (V)	2019/07/12	<0.0010		mg/L	
			Dissolved Zinc (Zn)	2019/07/12	<0.0030		mg/L	
9504202	HC7	RPD	Dissolved Aluminum (Al)	2019/07/12	NC		%	20
			Dissolved Antimony (Sb)	2019/07/12	NC		%	20
			Dissolved Arsenic (As)	2019/07/12	NC		%	20
			Dissolved Beryllium (Be)	2019/07/12	NC		%	20
			Dissolved Chromium (Cr)	2019/07/12	NC		%	20
			Dissolved Cobalt (Co)	2019/07/12	4.5		%	20
			Dissolved Copper (Cu)	2019/07/12	4.7		%	20
			Dissolved Lead (Pb)	2019/07/12	NC		%	20
			Dissolved Molybdenum (Mo)	2019/07/12	8.3		%	20
			Dissolved Nickel (Ni)	2019/07/12	0.86		%	20
			Dissolved Selenium (Se)	2019/07/12	11		%	20
			Dissolved Silver (Ag)	2019/07/12	NC		%	20
			Dissolved Thallium (Tl)	2019/07/12	NC		%	20
			Dissolved Tin (Sn)	2019/07/12	NC		%	20
			Dissolved Titanium (Ti)	2019/07/12	NC		%	20
			Dissolved Uranium (U)	2019/07/12	4.8		%	20
			Dissolved Vanadium (V)	2019/07/12	NC		%	20
			Dissolved Zinc (Zn)	2019/07/12	6.3		%	20
9505479	FM0	Matrix Spike	Total Barium (Ba)	2019/07/16		99	%	80 - 120
			Total Boron (B)	2019/07/16		99	%	80 - 120
			Total Calcium (Ca)	2019/07/16		96	%	80 - 120
			Total Iron (Fe)	2019/07/16		105	%	80 - 120
			Total Lithium (Li)	2019/07/16		99	%	80 - 120
			Total Magnesium (Mg)	2019/07/16		99	%	80 - 120
			Total Manganese (Mn)	2019/07/16		99	%	80 - 120
			Total Phosphorus (P)	2019/07/16		97	%	80 - 120
			Total Potassium (K)	2019/07/16		96	%	80 - 120
			Total Silicon (Si)	2019/07/16		100	%	80 - 120
			Total Sodium (Na)	2019/07/16		100	%	80 - 120
			Total Strontium (Sr)	2019/07/16		98	%	80 - 120
			Total Sulphur (S)	2019/07/16		98	%	80 - 120
9505479	FM0	Spiked Blank	Total Barium (Ba)	2019/07/16		98	%	80 - 120
			Total Boron (B)	2019/07/16		98	%	80 - 120
			Total Calcium (Ca)	2019/07/16		95	%	80 - 120
			Total Iron (Fe)	2019/07/16		103	%	80 - 120
			Total Lithium (Li)	2019/07/16		97	%	80 - 120
			Total Magnesium (Mg)	2019/07/16		98	%	80 - 120
			Total Manganese (Mn)	2019/07/16		98	%	80 - 120
			Total Phosphorus (P)	2019/07/16		95	%	80 - 120
			Total Potassium (K)	2019/07/16		94	%	80 - 120
			Total Silicon (Si)	2019/07/16		98	%	80 - 120
			Total Sodium (Na)	2019/07/16		98	%	80 - 120
			Total Strontium (Sr)	2019/07/16		96	%	80 - 120
			Total Sulphur (S)	2019/07/16		99	%	80 - 120

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
9505479	FM0	Method Blank	Total Barium (Ba)	2019/07/16	<0.010		mg/L	
			Total Boron (B)	2019/07/16	<0.020		mg/L	
			Total Calcium (Ca)	2019/07/16	<0.30		mg/L	
			Total Iron (Fe)	2019/07/16	<0.060		mg/L	
			Total Lithium (Li)	2019/07/16	<0.020		mg/L	
			Total Magnesium (Mg)	2019/07/16	<0.20		mg/L	
			Total Manganese (Mn)	2019/07/16	<0.0040		mg/L	
			Total Phosphorus (P)	2019/07/16	<0.10		mg/L	
			Total Potassium (K)	2019/07/16	<0.30		mg/L	
			Total Silicon (Si)	2019/07/16	<0.10		mg/L	
			Total Sodium (Na)	2019/07/16	<0.50		mg/L	
			Total Strontium (Sr)	2019/07/16	<0.020		mg/L	
			Total Sulphur (S)	2019/07/16	<0.20		mg/L	
9505479	FM0	RPD	Total Iron (Fe)	2019/07/16	NC		%	20
9505482	LQ1	Matrix Spike	Total Aluminum (Al)	2019/07/14		NC	%	80 - 120
			Total Antimony (Sb)	2019/07/14		108	%	80 - 120
			Total Arsenic (As)	2019/07/14		97	%	80 - 120
			Total Beryllium (Be)	2019/07/14		101	%	80 - 120
			Total Chromium (Cr)	2019/07/14		94	%	80 - 120
			Total Cobalt (Co)	2019/07/14		93	%	80 - 120
			Total Copper (Cu)	2019/07/14		90	%	80 - 120
			Total Lead (Pb)	2019/07/14		95	%	80 - 120
			Total Molybdenum (Mo)	2019/07/14		104	%	80 - 120
			Total Nickel (Ni)	2019/07/14		93	%	80 - 120
			Total Selenium (Se)	2019/07/14		101	%	80 - 120
			Total Silver (Ag)	2019/07/14		106	%	80 - 120
			Total Thallium (Tl)	2019/07/14		105	%	80 - 120
			Total Tin (Sn)	2019/07/14		119	%	80 - 120
			Total Titanium (Ti)	2019/07/14		94	%	80 - 120
			Total Uranium (U)	2019/07/14		115	%	80 - 120
			Total Vanadium (V)	2019/07/14		97	%	80 - 120
			Total Zinc (Zn)	2019/07/14		NC	%	80 - 120
9505482	LQ1	Spiked Blank	Total Aluminum (Al)	2019/07/14		92	%	80 - 120
			Total Antimony (Sb)	2019/07/14		109	%	80 - 120
			Total Arsenic (As)	2019/07/14		97	%	80 - 120
			Total Beryllium (Be)	2019/07/14		99	%	80 - 120
			Total Chromium (Cr)	2019/07/14		94	%	80 - 120
			Total Cobalt (Co)	2019/07/14		93	%	80 - 120
			Total Copper (Cu)	2019/07/14		93	%	80 - 120
			Total Lead (Pb)	2019/07/14		99	%	80 - 120
			Total Molybdenum (Mo)	2019/07/14		101	%	80 - 120
			Total Nickel (Ni)	2019/07/14		94	%	80 - 120
			Total Selenium (Se)	2019/07/14		100	%	80 - 120
			Total Silver (Ag)	2019/07/14		109	%	80 - 120
			Total Thallium (Tl)	2019/07/14		107	%	80 - 120
			Total Tin (Sn)	2019/07/14		110	%	80 - 120
			Total Titanium (Ti)	2019/07/14		92	%	80 - 120
			Total Uranium (U)	2019/07/14		97	%	80 - 120
			Total Vanadium (V)	2019/07/14		96	%	80 - 120
			Total Zinc (Zn)	2019/07/14		92	%	80 - 120
9505482	LQ1	Method Blank	Total Aluminum (Al)	2019/07/14	<0.0030		mg/L	
			Total Antimony (Sb)	2019/07/14	<0.00060		mg/L	
			Total Arsenic (As)	2019/07/14	<0.00020		mg/L	
			Total Beryllium (Be)	2019/07/14	<0.0010		mg/L	
			Total Chromium (Cr)	2019/07/14	<0.0010		mg/L	

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Total Cobalt (Co)	2019/07/14	<0.00030		mg/L	
			Total Copper (Cu)	2019/07/14	<0.00020		mg/L	
			Total Lead (Pb)	2019/07/14	<0.00020		mg/L	
			Total Molybdenum (Mo)	2019/07/14	<0.00020		mg/L	
			Total Nickel (Ni)	2019/07/14	<0.00050		mg/L	
			Total Selenium (Se)	2019/07/14	<0.00020		mg/L	
			Total Silver (Ag)	2019/07/14	<0.00010		mg/L	
			Total Thallium (Tl)	2019/07/14	<0.00020		mg/L	
			Total Tin (Sn)	2019/07/14	<0.0010		mg/L	
			Total Titanium (Ti)	2019/07/14	<0.0010		mg/L	
			Total Uranium (U)	2019/07/14	<0.00010		mg/L	
			Total Vanadium (V)	2019/07/14	<0.0010		mg/L	
			Total Zinc (Zn)	2019/07/14	<0.0030		mg/L	
9505482	LQ1	RPD	Total Aluminum (Al)	2019/07/14	NC		%	20
			Total Lead (Pb)	2019/07/14	NC		%	20
9505873	EH2	Spiked Blank	Turbidity	2019/07/13		96	%	80 - 120
9505873	EH2	Method Blank	Turbidity	2019/07/13	<0.10		NTU	
9505873	EH2	RPD	Turbidity	2019/07/13	2.1		%	20
9507484	LQ1	Matrix Spike	Dissolved Molybdenum (Mo)	2019/07/15		96	%	80 - 120
9507484	LQ1	Spiked Blank	Dissolved Molybdenum (Mo)	2019/07/15		94	%	80 - 120
9507484	LQ1	Method Blank	Dissolved Molybdenum (Mo)	2019/07/15	<0.00020		mg/L	
9507484	LQ1	RPD	Dissolved Molybdenum (Mo)	2019/07/15	NC		%	20
9508465	IK0	Spiked Blank	Alkalinity (Total as CaCO3)	2019/07/16		92	%	80 - 120
9508465	IK0	Method Blank	Alkalinity (PP as CaCO3)	2019/07/16	<1.0		mg/L	
			Alkalinity (Total as CaCO3)	2019/07/16	<1.0		mg/L	
			Bicarbonate (HCO3)	2019/07/16	<1.0		mg/L	
			Carbonate (CO3)	2019/07/16	<1.0		mg/L	
			Hydroxide (OH)	2019/07/16	<1.0		mg/L	
9508465	IK0	RPD [WB5703-01]	Alkalinity (PP as CaCO3)	2019/07/16	NC		%	20
			Alkalinity (Total as CaCO3)	2019/07/16	1.5		%	20
			Bicarbonate (HCO3)	2019/07/16	1.5		%	20
			Carbonate (CO3)	2019/07/16	NC		%	20
			Hydroxide (OH)	2019/07/16	NC		%	20
9508466	IK0	Spiked Blank	pH	2019/07/16		100	%	97 - 103
9508466	IK0	RPD [WB5703-01]	pH	2019/07/16	0.39		%	N/A
9508468	IK0	Spiked Blank	Conductivity	2019/07/16		100	%	90 - 110
9508468	IK0	Method Blank	Conductivity	2019/07/16	<2.0		uS/cm	
9508468	IK0	RPD [WB5703-01]	Conductivity	2019/07/16	2.7		%	10
9509199	RK3	Matrix Spike	Total Mercury (Hg)	2019/07/16		81	%	80 - 120
9509199	RK3	Spiked Blank	Total Mercury (Hg)	2019/07/16		90	%	80 - 120
9509199	RK3	Method Blank	Total Mercury (Hg)	2019/07/16	<0.0020		ug/L	
9509199	RK3	RPD	Total Mercury (Hg)	2019/07/16	NC		%	20
9509749	STI	Matrix Spike	Dissolved Chloride (Cl)	2019/07/16		NC	%	80 - 120
			Dissolved Sulphate (SO4)	2019/07/16		NC	%	80 - 120
9509749	STI	Spiked Blank	Dissolved Chloride (Cl)	2019/07/16		108	%	80 - 120
			Dissolved Sulphate (SO4)	2019/07/16		108	%	80 - 120
9509749	STI	Method Blank	Dissolved Chloride (Cl)	2019/07/16	<1.0		mg/L	
			Dissolved Sulphate (SO4)	2019/07/16	<1.0		mg/L	
9509749	STI	RPD	Dissolved Chloride (Cl)	2019/07/16	1.5		%	20

QUALITY ASSURANCE REPORT(CONT'D)

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
			Dissolved Sulphate (SO4)	2019/07/16	0.63		%	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Ghayasuddin Khan, M.Sc., P.Chem., QP, Scientific Specialist, Inorganics

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Maxxam
A Bureau Veritas Group Company

Calgary: 4000 19th St. NE, T2E 6P8. Toll Free (800) 386-7247
Edmonton: 9331-48 St. T6B 2R4. Toll Free (800) 386-7247
maxxam.ca

388

CHAIN OF CUSTODY RECORD

M 083881

Page 1 of 1

Invoice Information

Company: SLR Consulting (Canada) Ltd.
Contact Name: Robert Till
Address: 6940 Roper Road
Edmonton, AB
Phone: 780-490-7893
Email: rtill@slrconsulting.com
Copies: nyari@slrconsulting.com

Report Information (if differs from invoice)

Company: Summit Aggregates c/o
Contact Name: SLR Consulting ~~Robert Till~~
Address:
Phone:
Email: rtill@slrconsulting.com
Copies: nyari@slrconsulting.com

Project Information

Quotation #:
P.O. #/ AFE#: EDM4886
Project #:
Site Location:
Site #:
Sampled By:

Turnaround Time (TAT) Required

☒ 5 - 7 Days Regular (Most analyses)

PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS

Rush TAT (Surcharges will be applied)

☐ Same Day ☐ 2 Days
☐ 1 Day ☐ 3-4 Days

Date Required:
Rush Confirmation #:

Laboratory Use Only

	YES	NO	Cooler ID		
Seal Present	✓		Temp	5	5 5
Seal Intact	✓				
Cooling Media	✓				
	YES	NO	Cooler ID		
Seal Present			Temp		
Seal Intact					
Cooling Media					
	YES	NO	Cooler ID		
Seal Present			Temp		
Seal Intact					
Cooling Media					

Depot Reception

Analysis Requested

Regulatory Criteria

☒ AT1
☐ CCME
☐ Drinking Water
☐ D50 (Drilling Waste)
☐ Saskatchewan
☐ Other:

	Sample Identification	Depth (Unit)	Date Sampled (YYYY/MM/DD)	Time Sampled (HH:MM)	Matrix	# of containers	BTEX F1 ☐ VOC ☐	BTEX F1-F2	BTEX F1-F4	Routine Water	Regulated Metals Tot ☑ Diss ☑	Mercury Total ☒ Dissolved ☐	Salinity 4	Sieve (75 micron)	Texture (% Sand, Silt, Clay)	Basic Class II Landfill	Turbidity	Total Coliforms + E. coli	HOLD - DO NOT ANALYZE
1	BHS1		2019/07/10	1:45 pm	Water	6				X	X	X					X	X	
2	WW2		↓	2:52 pm	↓	6				X	X	X					X	X	
3	MW19-110		↓	4:48 pm	↓	6				X	X	X					X	X	
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Special Instructions

Metals preserved not filtered.

Please indicate Filtered, Preserved or Both (F, P, F/P)

Relinquished by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)	Received by: (Signature/ Print)	DATE (YYYY/MM/DD)	Time (HH:MM)
/ Naushin Yari	2019/07/10	19:00	JSH KWESBJY	2019/07/10	2035

10-Jul-19 20:35
Jenelle Feller
B955649
CCQ INS-0170

AB FCD-00331/7

APPENDIX H
Baseline Water Resources – Water Well Testing Results Letter Report

Hydrogeological Assessment Report
Mountain Ash Limited Partnership Aggregate Operation
NW and SW Section 31, Twp 26, Rge 3 W5M
Rocky View County, Alberta
SLR Project No. 212.06650.00003

BASELINE WATER
RESOURCE INC

Mr. K. Carroll
103 Dalcastle Mews NW
Calgary, Alberta
T3A 2N8

June 7, 2013

RE: **Water Well Testing Results: SE 06-027-03 W5M**
PENGROWTH ENERGY CORPORATION: 03-06-027-03 W5M
BASELINE WATER RESOURCE INC.: Project # 13-4007

INTRODUCTION

Baseline Water Resource Inc. (BWRI) was retained by Pengrowth Energy Corporation (Pengrowth) to conduct a baseline water well assessment (1 well) for Mr. Kevin Carroll in SE 06-027-03 W5M on May 7, 2013. Pengrowth plans to develop from a surface location within 03-06-027-03 W5M.

The table below displays the water well location, UTM co-ordinates and where available the corresponding Alberta Environment and Sustainable Resource Development (ESRD) Drilling Report GIC ID number (ESRD, 2013).

Water Well Name	Legal Land Location	NAD 83, UTM Zone 11	ESRD Well GIC ID
House Well	SE 06-027-03 W5M	5683479 m, 0680742 m	0360164

RESULTS

HOUSE WELL

Procedure

Testing was completed by discharging water from a hose bib off east side of the residence. Water was flowed through ¾" lines and discharged approximately 5 m east of the residence. Photographs of the well casing, discharge connection/sample area, and the Flow Through Cell at discharge follow this report.

Water Quantity

The water level at the start of the test was 35.100 m from the top of the well casing (TOC). The well was pumped at a constant flow rate of 24.0 L/min (5.28 IGPM) for 60 minutes. The water level at the end of the test was 35.270 m from the TOC (0.170 m total drawdown). The water level in the well recovered to 35.115 m in 60 minutes (90% Recovery). Yield test data is presented in Table 1.

Water Quality

Water quality samples were collected and submitted to ALS Laboratory Group Ltd (ALS) in Calgary, Alberta for routine potability, total metals, benzene, toluene, ethyl benzene and xylenes (BTEX) and petroleum hydrocarbon fractions (F1-F2) and bacteriological analysis (total coliforms and E. coli). A copy of the laboratory analytical report is attached.

Field parameters including electrical conductivity (EC), pH and temperature were measured prior to water sample collection. Field parameter results are included in the table below.

Water Well Name	Time	EC (µS/cm)	pH	Temp (°C)
House Well	1520 h	534	7.28	5.7

Water quality analytical results were compared to the "Guideline for Canadian Drinking Water Quality" (GCDWQ) standard (Health Canada, 2012). Guidelines are either health-based (Maximum Acceptable Concentration (MAC)) or Aesthetic Objectives (AO). Aesthetic Objectives are based on considerations such as taste, odour and colour, and do not constitute a health hazard. Water quality exceedances are summarized in the table below.

Parameter	Concentration	MAC	AO
Iron (Fe)-Total	0.927 mg/L	-	0.3 mg/L
Turbidity	6.70 NTU	1 NTU	-

The turbidity value (6.70 NTU) exceeded the MAC guidelines. It should be noted that this is an operational guideline intended for water treatment facilities and therefore is not directly related to private water wells.

In cases where a MAC has been exceeded, the landowner is encouraged to contact the local health unit.

BTEX and Petroleum Hydrocarbon Analysis

None of the analyzed parameters were detected above the laboratory's minimum reportable detection limits.

Free Gas Analysis

Water was directed through a Flow Through Cell (FTC) at a constant rate of 3.0 L/min for 60 minutes (180 L total). No free gas was observed during the sampling event

INTERPRETATION OF ANALYTICAL RESULTS

For assistance with the interpretation of your water sample analytical results, please find the attached interpretation guides provided by Alberta Health Services.

Any parameter exceedance relating to groundwater quality can be discussed with your local Health Office. For further information call the Health Link line at 1-866-408-LINK (5465) or go to the following website link:

http://www.healthlinkalberta.ca/default.htm

FOLLOW UP CONTACT FOR WATER WELL CONCERNS

Any concerns regarding baseline water well quality or performance should be directed to Alberta Environment and Sustainable Resources (ESRD). To reach a water well specialist at ESRD, the contact number is 1-800-222-6514.

CLOSURE

Baseline Water Resource Inc. is pleased to submit this report as fulfillment of Pengrowths' requirements for baseline water well testing.

Sincerely,

PROFESSIONAL GEOLOGIST ALBERTA
S. BRENT BOWERMAN

S. Brent Bowerman, P.Geol.
President
Baseline Water Resource Inc.

DISCLAIMER

Baseline Water Resource Inc. has used proficient skill and diligence conducting the water well assessment and preparation of this report. This report is a representation of the conditions and information present and available at the time of the assessment. Information received from all other sources is considered to be accurate but cannot be guaranteed. Baseline Water Resource Inc. is not responsible for any individual interpretation of this material nor any decisions based upon findings in this report.

REFERENCES

Alberta Environment and Sustainable Resource Development (ESRD), 2013. "Groundwater Information Centre Map". http://www.envinfo.gov.ab.ca/GroundWater/. Last accessed May 7, 2013.

Alberta Health Services, Environmental Health, 2009. Guide to Interpreting Your Drinking Water Chemical Test Results, June, 2009.

Alberta Health Services, Environmental Health, 2009. Interpretation of Bacteriological Results, June 2009.

Health Canada, 2012. "Guidelines for Canadian Drinking Water Quality Summary Table (Prepared by the Federal-Provincial-Territorial Committee on Drinking Water)".

Photograph 1. View of the well casing, located approximately 12 m west of the residence.

Photograph 2. View of the discharge connection and sample area located on the east side of the residence.

Photograph 3. View of the FTC at discharge, located approximately 5 m east of the residence.

TABLE 1. YIELD TEST DATA (House Well)

Total Drawdown: 0.170 m **90% Recovery: 35.117 m**

Drawdown		Recovery	
Time (minutes)	Depth to Water (m b.t.c.[1])	Time (minutes)	Depth to Water (m b.t.c.)
0	35.100	0	35.270
1	35.100	1	35.125
2	35.100	2	35.120
3	35.100	3	35.120
4	35.100	4	35.120
5	35.100	5	35.120
6	35.100	6	35.120
7	35.105	7	35.120
8	35.105	8	35.120
9	35.105	9	35.115
10	35.105	10	35.115 [2]
15	-		
20	35.230		
25	35.115		
30	35.140		
35	35.260		
40	35.135		
50	35.120		
60	35.270		

NOTES:

1. b.t.c. denotes "below top of well casing".
2. Denotes 90% Recovery achieved.
3. The constant pumping rate was 24.0 L/min (5.28 Igpm).
4. The distance between ground level and the top of the well casing 0.33 m.
5. All water level measurements were taken from the top of the well casing.
6. A water level tape was used to collect water level measurements.

BASELINE WATER RESOURCE INC.
ATTN: CLINT GANES
#7, 3800-19 STREET NE
CALGARY AB T2E 6V2

Date Received:	08-MAY-13
Report Date:	14-MAY-13 17:07 (MT)
Version:	FINAL

Client Phone: 403-282-3999

Certificate of Analysis

Lab Work Order #:	**L1298547**
Project P.O. #:	2013LC0027
Job Reference:	13-4007
C of C Numbers:	
Legal Site Desc:	03-06-027-03 W5M

Other Information: INV COMMENTS: 13-4007

Brent Whitehead
Senior Scientist

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ANALYTICAL GUIDELINE REPORT

13-4007

Sample Details Grouping Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits #1	 #2
L1298547-1 K. CARROLL							
Sampled By: GF on 07-MAY-13 @ 15:20							
Matrix: WATER							
Physical Tests							
Turbidity	6.70		0.10	NTU	10-MAY-13		
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	334		5.0	mg/L	08-MAY-13		
Bicarbonate (HCO3)	407		5.0	mg/L	08-MAY-13		
Carbonate (CO3)	<5.0		5.0	mg/L	08-MAY-13		
Chloride (Cl)	1.79		0.10	mg/L	08-MAY-13	250	
Conductivity (EC)	626		3.0	uS/cm	08-MAY-13		
Fluoride (F)	0.13		0.10	mg/L	08-MAY-13		1.5
Hardness (as CaCO3)	337			mg/L	11-MAY-13		
Hydroxide (OH)	<5.0		5.0	mg/L	08-MAY-13		
Ion Balance	101			%	11-MAY-13		
Nitrate and Nitrite (as N)	0.704		0.071	mg/L	10-MAY-13		10
Nitrate (as N)	0.633		0.050	mg/L	08-MAY-13		10
Nitrite (as N)	0.072		0.050	mg/L	08-MAY-13		1
pH	7.65		0.10	pH	08-MAY-13	6.5-8.5	
TDS (Calculated)	345			mg/L	11-MAY-13	500	
Sulfate (SO4)	18.7		0.50	mg/L	08-MAY-13	500	
Bacteriological Tests							
MPN - E. coli	<1		1	MPN/100mL	08-MAY-13		**0
MPN - Total Coliforms	<1		1	MPN/100mL	08-MAY-13		**0
Total Metals							
Aluminum (Al)-Total	<0.0050		0.0050	mg/L	10-MAY-13	0.1	
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	10-MAY-13		0.006
Arsenic (As)-Total	0.00011		0.00010	mg/L	10-MAY-13		0.01
Barium (Ba)-Total	0.108		0.000050	mg/L	10-MAY-13		1
Beryllium (Be)-Total	<0.00050		0.00050	mg/L	10-MAY-13		
Boron (B)-Total	0.016		0.010	mg/L	10-MAY-13		5
Cadmium (Cd)-Total	<0.000050		0.000050	mg/L	10-MAY-13		0.005
Calcium (Ca)-Total	66.3		0.10	mg/L	10-MAY-13		
Chromium (Cr)-Total	<0.00050		0.00050	mg/L	10-MAY-13		0.05
Cobalt (Co)-Total	<0.00010		0.00010	mg/L	10-MAY-13		
Copper (Cu)-Total	0.00183		0.00010	mg/L	10-MAY-13	1	
Iron (Fe)-Total	0.927		0.030	mg/L	10-MAY-13	*0.3	
Lead (Pb)-Total	0.00022		0.00010	mg/L	10-MAY-13		0.01
Lithium (Li)-Total	0.0100		0.0050	mg/L	10-MAY-13		
Magnesium (Mg)-Total	38.8		0.10	mg/L	10-MAY-13		
Manganese (Mn)-Total	0.0092		0.0050	mg/L	10-MAY-13	0.05	
Mercury (Hg)-Total	<0.000050		0.000050	mg/L	10-MAY-13		0.001
Molybdenum (Mo)-Total	0.00101		0.000050	mg/L	10-MAY-13		
Nickel (Ni)-Total	0.00055		0.00050	mg/L	10-MAY-13		
Potassium (K)-Total	2.27		0.50	mg/L	10-MAY-13		
Selenium (Se)-Total	0.0016		0.0010	mg/L	10-MAY-13		0.01
Silver (Ag)-Total	<0.000010		0.000010	mg/L	10-MAY-13		

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.

* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied

Federal Guidelines for Canadian Drinking Water Quality (AUG, 2012) = [Suite] - CA_CDWQ MAC and AO (includes "interim" MACs)

#1: GCDWQ - Aesthetic Objective

#2: GCDWQ - Maximum Acceptable Concentrations (MACs)

ANALYTICAL GUIDELINE REPORT

Sample Details Grouping	Analyte	Result	Qualifier	D.L.	Units	Analyzed	Guideline Limits			
L1298547-1	K. CARROLL									
Sampled By:	GF on 07-MAY-13 @ 15:20									
Matrix:	WATER						#1	#2		
Total Metals										
	Sodium (Na)-Total	11.0		1.0	mg/L	10-MAY-13	200			
	Thallium (Tl)-Total	<0.00010		0.00010	mg/L	10-MAY-13				
	Tin (Sn)-Total	<0.00010		0.00010	mg/L	10-MAY-13				
	Titanium (Ti)-Total	<0.0010		0.0010	mg/L	10-MAY-13				
	Uranium (U)-Total	0.00168		0.000010	mg/L	10-MAY-13		0.02		
	Vanadium (V)-Total	<0.0010		0.0010	mg/L	10-MAY-13				
	Zinc (Zn)-Total	<0.0050		0.0050	mg/L	10-MAY-13	5			
Volatile Organic Compounds										
	Benzene	<0.00050		0.00050	mg/L	10-MAY-13		0.005		
	Ethylbenzene	<0.00050		0.00050	mg/L	10-MAY-13	0.0024			
	Toluene	<0.00050		0.00050	mg/L	10-MAY-13	0.024			
	o-xylene	<0.00050		0.00050	mg/L	10-MAY-13				
	m+p-Xylene	<0.00050		0.00050	mg/L	10-MAY-13				
	Xylenes	<0.00050		0.00050	mg/L	10-MAY-13	0.3			
	F1(C6-C10)	<0.10		0.10	mg/L	10-MAY-13				
	F1-BTEX	<0.10		0.10	mg/L	10-MAY-13				
Hydrocarbons										
	F2 (C10-C16)	<0 25		0.25	mg/L	10-MAY-13				

** Detection Limit for result exceeds Guideline Limit. Assessment against Guideline Limit cannot be made.
* Analytical result for this parameter exceeds Guideline Limit listed on this report. Guideline Limits applied:

Federal Guidelines for Canadian Drinking Water Quality (AUG, 2012) = [Suite] - CA_CDWQ MAC and AO (includes "interim" MACs)

#1: GCDWQ - Aesthetic Objective

#2: GCDWQ - Maximum Acceptable Concentrations (MACs)

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Method Reference***
BTX,F1-CL	Water	BTEX and F1 (C6-C10)	EPA 5030/8015& 8260-P&T GC-MS/FID
CL-CL	Water	Chloride (Cl)	APHA 4110 B-Ion Chromatography

Inorganic Anions by ion chromatography (IC) in water and aqueaous extracts of soils.

ALS Test Code	Matrix	Test Description	Method Reference***
F-IC-CL	Water	Fluoride	APHA 4110 B-Ion Chromatography
F2-CL	Water	F2	EPA 3510/8000-GC-FID
HG-TOT-CVAFS-CL	Water	Total Mercury in Water by CVAFS	EPA 1631E

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry (EPA Method 245.7).

ALS Test Code	Matrix	Test Description	Method Reference***
IONBALANCE-CL	Water	Ion Balance Calculation	APHA 1030E
MET-DIS-ICP-CL	Water	Dissolved Metals by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference***
MET-TOT-ICP-CL	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion using a hotblock (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference***
MET-TOT-LOW-MS-CL	Water	Total Metals in Water by ICPMS	EPA SW-846 3005A/6020A
N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NO2-CL	Water	Nitrite-N	APHA 4110 B-Ion Chromatography
NO3-IC-CL	Water	Nitrate-N	APHA 4110 B-Ion Chromatography
PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320

All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample's capacity to neutralize acid
Conductivity measurement is based on the sample's capacity to convey an electric current

ALS Test Code	Matrix	Test Description	Method Reference***
SO4-CL	Water	Sulfate (SO4)	APHA 4110 B-Ion Chromatography
TC-EC-MPN-CL	Water	Total Coliforms and E. Coli by MPN	APHA METHOD 9223

This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The
sample is mixed with a mixture hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.

ALS Test Code	Matrix	Test Description	Method Reference***
TURBIDITY-CL	Water	Turbidity	APHA 2130 B-Nephelometer

A strong light beam is sent through a transparent tube containing the sample. Light that is reflected at 90 degrees to the axis by suspended particles is detected by the photocell. The electrical response is proportional to the sample turbidity.

*** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Chain of Custody numbers:

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA		

Additional Information:

INV COMMENTS	13-4007

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information.

ALS

L1298547-COFC

JSTODY / ANALYTICAL REQUEST FORM   CANADA TOLL FREE 1-800-668-9878   WWW.ALSENVIRO.COM

Pg._1_of_1_

DATE: 05/08/2013

LAB WORK ORDER #

REPORT TO:
COMPANY: Baseline Water Resource Inc.
CONTACT: Clint Ganes
ADDRESS: #7, 3800 - 19 Street NE
Calgary, AB T2E 6V2
PHONE: 403-282-3999   FAX:
CELL PHONE: 403-869-2592

REPORT DISTRIBUTION:
EMAIL_✓_ FAX___
FINAL RESULTS BY EMAIL ONLY
EMAIL 1: clintg@baselinewater.com
EMAIL 2: gregl@baselinewater.com
EMAIL 3: ____________
SELECT: pdf_x_ digital___ both___

SERVICE REQUESTED
☒ REGULAR SERVICE (DEFAULT)
☐ PRIORITY SERVICE (50% SURCHARGE)
☐ EMERGENCY SERVICE (100% SURCHARGE)

ANALYSIS REQUESTED

INVOICE TO: SAME AS ABOVE: [✓ NO]
COMPANY: Pengrowth Energy Corp.
CONTACT:
ADDRESS:

PHONE: (403)   FAX:

INDICATE BOTTLES: FILTERED/PRESERVED (F/P) → P (METALS TOTAL CCME)
BWRI PROJECT # 13-4007
JOB#
AFE: 2013LC0027

LSD: 03-06-027-03 W5M
QUOTE:

Lab Sample Number	SAMPLE ID	SAMPLING LOCATION	SAMPLED BY / DATE / TIME	SAMPLE TYPE	ROUTINE POTABILITY	METALS TOTAL CCME	TC-EC	BTEX	F1 & F2	Gas Comp										HAZARDOUS ? Y/N	HIGHLY CONTAMINATED ? Y/N	NUMBER OF CONTAINERS
1																						
2	K. Carroll	[illegible]. hose bib off residence.	GF 05/07/13 @ [illegible]H	H_2O	X	X	X	X	X												N	7
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
12																						

GUIDELINES / REGULATIONS

GCDWQ (Guidelines for Canadian Drinking Water Quality)

SPECIAL INSTRUCTIONS / NATURE OF HAZARDOUS MATERIAL

If Gas Compositional Analysis identifies the presence of methane gas, the PM must report directly to Clint Ganes (clintg@baselinewater.com) to determine if Gas Isotopic Analysis is required.

SAMPLE CONDITION
☐ FROZEN
☐ COLD
☐ AMBIENT
MEAN TEMPERATURE 9

Failure to complete all portions of this form may delay analysis. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the reverse of the white report copy.

RELINQUISHED BY: K Carroll	DATE & TIME: 05/08/13 @ 0920H	RECEIVED BY:	DATE & TIME: May 8 9:20am
RELINQUISHED BY:	DATE & TIME:	RECEIVED BY:	DATE & TIME:

SAMPLE CONDITION ACCEPTABLE UPON RECEIPT ? (Y/N)

GUIDE TO INTERPRETING YOUR DRINKING WATER CHEMICAL TEST RESULTS

The laboratory report on the chemical quality of your drinking water sample is attached.

The *Guidelines for Canadian Drinking Water Quality* provide maximum limits for substances in drinking water that can be harmful to your health, such as sodium, fluoride, nitrate and nitrite. For your protection, the maximum limits are set below the levels at which any harmful health effects have actually been observed.

The other chemical quality limits provided below (e.g. total hardness, sulphate and iron) are not significant to health, but describe water quality conditions that are best for various household uses and for aesthetic reasons such as the water's taste, smell, and appearance.

The amount of a substance in your water sample is described as milligrams per Litre (mg/L), which is equivalent to parts per million (ppm).

The test results for Conductivity, Cation/Anion Sum, Ion Balance, % Difference are for laboratory work purposes only.

PARAMETER (limit)	DESCRIPTION
pH (6.5 – 8.5)	A pH above 8.5 may lead to problems with scale formation (mineral deposits) on cookware, plumbing and appliance parts. Corrosion (rusting or eating away) of plumbing and appliance parts may be a problem below pH 6.5.
Sodium (200 mg/L)	Sodium in drinking water should not exceed 20 mg/L for people on sodium-reduced diet (if your doctor told you to cut down on salt). If in doubt consult your doctor. Over 200 mg/L will give water a salty taste, but poses no significant risk to people in good health.
Potassium (No guideline)	Potassium at levels of 50 to 100 mg/L may add to corrosion and scaling problems.
Calcium (No guideline)	Calcium adds to water hardness and is essential for human health.
Magnesium (No guideline)	Magnesium adds to water hardness and is essential for human health. High levels of magnesium can cause a laxative effect (loose stools) in new users.
Total Hardness (80 to 100 mg/L)	Water hardness results from the calcium, magnesium, and other minerals that water collects as it moves through the ground. Water hardness is described as follows: soft = 0 to <60 mg/L; medium hard = 60 to <120 mg/L; hard = 120 to <180 mg/L; and very hard = 180 mg/L or more. Soft water can increase corrosion while hard water increases scaling on pipes, water heaters and appliances. Hard water also requires more soap during washing. Water softeners will lower hardness to acceptable levels, but will increase sodium levels (see sodium).
Iron (0.3 mg/L)	At levels above 0.3 mg/L, iron can leave a reddish-brown stain on laundry and plumbing fixtures and produce unpleasant tastes in beverages. High iron levels also cause growth of iron bacteria on parts of the well, water system, and plumbing. Shock chlorination is used to control iron bacteria (shocking your well may have to be repeated every year). In really bad cases, an iron filter may be needed.
Total Dissolved Solids (TDS) (500 mg/L)	TDS is a measure of minerals in the water. High TDS can cause scaling and affect water's taste and smell. Low TDS can give water a flat taste.

PARAMETER **(limit)**	**DESCRIPTION**
Carbonate, Bicarbonate & Hydroxide (No guideline)	Carbonates, bicarbonates and hydroxides are related to water's alkalinity, salinity, and the amount of total dissolved solids. Higher levels of bicarbonates can cause more scale formation.
Total Alkalinity (No guideline)	Alkalinity is formed by bicarbonate, carbonate and hydroxide. Lower levels of alkalinity can cause corrosion problems while higher levels can cause more scale formation.
Fluoride (1.5 mg/L)	Fluoride levels over 1.5 mg/L may increase the risk of dental fluorosis (e.g. white spots on tooth enamel) in children with developing teeth (newborns to age thirteen). Contact your family dentist for information on the correct use of fluoride supplements for children in low-fluoride areas (less than 0.7 mg/L). Fluoride can be removed from drinking water by point-of-use devices such as reverse osmosis or distillation.
Nitrate (10 mg/L) **Nitrite** (1.0 mg/L)	Nitrate and nitrite levels above the limits can cause methemoglobinemia (often referred to as blue baby syndrome) in sensitive people, including pregnant women and infants less than 6 months of age. Nitrates and nitrites decrease the ability of the blood to carry oxygen, which can be life-threatening. Infants and sensitive people should not drink water or eat foods prepared with water that contains levels of nitrates or nitrites above the limit. Agricultural wastes (nitrates are a part of fertilizers) and malfunctioning or poorly designed onsite septic systems are common sources of nitrate and nitrite contamination of water wells. Nitrates and nitrites can be removed by point-of-use devices such as distillation and reverse osmosis.
Sulphate (500 mg/L)	Sulphates can occur naturally in water, or result from the decomposition of plants, animals and organic wastes. Ground water that naturally contains sulphates may also contain sulphate-reducing bacteria which change sulphates to hydrogen sulphide (a gas with a "rotten egg" odour). Sulphate-reducing bacteria can also cause corrosion problems. Aeration or chlorination followed by filtration will reduce hydrogen sulphide in well water. High levels of sulphate may have a laxative effect (loose stools) on new users. Regular users tend to become accustomed to high sulphate levels.
Chloride (250 mg/L)	Chloride over 250 mg/L may affect the taste of water and beverages. High levels of chloride may also cause either corrosion or scale formation, depending upon what else is in the water. A sudden increase in chloride levels may indicate pollution of your water supply (e.g. from road salt, irrigation drainage).

For more information contact

- www.albertahealthservices.ca/eph.asp
- HEALTH Link Alberta at 403-943-LINK or 1-866-408-LINK
- or your local health centre at one of the locations listed below.

Airdrie Airdrie Public Health Centre 604 Main Street South Airdrie, AB T4B 3K7 Phone: 403-912-8400 Fax: 403-912-8410	**Banff** Banff Health Centre 303 Lynx Street PO Box 1266 Banff, AB T1L 1B3 Phone: 403-762-2990 Fax: 403-762-5570	**Calgary/Mountain View/Rocky View** Calgary and Area 10101 Southport Rd SW Calgary, AB T2G 2E6 Phone: 403-943-2288 Fax: 403-943-8056	**Canmore** Canmore Public Health #104, 800 Railway Avenue Canmore, AB T1W 1P1 Phone: 403-678-5656 Fax: 403-678-5068
Claresholm Claresholm Public Health 5221 2nd Street W PO Box 1391 Claresholm, AB T0L 0T0 Phone: 403-625-4061 Fax: 403-625-4062	**Didsbury** Didsbury Health Unit PO Bag 130 1210 -20th Avenue Didsbury, AB T0M 0W0 Phone: 403-335-7292 Fax: 403-335-7610	**Okotoks** Okotoks Public Health Centre 11 Cimarron Commons Okotoks, AB T1S 2E9 Phone: 403-995-2600 Fax: 403-995-2639	**Strathmore** Public Health Building 650 Westchester Road Strathmore, AB T1P 1H8 Phone: 403-361-7200 Fax: 403-934-7244

Alberta Health Services

Environmental Health

Interpretation of Bacteriological Results

The Provincial Laboratory of Public Health performs laboratory tests on well water samples. Initially the laboratory looks for whether bacteria are present or absent in a sample. The presence of certain types of bacteria such as *E-coli* or Total Coliforms indicates that your water may be unsafe to drink. Private laboratories often test for fecal coliforms instead of *E-coli*.

If your well water sample result shows the presence of *E-coli* or Total Coliforms, you will be contacted by a Health Inspector to discuss these results and what further actions should be taken.

The following definitions will help you interpret your report:

DEFINITIONS

Absent: Indicates bacteria were **not** identified in the well water sample tested.

Present: Indicates bacteria **were** identified in the well water sample tested.

E-coli:

The presence of *E-coli* in a private water supply indicates that the water supply has recently been impacted by fecal contamination and **should not be considered safe to drink**. This situation should be discussed with the Health Inspector who can make recommendations about boiling your water or other treatment methods.

Total Coliforms:

The presence of Total Coliforms in a private water supply indicates the possible surface contamination of the water supply. Total Coliforms may also indicate inadequate water treatment (if treatment used). This situation should be discussed with the Health Inspector who can make recommendations on what further action you should take.

For more information contact:

- www.albertahealthservices.ca/eph.asp
- Health Link Alberta at 403-943-LINK or 1-866-408-LINK
- or your local health centre

global environmental solutions

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Whitehorse, YT Y1A 1N2
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Tel: (867) 689-2021

Yellowknife, NT
1B Coronation Drive
Yellowknife, NT X1A 0G5
Canada
Tel: (867) 688-2847

Appendix J

Water Management Plan/Stormwater Management Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Stormwater Management Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006

April 2021

Revision 3, May 2023

Stormwater Management Plan for Summit Pit

Rocky View County, Alberta

SLR Project No: 212.06650.00006

Prepared by:
SLR Consulting (Canada) Ltd.
200 – 708 11th Ave SW
Calgary, Alberta, T2R 0ER

for

Mountain Ash Ltd. Partnership
1945 Briar Crescent NW
Calgary, AB, T2N 3V6

April 2021
Administrative Amendment June 2021
Revision 1, July 2021
Revision 2, October 2021
Revision 3, May 2023

This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

Prepared by:

LUIS VASQUEZ
ID 284074
15 May. 2023

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1 electronic copy – SLR Consulting (Canada) Ltd.

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DATE: 2023-05-15
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The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

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TABLES

FIGURES

1.0 INTRODUCTION

Mountain Ash Limited Partnership (Mountain Ash) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will encompass approximately 208 acres (84 ha) excluding existing road rights-of-way. Mountain Ash is applying for Phase 1 of a six-phase mining plan. This land is currently owned by 1410266 Alberta Ltd. (a general partner of Mountain Ash). Summit Pit received land use and a master site development plan (MSDP) approval on March 2, 2021 (Land Use Bylaw C-8051-2020).

A conceptual Stormwater Management Plan (SWMP) was developed for the Project in 2016 (SLR 2016). The SWMP is required to ensure sustainable and effective management of surface water quality to protect existing local water users and the natural environment, which includes neighboring domestic wells and the Big Hill Springs Provincial Park. The conceptual SWMP has been revisited to consider the new phase mine plan developed in 2019. The water management strategy previously proposed, which is discussed in this report, has been maintained for the updated SWMP.

1.1 Hydrogeology

A hydrogeological assessment (SLR 2020) was undertaken as part of the MSDP application to assess the potential for groundwater impacts from the Project operations in relation to nearby groundwater users. A Groundwater Monitoring Plan (GMP) was subsequently prepared in relation to the operation of the Summit Pit. The objective of the GMP is to ensure the effects of site operations on groundwater resources in the vicinity of the site are monitored and negative impacts prevented wherever possible.

A total of 10 groundwater monitoring points were installed at the site and have been subject to periodic groundwater elevation monitoring between October 2014 and September 2019 (as detailed in the Hydrogeological Assessment, SLR 2020). A summary of the analysis related to the Storm Water Management Plan is presented below:

- The highest groundwater elevations are recorded in the sand and gravel at 1,274.87 masl (16.21 m below ground surface [bgs]) on November 20, 2014. Groundwater levels have been declining since, and in July 2019 had reached a low of 1273.65 masl (17.43 m bgs) at the same monitoring point.
- Minimal fluctuation in the groundwater levels within the sand and gravel indicates very little or no influence from pumping within residential wells completed in the bedrock in the area.

The base of the settlement ponds will be approximately 3 m bgs in the glacial till, and consequently a minimum of 10 m above the sand and gravel groundwater table. Groundwater monitoring will be ongoing to ensure that the base of the pit (and the infiltration areas) will be kept a minimum of 1.0 m above the maximum groundwater table. The drainage features will be designed to prevent direct interaction with the groundwater system.

1.2 Hydrology

1.2.1 Overview

The site is located approximately 1 km upslope of the Big Hill Springs Provincial Park and is located within the surface water catchment of an Unnamed Watercourse which forms a tributary to the larger Bighill Creek. No surface water bodies (streams or lakes) have been identified within the site area itself; however, there are two wetlands in the northwest corner considered as Class III (seasonal) wetlands which are to be retained on the landscape. The small wetlands scattered across the property where aggregate extraction will take place are not going to be retained. Mountain Ash will consider upgrading or replacing wetlands however possible at the time of reclamation.

The wetlands located in the northwest corner of the site (see wetland area on Figure 2), which do not have a surface discharge outlet, are fed by rainfall and snowmelt from the local catchment and from a portion of the catchment to the north of Highway 567 (via a culvert located beneath the highway). These wetlands will be retained on the landscape and this small area will not be developed for aggregate extraction with exception of construction of settlement Pond C (Figure 3C). The Hydrogeological Assessment (SLR 2020) also confirms that these wetlands are not groundwater fed.

Giving the impermeable nature of the surficial soils at surface, infiltration of precipitation (snow or rainfall) landing on the existing site would be limited; therefore, the predominant hydrological regime would be characterized by stormwater runoff.

1.2.2 Rainfall Data

Intensity Duration Frequency (IDF) rainfall data has been obtained from the Environment and Climate Change Canada Website for the rainfall gauge located at Calgary International Airport some 30 km southeast of the site (ID 3031094). The period of record used to derive the IDF statistics is from 1947 through 2015. The IDF graph represents rainfall storm duration against rainfall intensity for varying rainfall return periods and is used to inform the outline hydraulic design / sizing of stormwater management features.

1.3 Proposed Development

As shown on Figure 2, the northwest quarter of Section 31 (Figure 1) covers a total area of approximately 65 ha (160 acres), whereas the southwest quarter covers approximately 70 ha (173 acres). The ultimate excavation footprint covering a continuous parcel overlapping both quarter sections will be approximately 84 ha (208 acres). Surface runoff from the perimeter berm will have to be collected and sediment control will be provided. Once permitted, the property will be operated in six phases of uneven size (depending upon setbacks), each lasting about six years. Each phase will be worked via individual cells with a maximum of approximately four cells ‘open’ at any given time. A summary of the individual phases is provided below (see Figure 2):

- Phase 1 includes working cells 1 to 15.
- Phase 2 is immediately to the north and will be worked over cells 16 to 31.
- Phase 3 includes working cells 32 to 47.
- Phase 4 will be worked via cells 48 to 61. The two wetlands in the northwest corner will be retained and Phase 4 will be developed on the lands south and east of them.
- Phase 5 will be worked via cells 62 to 76, and 78.

- Phase 6 will be worked via cells 79 to 87.

Based on drilling investigations at the site, there is 4 m to 6 m of glacial till overburden overlying the sand and gravels. The till soils will be stripped and stockpiled around the perimeter of the relevant extraction phases for screening purposes and ultimately for future use in the site restoration.

The sand and gravel are the target deposit for extraction and lies immediately above the underlying bedrock. Groundwater in assessment boreholes were noted between 20 m and 24 m bgs and generally lies above the bedrock. It is anticipated that the site will be worked to 1.0 m above the maximum recorded groundwater level within the gravel deposit and will therefore be worked dry, with no requirement for operational or permanent dewatering. Actual depths will be determined with progressive investigation of water levels as the site is developed.

1.4 Objectives

The objectives of this SWMP are to demonstrate that stormwater water runoff within the site confines will be effectively and sustainably managed using City of Calgary[1], Rocky View County[2], and Province of Alberta[3] stormwater management techniques and best practice guidance (where applicable).

The underlying principles of this assessment are:

1) To ensure that storm water generated by incident rainfall on the site (and its immediate surrounds) is managed to prevent a potential increase in flood risk downstream in the catchment and maintain ‘dry’ working areas.

2) To provide suitable stormwater quality treatment to prevent potential pollution of the underlying aquifer and surface water bodies within the catchment.

3) To provide a passive or, gravity stormwater management system that does not require routine pumping.

4) To achieve separation of ‘clean’ (i.e., stormwater runoff from unworked land) and potentially ‘dirty’ (i.e., runoff from overburden tips) stormwater runoff where practically possible.

5) To provide stormwater management measures, which can be incorporated into the site development to prevent operational areas being impacted by stormwater runoff.

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[1] The City of Calgary Water Resources (2011) Stormwater Management & Design Manual, September 2011.

[2] Rocky View County (2013). County Servicing Standards, Section 700, May 2013.

[3] Alberta Environmental Protection (1999). Stormwater Management Guidelines for the Province of Alberta, January 1999.

2.0 STORMWATER MANAGEMENT PLAN

2.1 Strategy Overview

The stormwater management strategy will be implemented over six Surface Water Management Phases and the proposed strategy for each phase is presented on Figures 3A to 3F. Generally, the surface water management measures for each phase are similar and entail the following where applicable:

- Install perimeter (grassed / lightly vegetated) ditches (swales) at the outer foot of the screening berms / overburden stockpiles to route 'dirty' runoff (initial treatment) from the mounds to appropriately sized settlement / attenuation ponds (secondary treatment). Shallower longitudinal gradients in the swales would encourage longer residence times, lower velocities and thus improve treatment effectiveness. The perimeter ditches are identified with blue dashed lines and the ponds as blue rectangles on Figure 2 and Figures 3A to 3F.
- A locally created sump excavated into the underlying sands and gravels accepts the 'treated' outflow from the pond where the runoff will locally form groundwater recharge (via infiltration through the sands and gravels thus providing a tertiary level of surface water treatment) and reduction in surface water volumes. Sumps are to be connected to the outer settlement ponds by a culvert/pipe beneath the perimeter berm. The infiltration sumps are identified as magenta squares on Figure 2 and Figures 3A to 3F.
- Interception ditches are proposed upslope of the Surface Water Management Phases to prevent stormwater runoff from the up-gradient catchment entering the extraction areas. This water is considered 'clean' and therefore does not require treatment; instead, it is routed around the Surface Water Management Phases via diversion ditches and allowed to disperse overland (via a series of shallow excavated diffusion channels). This provides hydrological continuity between the upslope and downslope of the relevant Surface Water Management Phases. The diversion ditches are identified with orange dashed lines on Figures 3A to 3F.
- A temporary locally created sump excavated within the extraction area to collect clean runoff upslope of the Surface Water Management Phases during the development of Phases 2, 3 and 4 (see orange square on Figures 3B to 3D). Prior to Phase 4 extraction, the temporary sump will also collect water from Pond C during the Phase 3 extraction operation (Figure 3C). The temporary sump is to be located in a low topographic spot within the extraction area and is required due to topographic constraints that impede gravity flow of clean water away from the extraction area (see direction of diversion ditches discharging to the temporary sump). Water collected in the temporary sump will be infiltrated back into the ground.

2.2 Design Criteria

All stormwater management features (i.e., swales, settlement ponds and discharge sumps) are sized to the 1:100 year storm event as required by Provincial / County guidance. The stormwater management elements are sized using the rainfall intensities for varying storm durations taken from the IDF Graph.

With regards to swale design the application of the recommended 'Unit Area Release Rate Method' enables the peak runoff to be determined by incorporation of a conservative unit release rate = 90 l/s/ha (City of Calgary Stormwater Management & Design Manual). Freeboard allowances are incorporated into the outline design to provide snowmelt offsetting.

For the attenuation / settlement pond design, to achieve acceptable sedimentation the target velocity and particle size range for wet ponds is 2.8 x 10^{-4} m/s and 20 – 50 ųm, respectively (City of Calgary Stormwater Management & Design Manual). The outflow rate (m^3/s) and surface area (m^2) are determined from application of this minimum settlement velocity. The pond volume is determined by accommodating the stormwater runoff volume from its receiving catchment for the 1:100 year 24-hour storm event and is designed to maintain a 300 mm freeboard above this design storm event. The pond catchment areas are shown on Figure 2.

The sump(s) within the sands / gravel horizon are also sized to accommodate a 1:100 year 24-hour outflow hydrograph from the associated settlement pond (i.e., the design storm event) plus incident rainfall onto the extraction area. A proposed 300 mm freeboard is also recommended for the outline sump design. The hydraulic conductivity of the sands and gravels governs the rate of infiltration rate (i.e., discharge rate) into the sand and gravels and the lower in-situ permeability of 1 x 10^{-4} m/s is applied to adopt a conservative approach.

With respect to snowmelt contributions to stormwater runoff, this is inherently difficult to accurately quantify as recognized by the Alberta Stormwater Management Guidelines (Section 4.4.5 of the guidelines). Furthermore, review of the City of Calgary Stormwater Management & Design Manual and Rocky View Servicing Standards confirms that the design criteria for storage features is a 1:100 year (24 hour) storm (no detailed quantitative assessment of snowmelt appears to be required). Notwithstanding, a minimum freeboard allowance of 0.1 m on top of the 1:100 year 24-hour event have been incorporated into the outline design of the stormwater management features to provide additional conveyance capacity as a contingency for potential snowmelt contributions to site runoff.

Snow accumulations must be appropriately managed by site operatives to ensure the operational efficiency of the proposed SWMP is maintained where possible. This includes avoiding localized large snow piles along draining to only one ditch rather than making use of the network of ditches, and timely removal of snow and/or ice accumulation in the ditches as required to maintain conveyance capacity.

All stormwater management features are to be unlined as it is anticipated that the surficial till (clay) has sufficient stability and cohesive properties to facilitate the excavations. However, if liners are deemed to be necessary for particular features / reasons, this can be incorporated at the discretion of the developer. In any case, all features are to be grassed to enable filtration, reduce sediment transfer and enhance stability. The appropriate stormwater management elements will be constructed prior to commencement of the relevant excavations to enable establishment of the grass and their construction specifications verified before accepting the design flows.

2.3 Surface Water Quality

To account for the sensitive nature of the surrounding water environment, the proposed SWMP offers three stages of surface water quality treatment for stormwater runoff shed from overburden areas:

Stage 1	Filtration / aeration / biological interaction through conveyance of water in proposed surface water ditches.
Stage 2	Suspended solid settlement and further biological interaction within settlement / attenuation ponds. Residence time within the pond encourages settlement and is provided via appropriate hydraulic design (to achieve minimum settlement velocities).
Stage 3	Infiltration through the sands and gravels before entering the groundwater.

Plant areas located within the site should be developed with appropriate cross-falls to allow immediate positive drainage to proposed ditches. Surface water drainage from the site plant areas will be passed through an oil interceptor before discharging into receiving ditches.

2.4 Surface Water Runoff

2.4.1 Outside Extraction Areas

Surface water runoff from the overburden storage and screening areas (and the local up-gradient catchment where applicable) will be attenuated via settlement ponds designed to achieve appropriate sedimentation with a target velocity of 2.8×10^{-4} m/s taken from the City of Calgary Stormwater Management & Design Manual.

2.4.2 Within Sand and Gravel Extraction Areas

Each cell will be excavated first through the glacial till, which will be stockpiled, and then into the target sand and gravel. Incident rainfall onto the extraction areas within the glacial till horizon would need to be locally managed (due to limited permeability / infiltration capacity of the till) via integrating an appropriate cross fall within the base of the working area (i.e. 1% to 2%) to convey rainfall to a dedicated sump with proposed minimum dimensions of [5 m (W) x 5 m (L) x 1 m (D)] = 25 m^3. Each quadrant will be worked via individual cells with a maximum of approximately four cells 'open' at any given time. Numerical analysis (for the design 1:100 year 24-hour storm event) confirms limited accumulation of runoff within the extraction areas (maximum of 4 x cells = 40,000 m^2). The spread over the extraction base area is equivalent to <0.001 m of water depth during the storm event. It is also noted that the exposure of the till during excavations will be temporary until the underlying sands and gravels are reached.

Once the excavation enters the sand and gravel, incident rainfall (for the design 1:100 year 24-hour storm event) is readily infiltrated thus no management of precipitation within the extraction areas is required.

The aggregate extraction is dry i.e., groundwater will not be encountered. Taking the above into consideration, no regular requirement for dewatering the extraction areas via pumping is anticipated. However, in the event that groundwater is unexpectedly encountered it is recommended that extraction be limited in that area and the floor of the excavation area be raised for subsequent extraction. Given the flexible extent of the extraction area, no emergency pumping is deemed necessary.

2.5 Outline Design of Stormwater Management Features

The following subsections outline the hydraulic design for the proposed stormwater management elements.

2.5.1 Swales

A standard swale size is proposed for the development and has been determined by analyzing the swale with the largest contributing catchment area and shallowest longitudinal gradients.

Using the design criteria outlined in Section 2.2 the rate of runoff is determined by the Unit Area Release Rate Method:

$$Q = UARR\ x\ A$$

Where: Q = Peak Runoff Rate (l/s)

$UARR$ = Unit Area Release Rate (l/s/ha)

A = Catchment Area (ha)

Adoption of a higher UARR (i.e., 90 l/s/ha for this assessment) ensures a conservative approach to the swale hydraulic design. Table 1 summarizes the peak flow calculation for the swale with the largest catchment (corresponds to the Phase 2 north diversion ditch shown on Figure 3B).

Table 1 Swale Peak Flow Calculations

Parameter	ID	Unit	Value	Notes
Unit Area Release Rate	UARR	l/s/ha	90	The top end figure within the 'higher release rate' category as defined in the City of Calgary Stormwater Management & Design Manual for areas of moderate slopes where surface ponding storage is limited
Catchment Area	A	ha	27.33	Measured from AutoCAD development plans for the Phase 2 north diversion ditch shown on Figure 3B
Calculated Peak Flow	Q	m^3/s	2.46	Standard swale design is sized to accommodate this peak flow (plus freeboard allowances to provide offsetting of snowmelt contributions)

The channel geometry required to convey the anticipated peak flow has been determined through application of Manning's Equation. The Manning's 'n' coefficient of the swales, established from experience and referenced to respected literature[4], has been estimated to be 0.033. The proposed geometry is as follows:

Base Width = 0.750 m
Base to Top of Bank = 0.750 m
Side Slopes = 1 vertical to 2 horizontal
Minimum Longitudinal Gradient = 1%
Total Swale Top Width = 3.75 m

The proposed standardized swale design has sufficient capacity for all proposed swales within the stormwater management plan and review of the site contour data (2 m LiDAR) confirms that all ditches have an average longitudinal gradient >1% (thus the design capacity of the swales in practice will be >2.82 m^3/s given the proposed swale depth of 0.750 m).

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[4] Chow, V.T. (1959). Open Channel Hydraulics

The following construction and maintenance measures should be included in the design of the swales:

- Swales should be grassed to promote filtration and treatment of intercepted runoff whilst also providing stability integrity.
- Where acute bends within the alignment of swales are required, erosion protection measures (i.e., rip-rap or gravel) should be provided to prevent erosion of the swale.
- Erosion protection (i.e., rip-rap or gravel) should be provided for point discharges into / from swales to prevent erosion.
- Routine / inspection to ensure optimum operation efficiency – a potential maintenance strategy is outlined in Section 3.3.

2.5.2 Settlement Ponds

A total of three settlement / attenuation ponds will be constructed, Ponds A, B and C as depicted on Figures 3A to 3F. The exact positions of these will be determined by site management; however, the general location should be maintained as they are dictated by the surrounding topography and remove any requirement for pumping (i.e., ponds are located at low topographic points to allow for gravity drainage).

2.5.2.1 Storm Event Management

Using the design criteria specified in Section 2.2, the ponds are designed to accommodate a 1:100 year 24-hour storm event (as required by City of Calgary and Rocky View County Guidance) whilst also maintaining sufficient surface areas to facilitate sedimentation. The runoff generated from the storm event has been calculated using industry recognized SWMM software developed by the United States Environmental Protection Agency (Version 5.1, U.S. EPA, 2015). The City of Calgary Stormwater Management & Design Manual recommends using EPA SWMM in the design of dual (minor and major) drainage systems. Minor systems are typically flow conveyance structures such as ditches, whereas major systems are typically storage facilities such as ponds. A Chicago temporal distribution[5] has been applied to formulate the synthetic design storm as per the City of Calgary Stormwater Management & Design Manual. The runoff volumes and peak flows obtained from the modelling are summarized in Table 2. Peak inflow rates range from 0.07 m^3/s to 0.18 m^3/s. Pond storage required to retain the runoff resulting from the 1:100 year 24-hour storm event range from 1,201 m^3 to 2,957 m^3.

Table 2 also shows peak flows for the 1:5 year 24-hour storm event, required to evaluate pond geometry requirements for solids settling.

Table 2 Design Runoff Volumes for Selected 24-hour Rainfall Events

Parameter	Unit	Pond A	Pond B	Pond C
Catchment Area	ha	4.1	4.1	9.3
Width of Overland Flow Path	m	150	150	300
Average Catchment Surface Slope	%	1	1	1
Percentage of Impervious Area	%	5	5	5
1:5-year 24-hour Storm Event				
Total Rainfall	mm	52.8		
Total Runoff	mm	3.2	3.2	3.3
Peak Flow	m3/s	0.03	0.03	0.07
1:100-year 24-hour Storm Event				
Total Rainfall	mm	94.1		
Total Runoff	mm	30.8	30.6	31.8
Peak Flow	m3/s	0.07	0.07	0.18
Total Runoff Volume	m3	1,201	1,255	2,957

2.5.2.2 Storm Event Management

The ponds are designed to provide a minimum 85% removal of Total Suspended Solids (TSS) for particle sizes greater than, or equal to 50 µm (City of Calgary Stormwater Management & Design Manual). The settling velocity corresponding to a particle size of 50 µm for sediment removal is 2.8×10^{-4} m/s.

The distance required to settle out a certain size of sediment particle is determined by the settling length equation:

$$\text{Length} = [r\, Q_p / V_s]^{0.5}$$

Where: Length = horizontal settlement length (m)

r = length to width ratio of pond (using 3 for all the three ponds)

Q_p = peak flow rate corresponding to a 1:5-year event (m^3/s)

V_s = settling velocity (dependent on the desired particle size to settle)

Side slopes 3H:1V have been used to determine the pond dimensions. A summary of the settlement ponds hydraulic analysis and pond sizing is provided in Table 3.

Table 3 Summary of Settlement Ponds Hydraulic Analysis

Category	Parameter	Unit	Pond A	Pond B	Pond C	Notes
Pond Depth, Width and Length	Active Pond Depth	m	1	1	1	Active depth and vertical distance between pipe outlet invert and 1:100-year design water level
	Proposed Minimum Permanent Depth	m	2	2	2	A minimum depth from the pond bottom to pipe outlet invert (normal water level) must be 2.0 m.
	Freeboard Above HWL	m	0.35	0.35	0.35	A minimum freeboard of 0.30 m is required.
	Proposed Total Water Depth	m	3	3	3	Permanent pond depth plus active pond depth from the pond bottom to the design water level
	Pond Dimensions (L x W)	m	66 x 22	70 x 23	104 x 34	A Minimum Length (L) to Width (W) ratio 3:1, providing maximum settlement length
	Pond Surface Area	m3	1,452	1,615	3,543	Assuming pond with rectangle shape, pond top surface area is Length (L) by Width (W)
	Modelled Water Depths	m	0.92	0.92	0.93	1:100 Year modelled stormwater depth above pipe outlet invert (normal water level)
	Pond Side Slopes	-	3H:1V			Assumed slope for pond sizing purposes
Volume	Total Permanent Pond Volume	m^3	1,924	2,020	5,242	Extracted from pond hydraulic calculation
	Total Available Pond Treatment Volume	m^3	1,312	1,384	3,197	

Category	Parameter	Unit	Pond A	Pond B	Pond C	Notes
	Modelled Required Volume of Stormwater Attenuation	m^3	1,201	1,255	2,957	Total runoff volume of 1:100-year 24-hour storm event
Settlement Removal	Active Storage Detention Time	hr	24			Acceptable design criteria as per City of Calgary Stormwater Management & Design Manual (2011)
	85% Removal of Particle Size	µm	20 – 50			
	Settling Velocity	m/s	2.83×10^{-4}			
	1:5-year Peak Flow	m^3/s	0.03	0.03	0.07	Extracted result from model simulations
	Required Settling Length	m	17.8	18.0	27.5	Settling Calculations as per equation of City of Calgary Stormwater Management & Design Manual (2011)
Outflow Pipe (for discharge to infiltration sump)	Outflow Pipe Diameter	mm	450	450	600	Minimum Slope versus Pipe Size as per City of Calgary Stormwater Management & Design Manual (2011)
	Modelled Pipe Outflow	m^3/s	0.37	0.39	0.44	Extracted results from model simulations
	Modelled Pipe Outflow Velocity	m/s	1.07	1.08	1.34	

The required settlement lengths (i.e., 17.8 m to 27.5 m in Table 3) are much shorter than the proposed pond lengths (i.e., 66 m to 104 m in Table 3), which are required to meet the storage volumes needed to contain the runoff resulting from the 1:100 year 24-hour storm event.

It is worth noting that the excavated material resulting from the pond excavations can be integrated into the perimeter screening berms. Appropriate stormwater pond signage must be erected as described in Section 709 of the Rocky View County Servicing Standards Guidelines.

Pond inflow and outflow pipes will be fitted with a manual penstock valve to facilitate maintenance and to manually manage conveyance of water in the SWMP if required. The pond inlet and outlets are located at opposite ends to ensure maximum settlement potential. In order to maintain optimum pond efficiency, it is imperative that periodic / regular maintenance is undertaken as described in Section 3.4.

2.5.3 Groundwater Recharge / Discharge Sumps

Discharge sumps (Sump A, B and C) are required to discharge treated surface water runoff to unsaturated deposits of sand and gravel.

Figures 3A to 3F indicate the locations of the sumps; however, the exact positioning of these will be determined by site management. Nonetheless, the general siting location will be maintained as they are dictated by the location of the settlement ponds and perimeter swales.

As with the settlement ponds, the sumps will remain operational for the duration of the entire development (from commissioning as per the appropriate Surface Water Management Phases). Pond and sumps will be located within the perimeter screening area and thus the relevant standoff distances will be maintained.

Like the first two stages of the stormwater management plan, which have been sized to accommodate the 1:100-year storm event, the sump design has adopted the same standard to ensure collected surface water is adequately controlled. The hydrological inputs to the sumps are the outflow hydrographs from the respective settlement / attenuation ponds and incident rainfall landing within the sump footprint.

The maximum infiltration rate from the sump into sands and gravels will be controlled by the in-situ hydraulic conductivity of 1×10^{-4} m/s (lower end of the measured range of hydraulic conductivity was selected – see Section 1.3.2). The time taken for the inflow hydrograph from the design rainfall event into the sump to half drain is less than 24 hours. Therefore, the system has half drained within a day and thus provides some residual capacity in case there is another rainfall event the next day.

A standard sump outline design has been derived for all three sumps and a summary of the proposed sump dimensions is presented in Table 4.

It is recommended that the following design considerations are taken into account:

- A minimum 0.5 m depth earth berm (and appropriate fencing) around the sump opening for safety precautions and to prevent direct (potentially dirty) runoff entering the sump.
- Appropriate signage must be erected as described in Section 709 of the Rocky View Servicing Standards Guidelines and tailored accordingly for the sump.
- Any other safety considerations to be implemented as required by site management / Health & Safety legislation.
- Grass seeding of the sump embankment to improve stability, reduce siltation of the sand and gravel layer and provide filtration of resulting from runoff from the sump slopes.
- Suitable erosion protection (i.e. erosion control blanket / rip-rap) to be provided down the sump slope from culvert outfall to base in order to prevent scour and erosion into the sump embankment.
- Suitable side slopes from a stability perspective must be defined by a qualified geotechnical engineer for detailed design of the sumps.
- A 5 m standoff to swales / perimeter berm and other any other constraining features to provide access for maintenance or for raising berm heights should future weather conditions indicate a need for more freeboard.
- Regular / periodic maintenance should be undertaken to maintain optimum sump efficiency (typical maintenance requirements are outlined in Section 3.4).

Table 4 Summary of Sumps Sizing

Parameter	Unit	Sump A	Sump B	Sump C	Notes
Base Dimensions	m	8.0 x 9.0	8.0 x 9.0	8.0 x 9.0	Proposed (potential) standardized sump design
Minimum Base Area	m^2	72	72	72	
Assumed Side Slopes	1 in X	2	2	2	
Surface Area Footprint	m^2	1,056	1,056	1,056	
Total Sump Depth	m	6.0	6.0	6.0	
Total Available Sump Volume	m^3	3,384	3,384	3,384	
Maximum Water Depth	m	3.8	3.9	5.7	Pond outflow hydrograph retained within sump volume
Freeboard Depth	m	2.204	2.125	0.332	300 mm freeboard provided
Maximum Volume of Water Storage in Sump	m^3	1,201	1,255	2,957	Confirms freeboard capacity is available to provide offsetting of snowmelt contributions

3.0 MAINTENANCE AND OPERATIONAL REQUIREMENTS

3.1 Overview

All stormwater drainage features associated with the development will remain under private ownership and will be maintained and operated by Mountain Ash.

The following sections outline recommended maintenance requirements for various aspects of the surface water management system. If necessary, and once the site is in operation, these outlined maintenance and management proposals will be refined by the operators to suit specific conditions / requirements.

3.2 Pipe Systems / Culverts

The anticipated maintenance and management plan for culverts / pipes within the SWMP is outlined in Table 5.

Table 5 Typical Pipe/ Culvert Maintenance Requirements

Maintenance Schedule	Required Action	Minimum Frequency
Regular Maintenance	Ensure pipe intakes / outlets are clear of debris/silt.	Monthly (or as required)
	Jet wash any sediment accumulations in manholes (within the site 'plant' area) and remove any debris.	Monthly (or as required)
Intermittent maintenance	CCTV survey of inaccessible culverts / pipes to identify any defects/signs of performance degradation such as: Cracked/deteriorating pipe; Leaking joints/seals at manholes; Pipe settling and potential structural failure; High water lines showing regular high stage in pipes (sign of lack of capacity or downstream constraint); and Suspected infiltration or exfiltration.	Every 2 – 5 years
Seasonal Maintenance	During winter months pipes / culverts should be kept clear of ice / snow accumulations via appropriate methods (such as steaming).	Winter
Remedial actions	Repair defects using suitable methods. Effective temporary repairs may be sufficient in short term until scheduled improvements can be made.	As required
Monitoring	Record areas of surface ponding and manhole / culvert surcharging (photos, inundated areas, depths) during extreme storm events and investigate the reasoning for this post-storm.	As required

3.3 Swales

The proposed surface water management scheme uses linear swales to convey intercepted stormwater to settlement ponds. A potential maintenance and management plan for these features is outlined in Table 6.

Table 6 Typical Swale Operation and Maintenance Requirements

Maintenance Schedule	Required Action	Minimum Frequency
Regular Maintenance	Litter, debris, and leaf removal.	Every 2 Months (or as required)
	Grass cutting - to maintain sward to desired height for conveyance / treatment and landscape / ecological benefit.	Every 2 Months (during growing season, or as required)
	Manage other vegetation and remove nuisance plants.	Every 6 Months (at start, or as required)
	Remove silt accumulations within erosion protection rip-rap and inspect/maintain structural integrity.	Every 2 Months (or as required)
Occasional Maintenance	Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter and cut back adjacent vegetation where possible.	Annually
	Re-seed area of poor vegetation growth. Alter plant types to better suit conditions, if required.	Annually, or if bare soil is exposed over 10% or more of the swale treatment area
Remedial Actions	Repair of erosion or other damage by re-turning or re-seeding and providing subsequent erosion protection measures (such as stone rip-rap) if problems persist.	As required
	Re-level uneven surfaces and reinstate design levels.	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of soil surface.	As required
Monitoring	Inspect erosion protection measures (grass/rip-rap) and record/establish remediation frequencies and requirements (de-silting, structural integrity, etc.)	Every 2 Months
	Inspect infiltration surfaces for ponding, compaction, silt accumulation. Records areas where water is ponding for more than 48 hours.	Every 2 Months (or as required)
	Inspect silt accumulation rates and establish appropriate removal frequencies.	Every 6 Months

3.4 Settlement Ponds / Sumps

The proposed surface water management scheme utilizes stormwater settlement / attenuation ponds and sumps whose operational efficiency is critical in the management of stormwater associated with the development.

Therefore, anticipated maintenance requirements and management for the settlement ponds / sumps and their hydraulic control features are outlined in Table 7.

Table 7 Typical Attenuation Pond / Sump Maintenance Requirements

Maintenance Schedule	**Required Action**	**Minimum Frequency**
Regular Maintenance	Litter and debris removal.	Monthly (or as required)
	Grass cutting to maintain sward to desired height for conveyance/treatment and landscape/ecological benefit.	Monthly during growing season or as required
	Manage other vegetation and remove nuisance plants.	Monthly (or as required)
	De-silting of exposed sands and gravel layer at base of sump.	Monthly (or as required)
Occasional Maintenance	Manage submerged and emergent planting.	Annually
	Remove 25% of bank vegetation from water's edge to the pond crest.	Annually
	Tidy all dead growth before start of growing season.	Annually
Intermittent Maintenance	Remove sediment from one quadrant of the main body of the ponds.	2 – 10 years
	Remove sediment from the main body of the ponds when pool volume is reduced by 20%.	2 – 5 years (or as required)
Remedial Actions	Repair of erosion or other damage.	As required
	Aerate pond when signs of eutrophication are detected.	As required
	Realignment of rip-rap or other damage.	As required
	Repair/rehabilitation of hydraulic inlets and outlets.	As required
Monitoring	Inspect hydraulic structures for evidence of poor operation.	Monthly/after large storms
	Inspect banksides, structures, pipework, etc. for evidence of physical damage.	Monthly/after large storms

Maintenance Schedule	Required Action	Minimum Frequency
	Inspect water body for signs of eutrophication.	Monthly during warm seasons
	Inspect silt accumulation rates and establish appropriate removal frequencies.	Monthly

4.0 CONCLUSIONS

The conclusions of the assessment are as follows:

- The stormwater management assessment herein has been developed to sustainably manage surface water intercepted by or shed from the proposed development.
- Appropriate City, County and Provincial guidance documents relating to stormwater management have been referenced (where appropriate) to inform the assessment.
- A particular emphasis has been placed on surface water quality owing to the potentially 'sensitive' nature of the local water environment. As such, three stages of surface water treatment are proposed before surface water is ultimately discharged to groundwater.
- Excavations and workings are to take place at least 1.0 m above the groundwater table, therefore no dewatering of the sand and gravel unit is proposed.
- All elements of the surface water system have been sized to accommodate the design 1:100 year rainfall storm event. An overall conservative approach has been undertaken by providing freeboard allowances and modelling 'worst case' scenarios.
- Potential maintenance schedules for the stormwater management features have been outlined and their implementation is fundamental to ensure the efficacy of the surface water management system.
- The overall assessment confirms that the proposals to manage stormwater runoff are feasible, sustainable and practical and are appropriate for the duration of the development.

5.0 REFERENCES

Alberta Geological Survey, 1999. *Geological Map of Alberta, 1:1,000,000 scale.*

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Rocky View County (2013). County Servicing Standards

Alberta Environmental Protection (1999). Stormwater Management Guidelines for the Province of Alberta. Environmental Sciences Division

The City of Calgary (2011). Stormwater Management & Design Manual. The City of Calgary Water Resources

6.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR for Mountain Ash Limited Partnership., hereafter referred to as the “Client”. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. It is intended for the sole and exclusive use of the Client. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of SLR.

This report has been prepared for specific application to this site and site conditions existing at the time work for the report was completed. Any conclusions or recommendations made in this report reflect SLR’s professional opinion.

Information contained within this report may have been provided to SLR from third party sources. This information may not have been verified by a third party and/or updated since the date of issuance of the external report and cannot be warranted by SLR. SLR is entitled to rely on the accuracy and completeness of the information provided from third party sources and no obligation to update such information.

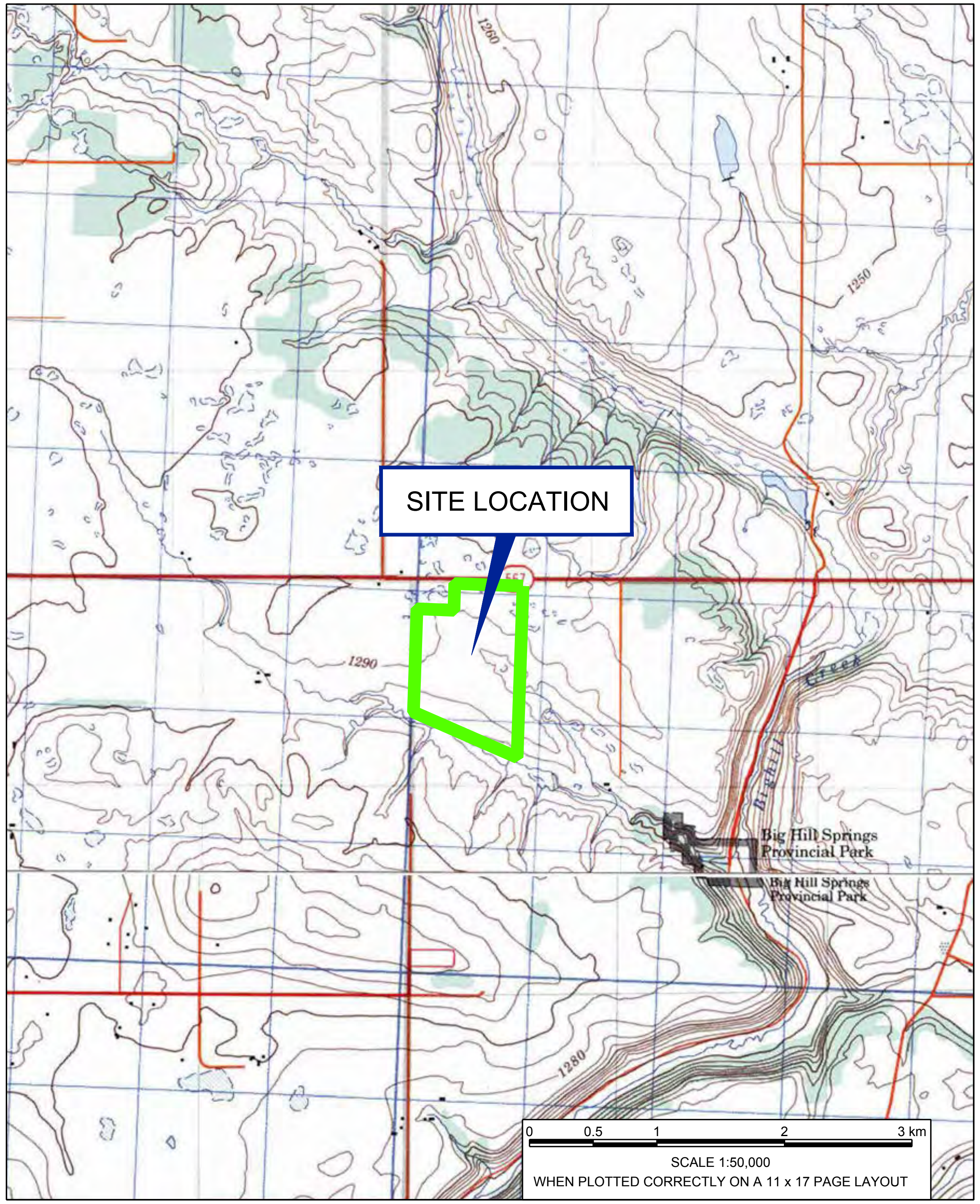
Nothing in this report is intended to constitute or provide a legal opinion. SLR makes no representation as to the requirements of compliance with environmental laws, rules, regulations, or policies established by federal, provincial, or local government bodies. Revisions to the regulatory standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions, and recommendations in this report may be necessary.

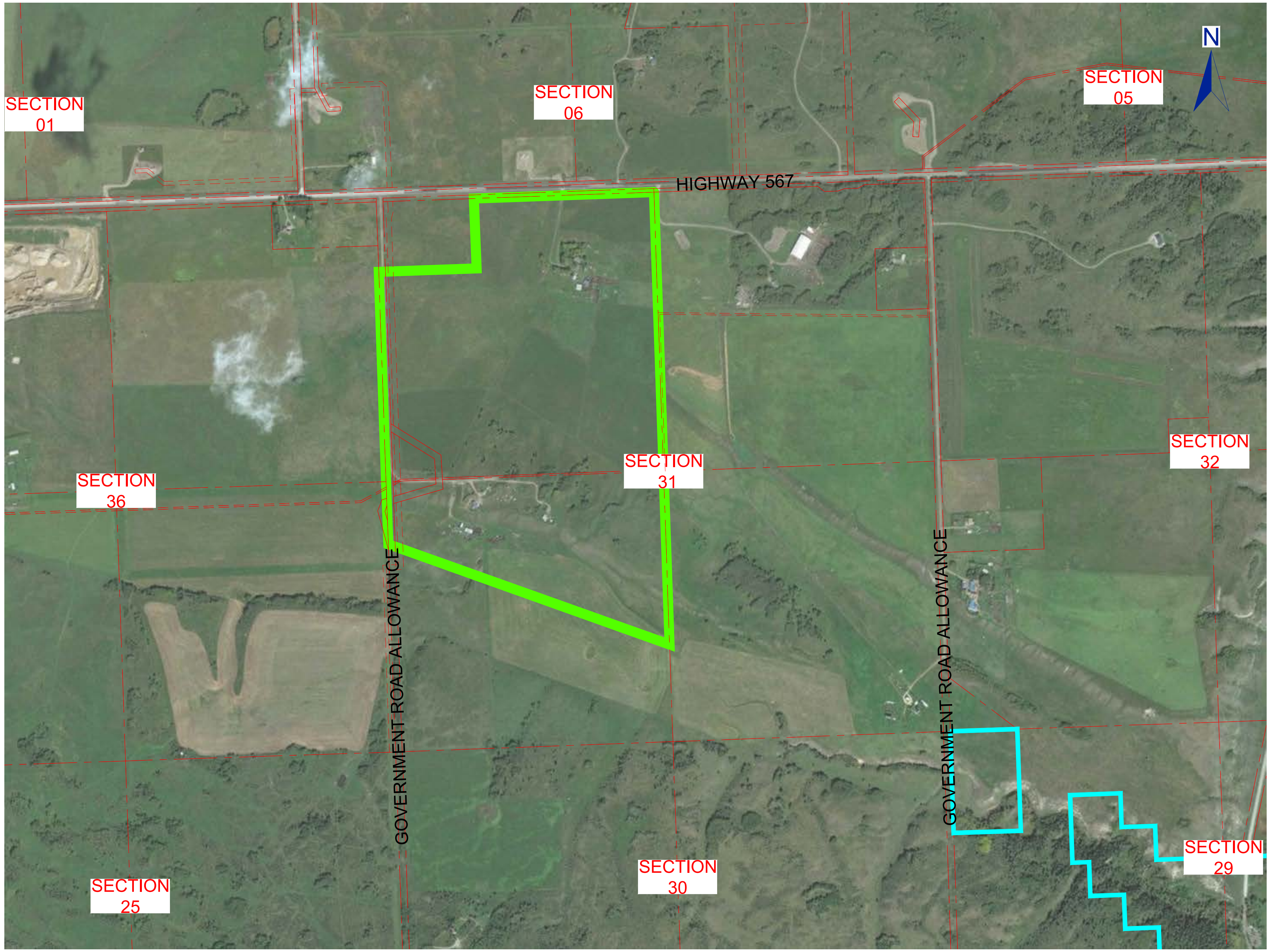
Figures

Stormwater Management Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No.: 212.06650.00006





NOTES:
DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

IMAGERY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY. IMAGERY DATE: SEPTEMBER 9, 2016.

LEGEND:

- - -	PROPERTY BOUNDARY
🟩	PROJECT BOUNDARY
🟦	BIG HILL SPRINGS PROVINCIAL PARK

0 0.25 0.5 1.0 km
SCALE 1:15,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

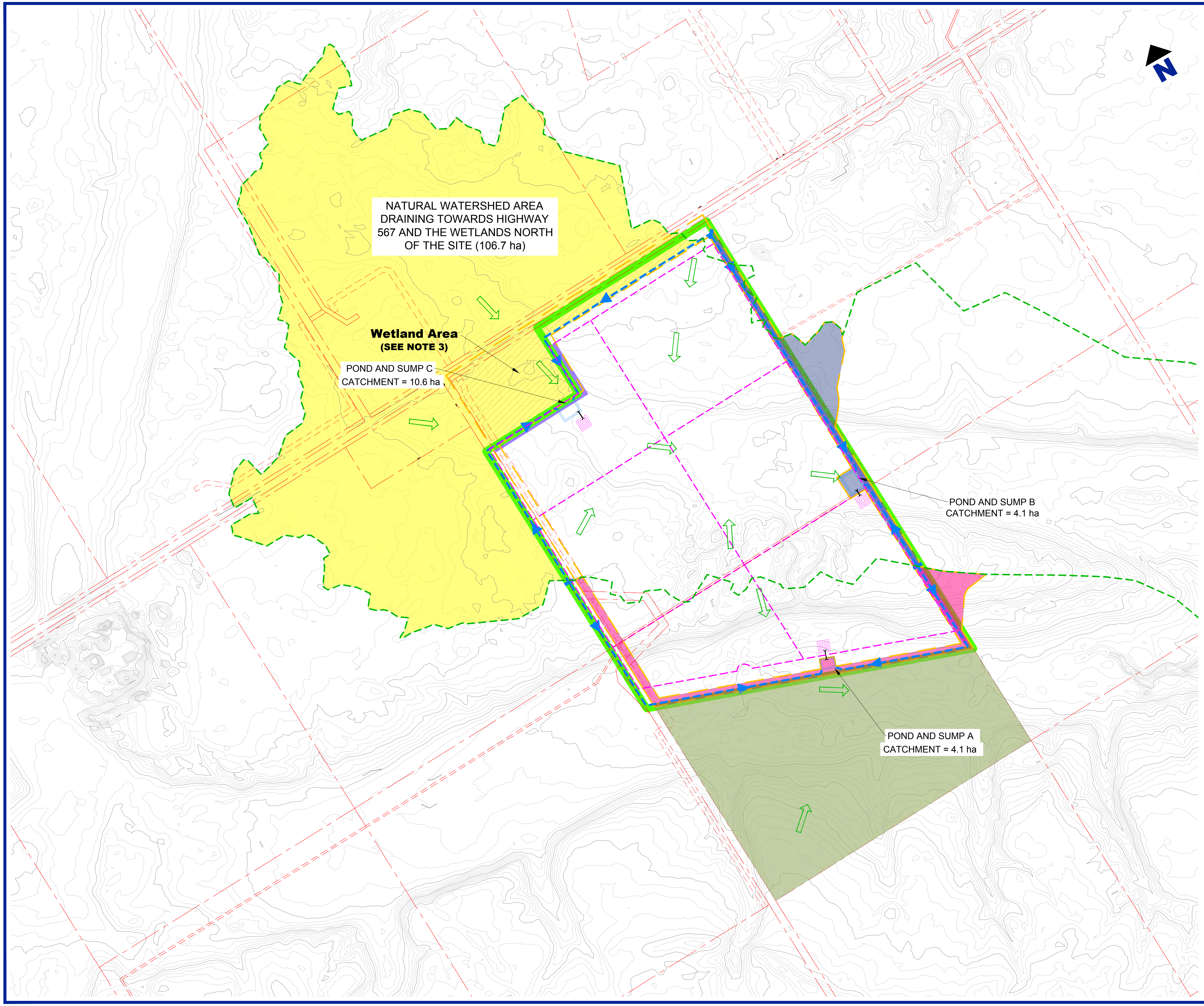
STORMWATER MANAGEMENT PLAN

SITE LOCATION &
STUDY AREA

Date: May 12, 2023
Project No. 212.06650.00007
Figure No. 1

SLR

Cadfile name: S_212-06650-00007-A9.dwg



NOTES:

1. DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND SITE RECONNAISSANCE INFORMATION.

2. LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

3. THE TWO WETLANDS LOCATED IN THE NORTHWEST CORNER OF THE SITE WILL BE RETAINED ON THE LANDSCAPE. THE NORTHWEST CORNER OF THE SITE WILL NOT BE DEVELOPED FOR AGGREGATE EXTRACTION. THE TWO WETLANDS DO NOT HAVE A SURFACE DISCHARGE OUTLET. THEY ARE FED BY RAINFALL AND SNOWMELT FROM THE LOCAL CATCHMENT AND FROM A PORTION OF THE CATCHMENT TO THE NORTH OF HIGHWAY 567 THAT IS NOT DIVERTED BY THE ROAD.

4. WATER MANAGEMENT FEATURES ILLUSTRATED ARE CONCEPTUAL ONLY, FINAL LOCATION ANS SIZING TO BE DETERMINED IN DETAILED DESIGN.

LEGEND:

───	MAJOR CONTOURS - GROUND SURFACE 5 m INTERVALS FROM LIDAR DATA
───	MINOR CONTOURS - GROUND SURFACE 1 m INTERVALS FROM LIDAR DATA
── ‒ ──	PROPERTY BOUNDARY/LEGAL LINES
🟩	PROJECT BOUNDARY
‒ ‒ ▶ ‒ ‒	PROPOSED DRAINAGE DITCH
▭	PROPOSED ATTENUATION/SETTLEMENT POND
▣	PROPOSED INFILTRATION SUMP (INDICATIVE)
)━(	PROPOSED CULVERT/PIPE
‒ ‒ ‒ ‒ ‒	EXISTING WATERSHED DIVIDE
── ──	POND DESIGN CATCHMENT AREAS
⇨	DIRECTION OF EXISTING SURFACE RUNOFF
■	POND A DESIGN CATCHMENT AREA
■	POND B DESIGN CATCHMENT AREA
▨	POND C DESIGN CATCHMENT AREA
🟨	NATURAL WATERSHED AREA UPSTREAM OF PROJECT FOOTPRINT
🟩	NATURAL AREA WITHIN PROPERTY BOUNDARIES BUT OUTSIDE PROJECT FOOTPRINT
‒ ‒ ‒ ‒ ‒	EXTRACTION (PIT) PHASE BOUNDARIES

0 100 200 400 600 m

SCALE 1:10,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

STORMWATER MANAGEMENT PLAN

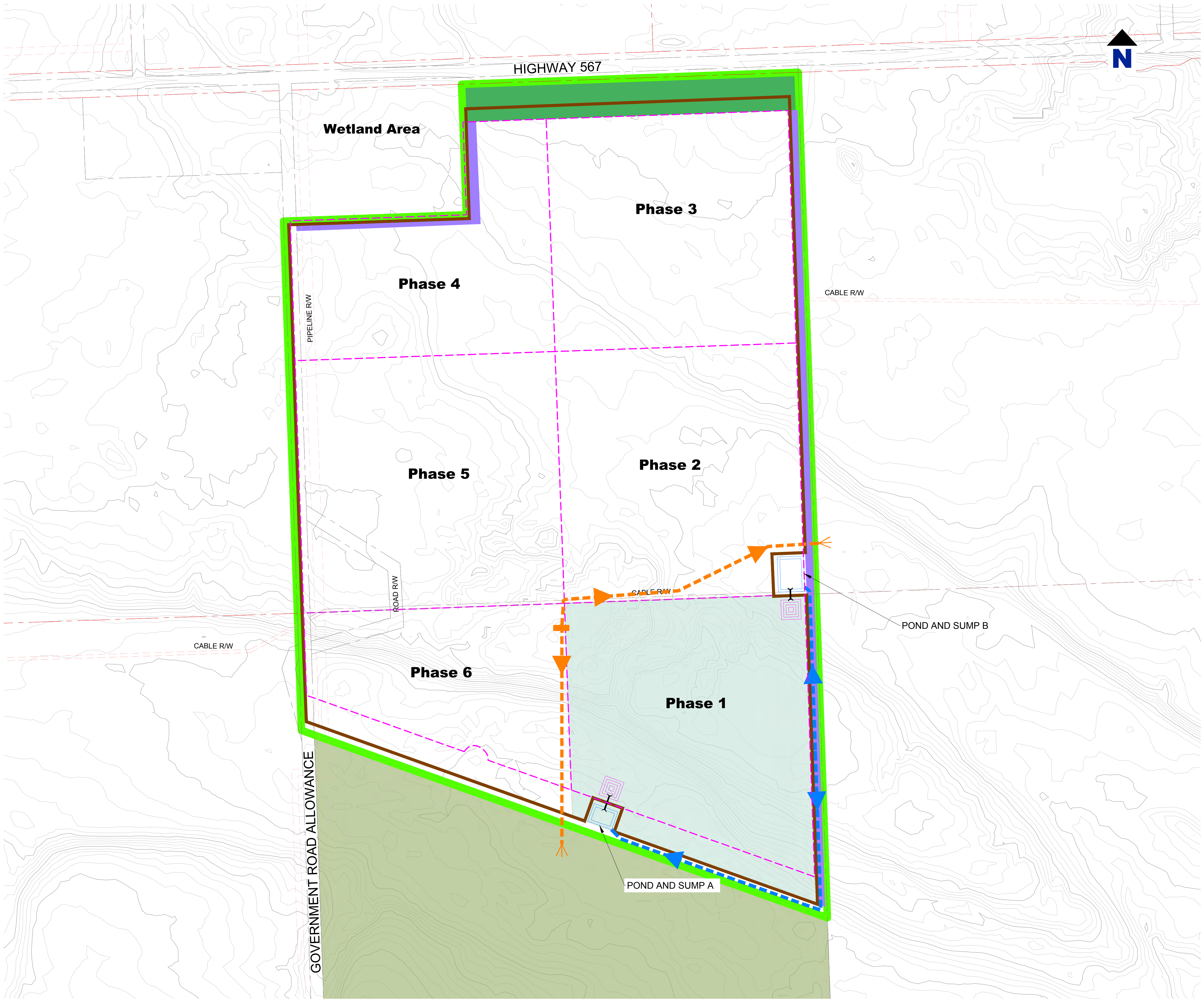
WATERSHED DIVIDES AND POND CATCHMENT AREAS

Date: May 12, 2023
Project No. 212.06650.00007

Figure No.
2

SLR

Cadfile name: S_212-06650-00007-A9.dwg



NOTES:
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LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

WATER MANAGEMENT FEATURES ILLUSTRATED ARE CONCEPTUAL ONLY, FINAL LOCATION AND SIZING TO BE DETERMINED IN DETAILED DESIGN.

LEGEND:

▭	PROJECT BOUNDARY
- - -	HIGHWAY AND/OR QUARTER SECTION PROPERTY BOUNDARY/LEGAL LINES
- - -	UTILITY/ PIPELINE RIGHT OF WAY PROPERTY BOUNDARY/LEGAL LINES
— - —	TOWNSHIP ROAD AND/OR SUBDIVISION PROPERTY BOUNDARY/LEGAL LINES
—	MAJOR CONTOURS - GROUND SURFACE 5 m INTERVALS FROM LIDAR DATA
—	MINOR CONTOURS - GROUND SURFACE 1 m INTERVALS FROM LIDAR DATA
—	TEMPORARY MATERIAL STORAGE
- -▶- -	PROPOSED DRAINAGE DITCH
- -▶- -	PROPOSED TEMPORARY DIVERSION DITCH
▣	PROPOSED TEMPORARY INFILTRATION SUMP
▭	PROPOSED ATTENUATION/SETTLEMENT POND
▣	PROPOSED INFILTRATION SUMP (INDICATIVE)
⟝⟞	PROPOSED CULVERT/PIPE
🟩	PERMANENT LANDSCAPE BUFFER AREA
🟪	TEMPORARY BUFFER AREA
▨	NATURAL AREA WITHIN PROPERTY BOUNDARIES BUT OUTSIDE PROJECT FOOTPRINT
- - -	EXTRACTION (PIT) PHASE BOUNDARIES
▨	EXTRACTION (PIT) PHASE 1

0 50 100 200 300 m

SCALE 1:6,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT

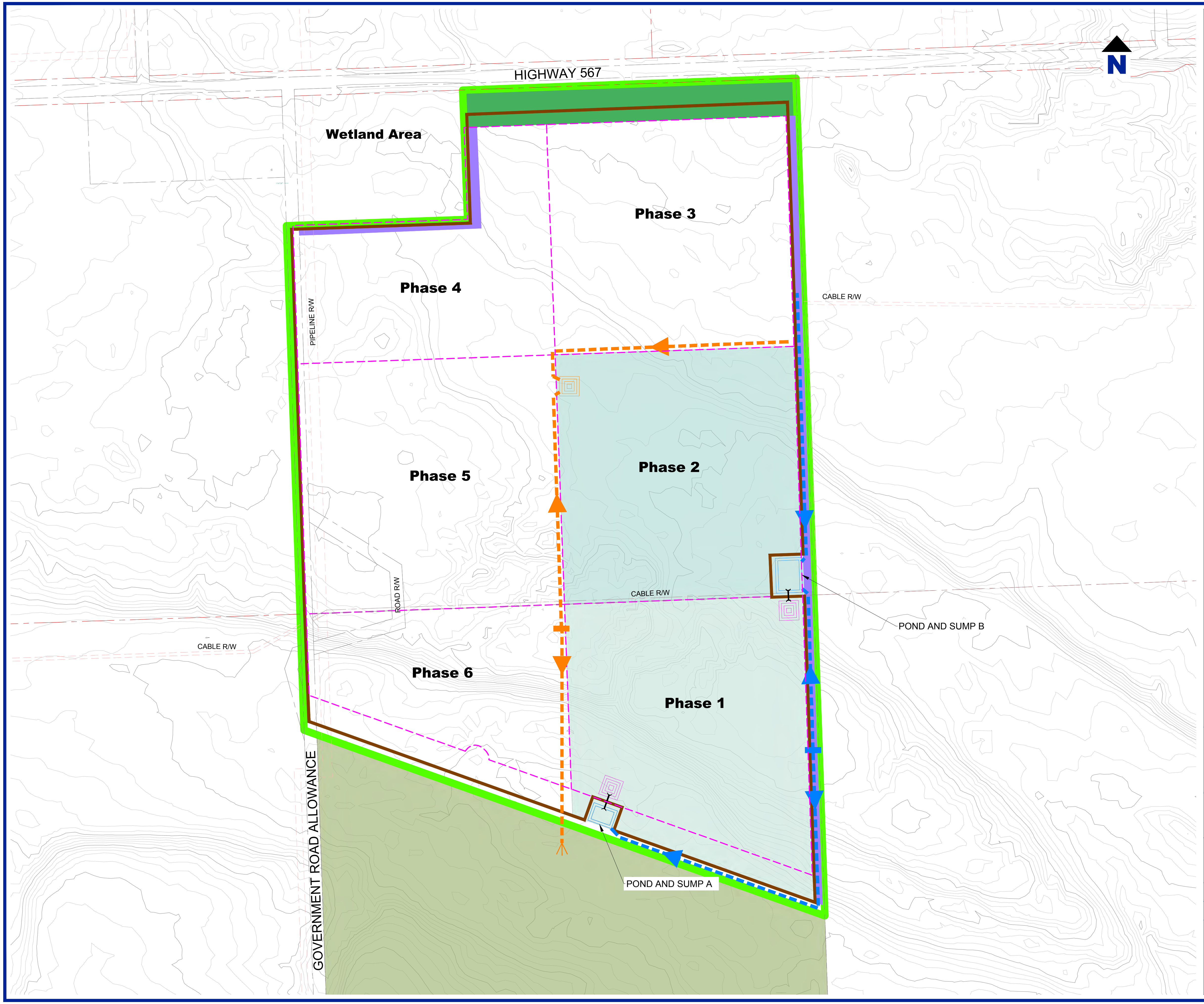
STORMWATER MANAGEMENT PLAN

EXTRACTION PHASE 1 - EXTERNAL CONTACT WATER MANAGEMENT

Date: May 12, 2023
Project No. 212.06650.00007
Figure No. 3A

SLR

Cadfile name: S_212-06650-00007-A9.dwg



NOTES:

DRAWING COMPILED FROM LIDAR DATA, PROPERTY LINE DATA AND AIR PHOTOS AS PROVIDED BY THE CLIENT, BING IMAGERY, NTS MAP 82 O/01 TITLED "CALGARY" AND 82 O/08 TITLED "CROSSFIELD" AND SITE RECONNAISSANCE INFORMATION.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

WATER MANAGEMENT FEATURES ILLUSTRATED ARE CONCEPTUAL ONLY, FINAL LOCATION AND SIZING TO BE DETERMINED IN DETAILED DESIGN.

LEGEND:

▭	PROJECT BOUNDARY
— - —	HIGHWAY AND/OR QUARTER SECTION PROPERTY BOUNDARY/LEGAL LINES
- - -	UTILITY/ PIPELINE RIGHT OF WAY PROPERTY BOUNDARY/LEGAL LINES
— - —	TOWNSHIP ROAD AND/OR SUBDIVISION PROPERTY BOUNDARY/LEGAL LINES
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- - -	EXTRACTION (PIT) PHASE BOUNDARIES
▨	EXTRACTION (PIT) PHASE 1
▨	EXTRACTION (PIT) PHASE 2

0 50 100 200 300 m

SCALE 1:6,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT

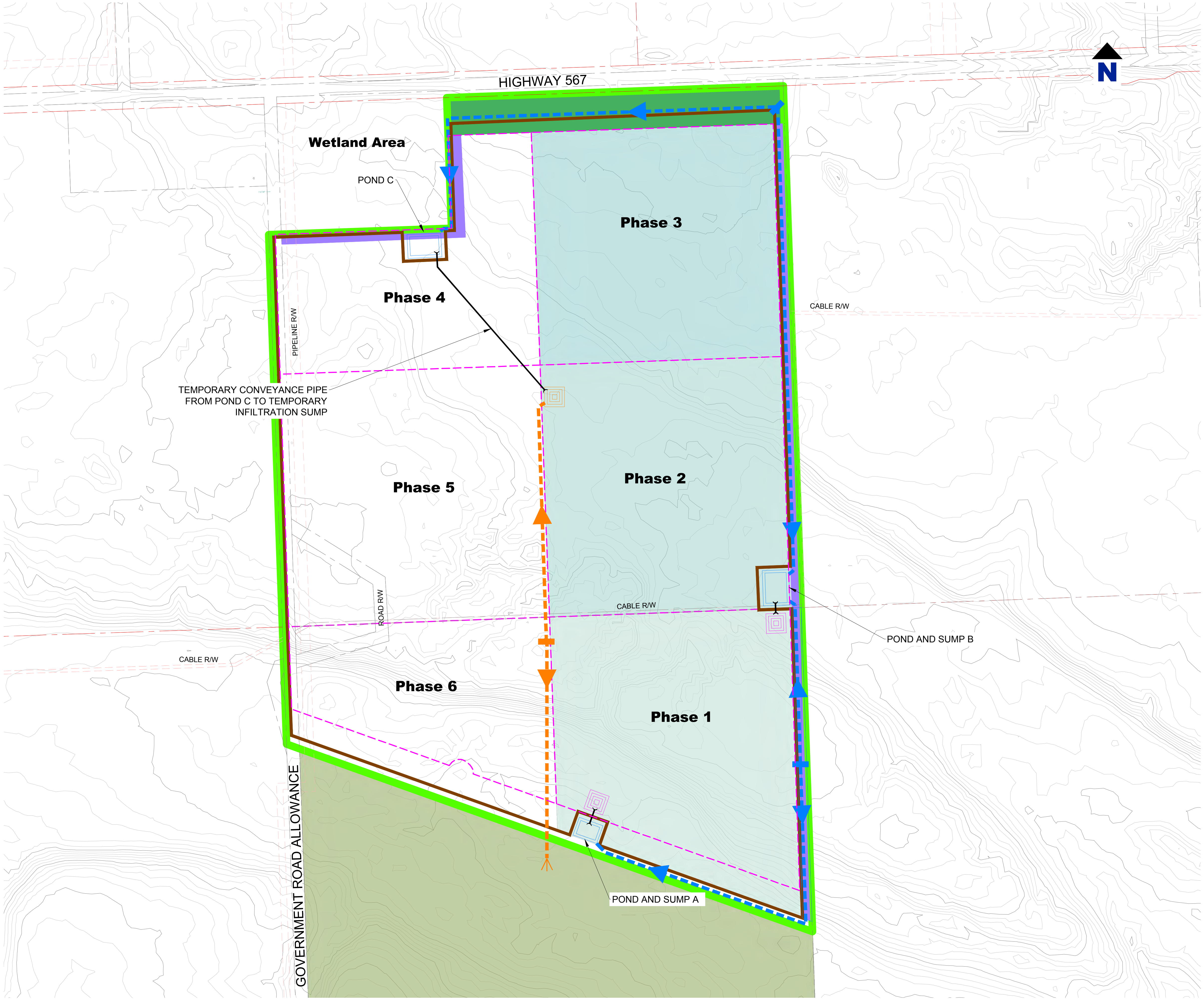
STORMWATER MANAGEMENT PLAN

EXTRACTION PHASE 2 - EXTERNAL CONTACT WATER MANAGEMENT

Date: May 12, 2023	Figure No. 3B
Project No. 212.06650.00007	

SLR

Cadfile name: S_212-06650-00007-A9.dwg



NOTES:
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LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

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🟩	PROJECT BOUNDARY
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🟪	TEMPORARY BUFFER AREA
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▨	EXTRACTION (PIT) PHASE 1
▨	EXTRACTION (PIT) PHASE 2
▨	EXTRACTION (PIT) PHASE 3

0 50 100 200 300 m

SCALE 1:6,000
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NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT

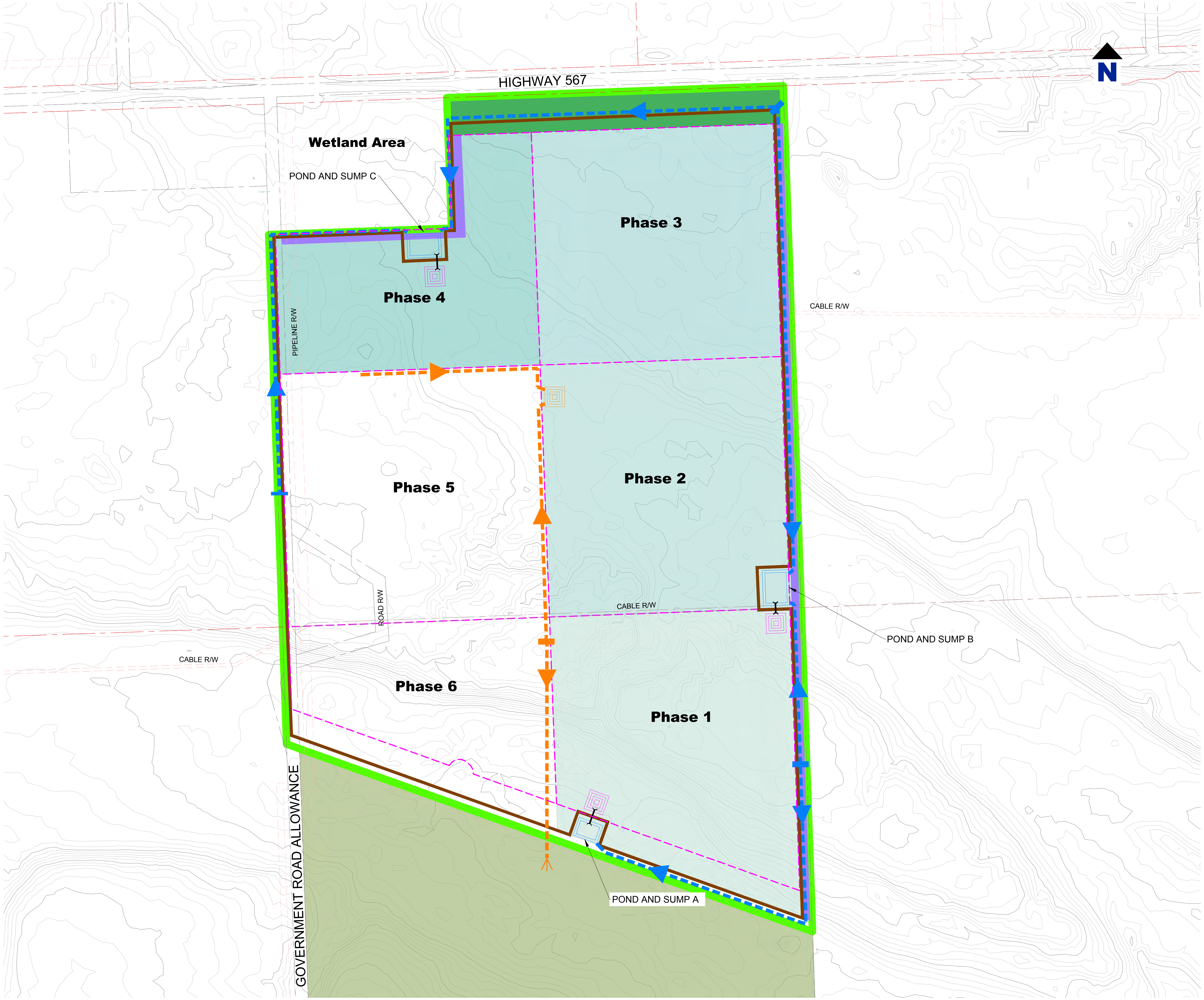
STORMWATER MANAGEMENT PLAN

EXTRACTION PHASE 3 - EXTERNAL CONTACT WATER MANAGEMENT

Date: May 12, 2023
Project No. 212.06650.00007
Figure No. 3C

SLR

Cadfile name: S_212-06650-00007-A9.dwg



NOTES:
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LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

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■	EXTRACTION (PIT) PHASE 1
■	EXTRACTION (PIT) PHASE 2
■	EXTRACTION (PIT) PHASE 3
■	EXTRACTION (PIT) PHASE 4

0 50 100 200 300 m

SCALE 1:6,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT

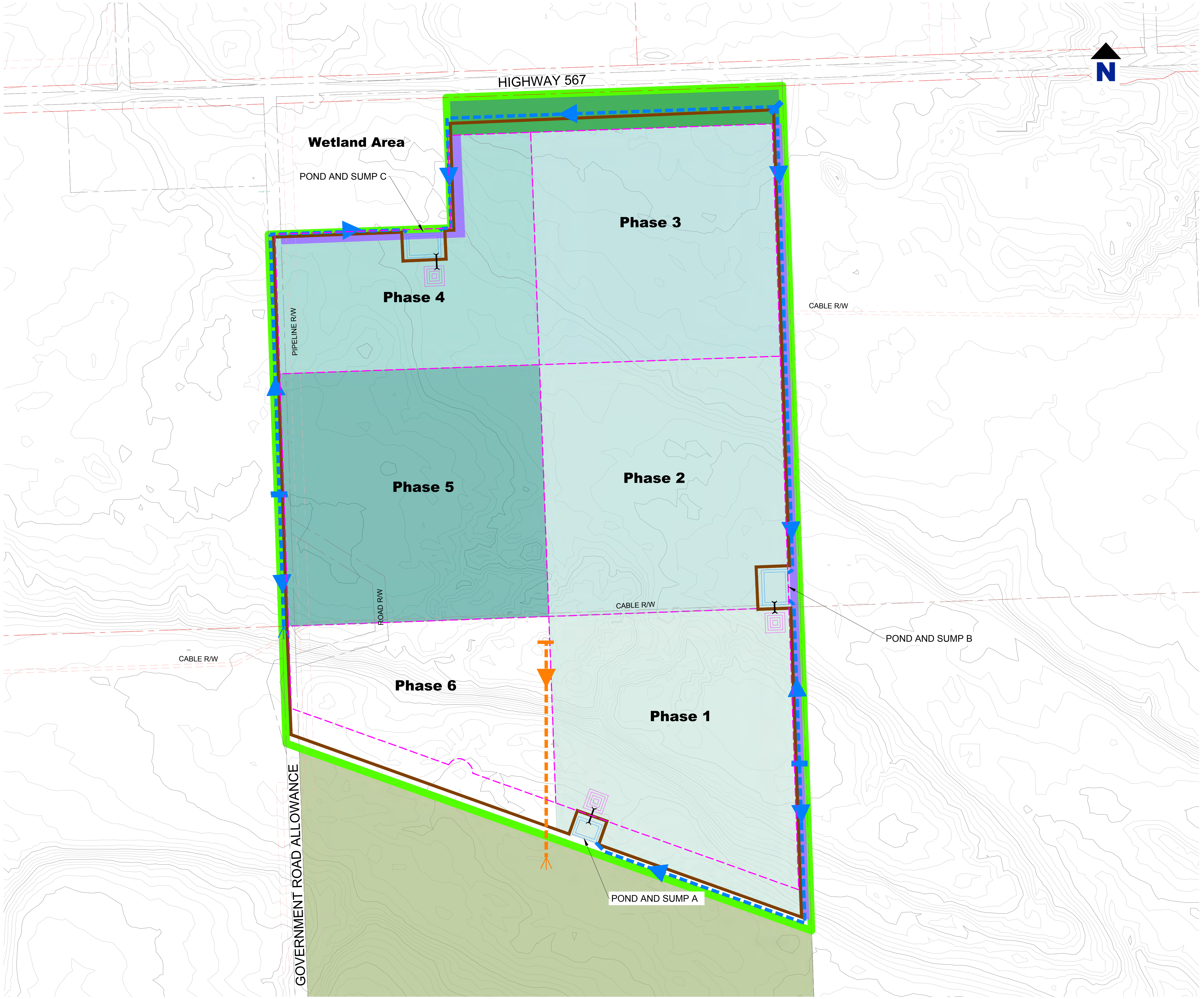
STORMWATER MANAGEMENT PLAN

EXTRACTION PHASE 4 - EXTERNAL CONTACT WATER MANAGEMENT

Date: May 12, 2023
Project No. 212.06650.00007
Figure No. 3D

SLR

Cadfile name: S_212-06650-00007-A9.dwg



NOTES:
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LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

WATER MANAGEMENT FEATURES ILLUSTRATED ARE CONCEPTUAL ONLY, FINAL LOCATION AND SIZING TO BE DETERMINED IN DETAILED DESIGN.

LEGEND:

🟩	PROJECT BOUNDARY
— – —	HIGHWAY AND/OR QUARTER SECTION PROPERTY BOUNDARY/LEGAL LINES
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- - -	EXTRACTION (PIT) PHASE BOUNDARIES
▨	EXTRACTION (PIT) PHASE 1
▨	EXTRACTION (PIT) PHASE 2
▨	EXTRACTION (PIT) PHASE 3
▨	EXTRACTION (PIT) PHASE 4
▨	EXTRACTION (PIT) PHASE 5

0 50 100 200 300 m

SCALE 1:6,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT

STORMWATER MANAGEMENT PLAN

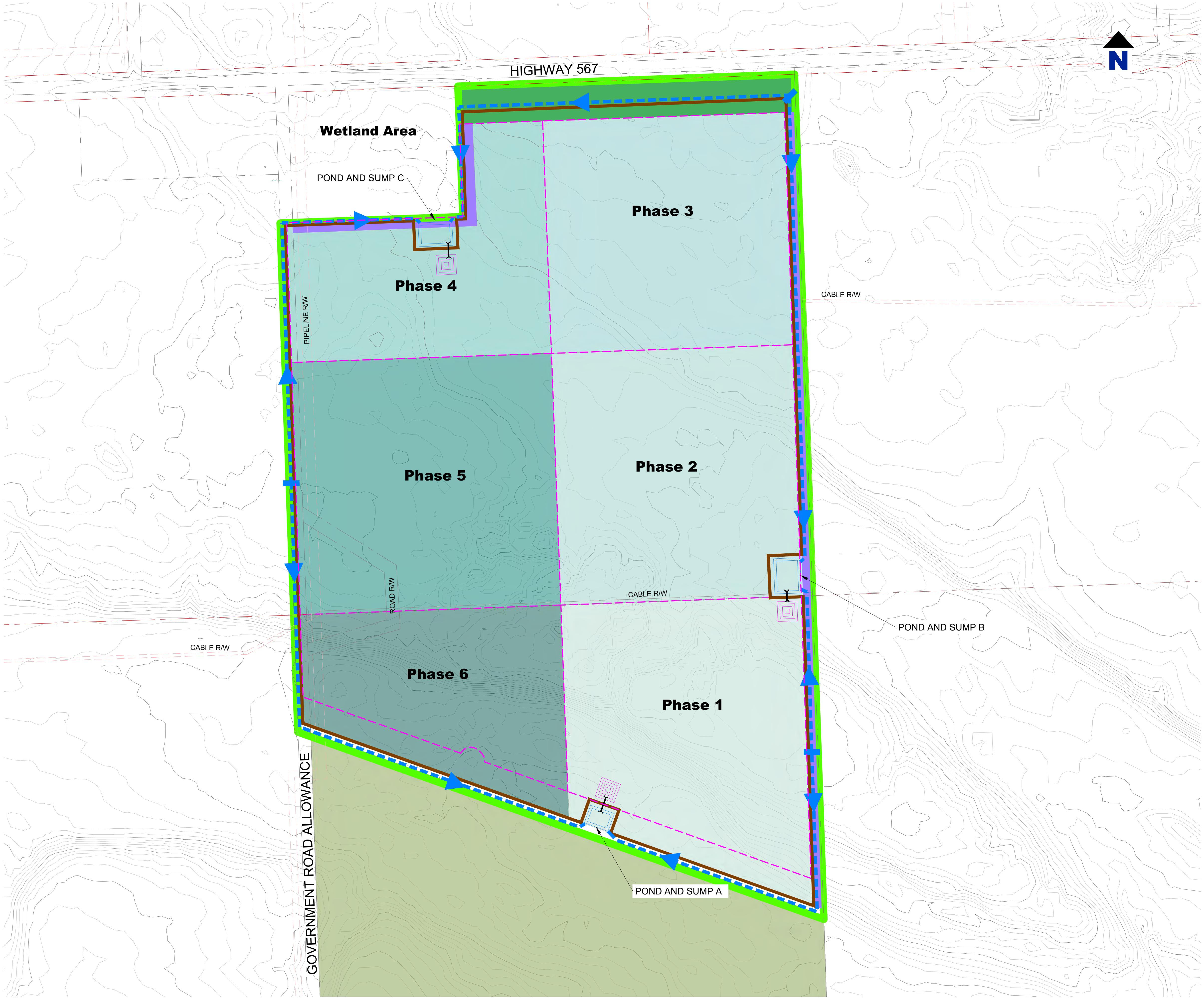
EXTRACTION PHASE 5 - EXTERNAL CONTACT WATER MANAGEMENT

Date: May 12, 2023
Project No. 212.06650.00007

Figure No.
3E

SLR

Cadfile name: S_212-06650-000007-A9.dwg



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LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

WATER MANAGEMENT FEATURES ILLUSTRATED ARE CONCEPTUAL ONLY, FINAL LOCATION AND SIZING TO BE DETERMINED IN DETAILED DESIGN.

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— - —	HIGHWAY AND/OR QUARTER SECTION PROPERTY BOUNDARY/LEGAL LINES
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—	MINOR CONTOURS - GROUND SURFACE 1 m INTERVALS FROM LIDAR DATA
▬	TEMPORARY MATERIAL STORAGE
- -▶- -	PROPOSED DRAINAGE DITCH
▭	PROPOSED ATTENUATION/SETTLEMENT POND
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🟪	TEMPORARY BUFFER AREA
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- - -	EXTRACTION (PIT) PHASE BOUNDARIES
■	EXTRACTION (PIT) PHASE 1
■	EXTRACTION (PIT)PHASE 2
■	EXTRACTION (PIT) PHASE 3
■	EXTRACTION (PIT) PHASE 4
■	EXTRACTION (PIT) PHASE 5
■	EXTRACTION (PIT) PHASE 6

0 50 100 200 300 m

SCALE 1:6,000
WHEN PLOTTED CORRECTLY ON A 11 x 17 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT

STORMWATER MANAGEMENT PLAN

EXTRACTION PHASE 6 - EXTERNAL CONTACT WATER MANAGEMENT

Date: May 12, 2023
Project No. 212.06650.00007

Figure No.
3F

SLR

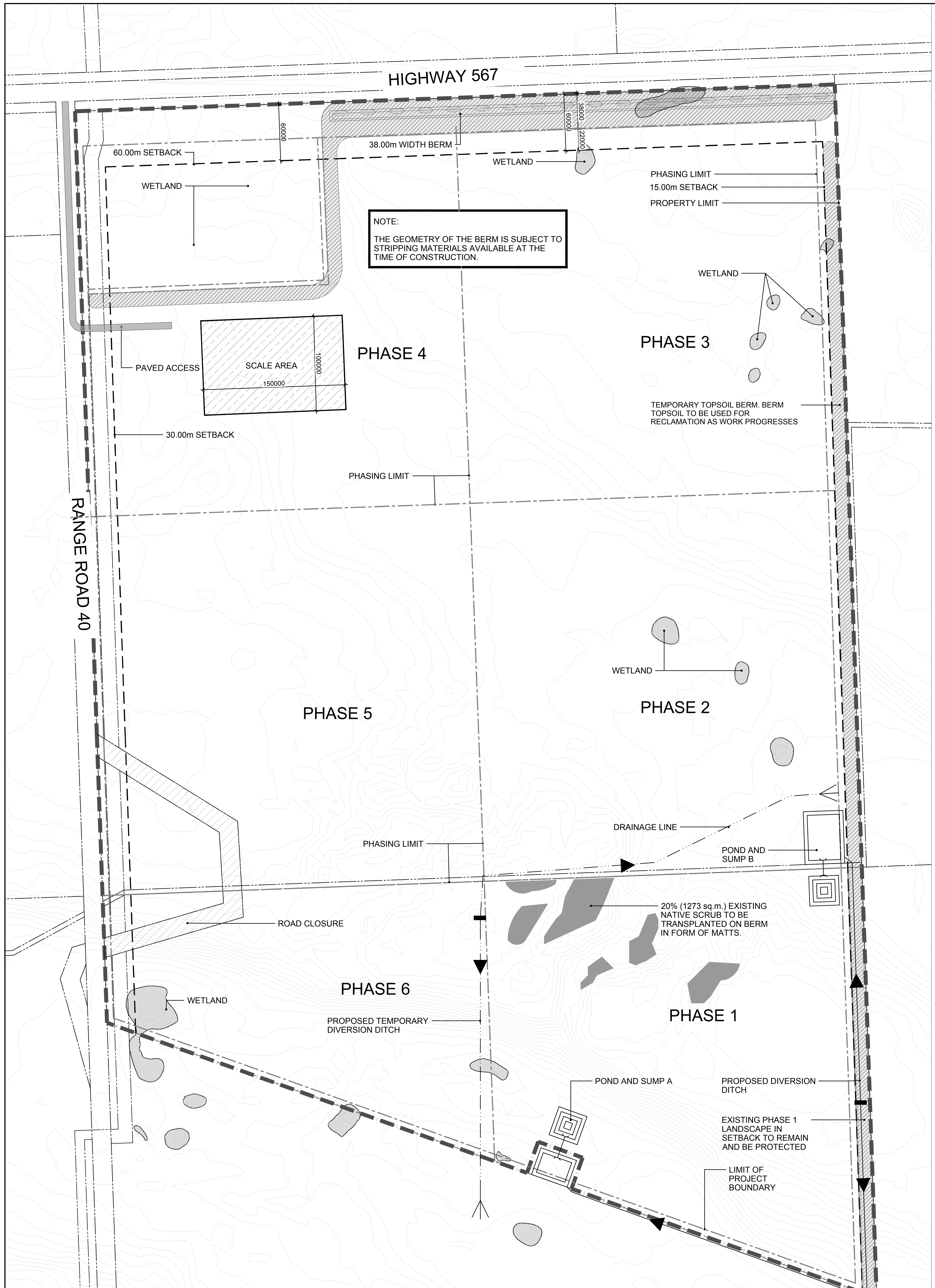
Cadfile name: S_212-06650-00007-A9.dwg

Appendix K

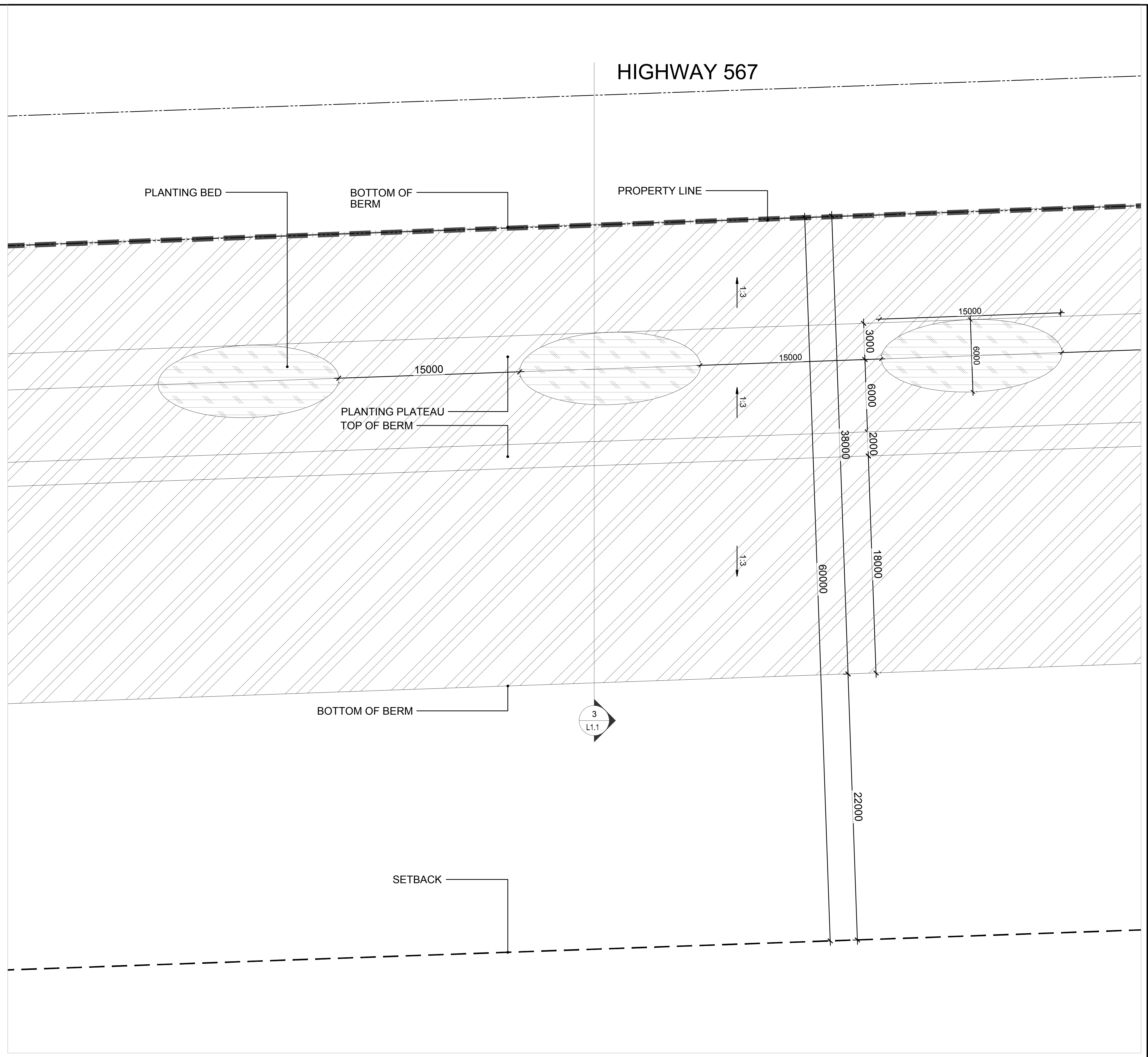
Landscape and Visual Screening Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

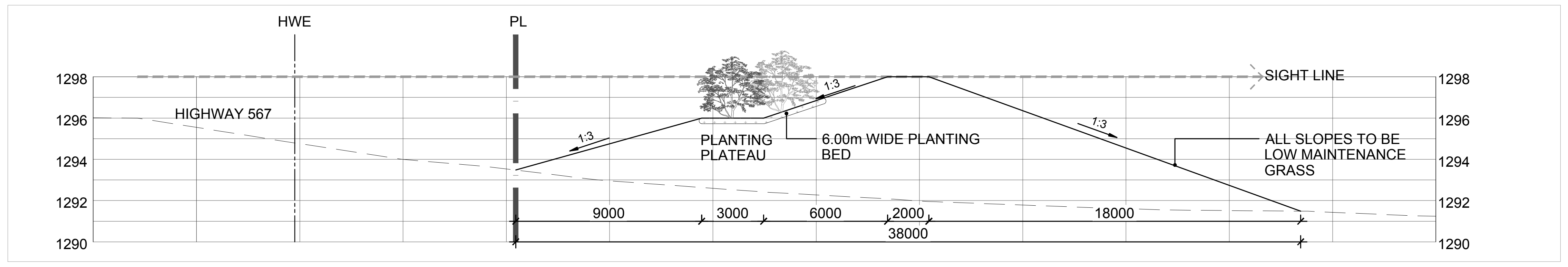
SLR Project No: 212.06650.00007/8



1 L1.1 LANDSCAPE PLAN
1:2500



2 L1.1 TYPICAL BERM PLANTING PLAN
1:250



3 L1.1 TYPICAL BERM SECTION
1:200

NOTES

1- PLANTING BED TO INCLUDE NATIVE SCRUB MATTS TRANSPLANTED FROM PHASE 1 DISTURBED AREA
2- IF REQUIRED, AREA TO BE PLANTED WITH 1 SPRUCE OR ASPEN TREE / 15 Sq.m. SPRUCE TO BE 1.50m AND ASPEN TO BE 35mm CAL.

CLIENT

SLR
global environmental solutions

LANDSCAPE CONSULTANT:

GEORGE HARRIS
COLLABORATIVE INC.
Landscape Architecture
/Urban Design

LEGAL DESCRIPTION:

W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTRY, ALBERTA .

LEGEND

▬ ▬	PROPERTY LINE
— —	SETBACK LINE
— · —	PHASING LIMIT
— · —	LEGAL LINE
—	MAJOR CONTOUR LINE
—	MINOR CONTOUR LINE
▭	CLOSED ROAD
■	WETLAND
▨	BERM
▨	PLANTING BED
◀	PROPOSED TEMPORARY DIVERSION DITCH
◀	PROPOSED DIVERSION DITCH
▭	PROPOSED ATTENUATION / SETTLEMENT POND
▣	PROPOSED INFILTRATION SUMP (INDICATIVE)

NOT FOR CONSTRUCTION

N

No.	Date	Issue / Description	Chkd
04	08 NOV. 21	ISSUED FOR DP	S.A
03	16 SEPT. 21	ISSUED FOR DP	S.A
02	01 SEPT. 21	ISSUED FOR DP	S.A
01	22 APR. 21	ISSUED FOR DP	S.A

PROJECT
MOUNTAIN ASH LIMITED
PARTNERSHIP AGGREGATE
OPERATION NW & SW 31-26-03 W5M

MUNICIPALITY
ROCKY VIEW COUNTY, ALBERTA

DRAWING TITLE
LANDSCAPING AND VISUAL SCREENING PLAN
DEVELOPMENT PERMIT

DESIGNED GH	DATE 15 APR. 21
DRAWN MM	DRAWING NO. L1.1
CHECKED SA	PROJECT NO. 21-663
SCALES AS SHOWN	REVISION 00 ISSUE 02

Appendix L

Noise Monitoring Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Noise Monitoring Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00006
April 2021

Noise Monitoring Plan

Mountain Ash Limited Partnership

Rocky View County, Alberta

SLR Project No: 212.06650.00006

Prepared by:
SLR Consulting (Canada) Ltd.
200 – 708 11th Ave SW
Calgary, Alberta, T2R 0ER

for

Mountain Ash Ltd. Partnership
1945 Briar Crescent NW
Calgary, AB, T2N 3V6

April 2021

This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

Prepared by:	Reviewed by:
Dan Clayton, BSc. MIoA. Consultant (Acoustics)	**Rick Lauzon, P.Biol., R.P.Bio.** Principal Environmental Consultant

Distribution: 1 copy (PDF) – Mountain Ash Limited Partnership
1 copy - SLR Consulting (Canada) Ltd.

Table of Contents

TABLES

FIGURES

1.0 INTRODUCTION

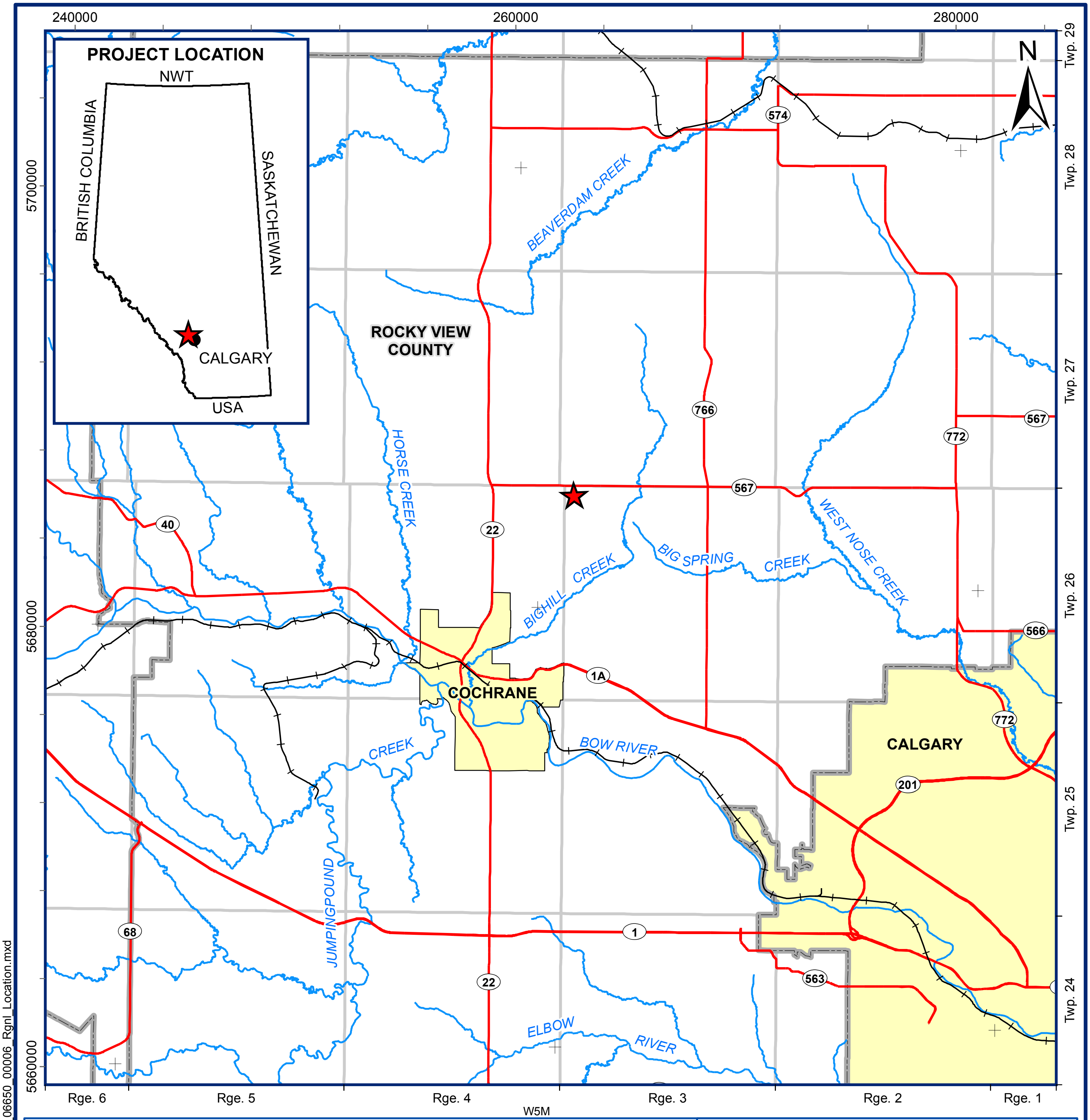
Mountain Ash Limited Partnership (Mountain Ash) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will encompass approximately 208 acres (84 ha) excluding existing road rights-of-way. Mountain Ash is applying for Phase 1 of a six-phase mining plan. This land is currently owned by 1410266 Alberta Ltd. (a general partner of Mountain Ash). Summit Pit received land use and a master site development plan (MSDP) approval on March 2, 2021 (Land Use Bylaw C-8051-2020).

An acoustic assessment was undertaken as part of the MSDP application to assess the potential sound egress from the Project operations in relation to the nearest noise sensitive receptors. As a requirement for the Code of Practice (COP) for Pits and Development Permit (DP) applications, this report details the Noise Monitoring Plan (NMP) in relation to the operation of the Summit Pit. The objective of the NMP is to monitor, continuously validate and keep a record of sound from the operational Summit Pit and from off-site sources. This is also consistent with a condition required as part of the land re-designation and MSDP. Ongoing monitoring and assessment of overall levels will be crucial for effective management of sound from operations.

Although several pits have been proposed for the area, no additional pits have been approved with a development permit that have the potential to add to the sound contributions from Summit Pit operations at adjacent receptors. There is an agreement between future operators to ensure that a cumulative impacts mitigation management agreement is in place to minimize the sound from their respective operations with respect to cumulative effects. Mountain Ash will participate with those operations to address cumulative effects/impacts in the area prior to submitting future development permit applications.

Several noise sensitive receptors exist near the proposed Project area, which have the potential to be impacted by sound from operations. The NMP has adequate consideration for these receptors and the influence from the existing acoustic environment. This NMP provides a detailed description of:

- current acoustic environment
- pertinent sound sources during operations
- monitoring objectives
- parameters that will be monitored
- sound monitoring procedure including locations, frequency, and duration



LEGEND

★ PROJECT LOCATION

— HIGHWAY

┼ RAILWAY

— WATERCOURSE

▭ COUNTY BOUNDARY

🟨 URBAN

NOTES

This map is for conceptual purposes only and should not be used for navigational purposes.
Basedata:AltaLIS Government of Alberta under the Alberta Open Data License.

5 0 5

SCALE: 1:250,000 KILOMETRES
WHEN PLOTTED CORRECTLY AT 8-1/2 x11
NAD 1983 UTM Zone 12N

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03 W5M
ROCKY VIEW COUNTY, ALBERTA

NOISE MONITORING PLAN

SUMMIT PIT LOCATION

April 8, 2021		Figure No. **1**
Project No.	212.06650.00006	

[redacted]

D:\Calgary\GIS_Projects_GIS\212_06650_MtnAsh\1.MXDs\fig1_212_06650_00006_Rgnl_Location.mxd

2.0 ACOUSTICAL GLOSSARY

The primary acoustical metrics used to describe environmental sound in this monitoring plan were as follows:

L_{eq}	Often referred to as the “Equivalent Continuous Sound Level”. The L_{eq} value is the sound energy average over the entire measurement time. It is defined as a calculated sound level over the measured time that has the same acoustic energy as the actual fluctuating sound levels that occurred during the same period. L_{eq} is the single number descriptor commonly used for environmental sound measurements. This parameter is often applied over 24 hours, or over distinct daytime and nighttime periods. For example, the daytime L_{eq} represents the cumulative effects of all sound occurring in the 15-hour daytime period from 07:00 hours to 22:00 hours. The nighttime L_{eq} represents the cumulative effects of all sound events occurring in the nighttime period from 22:00 hours to 07:00 hours.
L_{max}	The “Maximum Sound Level”. The L_{max} is the maximum sound level observed. This metric is useful for quantifying the highest sound level expected during short duration events such as a vehicle pass by or dog barking.
L_{min}	The “Minimum Sound Level”. The L_{min} is the minimum sound level observed.
L_{night}	is the average annual equivalent outdoor sound pressure level associated with a particular type of sound source during night-time (at least 8 hours).
L_{90}	The “Statistical Sound Level” equaled or exceeded 90% of the time. This level represents a good indicator of the baseline sound of the overall acoustic environment. A statistical measure of sound over a period and is defined as the sound level exceeded for a certain percentage of the time; and
L_w	is the sound power level. It is a measure of the total sound energy radiated by a source of sound and is used to calculate sound pressure levels at a distant location. The LWA is the A-weighted sound power level.

The following descriptions may prove useful when reading the information contained within this report:

Acoustic Environment:	the sound with contribution from all sources, as modified by the current environment and associated conditions;
Ambient Sound Level:	the sound level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The ambient sound level does not include sound from wind and must be determined without it and without sound from any source that is being assessed;
Atmospheric Attenuation:	the effect of sound absorption by moisture in the air;

A weighting:	the ear can recognize a sound depending on the pitch or frequencies found at the source. Microphones cannot differentiate sound in the same way as the ear and to counter this, the sound measuring instrument applies a correction to correspond more closely to the frequency response of the human ear by reducing the low and high frequencies. The correction factor is called 'A Weighting' and the resulting measurements are written as dBA, for broadband sound level. The dBA is internationally accepted and has been found to correspond well with subjective reaction to sound;
Comprehensive Sound Level (CSL):	defined in multiple Alberta Regulations as "The sound level that is a composite of different airborne sounds from many sources far away from near the point of measurement. The CSL does include industrial components and should be measured with them, but abnormal noise events are excluded. The CSL is used to determine whether a facility is consistent with this guideline".
C weighting:	the A weighting, this is a correction to account for the difference between the frequency response of a microphone and the human ear. However, the C weighting is tailored towards higher sound levels and has less attenuation in the low and high frequency regions. The C weighting is typically used to assess high sound levels in relation to human exposure and an indication of the low frequency content when compared to the A weighted sound level for the same situation. It is typically quoted as a broadband sound level;
dB Average Sound Level	refers to the logarithmic average (acoustically referred to as the decibel average) of recorded data values for a sound level parameter over the entire monitoring survey;
Free Field Sound Field:	a sound field in which the effects of obstacles or boundaries on propagating sound are negligible;
Frequency:	the number of wave oscillations per second (hertz) of an acoustic pressure wave propagating through the air. This is linked to the subjective phenomenon pitch;
Sound Pressure Level:	the physical measurement of sound, which utilizes a logarithmic scale and quantifies the amplitude or volume of acoustic pressure waves propagating through the air;
Mean Sound Level	refers to the arithmetic average (mean) of recorded data values for a sound level parameter over the entire monitoring survey;
Mode Sound Level	refers to the most repeated value (mode) of recorded data values for a sound level parameter over the entire monitoring survey;
One-third Octave Bands:	used to represent the frequency or content of a sound. Bass and Treble on a Hi-Fi system is a very basic representation of the frequency content of sound. One-third octave bands are derived by splitting the audio signal into discrete entities. A single octave band comprises 3 one-third octave bands. One-third octave and octave bands are usually presented without a weighting/filter such as A weighting, however such weightings can be applied to frequency spectra to then derive a weighted overall single result;
Sound Level Contribution:	the contribution of sound from one or more sources to the overall sound level from all sources affecting a location;
Spectrum:	the quantification of the components of a sound as a function of frequency.

Third-Octave:	the interval in frequency between two sounds having a ratio of 2 to the one-third power, or approximately 1.26;
Third-Octave Band Sound Pressure Level:	the total sound pressure level of sound components in a specific one-third octave band;
Tonality:	tonal sound contains a prominent frequency and is characterized by a definite pitch. A broadband sound such as white noise or television static has no tonality, whereas a guitar string when plucked is a tonal sound; and
Z Weighting:	Indicates that the sound level has no frequency weighting applied, representing the unweighted levels from the microphone. This is typically used for frequency sound levels such as one-third-octave/octave bands.

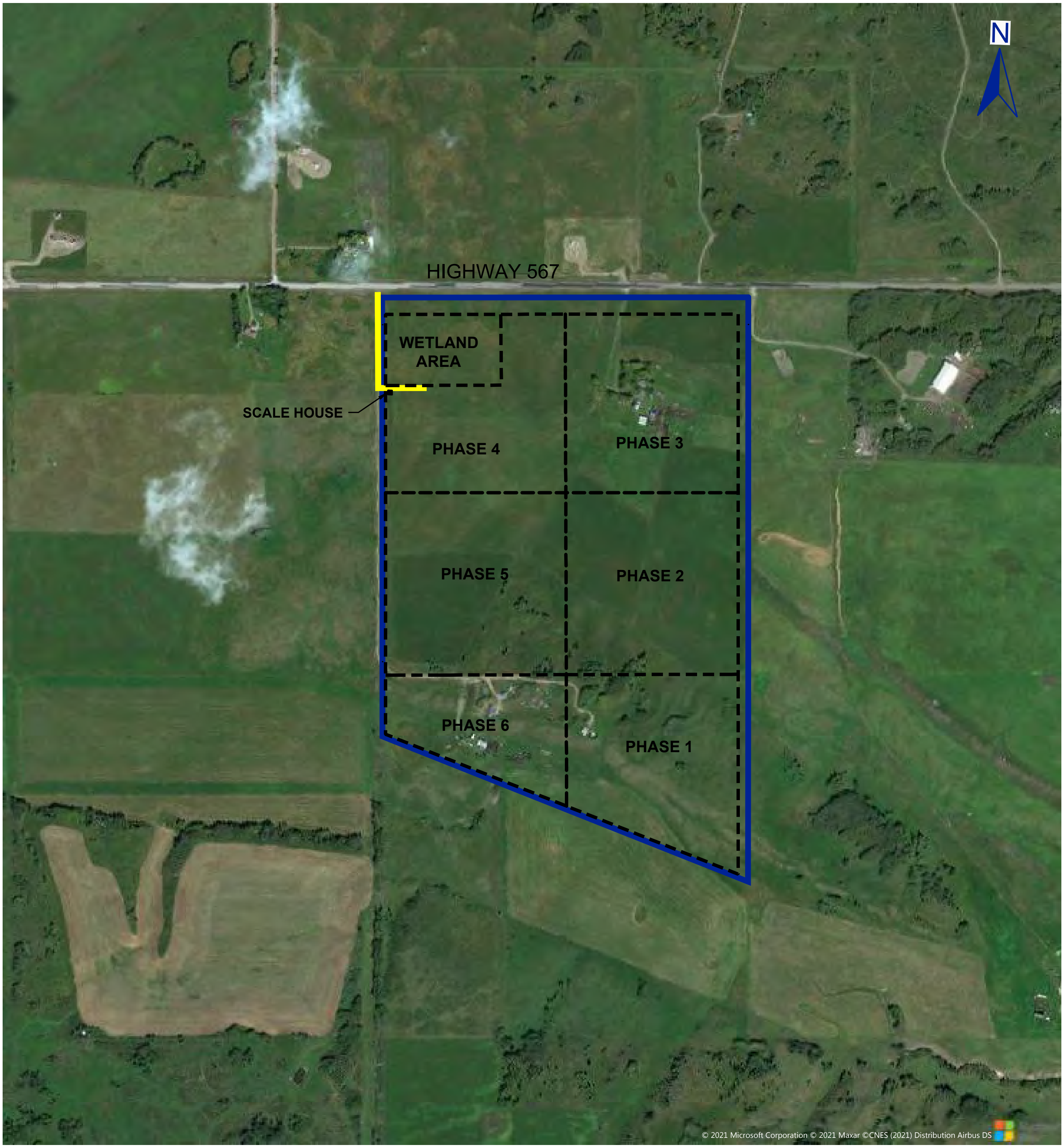
Table 1 Typical Sound Sources and Acoustic Environments

Sound Pressure Level dB(A)	Example
0	Threshold of hearing for normal young people
20	Recording studio, ambient level
40	Quiet residential neighborhood, ambient level
60	Department store, restaurant, speech levels
80	Next to busy highway, shouting
100	Textile mill; press room with presses running, punch press and wood planers, at operator's position
120	Ship's engine room, rock concert; in front and close to speakers
140	Moon launch at 100mm, artillery fire; gunner's position and threshold of pain

3.0 OPERATIONS AND EQUIPMENT DETAILS

3.1 Site Details

An overview of the Summit Pit is shown in Figure 2, indicating each phase of the mining plan. The mining plan will start at Phase 1 in the south-east portion of the site and go counter clockwise to Phase 6 in the south-west portion.



NOTES:
DRAWING COMPILED FROM DATA AS PROVIDED BY THE CLIENT.

LEGAL DESCRIPTION:
W 1/2 SEC 31 TWP 026 RGE 03 W5M
ROCKY VIEW COUNTY, ALBERTA

LEGEND:

- ▭ SITE LOCATION
- ▭ EXTRACTION PHASE BOUNDARIES
- 🟨 MOUNTAIN ASH PAVED ACCESS ROAD

0 100 200 400 600 800 m

SCALE 1:12,500
WHEN PLOTTED CORRECTLY ON A 8.5 x 11 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.

MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

NOISE MONITORING PLAN

PLAN OVERVIEW OF SUMMIT PIT SITE

Date: April 12, 2021
Project No. 212.06650.00006

Figure No.
2

Cadfile name: S_212-06650-00006-A3.dwg

3.2 Equipment Details

The sound generating equipment to be used for each operation is identified in Table 2.

Table 2 Equipment Sound Sources

Equipment & Model	No.	Power Rating	Hrs/Day	Usage/Working Area	LWA, dB(A)
CAT 374F Excavator	1	472 HP	10	Mining Area, 80% Utilization	107
Twin Engine 657G Motor Scraper	2	600 HP	10	Stripping / Reclamation Areas, 100% Utilization	113
1 MW Crusher Generator	1	1 MW	10	Crusher Area	102
CAT 980M Wheel Loaders	2	425 HP	10	Feed Crusher, 100% Utilization	112
CAT966L Loader	1	207 kW	7	Sales, 6 days/week	111
CAT D-7E Dozer	1	238 HP	6	Remediation, 50% Runtime	110
CAT 14M Grader	1	275 HP	3	Remediation, Haul Road, 30% Runtime	110
Tandem Water Truck	1	550 HP	10	Various	109
Peterbit Quad Trailer - Haul Truck	1	500 HP	8 (7 trips along phase haul route per hour)	Sales, Haul Road	114
Elrus Jaw Crusher	2	450 HP	10	Crushing Area	124*

*Raw LWA, approximately 5 dB attenuation accounted for by acoustic shrouds.

3.3 Operating Times

The site operating times are detailed in Table 3 for the Summit Pit.

Table 3 Site Operating Times

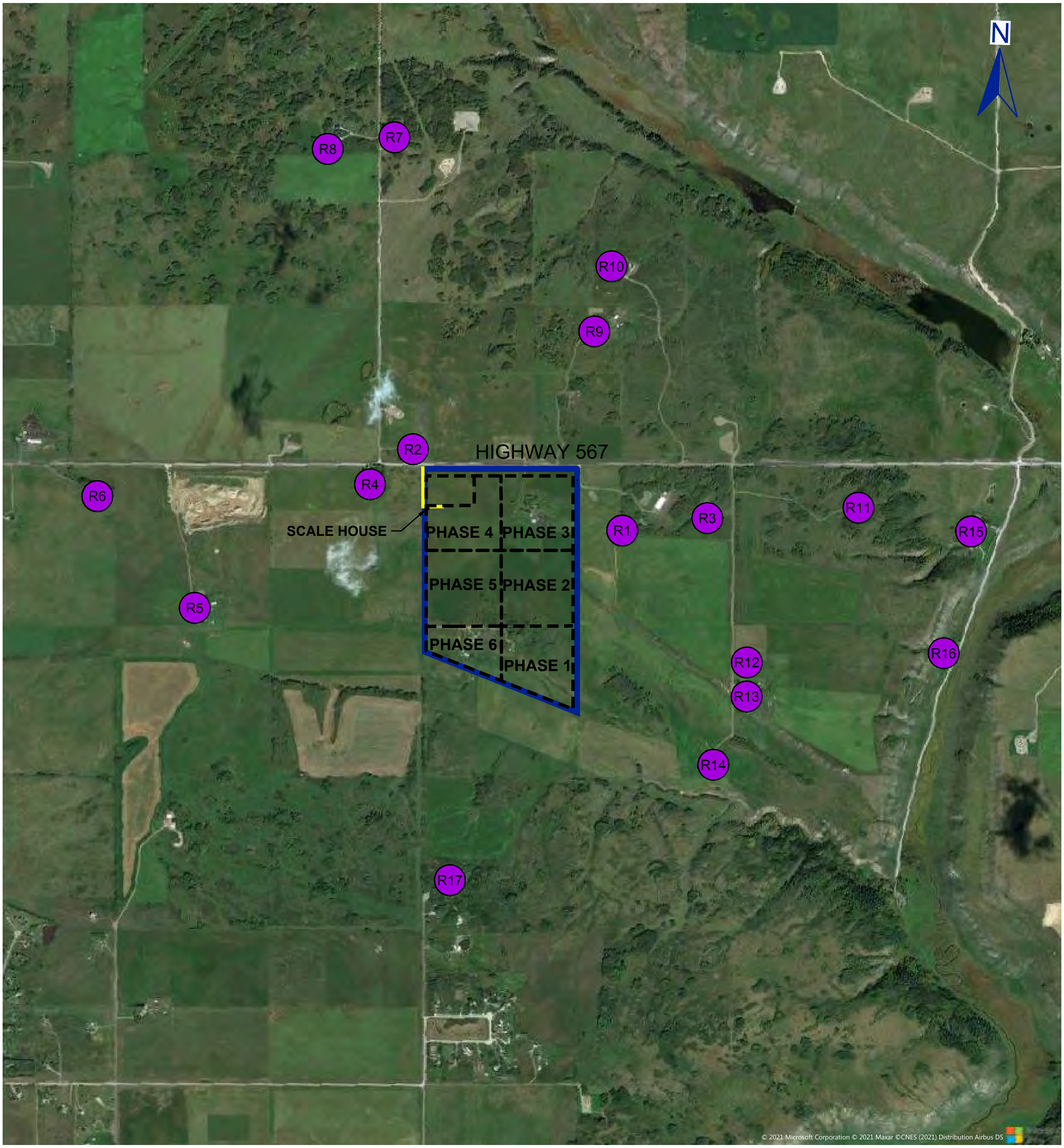
Days	Operating Periods
Monday - Friday	0700 hrs – 1900 hrs
Saturdays	0700 hrs – 1700 hrs
Sundays and Statutory Holidays	No Operations

4.0 NOISE SENSITIVE RECEPTORS

The noise sensitive receptors within the vicinity of the Project are identified in Table 4 and displayed in Figure 3.

Table 4 Noise sensitive receptors

Receptor	Distance from Property Line (m)	Direction from Site	Easting (m)	Northing (m)
R1	245	E	681019	5682785
R2	106	NW	679899	5683176
R3	695	E	681466	5682866
R4	280	W	679679	5682983
R5	1195	W	678776	5682298
R6	1724	W	678241	5682870
R7	1753	NW	679744	5684819
R8	1790	NW	679394	5684746
R9	731	NE	680835	5683831
R10	1066	NE	680914	5684178
R11	1488	E	682262	5682949
R12	905	E	681701	5682111
R13	907	E	681706	5681931
R14	796	SE	681543	5681565
R15	2091	E	682861	5682844
R16	1945	E	682739	5682196
R17	1085	SW	680173	5680907



NOTES:
REFER TO FIGURE 2.

LEGEND:

▭ SITE LOCATION

⬚ EXTRACTION PHASE BOUNDARIES

🟨 MOUNTAIN ASH PAVED ACCESS ROAD

① NOISE RECEPTOR

0 0.25 0.5 1.0 1.5 km

SCALE 1:30,000
WHEN PLOTTED CORRECTLY ON A 8.5 x 11 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

NOISE MONITORING PLAN

NOISE SENSITIVE RECEPTOR LOCATIONS

Date: April 12, 2021
Project No. 212.06650.00006
Figure No.
3

Cadfile name: S_212-06650-00006-A3.dwg

5.0 BASELINE SOUND LEVEL DATA

Baseline sound level data was collected at three locations at several noise sensitive receptors over multiple days during October 2019. The collections points were based on proximity to the proposed Project area with the intent to evaluate the existing sound levels in the acoustic environment to inform assessment criteria. Sound monitoring was undertaken at these locations to provide a good representation of the existing acoustic environment near the Project site.

Figure 4 shows the plan view of the sound monitoring locations (SML) used in the sound monitoring survey. A summary of the baseline sound level data for each location is provided in Table 5.

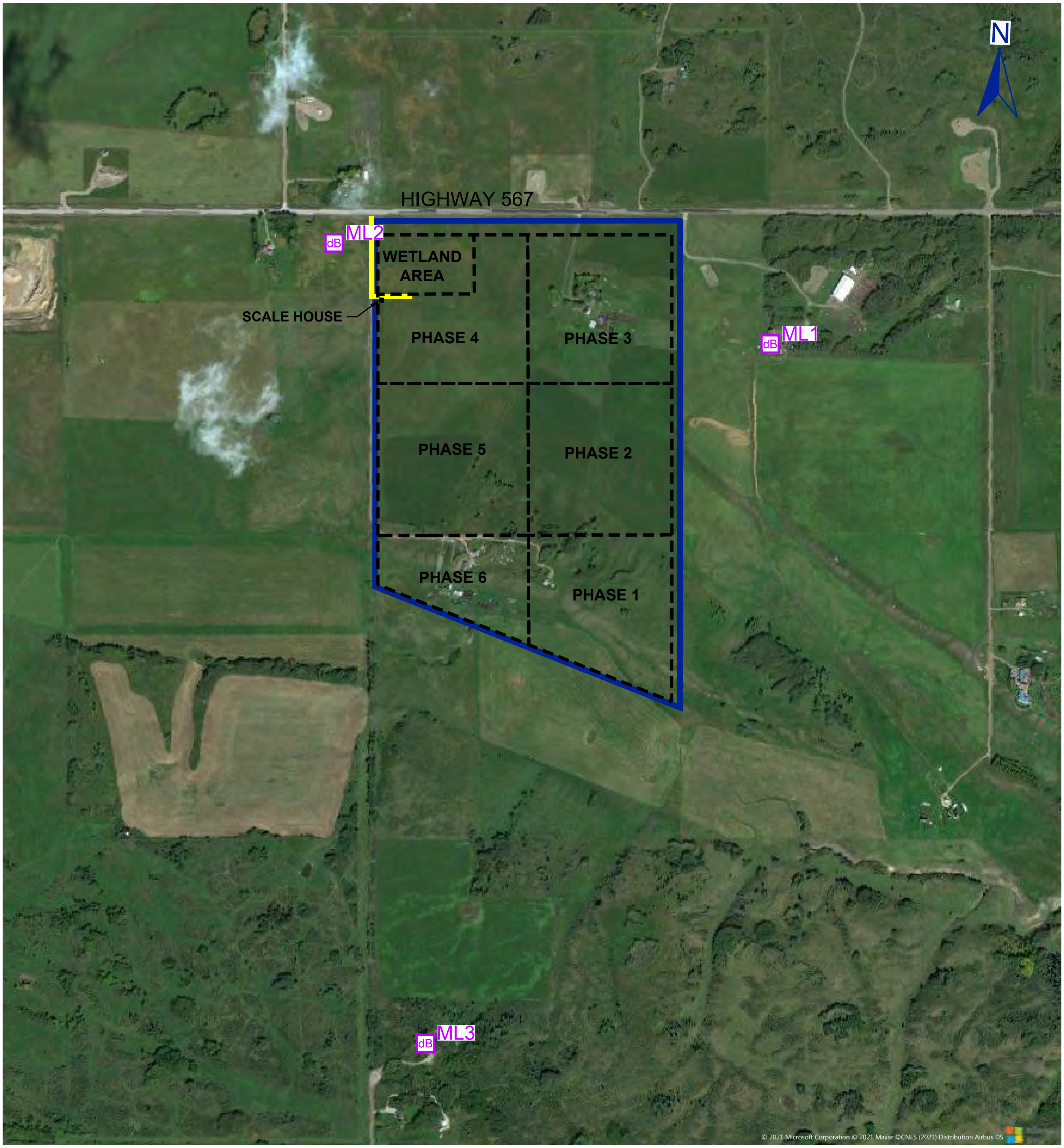
Table 5 Baseline Acoustic Environment Summary

Monitoring Location (ML)	Descriptor	*Mean*	*Min*	*Max*	*Environment Description*
ML1	L_{Aeq}	49*	39	63	Acoustic environment comprised of road traffic on Big Hill Springs Road, occasional sound from existing aggregate uses, birdsong, and aircraft overhead.
	L_{A90}	42	34	48	
ML2	L_{Aeq}	59*	52	63	Acoustic environment comprised of road traffic on Big Hill Springs Road, occasional sound from existing aggregate uses, birdsong, aircraft overhead and livestock.
	L_{A90}	44	30	53	
ML3	L_{Aeq}	48*	33	59	Acoustic environment is dominated by distant road traffic to the west and south.
	L_{A90}	41	29	56	

*logarithmic average

6.0 RELEVANT GUIDANCE AND CRITERIA METHODOLOGY

The RVC regulates noise through the Noise Control Bylaw No. C-5772-2003. The bylaw states that no person shall “make, continue, cause, or allow to be made or continued any excessive, unnecessary, or unusual noise of any type.” The bylaw also states that, if an activity “necessarily involves the creation of noise,” the noise must be “minimized as much as practicable.” This bylaw does not prescribe quantitative limits for noise emissions.



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NOTES:
REFER TO FIGURE 2.

LEGEND:

▭ SITE LOCATION

dB ID SLM LOCATION

⬚ EXTRACTION PHASE BOUNDARIES

▬ MOUNTAIN ASH PAVED ACCESS ROAD

0 0.25 0.5 1.0 km

SCALE 1:15,000
WHEN PLOTTED CORRECTLY ON A 8.5 x 11 PAGE LAYOUT
NAD 1983 UTM ZONE 11N

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MOUNTAIN ASH LIMITED PARTNERSHIP
SUMMIT PIT
NW & SW 31-26-03-W5M
ROCKY VIEW COUNTY, ALBERTA

NOISE MONITORING PLAN

SLM LOCATIONS PLAN VIEW

Date: April 12, 2021
Project No. 212.06650.00006

Figure No.
4

Cadfile name: S_212-06650-00006-A3.dwg

The assessment criteria for each receptor were developed using methodology agreed to in consultation with RVC, based on what was proposed within the draft resource plan for aggregate industries. The RVC draft resource plan for aggregate industries states that daytime operations should not exceed the following for aggregate extraction and/or processing development:

- daytime (07:00 hrs to 22:00 hrs on weekdays, 09:00 hrs to 22:00 hrs on weekends):
    - 55 dB L_{Aeq} (1 hour, free field) or 10 dB above recorded ambient sound levels (measured as L_{A90}), whichever is the lesser, at the nearest or most impacted dwellings.

SLR used measured sound levels to determine appropriate assessment criterion at each noise sensitive receptor. A proxy location was used in many instances due to the number of receptors.

The L_{eq} sound level from Summit Pit operations was modelled to be equal or below that of the existing sound levels at the assessed receptors. Figure 5 shows the sound level for each of the phases compared to the baseline. Figure 6 shows the modelled worst-case Summit Pit sound levels combined with existing sound levels then compared to the existing sound levels. This information has been used to assess appropriate sound level criteria for this NMP.

A guideline for determining sound criteria for monitored levels was based on 3dB above baseline. Measured levels may be above this due to variations in ambient sound level. However, this level is a reasonable basis to have from the outset of operations. Adjustments may be made to the monitoring criteria, if necessary.

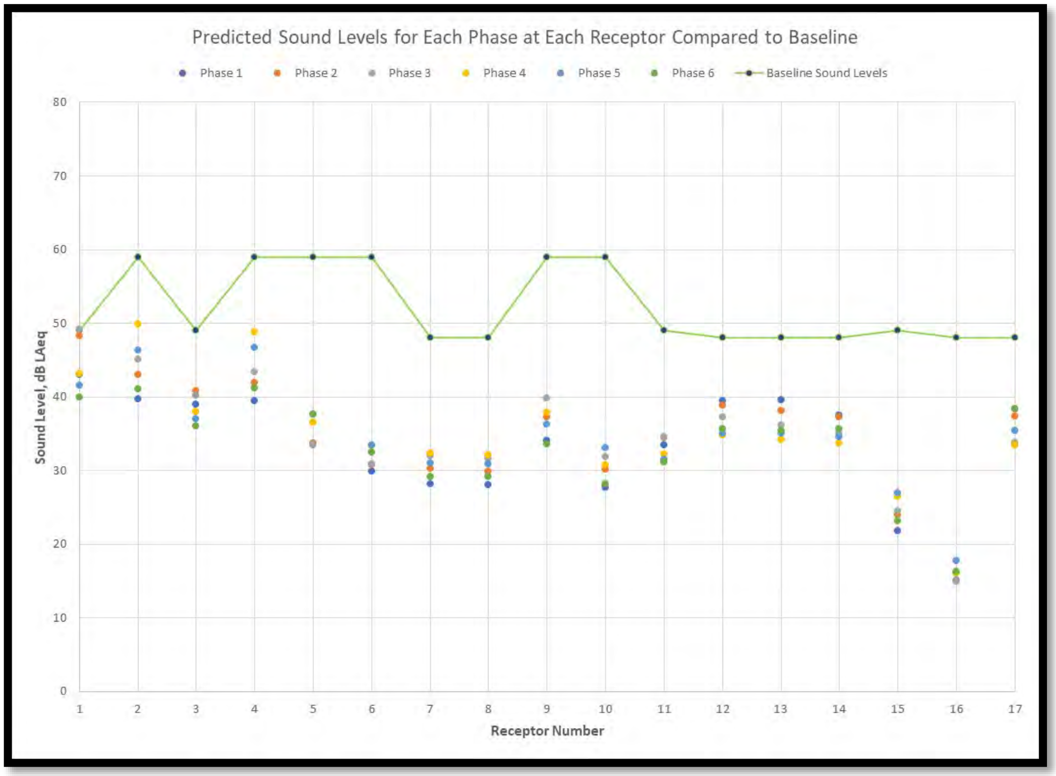


Figure 5 Modelled Operational Compared to Baseline Sound Levels

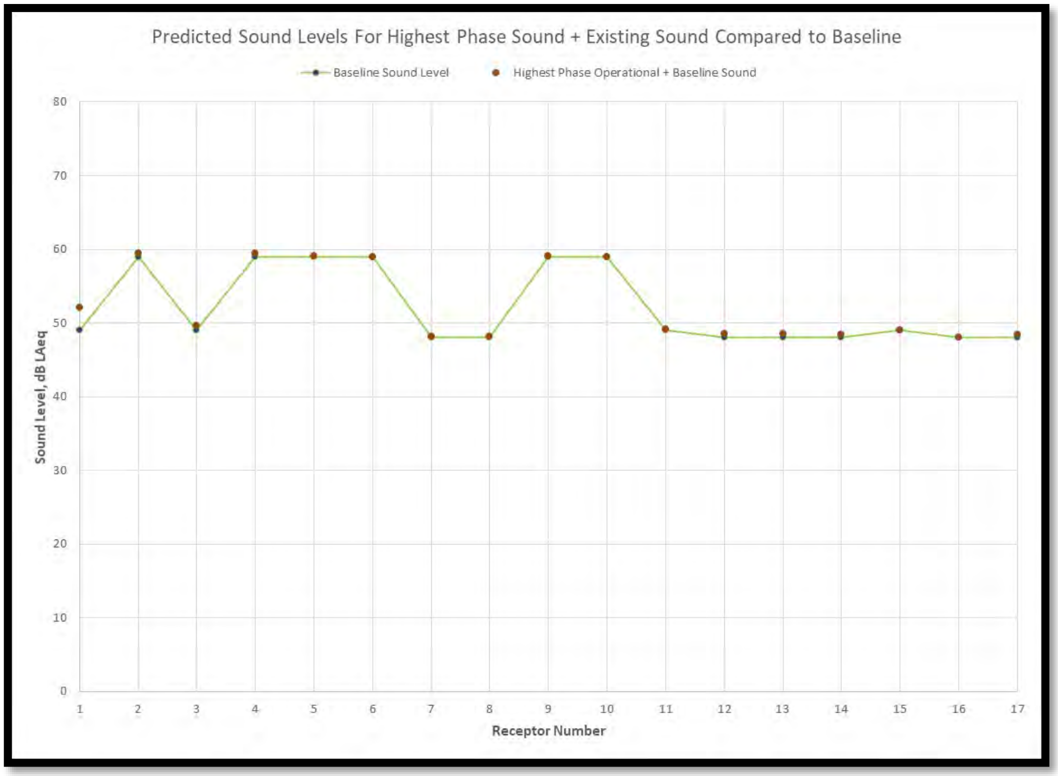


Figure 6 Modelled Operational + Baseline Sound Levels Compared to Baseline

7.0 SOUND MONITORING PROGRAM

The Sound Monitoring Program (SMP) is designed to ensure that sound is measured at representative locations in the vicinity of the Summit Pit. Data from the SMP will be used to assess the ongoing noise impact of the Summit Pit operations at the surrounding noise sensitive receptors.

7.1 General Sound Monitoring Plan Requirements

Sound measurements required in accordance with the SMP will be undertaken by a suitably qualified and experienced acoustic expert. The sound measurement procedures employed throughout the monitoring program will be guided by the requirements of American National Standard ANSI/ASA S12.9 (1992) *Quantities and Procedures for Description and Measurement of Environmental Sound – Part 2: Measurement of Long-Term, Wide-Area Sound*.

Noise monitoring reports will be reviewed by the Summit Pit site manager or designate. If monitoring reports or site activities indicate noise levels above SMP goals, Summit Pit will review site operations with the objective of understanding the causes and effectively managing sound egress.

Sound monitoring reports will also be made available to the public.

7.2 Instrumentation and Measurement Parameters

All acoustic instrumentation employed will be designed to comply with the requirements of IEC 61672.1 – 2013 (or latest version) *Electroacoustics—Sound level meters - Specifications* with appropriate calibration procedures in place.

7.3 Sound Monitoring

Attended, daytime, monthly sound monitoring will be undertaken to evaluate changes from the baseline sound levels and compliance with the NMP goals. Monitoring will be undertaken at three locations, as per the original acoustic assessment, which are close to residential properties. These provide good coverage for a variety of receptors and at different distances and acoustic screening from the operations. The monitoring will last approximately 2 hours at each location for each survey. Monitoring will be undertaken at 1.5 m above local ground.

7.4 Monitoring Locations

Figure 4 shows the plan view of the monitoring locations used in the sound monitoring survey.

Operator attended sound monitoring surveys may be conducted at other locations, if required, to enable investigation of sound emissions. All sound measurements shall be accompanied by both qualitative description and quantitative measurements of prevailing local weather conditions throughout the survey period. Mountain Ash shall obtain information regarding the relevant fixed plant and mobile equipment operating logs to be included in the monitoring report.

7.5 Monitored Sound Level Criteria

There was a variation in sound level observed at each monitoring location during the baseline evaluation stage. The criteria for each receptor were based on the long-term average, L_{A90}, sound level, considering all days. Monitored sound levels during operations will include the sound from the general acoustic environment and have the potential to be above the L_{Aeq} criteria used in the Summit Pit acoustic assessment, considering ambient sources only. Therefore, using the criteria from the Summit Pit acoustic assessment for any operational sound limits would not be appropriate for assessing compliance/non-compliance with noise management goals.

Table 6 details the criteria to be used as a basis of comparison for the operational sound monitoring. Reference should be made to the L_{Aeq} values in Table 5, with respect to the likely variance in ambient sound levels. There is also likely benefit in updating the baseline sound levels, throughout the operation of Summit Pit. This is to account for changes to sound sources in the area, especially with respect to fluctuations in road traffic volumes.

Table 6 Sound Monitoring Criteria

Monitoring Location	Nearest Receptor Location	*Existing Average Baseline, L_{Aeq}*	*Sound Monitoring Level Criteria, L_{Aeq}*
ML1	R1	49	52
ML2	R2/R4	59	62
ML3	R17	48	51

8.0 REPORTING

A monthly monitoring report will be produced detailing the sound monitoring procedure, sound level results, weather conditions, site activities, subjective observations, comparison against monitoring criteria and applicable action items after each survey. The monthly report will also provide details of any complaints relating to sound and their state of resolution. An annual monitoring report will collate the findings of the previous monitoring reports.

9.0 CONTINGENCY PROTOCOL

The sections below outline the contingency plan for managing noise impacts and complaints.

9.1 Complaints Handling

All complaints received regarding operational noise emissions from the Summit Pit will be responded to within 72 hours by appropriate personnel. Summit Pit will keep a record of any complaint made in relation to operational noise from the site. Records will include:

- date and time of complaint
- method by which the complaint was made
- identification of the complainant (if provided)
- nature of the complaint
- weather conditions corresponding to the time of the complaint
- action taken by Summit Pit Operatives and any follow up actions
- if no action was taken, the reason why no action was taken

Proposed contact record and complaint log sheets are shown in Figure 7 and Figure 8.

9.2 Non-Compliance Response Procedure

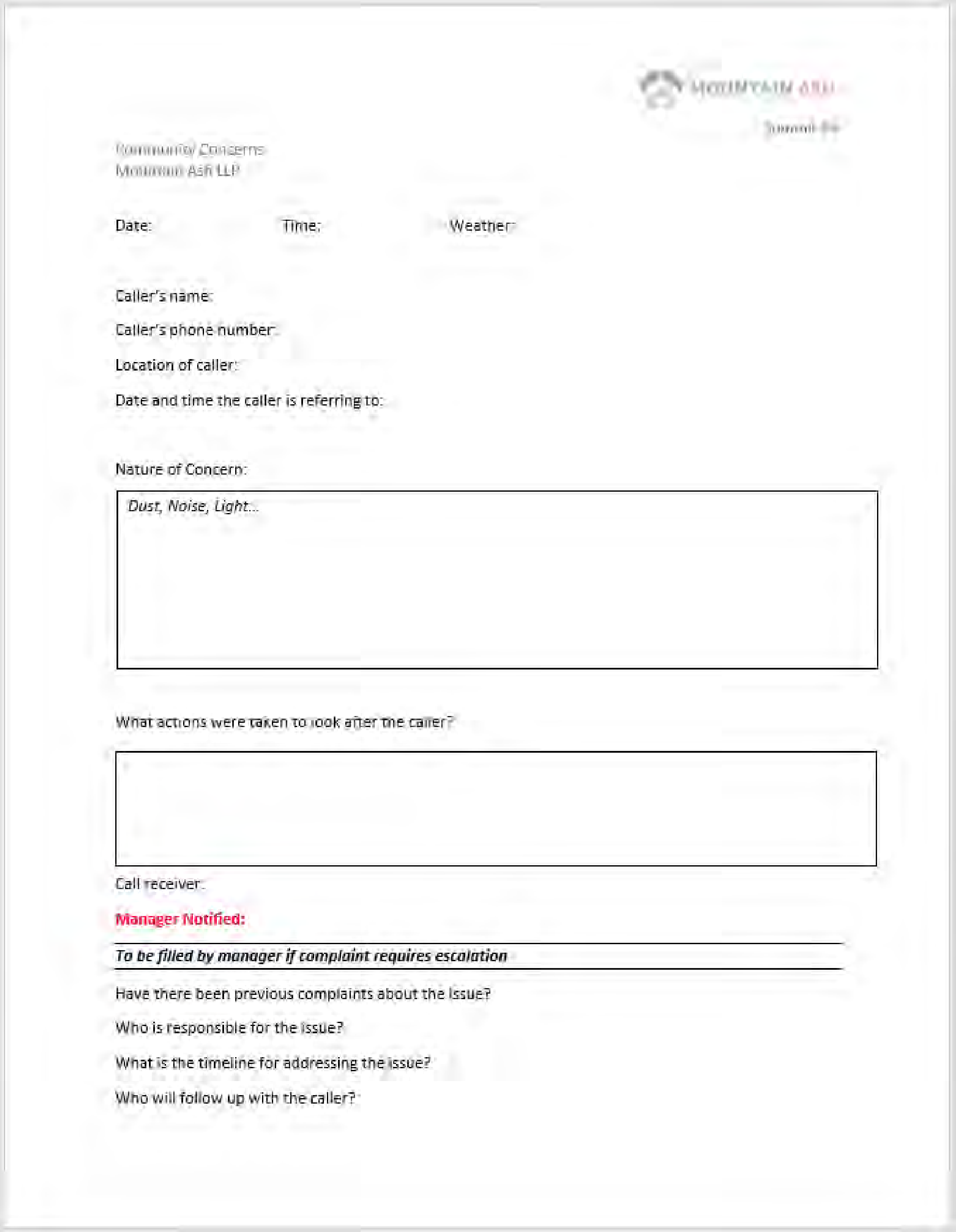
In the event of a measured exceedance of the relevant sound monitoring criteria or an increase in the baseline sound emissions (as appropriate) the following actions will be undertaken:

- Identify the sound source responsible for the issue. This would be completed by reviewing sound monitoring data. Additional methods such as attended or near field monitoring may be used to investigate Summit Pit sound emissions, or to determine compliance with the criteria, where potential non-compliances have been measured but are difficult to attribute to the Summit Pit.

- Reassess the sound reduction techniques employed at the site and evaluate and implement reasonable and feasible additional controls to reduce impacts.

- Conduct follow-up monitoring, after sound control implementation, to evaluate the effectiveness of the mitigation strategy.

- Communicate details of any non-compliance, the results of sound monitoring/investigations and follow-up noise management activities to the County.



MOUNTAIN ASH
Summit Pit

Community Concerns
Mountain Ash LLP

Date: Time: Weather:

Caller's name:

Caller's phone number:

Location of caller:

Date and time the caller is referring to:

Nature of Concern:

Dust, Noise, Light...

What actions were taken to look after the caller?

Call receiver:

Manager Notified:

To be filled by manager if complaint requires escalation

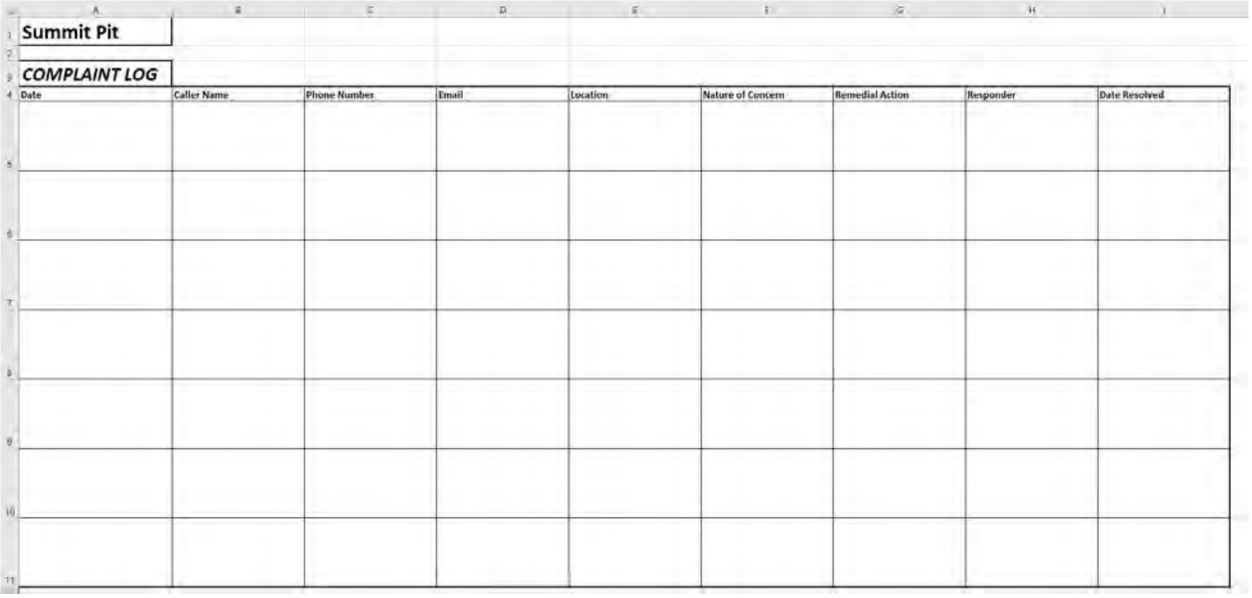
Have there been previous complaints about the issue?

Who is responsible for the issue?

What is the timeline for addressing the issue?

Who will follow up with the caller?

Figure 7 Proposed Contact Record Sheet



Summit Pit

COMPLAINT LOG

Date	Caller Name	Phone Number	Email	Location	Nature of Concern	Remedial Action	Responder	Date Resolved

Figure 8 Proposed Complaints Log

10.0 STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR for Mountain Ash Limited Partnership., hereafter referred to as the "Client". The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. It is intended for the sole and exclusive use of the Client. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of SLR.

This report has been prepared for specific application to this site and site conditions existing at the time work for the report was completed. Any conclusions or recommendations made in this report reflect SLR's professional opinion.

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Nothing in this report is intended to constitute or provide a legal opinion. SLR makes no representation as to the requirements of compliance with environmental laws, rules, regulations, or policies established by federal, provincial, or local government bodies. Revisions to the regulatory standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions, and recommendations in this report may be necessary.

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Appendix M

Stripping and Grading Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Stripping and Grading Plan

Mountain Ash Limited Partnership Summit Pit

SLR Project No: 212.06650.00007/8
October 2021
Revised May 2023

Stripping and Grading Plan

Mountain Ash Limited Partnership

Rocky View County, Alberta

SLR Project No: 212.06650.00007/8

Prepared by:
SLR Consulting (Canada) Ltd.
200 – 708 11th Ave SW
Calgary, Alberta, T2R 0ER

for

Mountain Ash Ltd. Partnership
1945 Briar Crescent NW
Calgary, AB, T2N 3V6

April 2021

Revised May 2023

This document has been prepared by SLR Canada. The administrative change to revision May 2023.

Administrative change Approved by:

Jason J. Cox, P.Eng
Global Technical Director – Mining Advisory

Distribution:	1 copy (PDF) – Mountain Ash Limited Partnership 1 copy - SLR Consulting (Canada) Ltd.

Table of Contents

TABLES

DRAWINGS

1.0 INTRODUCTION

Mountain Ash Limited Partnership (Mountain Ash) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County (RVC), Alberta (Figure 1). The Project will encompass approximately 208 acres (84 ha) excluding existing road rights-of-way. Mountain Ash is applying for Phase 1 of a six-phase mining plan. This land is currently owned by 1410266 Alberta Ltd. (a general partner of Mountain Ash). Summit Pit received land use and a master site development plan (MSDP) approval on March 2, 2021 (Land Use Bylaw C-8051-2020).

2.0 STRIPPING AND GRADING ACTIVITIES

The portion of the pit to be used shall be cleared and grubbed, and the area from which materials are to be taken shall be stripped of topsoil and overburden as provided in Section 3 and outlined in the soil conservation and reclamation plan. Stripping at the site shall consist of the removal, after clearing and grubbing, of the surface material and overburden which is unsuitable for the kind of material to be borrowed or produced for use. Materials from stripping, to be used later as provided on the site reclamation plan, shall be deposited within the pit at such a location as not to interfere with future development within the site.

Before placing aggregates upon the stockpile site, the site shall be cleared of vegetation, trees, stumps, brush, rocks, or other debris and the ground leveled to a smooth, firm, uniform surface. The debris resulting from clearing and preparing the site shall be disposed of according to the vegetation and soil management plan and outlined in Bylaw C-8051-2020.

All Stripping and grading activities will follow Bylaw C-8051-2020 as issued and commitments made under the visual screening plan, erosion and sedimentation control plan and the Soils Conservation plan.

3.0 QUANTITIES

Table 1 Quantities of Non-Mineral Materials to be Stripped

Phase	Surface Area	Topsoil	Subsoil	Overburden	Total	Average Overburden Thickness
1	128,424 m²	32,106 m³	25,685 m³	326,834 m³	384,625 m³	2.54 m
2	151,720 m²	37,930 m³	30,344 m³	503,946 m³	572,220 m³	3.32 m
3	151,989 m²	37,997 m³	30,398 m³	747,349 m³	815,744 m³	4.92 m
4	116,171 m²	29,043 m³	23,234 m³	396,560 m³	448,837 m³	3.41 m
5	158,236 m²	39,559 m³	31,647 m³	419,431 m³	490,637 m³	2.65 m
6	83,430 m²	20,857 m³	16,686 m³	333,964 m³	371,507 m³	4.00 m
Total	**789,970 m²**	**197,492 m³**	**157,994 m³**	**2,728,085 m³**	**3,083,571 m³**	**3.45 m**

Table 2 Quantities of Materials used to Reclaim Site Post Mining

Phase	Surface Area	Topsoil	Subsoil	Overburden & Rejects (@15% Gravel)	Total
1	128,424 m²	32,106 m³	25,685 m³	556,573 m³	614,364 m³
2	151,720 m²	37,930 m³	30,344 m³	749,523 m³	817,797 m³
3	151,989 m²	37,997 m³	30,398 m³	1,093,980 m³	1,162,375 m³
4	116,171 m²	29,043 m³	23,234 m³	675,215 m³	727,492 m³
5	158,236 m²	39,559 m³	31,647 m³	770,145 m³	841,351 m³
6	83,430 m²	20,857 m³	16,686 m³	408,136 m³	445,679 m³
Total	**789,970 m²**	**197,492 m³**	**157,994 m³**	**4,253,571 m³**	**4,609,058 m³**

4.0 STATEMENT OF LIMITATIONS

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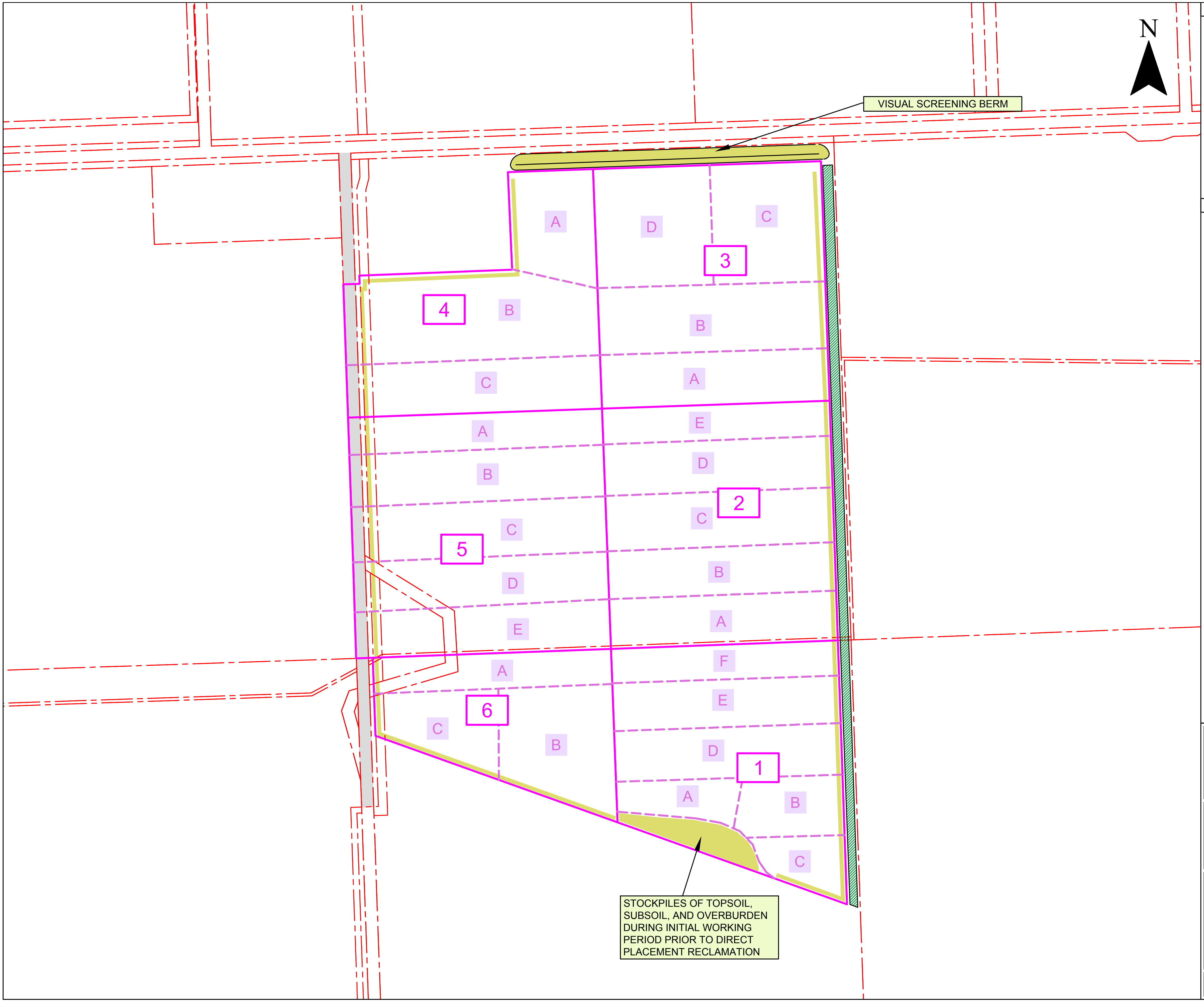
DRAWINGS

Stripping and Grading Plan

Mountain Ash Limited Partnership
Summit Pit
SLR Project No: 212.06650.00007/8



VISUAL SCREENING BERM

STOCKPILES OF TOPSOIL, SUBSOIL, AND OVERBURDEN DURING INITIAL WORKING PERIOD PRIOR TO DIRECT PLACEMENT RECLAMATION

NOTES

THIS PLAN SHOWS THE GENERAL ORDER OF WORKING, WITH MINING BLOCKS PROGRESSING IN AN ANTICLOCKWISE DIRECTION FROM THE SOUTH EAST.

EACH MINING BLOCK WILL BE NO GREATER THAN 150m X 150m (22,500m³).

LEGEND

▭	EXTRACTION PHASE BOUNDARY
⬚	MINING BLOCK - SHOWING INDICATIVE PROGRESSION
⬚	LEGAL BOUNDARIES
■	OVERBURDEN / SOIL STORAGE
▬	ACCESS ROAD

MOUNTAIN ASH LIMITED PARTNERSHIP.
SUMMIT AGGREGATES RESOURCE
W 1/2 SEC 31 TWP 026 RGE 03 W5M
COCHRANE
ALBERTA

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global environmental solutions

SLR Consulting (Canada) Ltd.
200 - 708 11th Ave SW
Calgary,
Alberta, T2R 0ER
www.slrconsulting.com

STRIPPING & GRADING

212.06650.00006

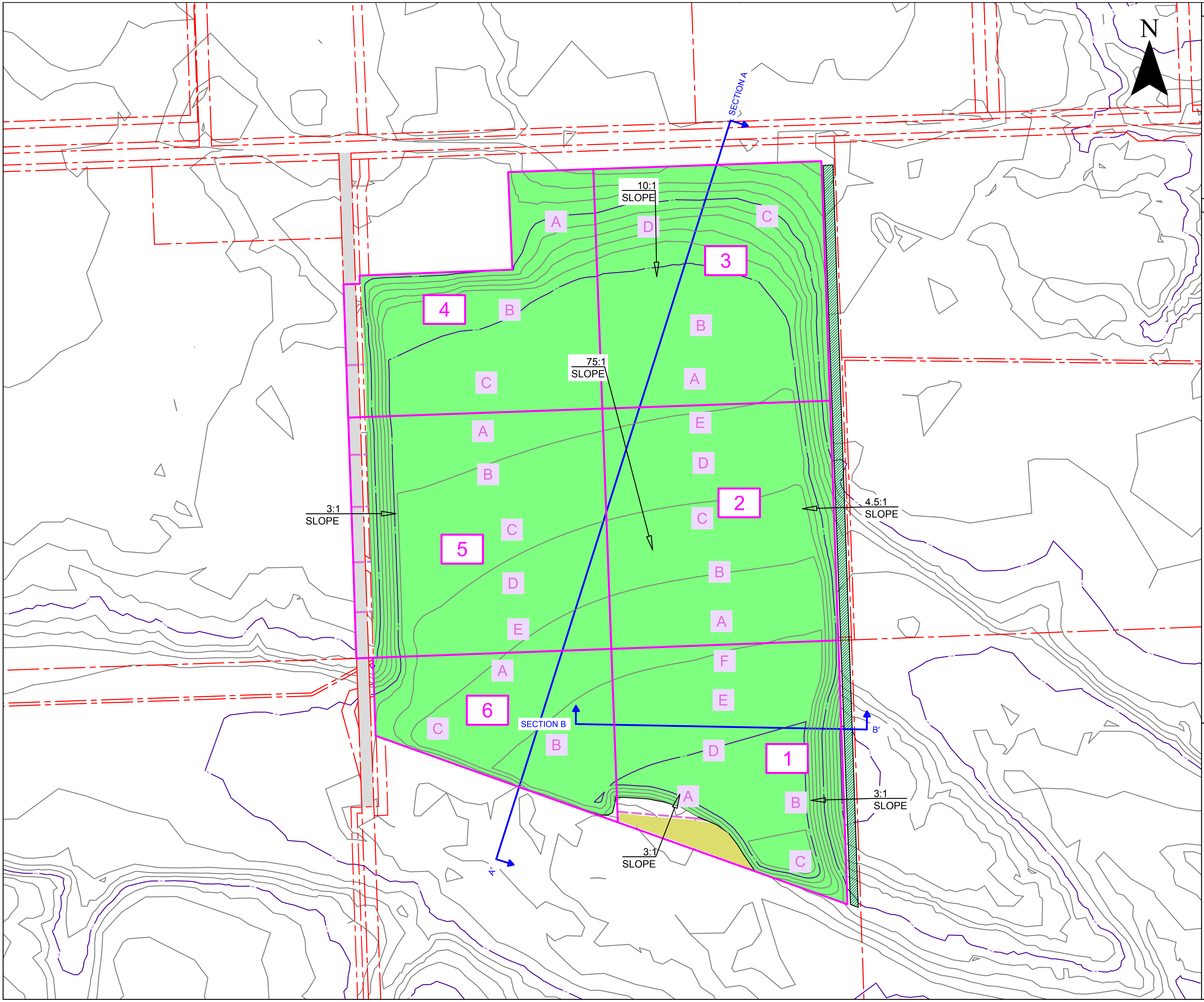
OVERALL WORKING PROGRESSION

01

Scale
1:6,000 @ A3

Date
MAY 2023

SG01_OVERALL PHASING_v4.dwg



SG02_FINAL RECLAMATION GRADING PLAN_v4.dwg

NOTES

THIS PLAN SHOWS THE GENERAL ORDER OF WORKING, WITH MINING BLOCKS PROGRESSING IN AN ANTICLOCKWISE DIRECTION FROM THE SOUTH EAST.

EACH MINING BLOCK WILL BE NO GREATER THAN 150m X 150m (22,500m³).

LEGEND

▭	EXTRACTION PHASE BOUNDARY
🟩	RECLAIMED AREA
▭	LEGAL BOUNDARIES
▬	RANGE ROAD 40
← H:V SLOPE	GRADING OF RECLAIMED LAND (HORIZONTAL : VERTICAL RATIO)
―	LINE OF CROSS SECTION (SEE DRAWING 03)

MOUNTAIN ASH LIMITED PARTNERSHIP.
SUMMIT AGGREGATES RESOURCE
W 1/2 SEC 31 TWP 026 RGE 03 W5M
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STRIPPING & GRADING

212.06650.00006

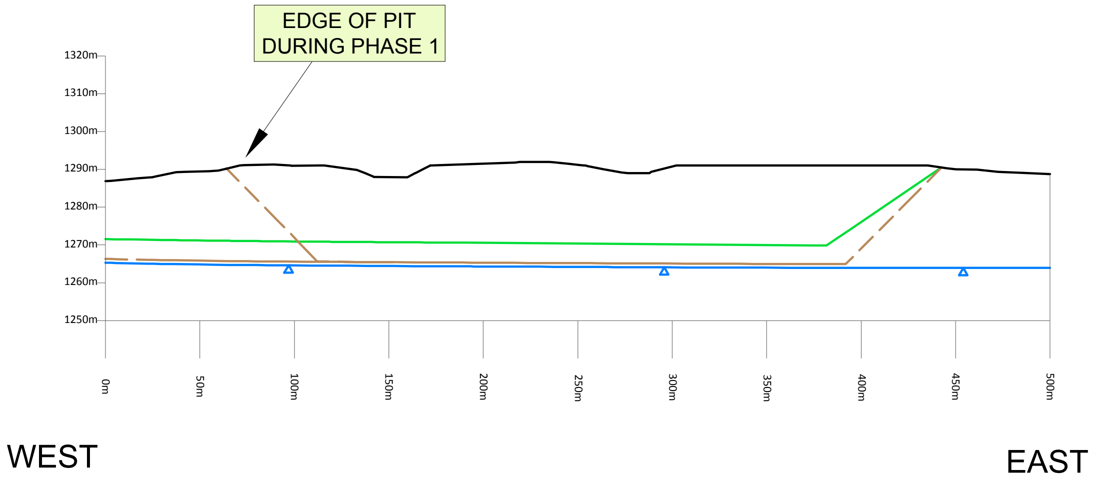
RECLAIMED LAND - GRADING

02

Scale
1:6,000 @ A3

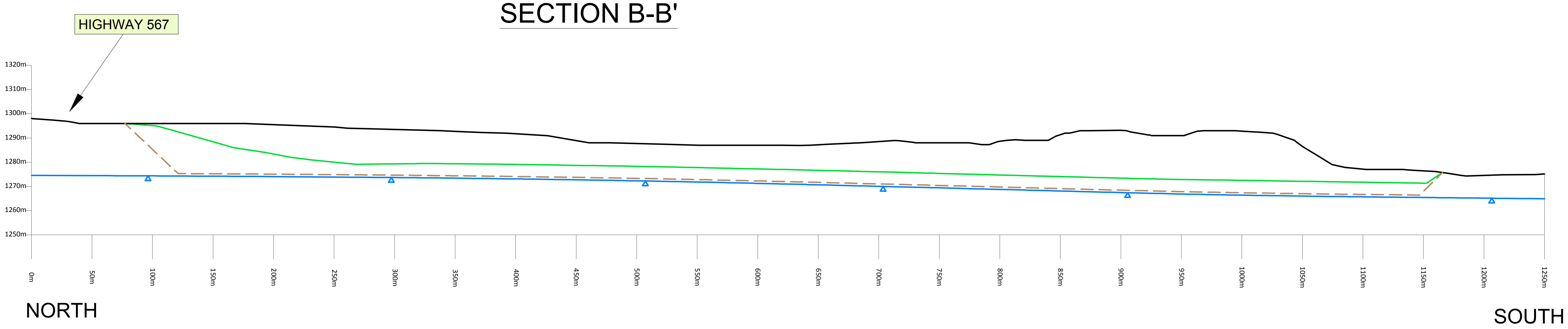
Date
MAY 2023

SECTION A-A'



SCALE:
1:2,000 @A3
(VERTICAL)
1:4,000 @A3
(HORIZONTAL)
2x VERTICAL
EXAGGERATION

SECTION B-B'



NOTES

LEGEND

- RECLAMATION PROFILE
- AVERAGE MAXIMUM GROUNDWATER LEVEL
- PIT PROFILE
- PRE-MINING TOPOGRAPHY

MOUNTAIN ASH LIMITED PARTNERSHIP.
SUMMIT AGGREGATES RESOURCE
W 1/2 SEC 31 TWP 026 RGE 03 W5M
COCHRANE
ALBERTA

SLR
global environmental solutions

SLR Consulting (Canada) Ltd.
200 - 708 11th Ave SW
Calgary,
Alberta, T2R 0ER
www.slrconsulting.com

STRIPPING & GRADING

212.06650.00006

CROSS SECTIONS

03

Scale	Date
SEE INSET	JULY 2021

SG03_SECTIONS_v2.dwg

www.slrconsulting.com

Appendix N

Mining and Excavation Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Appendix O

Security Estimate Deliverables

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Full Cost Security Calculation

Summit Pit - West Half Sec. 31 Twp. 26 Rge.3 W5M

1. Cost of Replacing Reclamation Materials

	Volume	Cost/m3	Total	Notes
Surveyed Topsoil Volume		$ 2.50	$ -	NA until 5 Year Report
Surveyed Subsoil Volume				NA until 5 Year Report
Surveyed Overburden Volume		$ 2.50	$ -	NA until 5 Year Report
Surveyed Reject Sand Volume		$ 2.50	$ -	NA until 5 Year Report
		TOTAL	**$ -**	

	Phase 1 Disturbed Area (m2)	Strata Depth (m)	Reject Factor	Volume (m3)	Cost/m3	Total	Notes
Estimated Topsoil Volume	76,026	0.25		19006.5	$ 2.50	$ 47,516.25	Area (m2) includes Mining Blocks A,B,C,and D
Estimated Subsoil Volume	76,026	0.25		19006.5	$ 2.50	$ 47,516.25	
Estimated Overburden Volume	76,026	3.11		236440.86	$ 2.50	$ 591,102.15	
Estimated Reject Sand Volume	0	0	15%	0	$ 2.50	$ -	
	0	3.61		274453.86	**Total**	**$ 686,134.65**	

Total Stockpile Volume	274,453.9	m3
Cost to Replace Stockpile Volume per m3	$ 2.50	m3
Total Cost	**$ 686,134.65**	

2. Cost to Remove Stockpile Area, Crash Banks, De-compact and Final Grading

	Equipment Type	Hours	Hourly Rate	Total Mobilization/ Demobilization	Total	Notes
Cost to Remove Stockpile Area and Stockpiles	John Deere 470 Excavator	20	$ 261.00	$ 4,000.00	$ 9,220.00	2018 Road Builders
	CAT 740 Dump Truck	20	$ 235.00	$ 1,500.00	$ 6,200.00	2018 Road Builders
	CAT 627G - Motor Scraper	20	$ 401.00	$ 3,500.00	$ 11,520.00	2018 Road Builders
Cost to Crash Banks	CAT D8 Crawler Tractor	20	$ 278.00	$ 1,800.00	$ 7,360.00	2018 Road Builders
Cost to De-Compact	CAT D8 Crawler Tractor	20	$ 278.00	$ -	$ 5,560.00	See MOB/DEMOB Above 2016 Road Builders
Final Grading	CAT 140M Grader	20	$ 192.00	$ 1,500.00	$ 5,340.00	2018 Road Builders
	Total	**120**		**Total**	**$ 45,200.00**	

3. Cost of Re-Seeding, Fertilizing, Maintaining Area

	Equipment Type	Hours	Hourly Rate (Equipment or Labour)	Seeding Rate (per acre)	Registered Area (acres)	Fertilizer Application Rate (per acre)	Pesticide Application Rate (per acre)	Fertilizer Cost (per acre)	Herbicide Cost (per acre)	Total
Seed Bed Preparation	Wheel Tractor (Group 2) with Harrow	12	$ 85.00		**18.78**					$ 1,020.00
Seeding Application	Air Seeder/Air Drill/Labour	12	$ 40.00	$ 35.00	**18.78**					$ 1,794.60
Fertilization	Granular Fertilizer Application - Floater Truck/Labour	4	$ 40.00		**18.78**			$ 11.75		$ 601.33
Maintenance (2 Years)	Granular Herbicide Application - Floater Truck/Labour		$ 40.00		**18.78**				$ 9.75	$ 366.21
									Total	**$ 3,782.14**
									Cost per Acre	$ 201.39

Source : Custom Rates 2016 - Seeding (Alberta Agriculture Website)

www.agric.gov.ca

4. Cost of Contingencey/Administration and Removal of Pit Infrastructure (Scale, Scale House, Gates, Fuel Tanks)

Total Estimated Cost of Reclamation	$ 735,116.79
Cost of Contingency	**10%**
Total Cost of Contingency	**$ 73,511.68**

5. Total Security To Be Provided	**$ 808,628.47**

Phase 1 Materials Calculations by Sub-Phase

Basis of calculation	*Calculated from models*	*Calculated from models*	*=A x 0.25*	*=A x 0.25*	*= B – (C+D)*	*=B/A*	*=E/A*	*Calculated from models*	*= H * 0.15*	*= H - I*	*= J x 2*	*=K/A*
Sub-Phase (parts of phase 1)	3D Surface Area	TOTAL Stripping Volume (Overburden & Soils)	TOPSOIL Stripping Volume (@0.25m)	SUBSOIL Stripping Volume (@0.25m)	REMAINING OVERBURDEN Stripping Volume (to top of gravel)	Average TOTAL Stripping thickness (incl. Soils)	Average NET Stripping thickness (excl. Soils)	Gross Mining Volume	Rejects (@15%)	Net Mining Volume	Net Mining Tonnes (@ 2t/m^3)	Average Mining Thickness (to 1m above maximum groundwater)
A	12,970 m^2	4,387 m^3	3,242 m^3	3,242 m^3	0 m^3	0.34 m	0.00 m	118,236 m^3	17,735 m^3	100,500 m^3	201,001 t	9.12 m
B	17,705 m^2	80,241 m^3	4,426 m^3	4,426 m^3	71,388 m^3	4.53 m	4.03 m	263,848 m^3	39,577 m^3	224,271 m^3	448,542 t	14.90 m
C	12,864 m^2	45,817 m^3	3,216 m^3	3,216 m^3	39,385 m^3	3.56 m	3.06 m	91,215 m^3	13,682 m^3	77,533 m^3	155,066 t	7.09 m
D	32,487 m^2	98,331 m^3	8,122 m^3	8,122 m^3	82,087 m^3	3.03 m	2.53 m	597,516 m^3	89,627 m^3	507,889 m^3	1,015,777 t	18.39 m
E	30,366 m^2	95,397 m^3	7,592 m^3	7,592 m^3	80,214 m^3	3.14 m	2.64 m	592,349 m^3	88,852 m^3	503,496 m^3	1,006,993 t	19.51 m
F	22,032 m^2	60,550 m^3	5,508 m^3	5,508 m^3	49,535 m^3	2.75 m	2.25 m	396,056 m^3	59,408 m^3	336,647 m^3	673,294 t	17.98 m
Total	***128,424 m^2***	***384,723 m^3***	***32,106 m^3***	***32,106 m^3***	***322,609 m^3***	***3.00 m***	***2.51 m***	***2,059,219 m^3***	***308,883 m^3***	***1,750,336 m^3***	***3,500,673 t***	***16.03 m***

Appendix P

Guide to COP Schedules/ Development Permit Approval

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Code of Practice for Pits
Registration Application (Schedule 1)

Date: July 9 2021

Previous *Environmental Protection and Enhancement Act* Approval Number: N/A

Water Act authorization required? ☑ Yes ☐ No

If Yes, ☑ application submitted or current *Water Act* Authorization Number: In Progress

Name of Applicant (company or person in whose name the pit will be registered):
Mountain Ash Limited Partnership
Address: 35181 Big Hill Springs Road, Rocky View County, AB, T4C 3A2
Phone: 403.690.3076 Facsimile:
e-mail: tige.brady@telus.net

Name of Person Submitting Application: Jesse Dirom
Company Name: SLR Consulting (Canada) Ltd.
Job Title: Senior Consultant/Planner
Address: #200, 708 - 11 Avenue SW, Calgary, AB T2R 0E4
Phone: (403) 808-4869 Facsimile:
e-mail: jdirom@slrconsulting.com
Signature:

Name of Primary Contact for Pit: Tige Brady
Job Title: Project Manager
Address: 35181 Big Hill Springs Road, Rocky View County, AB, T4C 3A2
Phone: 403.690.3076 Facsimile:
e-mail: tige.brady@telus.net

Pit Location Municipal Address or LSD-Sec-Twp-Rge-Mer	Registered Owners Name, Address and Phone Number	Occupants Name, Address and Phone Number
W 1/2 31-26-3 W5M	1410266 Alberta Ltd., 35181 Big Hill Springs Road, 403.690.3076	Tige Brady, 35181 Big Hill Springs Road, 403.690.3076

9.2 Activities Plan Checklist and Form

Items on the checklist that are indented are useful for preparing the application but are not required to be submitted.

Part 1

- ☑ The type of product that will be removed
- ☑ The current pit size – include access roads, stockpile sites and all other locations where infrastructure is present. If there is no pit indicate Not Applicable or No Pit Yet
- ☑ The average thickness (in centimetres or metres) of each of topsoil, subsoil, overburden, and aggregate
- ☑ The texture(s) of the topsoil - organic soil, mineral soil, clay loam, silty loam, sand, sandy loam, loam, clay, silt, or other (describe)
- ☑ The techniques that will be used to prevent wind and water erosion and control dust
- ☑ Involvement in local or regional air monitoring programs
- ☑ Inactive pit reclamation plans – for portions of the pit that will be inactive for more than two years
- ☑ Scale drawings of existing pit conditions and the proposed pit operations
- ☑ Cross-section drawings of the pit
    - ☑ Aggregate and overburden inventory or testing reports
    - ☑ Estimated percentage of the deposit that is reject material
    - ☑ The texture of the subsoil – clay, heavy clay, silt, silty clay, sand, sandy clay, or other (describe)

Part 2

- ☑ The maximum planned pit size – include access roads, stockpiles sites and all other locations where infrastructure will be present
- ☑ The depth to water in any test holes; indicate depth in each test hole where water was found
- ☑ The type of operation(s) at the pit - wet pit excavation, concrete production, salt mixing, asphalt mixing, spraying truck box liners, aggregate washing, use of other materials for reclamation
- ☑ Measures to prevent or mitigate adverse effects from the above activities
- ☑ The proposed end land uses and their percentage of the reclaimed landscape – cultivation, hayland, pasture, native range, grassland, forest, wildlife habitat, water body, proposed subdivision, other (describe)
- ☑ Information on the release of pit water – need for release, methods, location, timing
- ☑ Replacement thickness of topsoil and subsoil
- ☑ Scale drawings of the reclaimed pit

- ☑ Cross-section drawings of the reclaimed pit
- ☑ Reclaimed surface water body information
  - ☑ The average depth of excavation including the removal of topsoil, subsoil, overburden and materials
  - ☑ The expected life of the deposit in years
  - ☑ The equipment that will be used for removing and replacing topsoil and subsoil – bulldozer, grader, scraper/ buggy, front end loader, other (describe)
  - ☑ How the property boundaries and buffers have been located and marked
  - ☑ The extraction setback – show calculation for each different setback
  - ☑ A detailed description of the quality, depth and variation of any groundwater encountered in test holes or identified from surveys, databases or reports
  - ☑ The CLI soil capability class for agriculture of the pre-disturbed landscape and the expected capability class in the reclaimed landscape – the relationship of slopes to soil capability classes are

Class 1, 2, 3	Level, nearly level or very gentle slopes no steeper than 20:1
Class 4	Gentle slopes; no steeper than 10:1
Class 5	Moderate slopes; no steeper than 6:1
Class 6	Strong slopes; no steeper than 3:1
Class 7	Very strong slopes; no steeper than 2:1

  - ☑ The seed mixtures or other forms of revegetation to be used.
  - ☑ Signature and title of person who developed the Activities Plan

Activities Plan (Schedule 2)

Part 1 Information

Aggregate Type (check off all that apply): ☑ Gravel ☑ Sand ☐ Clay ☐ Marl

Current Size of Pit: N/A (hectares / acres)

Average Thickness (indicate metres or centimetres for each one):
Topsoil 0.25m Subsoil 0.25m Overburden 3.39 m Aggregate 13.17 m

Topsoil Texture (check all that apply):
☐ organic soil ☐ mineral soil ☑ clay loam ☐ silty loam ☐ sand ☑ sandy loam
☑ loam ☐ clay ☐ silt ☐ other ______

Description of techniques to prevent wind and water erosion, and to limit the movement of dust from the pit: See Appendix B (Erosion and Sedimentation Plan) in the "COP for Pits in Alberta Application" Document.

Participation in local or regional air monitoring initiative: Please see appendix D of the COP Application Document

Inactive pit conservation and reclamation techniques: See pages 1 through 34 and Section 4.6 in the "COP for Pits in Alberta Application"

☑ Scale drawings and cross-sections of existing pit conditions and planned sequence of operation attached.

Part 2 Information

Maximum planned size of pit: ~228 (hectares [✓ / acres])

Depth to groundwater (metres) in test holes (indicate each depth if multiple holes): See Appendix I

Planned activities at the pit (check off all that apply): ☐ wet pit excavation
☐ concrete production ☐ mixing salt and aggregate ☐ mixing asphalt with aggregate
☐ spraying truck boxes ☐ aggregate washing ☐ use of alternative materials for reclamation

Mitigative measures for all of the above activities: ______

Proposed land uses for reclaimed pit (check all appropriate boxes):

☐ cultivation ____%
☐ native range ____%
☐ wildlife habitat ____%
☐ other (specify) ____%
☑ hayland 70 %
☐ grassland ____%
☐ waterbody ____%
☑ pasture 30 %
☐ forest ____%
☐ proposed subdivision ____%

Pit water release (rationale for release, techniques and discharge points): See Appendix J (Stormwater Management Plan) in "COP for Pits in Alberta Application" for detailed information and engineered drawings

Average topsoil replacement depth (cm): 0.217m
Average subsoil replacement depth (cm): 0.m

A 15% loss due to soil handling techniques.

☑ Scale drawings and cross-sections of reclaimed pit conditions attached.

Description of surface water bodies in the reclaimed pit:
Design: At this point in the detailed design phase Mountain Ash is not intending to reclaim the pit to have permanent water features
Intended use: ______

Water elevation at full supply level: N/A

Slope of land one metre above full supply level: N/A

Slope of land one metre below full supply level: N/A

Signature and title of person who developed Activities Plan: ______

9.3 Security Estimate Checklist and Form

☑ The area of land (in acres) secured at $250/acre

☑ Calculation details for full-cost security on the remainder of the disturbed land

☑ The area (in acres or hectares) covered by the full-cost security above and the average cost per acre or hectare of the full-cost security

☑ Proposal for the amount of security (total of $250/acre security plus full-cost security)

☑ Proposal for the form of security to be provided

  ☑ Signature and title of person submitting the security estimate

Security Estimate (Schedule 3)

Acres of land certified at $250/acre: 18.78

Acres x $250 = 4,695 (a)

☑ Detailed full-cost security calculation attached

Total full-cost = 798,174.8 (b)

Area of land at full-cost 18.78 (hectares / acres)

Cost/hectare or acre = 42,501.27

Total security to be provided ((a) + (b)): 802,869

Proposed method of payment: ☑ Letter of Credit ☐ Cash ☐ Other (explain) ____

Signature and title of person submitting estimate: Tige Brady

9.4 Five-Year Report Checklist and Form

The report is due five-years after the date of the registration and every five years afterwards until the date of submission of the Final Reclamation Report or until the entire pit has been certified, whichever comes first.

- ☐ The registration number – make sure it is for the correct pit
- ☐ The legal location of the pit – include access roads, stockpiles sites and all other locations where infrastructure is present
- ☐ Total area of pit – all lands that have been disturbed by pit activities over the life of the pit (including lands disturbed by a previous operator whom transferred the registration to you)
- ☐ Active area – sum of the areas of the pit where aggregate is being extracted or processed, stockpiles are placed and infrastructure is located
- ☐ Reclaimed area – the area of a pit where the landscape has been re-established, the topsoil has been replaced and vegetation has been established, but does not include any certified area
- ☐ Certified area - the area of a pit that is the subject of a reclamation certificate
- ☐ Check to ensure that the values reported make sense in this report (e.g., Total Area = active + reclaimed + certified) and when compared to the previous report
- ☐ Scale drawing of pit attached
- ☐ Date pit size measured – must be less than 60 days prior to the report date
- ☐ Date scale drawing made – must be less than 60 days prior to the report date
  - ☐ Signature and title of person submitting the form

Five-Year Report (Schedule 4, Part 1)

Pit Registration Number: ________________ Date: ________________________________

Name of registration holder: ____

Address: ____

Phone: ___________________________ Facsimile: ___________________________

e-mail: ________________________________

Pit Location Municipal Address or LSD-Sec-Twp-Rge-Mer

Pit size:

Total area (hectares / acres): ________________

Active area (hectares / acres): ______________

Reclaimed area (hectares / acres): ___________

Certified area (hectares / acres): ____________

☐ Scale drawing of pit attached

Date pit size measured: ____________________

Date drawing made: ______________________

Signature and title of person submitting form: _____________________________________

9.5 Final Report Checklist and Form

The report is due no later than 3 years after the entire pit has been revegetated. The report does not need to be sent in if the entire site has received a reclamation certificate.

- ☐ The registration number – make sure it is for the correct pit
- ☐ The legal location of the pit – include access roads, stockpiles sites and all other locations where infrastructure is present
- ☐ The registered land owner's information – include all the names on each title
- ☐ Total area of the pit - all lands that have been disturbed by pit activities over the life of the pit (including lands disturbed by a previous operator whom transferred the registration to you)
- ☐ Scale and cross-section drawings of reclaimed pit
- ☐ Written acknowledgement of all registered landowners that they received the report
  - ☐ Signature and title of person submitting the form

Final Reclamation Report (Schedule 4, Part 2)

Pit registration number: ____________________ Date: ________________________________

Name of registration holder: ____

Address: ____

Phone: ______________________________ Facsimile: ________________________________

e-mail: ________________________________

Pit Location Municipal Address or LSD-Sec-Twp-Rge-Mer	Registered Owners Name, Address and Phone Number

Pit size:

Total area (hectares / acres): __________

☐ Scale and cross-section drawings of reclaimed pit attached

☐ Written acknowledgement of all registered landowners that they received this report attached

Signature and title of person submitting form: ____

ROCKY VIEW COUNTY

262075 Rocky View Point
Rocky View County, AB, T4A 0X2

403-230-1401
questions@rockyview.ca
www.rockyview.ca

This is not a development permit

Wednesday, July 21, 2020

B&A Planning Group (Ken Venner)
#600, 215 - 9 Ave SW
Calgary, AB T2P 1K3

File: PRDP20211744

RE: DEVELOPMENT PERMIT TRANSMITTAL OF DECISION

At its meeting on July 13, 2021, Rocky View County Council considered Administration's request to approve a Development Permit for Natural Resource Extraction/Processing (Phase 1).

Your development permit is **CONDITONALLY APPROVED, as amended**.

Description:

1. That Natural Resource Extraction/Processing (Phase 1) may operate on the subject site as approved in accordance with the *Master Site Development Plan: The Summit Pit, dated December 7, 2020* (MSDP), submitted application and supporting technical reports, and includes:
    i. Field-testing facilities, including up to two temporary portable crushers;
    ii. Portable Scale House, located on conjoining trailers (up to 2,690.98 sq. ft. in area);
    iii. Portable Field Office/Maintenance building(s), (up to 2,690.98 sq. ft. in area);
    iv. Outdoor Storage Area, as per the approved Mining & Extraction Plan, as prepared by SLR, Proj. No. 212.06650.00006, dated April 2021;
    v. Temporary Stockpiling (of mineral and non-mineral materials);
    vi. Signage; installation of three (3) freestanding signs;
        a. That the minimum freestanding signage setback requirement from a roadway intersection is relaxed from *25.00 m (82.02 ft.) to 5.00 m (16.40 ft.).*
        b. Final signage details shall be submitted to the County, prior to installation on site.

This is not a development permit

Prior to Release:

2. That prior to release of this Development Permit, the Owner shall be required to enter into a Development Agreement with the County, in accordance with the County's Servicing Standards, for:
    - i. The upgrade of Range Road 40 to an industrial paved standard (400.6) from Highway 567 to the site access;
    - ii. Upgrade of the intersection of Range Road 40 and Highway 567 to a Type IVa standard including all signage and any other roadside indicators to the satisfaction of Alberta Transportation (AT) and the County;
    - iii. Obtaining Roadside Development Permit and other necessary approvals from AT for the Highway Intersection improvements;
    - iv. Removal and reclamation of the existing access from Highway 567 to the satisfaction of AT;
    - v. Registration of necessary easement, right-of-ways, and/or restrictive covenants to the satisfaction of the AT and the County;
    - vi. Submission and implementation of the recommendations of the geotechnical report and pavement structure design;
    - vii. Submission and implementation of the recommendations of the stormwater management report for the intersection and road upgrades;
    - viii. Submission and implementation of the recommendations of the construction management plan; and
    - ix. Submission and implementation of the recommendations of the erosion & sedimentation control plan.
3. That prior to release of this Development Permit, the Applicant/Owner shall submit payment of the Transportation Offsite Levy, in accordance with Transportation Offsite Levy Bylaw C-8007-2020, for the total gross acreage of the gravel pit and areas associated for gravel extraction activities relating to Phase 1 operations.
4. That prior to release of this Development Permit, the Applicant/Owner shall submit an updated Erosion & Sedimentation Control Plan (ESC), prepared by a qualified professional in accordance with County's Servicing Standards.
5. That prior to release of this Development Permit, the Applicant/Owner shall submit an updated Stormwater Management plan and Stripping & Grading Plan, prepared by a qualified professional in accordance with County's servicing standards.
6. That prior to release of this Development Permit, the Applicant/Owner shall submit an updated Landscape plan, confirming the proposed east berm, 15.00 m (49.21 ft.) in size, to be constructed and the relocation of the southern pond and sump A to be located within the Phase 1 boundary.

7. That prior to release of this development permit, the Good Neighbouring Plan as submitted shall be reviewed, amended and approved by the County to include a Complaint protocol requirement that includes a phone number and other forms of contact to be provided as per the Summit MSDP, and made available 24/7 to the area residents during the life of the pit. This plan will also be required to address assisting the neighbours should any groundwater wells be affected by the pit operations.

Upon Implementation & Site Occupancy:

8. That upon completion, that Applicant/Owner shall submit as-built drawings of the constructed onsite stormwater management facilities, prior to the issuance of additional Phase 1 development permits.
   i. Once received, the County shall perform an inspection of the proposed stormwater management facilities ensuring the proposed facilities were constructed as per the approved Stormwater designs.
9. That upon completion, Construction Completion Certificates shall be issued on the constructed Type IVa intersection, upgrades to Range Road 40, and all work completed under the issued Development Agreement, prior to the issuance of additional Phase 1 development permits.

Permanent:

10. That any plan, technical submission, agreement, or other matter submitted and approved as part of the subject application, PL20200031 or PL20200034, prior to release or occupancy conditions, shall be implemented and adhered to in perpetuity, including but not limited to:
    i. That Gravel operation shall construct and implement any necessary stormwater management facilities, in accordance with the approved site Stormwater Management Plan, in perpetuity.
    ii. That the Gravel operation shall follow the recommendations of the Biophysical Impact Assessment, prepared by SLR, Proj. No 212.06650.00003, dated January 2020, in perpetuity.
    iii. That the Gravel operation shall follow the recommendations of the Acoustic Assessment Report, prepared by SLR, Proj. No. 203.50207.00000, dated May 2020, and the Air Quality Assessment, prepared by SLR, Proj. No. 203.50207.00000, dated May 21, 2020 (including ongoing air quality monitoring detailing), in perpetuity. Quarterly reports are required to be submitted to the County for review.
11. The site shall operate in accordance with the Summit Pit MSDP, including the Joint Commitments, at all times.
12. That all activity and equipment associated with the Natural Processing Extraction operation shall be located in accordance with the approved Site plan for the Phase development permit.

This is not a development permit

13. That phase reclamation shall proceed behind extraction activities such that no more than 16.00 hectares (40.00 acres) shall be open at any time for Phase 1.
14. That there shall not be any storage of any materials or vehicles on the property that are not directly related to the operation of the gravel pit.
15. That no activity shall occur within the Habitat Preservation Area, located on SW-31-26-W5M, as identified under the Summit Pit MSDP, Figure 7, Development Concept.
16. That all portable buildings placed onsite shall comply with the minimum DC 170 setback requirements.
17. That all signage shall be kept in a safe, clean, and tidy condition at all times.
18. That any on-site wayfinding signage including for direction and information purposes shall be permitted, where in keeping with the design of the overall development, to the satisfaction of the County.
19. That no business temporary signage shall be place on the site at any time except any temporary signs required during development construction. No temporary signage shall be placed within the Highway Road Allowance at any time.
20. That no crushing, within Phase 1, shall occur within the restricted crushing buffer area, as identified on the Summit Pit Site Plan, as prepared by SLR, Proj. No. 21206650.00006, dated April 23, 2021, or as amended.
21. That only on-site extraction materials may be processed on-site, except on occasion whereby blend materials from off-site are required to bring products to specification.
22. That any gravel extraction and processing operation shall occur 1.00 m (3.28 ft.) above the highest recorded groundwater table, as approved with the updated groundwater table readings and includes:
    i. That the Applicant/Owner shall implement or continue to implement a groundwater measurement program, for which the Applicant/Owner is to install piezometers within the open pit area to take monthly readings of the groundwater levels. The readings will ensure mining activities remain a minimum of 1.00 m (3.28 ft.) above the recorded groundwater levels at all times. The Applicant/Owner shall be required to keep a log to record the readings and submit any reporting to the County, upon request, and include the log and reporting in the Annual Report submissions.
        a. That should any extraction operations negatively impact groundwater on adjacent parcels, further groundwater testing and corrective recommendations may be required, upon request from the County and/or Province, at the Applicant/Owner's expense.
23. That no topsoil shall be removed from the site and any soil materials will be salvaged in accordance with industry best practice to ensure their conservation.

24. That all topsoil & overburden excavated within the site may be stockpiled to be used to reclaim the excavated areas. Stockpiled topsoil & overburden will be placed in the depleted areas in the same order they were removed in accordance with the Code of Practice for Pits in Alberta.
    i. Reclamation of mined areas shall consist of the replacement of salvaged overburden, subsoil, and topsoil with a 3:1 side slope around the mined areas.
25. That any overburdened stockpiles and/or similar earthworks shall be seeded and maintained using erosion control measures.
26. That all landscaping, including the perimeter berming along the east property line, shall be installed onsite within 24 months of permit approval, in accordance with the final approved Landscape Plan, as amended.
27. That dust control measures shall be utilized for all vehicles during mining and transport of material, and shall be applied to haul and access roads so that no visible dust is allowed on adjacent lands from the site.
28. That in the case of any spillage of hazardous materials, AEP and the County shall be notified immediately, and the appropriate clean-up procedures shall be implemented.
29. That the hours of operation, for any Natural Resource Extraction/Processing activities, shall be limited to the following:
    i. Monday to Friday: 7:00 a.m. to 7:00 p.m.
    ii. Saturday: 7:00 a.m. to 5:00 p.m.
    iii. Sunday & Statutory Holidays: Closed
30. That recorded noise levels generated by aggregate operations shall not exceed *65 dba LAeq (one (1) hour)* at the receptors' location, in accordance with the approved Noise Monitoring Plan, as prepared by SLR, Proj. No. 212.06650.00006, dated April 2021 and the Acoustic Assessment Report, as prepared by SLR, Proj. No. 203.50207.00000, dated May 2020.
31. That the existing dwelling units and accessory buildings onsite shall remain deemed non-conforming, under the Direct Control District and may remain as is, until otherwise significantly altered, relocated, removed or phase extraction activities are within 150.00 m (492.13 ft.). At that time, the units shall be brought into compliance with the Direct Control District.
32. That all on-site lighting, including private, site security, and parking area lighting, shall be designed to conserve energy, reduce glare, and reduce uplight. All lighting shall be full cut-off (shielded) and be located and arranged so that no direct rays of light are directed at any adjoining properties, which may interfere with the use and enjoyment of neighbouring lands, or interfere with the effectiveness of any traffic control devices or the vision/safety of motorists.

This is not a development permit

33. That the Applicant/Owner shall submit an Annual Report to the County, that includes all pertinent operation details, no later than six months after each operating year.
    i. The report shall include but not be limited to Site Operations Manager contact information, site complaints/incident reports, groundwater elevations, all required quarterly monitoring summaries, all extraction details (tonnages and gradation exported, volumes of stockpiled onsite material), and onsite procedure updates.
34. That if this development permit is not issued by **MARCH 31, 2022,** or the approved extension date, then this approval is null and void and the development permit shall not be issued.
35. That this Development Permit, if and when issued, shall be valid for **five (5) years** from the date of issue or until the completion of Phase 1.

Advisory:

36. The Applicant/Owner shall submit payment of the Community Aggregate Payment Levy, annually, in accordance with Bylaw C-7748-2018, as amended, in the amount of $0.40 per ton of aggregate extracted and removed.
37. That the County's Noise Bylaw C-8067-2020 shall be adhered to at all times, except as noted or approved as conditions of this approval.
38. That at renewal stage of Phase 1, the Applicant/Owner shall, in conjunction with the other gravel pit operators in the area, work collaboratively by sharing technical information and proportionally funding, if necessary to establish and implement operating practices with an objective of mitigating cumulative effects relative to the site operation, in accordance with the Summit MSDP.
39. That a Building Permit(s) shall be obtained for any proposed buildings on-site through Building Services, prior to placement on-site.
40. That the site shall remain free of restricted and noxious weeds and maintained in accordance with the approved Weed Management submissions and the *Alberta Weed Control Act* [*Statutes of Alberta, 2008 Chapter W-5.1, December 2017*].
41. That any other Federal, Provincial or Municipal approvals, regulations, or policies are the sole responsibility of the Applicant/Owner.
    i. That an AEP Registration for Pit Operation and any approvals under the *Water Act* for any Wetland Disturbances shall be obtained, prior to extraction activity commencement.
    ii. That the Applicant/Owner shall operate within the requirements of the Provincial Code of Practice for Pits at all times.
    iii. That the Applicant/Owner shall submit confirmation that authorization and clearance have been obtained under the *Historical Resources Act*, for the onsite mining activities located on SW-31-26-03-W5M.

    iv. That the Applicant/Owner shall submit a copy to the County, of the Pit Registration and any other Activity Plan Registrations from AEP and a copy of the issued Roadside Development Permit (RSDP029840-1) from AT.

42. That the Applicant/Owner shall maintain the existing access/approach, off Highway 567, to the required standard, until the intersection upgrade is complete and the existing access is reclaimed.

43. That no water shall be used for washing of gravel unless and until written approval has been received from AEP. If washing is approved by AEP, the washing of gravel shall adhere to the approved days and hours of operation condition on the Development Permit.

44. That no wash water shall be discharged off of the site or into any water channel.

45. That all sanitary sewage and water services shall be supplied in accordance with AEP and the *Alberta Safety Codes Act*.

46. That any fire suppression and abatement measures shall be followed in accordance with the Alberta Fire Code.

Should you have any questions or concerns, please contact Jacqueline Targett for assistance and quote the file number as noted above.

Michelle Mitton
Legislative Coordinator
403-520-1290
mmitton@rockyview.ca

Appendix Q

Soils Survey & Profiles by AECOM 2022

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Technical Memorandum

To:	Alberta Environment and Parks Terrina Perley, CET Senior Land and Water Specialist	**From:**	SLR Consulting (Canada) Ltd.
AEP File No.	DAPP0001717 ECM 00481044 EPEA 00478753	**Project:**	Mountain Ash Limited Partnership Summit Project
		Date:	January 11, 2023

RE: Response to Supplemental Information Request
D. *Environmental Protection and Enhancement Act*, Code of Practice Application Requirements

---

SIRs No. D5 and D6

Section C of the Supplemental Information Request provided by AEPA on December 1, 2022, dealt with hydrology/hydrogeology. Comments 11 and 12 on Hydrology/Hydrogeology are related and specifically requested:

D5

"Thank you for providing the locations showing soil sampling. The Table provided in the SIR identifies "topsoil" and "subsoil" but not complete depths, the depths stop at 30 cm, however the original applications states that soils were investigated to approximately 1 m. The table does not provide texture or any other data. The Appendices referenced in the SIR response does not reflect necessary soil data. The original application and the SIR response still do not provide a source of cohesive data for soils to inform conservation, operation and reclamation planning and support the security calculations. The results of soil inspection locations typically appear in a tabular format as shown below."

Response

The table provided by AEPA was noted. Attachment A provides the requested information produced by AECOM.

The soils field program completed by AECOM, December 29 and 30, 2022 concluded that average thickness of subsoil material is 0.25m (original was 0.20m). Table 5 from Section 4.15 from the Code of Practice for Pits (COP) reflects is presented below with new subsoil material and total material calculations.

Table 1: Quantities of Materials used to Reclaim Site Post Mining

Phase	Surface Area (m^2)	Topsoil (m^2)	Subsoil (m^2)	Overburden & Rejects (@15% Gravel) (m^2)	Total (m^3)
1	128,424	32,106	32,106	556,573	620,785
2	151,720	37,930	37,930	749,523	825,383
3	151,989	37,997	37,997	1,093,980	1,169,974

Phase	Surface Area (m^2)	Topsoil (m^2)	Subsoil (m^2)	Overburden & Rejects (@15% Gravel) (m^2)	Total (m^3)
4	116,171	29,043	29,043	675,215	733,301
5	158,236	39,559	39,559	770,145	849,263
6	83,430	20,857	20,857	408,136	449,850
Total	**789,970**	**197,492**	**197,492**	**4,253,571**	**4,609,058**

Due to a change in subsoil thickness, the security estimate changed. The security estimate was included as Appendix O in the COP. The updated security estimate is attached as Attachment B of this document.

Full cost security has been re-calculated based on the total lands disturbed and the total volume of material being stripped. The total estimated cost of reclamation has been re-calculated to be $735,116.79. Mountain Ash has included a 10% contingency on top of this of $73,511.68. The total security proposed to be provided is $808,628.47.

D6

"Thank-you for the detail in the response, however, what is needed a drawing showing current drainage for the project site, with the proposed boundary visible, and at a scale comparable to the reclamation drawings. The level of detail, and scale should be similar to the drawing that was provided for the drainage proposed for the site when reclaimed. The image is shown below."

Response

The image provided by AEPA was noted. Attachment C provides the requested information produced by Badke Consulting Ltd.

Sincerely,

Carolyn Carruthers

Carolyn Carruthers, B.Sc., PMP, EP
Project Manager

Attachments: Attachment A: AECOM SIR Response D5
Attachment B: Summit Pit Security Estimate
Attachment C: Badke Consulting Ltd. SIR 2 Response

Statement of Limitations

SLR, AECOM and Badke Consulting Ltd. are relaying information obtained during work conducted for Mountain Ash Limited Partnership. SLR accepts no responsibility or liability for the use of this information for any purpose by any other entity except provincial review agencies. The regulatory agency (or agencies) can rely on the information in this document for the purposes of review, comment, and regulatory approvals.

AECOM

AECOM Canada Ltd.
48 Quarry Park Boulevard SE
Suite 300
Calgary, AB T2C 5P2
Canada

T: 403.254.3301
F: 403.270.0399
aecom.com

To:
Terrina Perley, CET
Senior Land and Water Specialist
Alberta Environment and Protected Areas

Your files:
DAPP0001717
ECM 00481044
EPEA 00478753

Date:
January 10, 2023

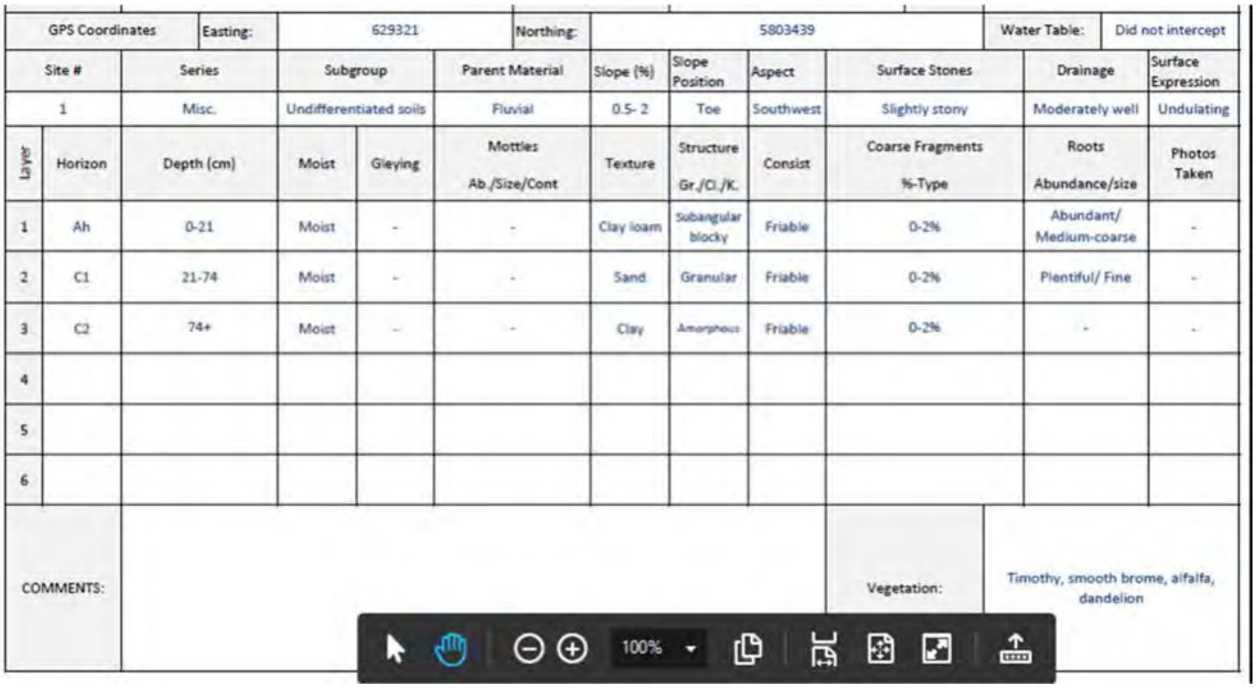
Project:
Mountain Ash Limited Partnership Summit Project

RE: Response to Supplemental Information Request – D. *Environmental Protection and Enhancement Act*, Code of Practice Application Requirements

SIR No. D5:

The depth and textures of reclamation material (topsoil and subsoil) have been provided; however, the locations and results for each location where soil inspections were completed were not supplied in the application to substantiate the information. Please show the soil inspection locations on a scale drawing and provide a table with the results, and borehole log testing information.

Thank you for providing the locations showing soil sampling. The Table provided in the SIR identifies “topsoil” and “subsoil” but not complete depths, the depths stop at 30 cm, however the original applications states that soils were investigated to approximately 1 m. The table does not provide texture or any other data. The Appendices referenced in the SIR response does not reflect necessary soil data. The original application and the SIR response still do not provide a source of cohesive data for soils to inform conservation, operation and reclamation planning and support the security calculations. The results of soil inspection locations typically appear in a tabular format as shown below.



GPS Coordinates	Easting:	629321	Northing:	5803439	Water Table:	Did not intercept

Site #	Series	Subgroup	Parent Material	Slope (%)	Slope Position	Aspect	Surface Stones	Drainage	Surface Expression
1	Misc.	Undifferentiated soils	Fluvial	0.5- 2	Toe	Southwest	Slightly stony	Moderately well	Undulating

Layer	Horizon	Depth (cm)	Moist	Gleying	Mottles Ab./Size/Cont	Texture	Structure Gr./Cl./K.	Consist	Coarse Fragments %-Type	Roots Abundance/size	Photos Taken
1	Ah	0-21	Moist	-	-	Clay loam	Subangular blocky	Friable	0-2%	Abundant/ Medium-coarse	-
2	C1	21-74	Moist	-	-	Sand	Granular	Friable	0-2%	Plentiful/ Fine	-
3	C2	74+	Moist	-	-	Clay	Amorphous	Friable	0-2%	-	-
4											
5											
6											

COMMENTS:		Vegetation:	Timothy, smooth brome, alfalfa, dandelion

Response

Soils Field Assessment Methods

On December 29 and 30, 2022, AECOM Canada Ltd.'s soils scientist, accompanied by Mountain Ash Limited Partnership (MALP), conducted a soils assessment using a tracked excavator under frozen soil conditions within the Project Boundary in the NW and SW quarter sections 31-026-03 W5M (Figure 1). As indicated in the response to SIR1, there were 11 sites assessed for soils within the Project Boundary in 2019. New sites were selected for the 2022 soils survey to provide a broader understanding of soils conditions within the Project Boundary.

The soils field assessment comprised of 13 sites within the Project Boundary (Figure 1). Each location was classified and assessed to a 1.0 m depth as per the Canadian Soils Classification System methodology (Agriculture Canada 1998). For each soils assessment location, details on depths and texture of the A horizon (topsoils), B horizon (upper subsoil) and C horizon (lower subsoil) was collected. A soil profile description of each location was also described to a 1.0 m depth.

The soils were found to be frozen to a 15 cm depth at the time of the assessment and the shallow frozen condition was not found to be an issue for soil classification purposes as all soil characteristics and properties were readily discernable in the field (i.e., soil color, soil horizon thickness and soil structure). Soil properties for each horizon were collected from each of the 13 sites. In addition, 10 soil samples from 4 sites (i.e., sites 1, 5, 12 and 13) were selected and submitted for soil textural analysis to Element Labs in Edmonton and the laboratory results are attached in Appendix A. The remaining soil samples were hand textured in the office to confirm soil texture of the investigated soil horizons.

Soils Assessment Results

The detailed results of the soils assessment are provided in Table 1. Table 2 provides a summary of all the required information from all 13 sites and Appendix A provides the laboratory results for the 10 samples collected at 4 sites (i.e., sites 1, 5, 12 and 13).

All 13 soils assessment locations were located in upland pasture, meadow, or hayland. All soils were classified as Dunvargen soils series as per the Alberta Soils Names file (Generation 4.0) User's Handbook (Alberta Soil Information Centre 2016); which are described as being Orthic Black Chernozemic soils; five locations in the center and north central area of the proposed development contained stony and gravelly soil profiles.

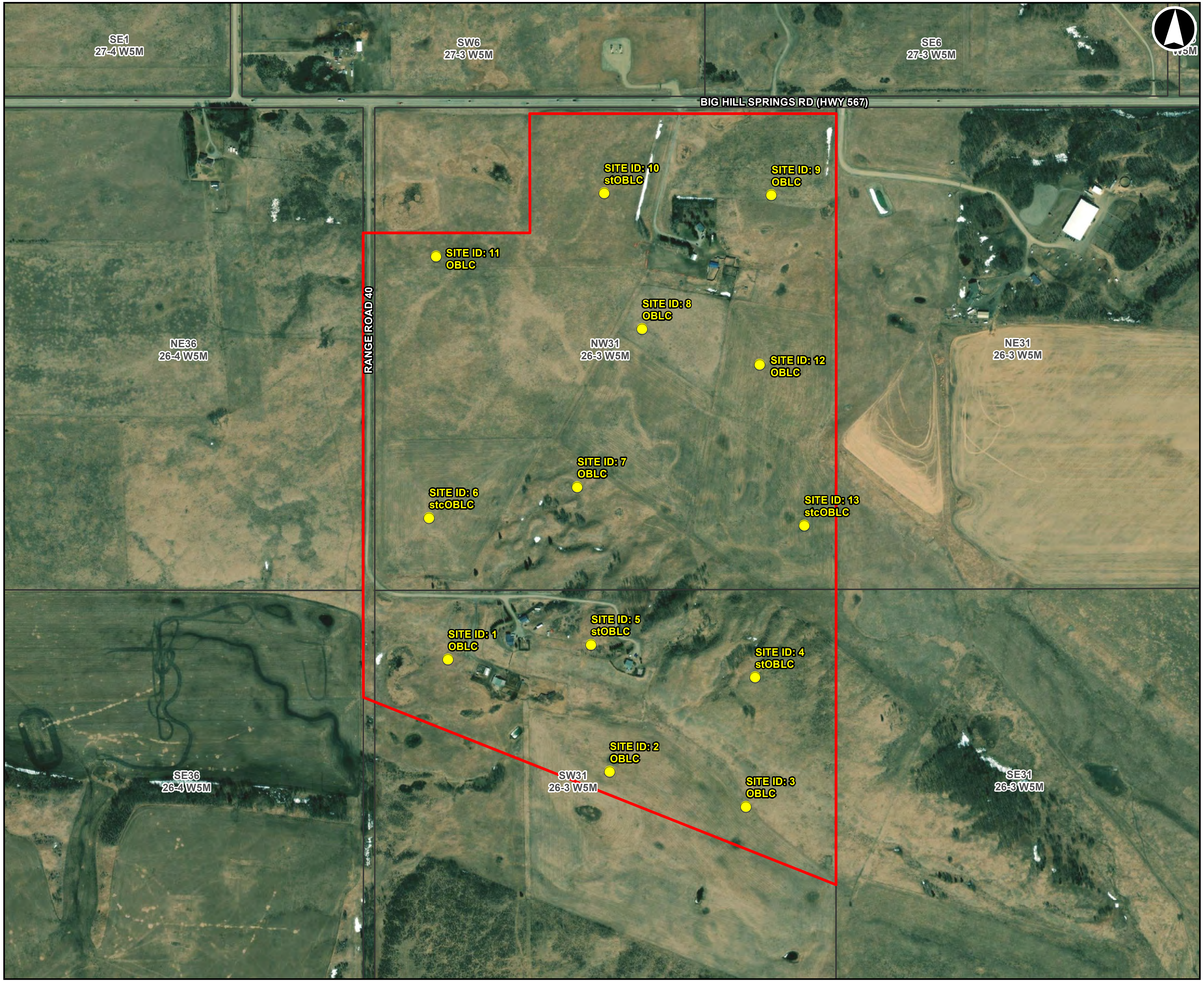
The A horizon (topsoils) encountered were black in color and had good granular soil structure. The depth of the topsoils ranged from 18 to 40 cm, with the deeper topsoils associated with low lying areas. The average depth of topsoil within the Project Boundary was 25 cm.

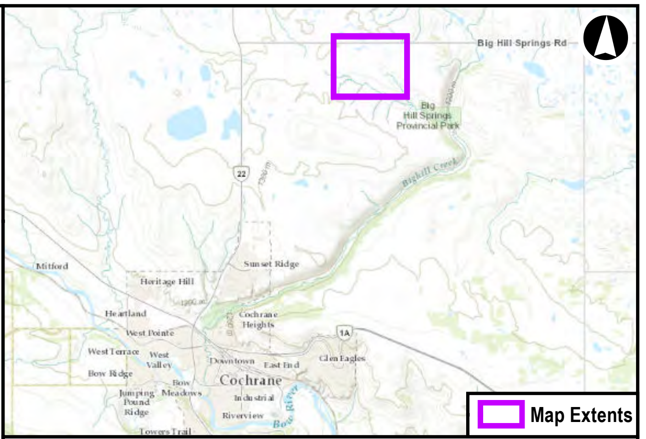
The soil texture of the topsoils ranged from Silt loam, Loam, Silty Clay Loam and Clay Loam. There was good color definition between topsoils (black) over upper subsoils (B Horizons) which were Dark Yellow Brown or Yellow Brown in color.

Topsoils are recommended to be stripped to color change, Black over Dark Yellow Brown to Yellow Brown.

The B horizon (upper subsoils) observed during the soil investigation were Dark Yellow Brown to Yellow Brown in color and had weakly developed sub angular blocky structure to moderate sub angular blocky structure. The depths of the upper subsoils ranged from 15 to 32 cm. The average depth of upper subsoil was 25 cm in thickness within the Project Boundary and had different coloring from the underlying calcareous C horizon (lower subsoils).

The upper subsoils ranged in texture from Loam, Clay Loam to Silty Clay Loam.





Legend

●	Soil Survey Location
▭	Project Boundary

SUMMIT PROJECT

SOIL SURVEY

0 60 120 180 240
Metres

Datum: NAD 1983 UTM Zone 11N

Jan, 2023	PN#: 60687520	1:6,500 * when printed 11"x17"

Figure 1

Data Sources: AltaLIS, NRCan - Canvec
Main Map: Esri World Imagery (4/17/2021)
Key Map: Esri World Topographic Map

Map location: \\na.aecomnet.com\LFS\AMER\Calgary-CACGY3\DCS\Projects\ENV\60687520_Summit_Pit_Project\900_CAD_GIS\920_GIS\02_MXDs\Soil Survey\MXD_Fig1_20230105_SoilSurvey_60687520.mxd
Date Saved: 1/5/2023 User Name: Stephanie.Clark

Table 1: Detailed Soil Profile Description

Project Location	Sec.NW & SW 31-026-03 W5M	Assessor: Jim Burke	Date: December 29 & 30, 2022

Site 1 - SW31	GPS Coordinates: 51.26200 -114.41823					Land use: Pasture		
	Soil Subgroup	Parent Material	Slope			Stoniness Class	Drainage	Surface Expression
			%	Aspect	Position			
	O.BLC	Till	5-9	South	Upper	S0	Well	Gently Und.

Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments	Sample
Ah	0-30	10YR 3/2	Silt Loam	Granular	Friable	<2		Yes
Bm	30-55	10YR 4/4	Silty Clay Loam	w Subangular Blocky	Friable-Firm	<2	Site at the bottom of a coulee	Yes
Ck	55-100	2.5Y 5/3	Clay	Massive	Firm	2-5		Yes

Site 2 - SW31	GPS Coordinates: 51.26024 -114.41419					Land use: Pasture		
	Soil Subgroup	Parent Material	Slope			Stoniness Class	Drainage	Surface Expression
			%	Aspect	Position			
	O.BLC	Till	2-5	Southwest	Mid	S2	Moderately Well - Well	Gently Und.

Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments	Sample
Ap	0-20	10YR 3/2	Loam- Clay Loam	Granular	Friable	2-5		Yes
Bm	20-40	10YR 5/4	Clay Loam	w Subangular Blocky	Firm	2-5		Yes
Ck	40-100	2.5Y 5/2	Clay Loam	Massive	Firm	2-5		Yes
							HCL Reaction in C Horizon	

Site 3 - SW31	GPS Coordinates: 51.25969 -114.41078					Land use: Pasture		
	Soil Subgroup	Parent Material	Slope			Stoniness Class	Drainage	Surface Expression
			%	Aspect	Position			
	caO.BLC	Till	10-15	South west	Mid	S0	Well	Und.

Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments	Sample
Ap	0-40	10YR 3/2	Loam	Granular	Friable	<2		Yes
Bm	40-68	10YR 4/3	Clay Loam- Loam	w Subangular Blocky	Friable	<2		Yes
BCk	68-88	10Yr 4/4	Clay Loam	w Subangular Blocky	Firm	<2		Yes
Ck	88-100	2.5Y 5/3-5/2	Clay Loam	Massive	Firm	<2		Yes

Site 4 - SW31	GPS Coordinates: 51.26172 -114.41055					Land use: Pasture		
	Soil Subgroup	Parent Material	Slope			Stoniness Class	Drainage	Surface Expression
			%	Aspect	Position			
	stcO.BLC	Till	2-4	Level	Upper	S0	Well	Nearly level

Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments	Sample
Ap	0-28	10YR 3/2	Loam	Granular	Friable	<5	Shrubs and Aspen on the top of the hill	Yes
Bm	18-60	10YR 4/4	Loam	w Subangular Blocky	Friable -Firm	5		Yes
Ck	60-100	2.5Y 5/3	Clay Loam	Massive	Firm	5-15	Gravels and cobbles in C Horizon	Yes

Table 1: Detailed Soil Profile Description

Project Location	Sec.NW & SW 31-026-03 W5M	Assessor: Jim Burke	Date: December 29 & 30, 2022
Site 5 - SW 31	GPS Coordinates: 51.26223 -114.41465		Land use: Pasture

	Soil Subgroup	Parent Material	Slope %	Slope Aspect	Slope Position	Stoniness Class	Drainage	Surface Expression
	stO.BLC	Till	2-5	South	Upper	S2	Well	Gently Und.

Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments	Sample
Ap	0-20	10YR 3/2	Clay Loam	Granular	Friable	10-15		Yes
Bm	20-38	10YR 4/4	Clay Loam	w Subangular Blocky	Friable	15-25		Yes
Ck	38-95	2.5Y 5/3- 6/3	Clay Loam	Massive	Firm	15-20	gravelly profile	Yes

Site 6 - NW31	GPS Coordinates: 51.26422 -114.41870	Land use: Hayland

	Soil Subgroup	Parent Material	Slope %	Slope Aspect	Slope Position	Stoniness Class	Drainage	Surface Expression
	stcO.BLC	Stony Till	2-5	Northwest	Upper	S2	Well	Gently Und.

Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments	Sample
Ap	0-18	10YR 3/2	Clay Loam	Granular	Friable	<5		Yes
Bm	18-40	10YR 4/3-3/3	Silty Clay Loam	w Subangular Blocky	Friable	10-15		Yes
st Ck	40-100	2.5Y 5/3-5/2	Clay Loam- Silty Clay Loam	Massive	Firm	15-25	Gravels in C Horizon	Yes

Site 7 - NW31	GPS Coordinates: 51.264703 -114.414999	Land use: Meadow

	Soil Subgroup	Parent Material	Slope %	Slope Aspect	Slope Position	Stoniness Class	Drainage	Surface Expression
	O.BLC	Till	2-3	Level	Lower	S0	Moderately Well	Level

Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments	Sample
Ap	0-28	10YR 3/2	Clay Loam	w Subangular Blocky	Friable	0	Meadow soil	Yes
Bm	28-55	10YR 4/3	Clay Loam	w Subangular Blocky	Firm	0		Yes
Ck	40-90	10YR 5/3	Clay Loam	Massive	Firm	0		Yes
CK2	90-100	2.5Y 5/3-5/2	Clay Loam	Massive	Firm	0		Yes

Site 8 - NW31	GPS Coordinates: 51.26718 -114.41370	Land use: Pasture

	Soil Subgroup	Parent Material	Slope %	Slope Aspect	Slope Position	Stoniness Class	Drainage	Surface Expression
	O.BLC	Till	3-9	South west	Mid	S0	Moderately Well	Und.

Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments	Sample
Ap	0-30	10YR 2/2-3/2	Silty Loam- Silty Clay Loam	Granular	Friable	<1		Yes
Bm	30-60	10YR 5/4	Silty Clay Loam	w Subangular Blocky	Friable- Firm	<1		Yes
Ck	60-100	2.5Y 5/3	Silty Clay Loam - Clay	Massive	Firm	<1		Yes

Table 1: Detailed Soil Profile Description

Project Location	Sec.NW & SW 31-026-03 W5M			Assessor: Jim Burke			Date: December 29 & 30, 2022		
Site 9 - NW31	GPS Coordinates: 51.26928 -114.41014						Land use: Hayland		
	Soil Subgroup		Parent Material	Slope			Stoniness Class	Drainage	Surface Expression
				%	Aspect	Position			
	stO.BLC		Till	3-5	East	Mid	S1	Well	Gently Und.
Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments		Sample
Ap	0-28	10YR 3/2-2/3	Silt Loam	w Subangular Blocky	Friable	<5			Yes
Bm-Bt	28-49	10YR 4/5	Clay Loam-Silty Clay Loam	w Subangular Blocky	Firm- Friable	<5			Yes
Ck	49-95	2.5Y 5/3	Clay Loam-Silty Clay Loam	Massive	Firm	<5			Yes

Site 10 - NW31	GPS Coordinates: 51.26931 -114.41432						Land use: Pasture		
	Soil Subgroup		Parent Material	Slope			Stoniness Class	Drainage	Surface Expression
				%	Aspect	Position			
	stO.BLC		Stony Till	5-9	South west	Mid	S2-S3	Well - Rapidly	Und.
Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments		Sample
Ap	0-20	10YR 3/2	Loam	Granular	Friable	25			Yes
Bm	30-50	10YR 4/4	Clay Loam	w Subangular Blocky	Friable	25-50			Yes
Ck	50-100	2.5Y 5/3	Clay Loam	Massive	Firm	25-50	Very stony and gravelly profile		Yes

Site 11 - NW31	GPS Coordinates: 51.26832 -114.41852						Land use: Pasture		
	Soil Subgroup		Parent Material	Slope			Stoniness Class	Drainage	Surface Expression
				%	Aspect	Position			
	O.BLC		Till	5-9	North East	Mid	S2	Well	Und.
Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments		Sample
Ap	0-25	10YR 3/2	Loam	w Subangular Blocky	Friable	<2	No stones in profile		Yes
Bm	25-40	10YR 4/6	Clay Loam	w Subangular Blocky	Friable	<2			Yes
Ck	40-120	2.5Y 5/3	Clay Loam	Massive	Firm	<2			Yes

Site 12 - NW31	GPS Coordinates: 51.26662 -114.41043						Land use: Hayland		
	Soil Subgroup		Parent Material	Slope			Stoniness Class	Drainage	Surface Expression
				%	Aspect	Position			
	O.BLC		Till	2-5	South West	Mid	S0	Well	Gently Und.
Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments		Sample
Ap	0-28	10YR 3/2	Loam - Silt Loam	Granular	Friable	<2			Yes
Bm	28-50	10YR 4/4	Silty Clay Loam	w Subangular Blocky	Friable	<2			Yes
Ck	50-110	2.5Y 5/3	Silty Clay Loam	Massive	Firm	<2	No stones in profile		Yes

Table 1: Detailed Soil Profile Description

Project Location	Sec.NW & SW 31-026-03 W5M		Assessor: Jim Burke			Date: December 29 & 30, 2022		
Site 13 - NW31	GPS Coordinates: 51.26410 -114.40932					Land use: Hayland		
	Soil Subgroup	Parent Material	Slope			Stoniness Class	Drainage	Surface Expression
			%	Aspect	Position			
	stcO.BLC	Till	2-3	level	Mid	S1	Well - Moderately Well	Nearly level

Horizon	Depth (cm)	Colour	Texture	Structure	Consistence	Coarse Fragment %	Comments	Sample
Ap	0-18	10YR 3/2	Loam	Granular	Friable	<5		Yes
Bmk	18-40	10YR 4/3-3/3	Clay Loam	w Subangular Blocky	Firm	10-15		Yes
Ck	40-100	2.5Y 5/3-5/2	Clay Loam	Massive	Firm	>25	Stones and gravels in C Horizon	Yes

Table 2 - Summary of Soil Profile Description

Site ID	Lab Analysis	GPS		Ground surface General Description						Soil Classification				Topsoil stripping Recommendations					Comments
		Latitude	Longitude	Land Use	Vegetation	Surface Expression	Slope Position	Slope Class	Surface Stoniness	Soil Series	Soils classification	Parent Material	Drainage	A Horizon (cm) Top Soil Depth	Soil Handling Recommendation	Soil Construction Issues and Concerns	B Horizon Depth (cm)	A Horizon Texture/ B Horizon Texture	
1	Yes	51.262	-114.41823	Pasture	Grasses	U	Lower	4	S0	Dunvargen	OBLC	Till	Well	30	Strip topsoil to 30 cm depth	Good color change evident between topsoil and subsoil (Black over Yellow Brown) Deep Topsoils	25	Silt Loam/Silty clay loam	Site at bottom of a coulee
2	No	51.26024	-114.41419	Pasture	Grasses	GU	Mid`	3	S2	Dunvargen	OBLC	Till	Moderately Well - Well	20	Strip topsoil to 20 cm depth	Good color change evident between topsoil and subsoil (Black over Yellow Brown)	20	Loam to Clay loam/Clay loam	Strong rxn in C horizon lower area of the landscape
3	No	51.25969	-114.41078	Pasture	Grasses	U	Mid`	5	S0	Dunvargen	OBLC	Till	Well	40	Strip topsoil to 40 cm depth	Deep topsoils in field Good color change evident between topsoil and subsoil	28	Loam/Clay Loam- Loam	Site is on the mid slope of a hill
4	No	51.26172	-114.41055	Treed	Aspen and shrubs	GU	Upper	2-3	S1	Dunvargen	stOBLC	Stony Till	Well	28	Strip topsoil to 30 cm depth	Deep topsoils in field Good color change evident between topsoil and subsoil	32	Loam / Loam	Stony and cobbly C horizon
5	Yes	51.26223	-114.41465	Pasture	Grasses	GU	Upper	3	S2	stDunvargen	stOBLC	Stony Till	Well	20	Strip topsoil to 20 cm depth	Color change evident between topsoil and subsoilvery gravelly and stony surface	20	Stony Clay Loam/gr Clay Loam	Stony and cobbly A,B and C horizon throughout the profile
6	No	51.26422	-114.4187	Hayland	Forage	GU	Upper	2-3	S2	stcDunvargen	stcOBLC	Till	Well	18	Strip topsoil to 20 cm depth	Good color change evident between topsoil and subsoil stony c horizon profile	22	Clay Loam/ Silty Clay Loam	Stony and cobbly C horizon
7	No	51.264703	-114.414999	Meadow	Grasses	L	Lower	2-3	S0	Dunvargen	OBLC	Till	Moderately Well	28	Strip topsoil to 30 cm depth	Good color change evident between topsoil and subsoil clay loam soils susceptible to compaction if moist	27	Clay Loam / Clay Loam	Meadow soil in low lying area
8	No	51.26718	-114.41337	Pasture	Grasses	U	Mid	3-4	S0	Dunvargen	OBLC	Till	Moderately Well	30	Strip topsoil to 30 cm depth	Good color change evident between topsoil and subsoil Clay Loam soils susceptible to compaction if moist	30	Silty Clay loam to Silt Loam/ Silty Clay Loam	Excellent pasture lands
9	No	51.26928	-114.41014	Hayland	Grasses	GU	Mid	3	S1	Dunvargen	OBLC	Till	Well	20	Strip topsoil to 20 cm depth	good color change evident between topsoil and subsoil clay loam soils susceptible to compaction if moist	21	Silt Loam/clay loam - Silty Clay Loam	Hayfield
10	No	51.26931	-114.41432	Pasture	Grasses	GU	Mid	3-4	S2-S3	stDunvargen	stOBLC	Stony till	Well	20	Strip topsoil to 20 cm depth	Good color change evident between topsoil and subsoil very stony profile difficult to strip clay Loam soils susceptible to compaction if moist	30	Loam/clay loam	Very stony soil profile
11	No	51.26832	-114.41852	Pasture	Grasses	U	Mid	3-4	S0	Dunvargen	OBLC	Till	Well	25	Strip topsoil to 25 cm depth	Good color change evident between topsoil and subsoil clay loam soils susceptible to compaction if moist	15	Loam / Clay Loam	Undulating pasture land no stones in profile
12	Yes	51.26662	-114.41043	Hayland	Grasses	GU	Mid	3	S0	Dunvargen	OBLC	Till	Well	28	Strip topsoil to 30 cm depth	Good color change evident between topsoil and subsoil clay loam soils susceptible to compaction if moist	22	Loam - silty loam / Silty Clay Loam	No stones in profile
13	Yes	51.2641	-114.40932	Hayland	Grasses	2	Lower	2	S1	stDunvargen	stcOBLC	Till	Well - Moderately Well	18	Strip topsoil to 20 cm depth	Good color change evident between topsoil and subsoil clay loam soils susceptible to compaction if moist	22	Loam / Clay Loam	Stones found in the C horizon

Yours sincerely,

James Burke

Jim Burke
Senior Environmental Scientist
AECOM Canada Ltd.
E: jim.burke1@aecom.com

Rick Lauzon; P.Biol, R.P.Bio
Senior Wildlife Biologist
AECOM Canada Ltd.
E: rick.lauzon@aecom.com

References

Agriculture Canada. 1998. The Canadian System of Soil Classification. Soil Classification Working Group. NRC Research Press. Ottawa, Ont. Canada. 187 pp.

Alberta Soil Information Centre. 2016. Alberta Soil Names File (Generation 4) User's Handbook. M.D. Bock (ed.). Agriculture and Agri-Food Canada, Science and Technology Branch, Edmonton, AB.

Appendix A

Element
7217 Roper Road NW
Edmonton, Alberta
T6B 3J4, Canada

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W: www.element.com

Report Transmission Cover Page

Bill To: AECOM Canada Ltd
300-48 Quarry Prk Blvd SE
Calgary, AB, Canada
Attn: Jim Burke
Sampled By: Jim Burke
Company: AECOM

Project ID:
Project Name: Summit
Project Location: NW & SW 31-026-03 W5M
LSD: 31-026-03-W5M
P.O.:
Proj. Acct. code:

Lot ID: **1623790**
Control Number:
Date Received: Dec 30, 2022
Date Reported: Jan 4, 2023
Report Number: 2831444

Contact	Company	Address	
Jim Burke	**AECOM Canada Ltd**	300-48 Quarry Prk Blvd SE Calgary, AB Phone: (403) 660-0365 Email: jim.burke1@aecom.com	Fax:

Delivery	Format	Deliverables
Email - Multiple Deliverables By Lot	PDF	COC / Test Report
Email - Multiple Deliverables By Lot	PDF	Test Report

Notes To Clients:

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Analytical Report

Bill To: AECOM Canada Ltd
300-48 Quarry Prk Blvd SE
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Attn: Jim Burke
Sampled By: Jim Burke
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Project ID:
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P.O.:
Proj. Acct. code:

Lot ID: **1623790**
Control Number:
Date Received: Dec 30, 2022
Date Reported: Jan 4, 2023
Report Number: 2831444

	Reference Number	1623790-1	1623790-2	1623790-3	
	Sample Date	Dec 29, 2022	Dec 29, 2022	Dec 29, 2022	
	Sample Time	NA	NA	NA	
	Sample Location				
	Sample Description	Site 1 / Ah / 0-30 / 15.1°C	Site 1 / Bm / 30-55 / 15.1°C	Site 1 / Ck / 55-100 / 15.1°C	
	Matrix	Soil	Soil	Soil	

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Silt Loam	Silty Clay Loam	Clay	
Sand	50 µm - 2 mm	% by weight	22	20	12	0.1
Silt	2 µm - 50 µm	% by weight	56	51	39	0.1
Clay	<2 µm	% by weight	22	29	49	0.1

Analytical Report

Bill To: AECOM Canada Ltd
300-48 Quarry Prk Blvd SE
Calgary, AB, Canada
Attn: Jim Burke
Sampled By: Jim Burke
Company: AECOM

Project ID:
Project Name: Summit
Project Location: NW & SW 31-026-03 W5M
LSD: 31-026-03-W5M
P.O.:
Proj. Acct. code:

Lot ID: **1623790**
Control Number:
Date Received: Dec 30, 2022
Date Reported: Jan 4, 2023
Report Number: 2831444

Reference Number	1623790-4	1623790-5	1623790-6
Sample Date	Dec 29, 2022	Dec 29, 2022	Dec 29, 2022
Sample Time	NA	NA	NA
Sample Location			
Sample Description	Site 5 / Ap / 0-20 / 15.1°C	Site 5 / Bm / 20-38 / 15.1°C	Site 5 / Ck / 38-95 / 15.1°C
Matrix	Soil	Soil	Soil

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Clay Loam	Clay Loam	Clay Loam	
Sand	50 µm - 2 mm	% by weight	34	26	25	0.1
Silt	2 µm - 50 µm	% by weight	37	41	40	0.1
Clay	<2 µm	% by weight	29	33	35	0.1

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Analytical Report

Bill To:	AECOM Canada Ltd 300-48 Quarry Prk Blvd SE Calgary, AB, Canada	Project ID:		Lot ID:	**1623790**
Attn:	Jim Burke	Project Name:	Summit	Control Number:	
Sampled By:	Jim Burke	Project Location:	NW & SW 31-026-03 W5M	Date Received:	Dec 30, 2022
Company:	AECOM	LSD:	31-026-03-W5M	Date Reported:	Jan 4, 2023
		P.O.:		Report Number:	2831444
		Proj. Acct. code:			

		Reference Number	1623790-7	1623790-8	1623790-9
		Sample Date	Dec 30, 2022	Dec 30, 2022	Dec 30, 2022
		Sample Time	NA	NA	NA
		Sample Location			
		Sample Description	Site 12 / Bm / 28-50 / 15.1°C	Site 12 / Ck / 50-110 / 15.1°C	Site 13 / Bm / 18-40 / 15.1°C
		Matrix	Soil	Soil	Soil

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Silty Clay Loam	Clay Loam	Clay Loam	
Sand	50 µm - 2 mm	% by weight	19	27	29	0.1
Silt	2 µm - 50 µm	% by weight	46	38	36	0.1
Clay	<2 µm	% by weight	35	35	35	0.1

Analytical Report

Bill To:	AECOM Canada Ltd 300-48 Quarry Prk Blvd SE Calgary, AB, Canada	Project ID:		Lot ID:	**1623790**
		Project Name:	Summit	Control Number:	
Attn:	Jim Burke	Project Location:	NW & SW 31-026-03 W5M	Date Received:	Dec 30, 2022
Sampled By:	Jim Burke	LSD:	31-026-03-W5M	Date Reported:	Jan 4, 2023
Company:	AECOM	P.O.:		Report Number:	2831444
		Proj. Acct. code:			

Reference Number	1623790-10
Sample Date	Dec 30, 2022
Sample Time	NA
Sample Location	
Sample Description	Site 13 / Ck / 40-100 / 15.1°C
Matrix	Soil

Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Physical and Aggregate Properties						
Texture			Clay Loam			
Sand	50 µm - 2 mm	% by weight	37			0.1
Silt	2 µm - 50 µm	% by weight	31			0.1
Clay	<2 µm	% by weight	32			0.1

Approved by: RL Neumann

Randy Neumann, BSc
Director

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Quality Control

Bill To:	AECOM Canada Ltd 300-48 Quarry Prk Blvd SE Calgary, AB, Canada	Project ID:		Lot ID:	**1623790**
Attn:	Jim Burke	Project Name:	Summit	Control Number:	
Sampled By:	Jim Burke	Project Location:	NW & SW 31-026-03 W5M	Date Received:	Dec 30, 2022
Company:	AECOM	LSD:	31-026-03-W5M	Date Reported:	Jan 4, 2023
		P.O.:		Report Number:	2831444
		Proj. Acct. code:			

Physical and Aggregate Properties

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Sand	% by weight	29	19	32	yes
Silt	% by weight	42	33	54	yes
Clay	% by weight	29	25	37	yes

Date Acquired: January 03, 2023

Client Sample Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Sand	% by weight	19	18	10	0	yes
Silt	% by weight	33	33	10	0	yes
Clay	% by weight	48	49	10	0	yes

Date Acquired: January 03, 2023

element

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Methodology and Notes

Bill To: AECOM Canada Ltd
300-48 Quarry Prk Blvd SE
Calgary, AB, Canada
Attn: Jim Burke
Sampled By: Jim Burke
Company: AECOM

Project ID:
Project Name: Summit
Project Location: NW & SW 31-026-03 W5M
LSD: 31-026-03-W5M
P.O.:
Proj. Acct. code:

Lot ID: **1623790**
Control Number:
Date Received: Dec 30, 2022
Date Reported: Jan 4, 2023
Report Number: 2831444

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Particle Size Analysis - GS	Carter	*	Hydrometer Method, 55.3	Jan 3, 2023	Element Edmonton - Roper Road

** Reference Method Modified*

References

Carter	Soil Sampling and Methods of Analysis.

Please direct any inquiries regarding this report to our Client Services group.
Results relate only to samples as submitted.
The test report shall not be reproduced except in full, without the written approval of the laboratory.

Full Cost Security Calculation

Summit Pit - West Half Sec. 31 Twp. 26 Rge.3 W5M

1. Cost of Replacing Reclamation Materials

	Volume	Cost/m3	Total	Notes
Surveyed Topsoil Volume		$ 2.50	$ -	NA until 5 Year Report
Surveyed Subsoil Volume				NA until 5 Year Report
Surveyed Overburden Volume		$ 2.50	$ -	NA until 5 Year Report
Surveyed Reject Sand Volume		$ 2.50	$ -	NA until 5 Year Report
		TOTAL	**$ -**	

	Phase 1 Disturbed Area (m2)	Strata Depth (m)	Reject Factor	Volume (m3)	Cost/m3	Total	Notes
Estimated Topsoil Volume	76,026	0.25		19006.5	$ 2.50	$ 47,516.25	Area (m2) includes Mining Blocks A,B,C,and D
Estimated Subsoil Volume	76,026	0.25		19006.5	$ 2.50	$ 47,516.25	
Estimated Overburden Volume	76,026	3.11		236440.86	$ 2.50	$ 591,102.15	
Estimated Reject Sand Volume	0	0	15%	0	$ 2.50	$ -	
	0	3.61		274453.86	**Total**	**$ 686,134.65**	

Total Stockpile Volume	274,453.9	m3
Cost to Replace Stockpile Volume per m3	$ 2.50	m3
Total Cost	**$ 686,134.65**	

2. Cost to Remove Stockpile Area, Crash Banks, De-compact and Final Grading

	Equipment Type	Hours	Hourly Rate	Total Mobilization/ Demobilization	Total	Notes
Cost to Remove Stockpile Area and Stockpiles	John Deere 470 Excavator	20	$ 261.00	$ 4,000.00	$ 9,220.00	2018 Road Builders
	CAT 740 Dump Truck	20	$ 235.00	$ 1,500.00	$ 6,200.00	2018 Road Builders
	CAT 627G - Motor Scraper	20	$ 401.00	$ 3,500.00	$ 11,520.00	2018 Road Builders
Cost to Crash Banks	CAT D8 Crawler Tractor	20	$ 278.00	$ 1,800.00	$ 7,360.00	2018 Road Builders
Cost to De-Compact	CAT D8 Crawler Tractor	20	$ 278.00	$ -	$ 5,560.00	See MOB/DEMOB Above 2016 Road Builders
Final Grading	CAT 140M Grader	20	$ 192.00	$ 1,500.00	$ 5,340.00	2018 Road Builders
	Total	**120**				
				Total	**$ 45,200.00**	

3. Cost of Re-Seeding, Fertilizing, Maintaining Area

	Equipment Type	Hours	Hourly Rate (Equipment or Labour)	Seeding Rate (per acre)	Registered Area (acres)	Fertilizer Application Rate (per acre)	Pesticide Application Rate (per acre)	Fertilizer Cost (per acre)	Herbicide Cost (per acre)	Total
Seed Bed Preparation	Wheel Tractor (Group 2) with Harrow	12	$ 85.00		**18.78**					$ 1,020.00
Seeding Application	Air Seeder/Air Drill/Labour	12	$ 40.00	$ 35.00	**18.78**					$ 1,794.60
Fertilization	Granular Fertilizer Application - Floater Truck/Labour	4	$ 40.00		**18.78**			$ 11.75		$ 601.33
Maintenance (2 Years)	Granular Herbicide Application - Floater Truck/Labour		$ 40.00		**18.78**				$ 9.75	$ 366.21
									Total	**$ 3,782.14**
									Cost per Acre	$ 201.39

Source : Custom Rates 2016 - Seeding (Alberta Agriculture Website)

www.agric.gov.ca

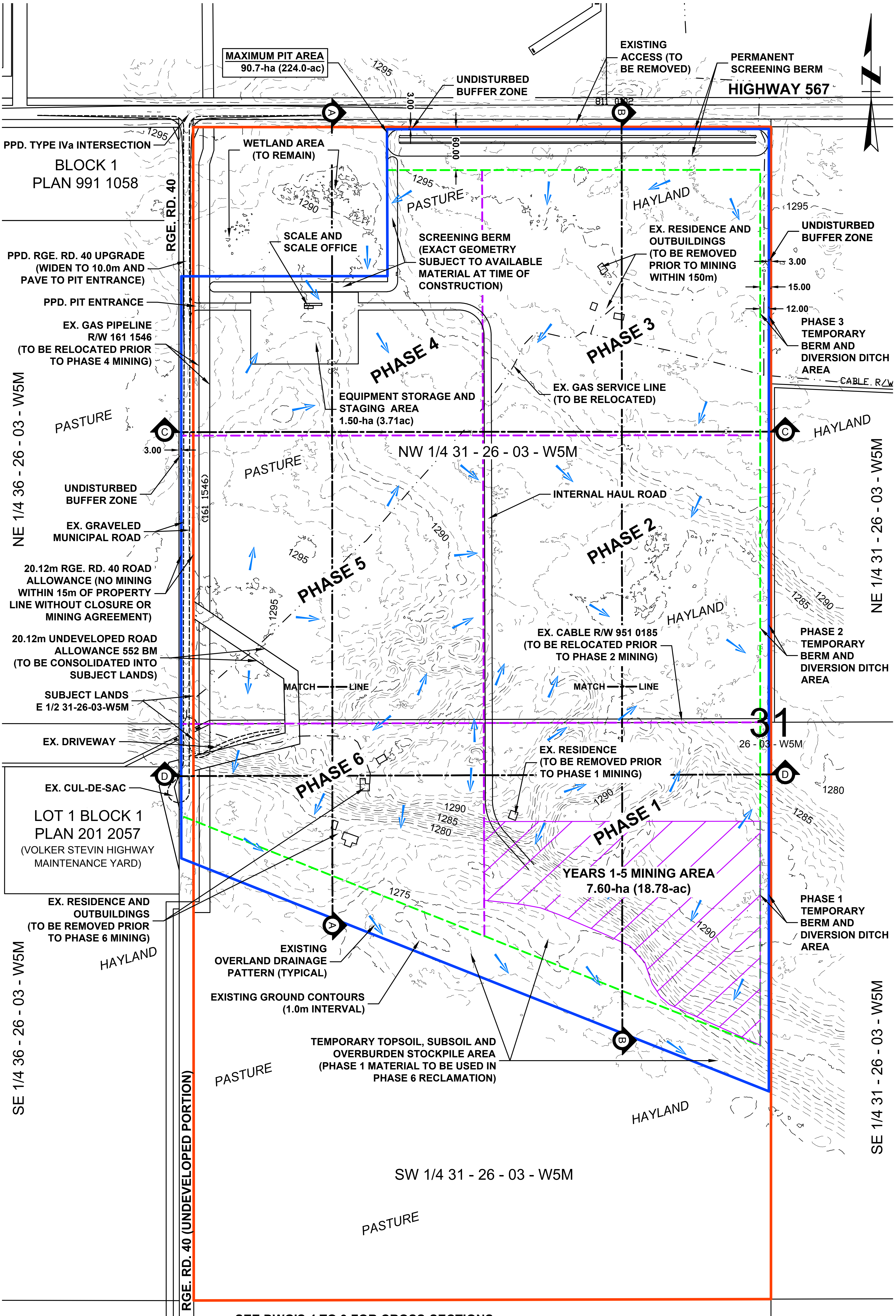
4. Cost of Contingencey/Administration and Removal of Pit Infrastructure (Scale, Scale House, Gates, Fuel Tanks)

Total Estimated Cost of Reclamation	$ 735,116.79
Cost of Contingency	**10%**
Total Cost of Contingency	**$ 73,511.68**

5. Total Security To Be Provided	**$ 808,628.47**

Phase 1 Materials Calculations by Sub-Phase

Basis of calculation	*Calculated from models*	*Calculated from models*	*=A x 0.25*	*=A x 0.25*	*= B – (C+D)*	*=B/A*	*=E/A*	*Calculated from models*	*= H * 0.15*	*= H - I*	*= J x 2*	*=K/A*
Sub-Phase (parts of phase 1)	3D Surface Area	TOTAL Stripping Volume (Overburden & Soils)	TOPSOIL Stripping Volume (@0.25m)	SUBSOIL Stripping Volume (@0.25m)	REMAINING OVERBURDEN Stripping Volume (to top of gravel)	Average TOTAL Stripping thickness (incl. Soils)	Average NET Stripping thickness (excl. Soils)	Gross Mining Volume	Rejects (@15%)	Net Mining Volume	Net Mining Tonnes (@ 2t/m^3)	Average Mining Thickness (to 1m above maximum groundwater)
A	12,970 m^2	4,387 m^3	3,242 m^3	3,242 m^3	0 m^3	0.34 m	0.00 m	118,236 m^3	17,735 m^3	100,500 m^3	201,001 t	9.12 m
B	17,705 m^2	80,241 m^3	4,426 m^3	4,426 m^3	71,388 m^3	4.53 m	4.03 m	263,848 m^3	39,577 m^3	224,271 m^3	448,542 t	14.90 m
C	12,864 m^2	45,817 m^3	3,216 m^3	3,216 m^3	39,385 m^3	3.56 m	3.06 m	91,215 m^3	13,682 m^3	77,533 m^3	155,066 t	7.09 m
D	32,487 m^2	98,331 m^3	8,122 m^3	8,122 m^3	82,087 m^3	3.03 m	2.53 m	597,516 m^3	89,627 m^3	507,889 m^3	1,015,777 t	18.39 m
E	30,366 m^2	95,397 m^3	7,592 m^3	7,592 m^3	80,214 m^3	3.14 m	2.64 m	592,349 m^3	88,852 m^3	503,496 m^3	1,006,993 t	19.51 m
F	22,032 m^2	60,550 m^3	5,508 m^3	5,508 m^3	49,535 m^3	2.75 m	2.25 m	396,056 m^3	59,408 m^3	336,647 m^3	673,294 t	17.98 m
Total	***128,424 m^2***	***384,723 m^3***	***32,106 m^3***	***32,106 m^3***	***322,609 m^3***	***3.00 m***	***2.51 m***	***2,059,219 m^3***	***308,883 m^3***	***1,750,336 m^3***	***3,500,673 t***	***16.03 m***



SEE DWG'S 4 TO 9 FOR CROSS-SECTIONS

PLAN LEGEND

▬	MAXIMUM PIT AREA
▬ ▬	CURRENT ACTIVE PIT AREA
▬ ▬	EXTRACTION SETBACK
▬ ▬	MINING PHASE BOUNDARY
TS	TOPSOIL STOCKPILE
SS	SUBSOIL STOCKPILE
OB	OVERBURDEN STOCKPILE

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:5000
0 25 50 100 200 300 m

1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

EXISTING GROUND

BADKE CONSULTING LTD.
(403)982–7773

DRAWN: BCD
CHK'D: JDB
FILE #: 1638.M1
DATE: NOV. 2021
DWG. 2
REV. 23/01/05 1

Appendix R

Project Mitigation Measures

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Technical Memorandum

To:	Alberta Environment and Parks Terrina Perley, CET Senior Land and Water Specialist	**From:**	SLR Consulting (Canada) Ltd.
AEP File Nos:	DAPP0001717 ECM 00481044 EPEA 00478753	**Project:**	Mountain Ash Limited Partnership Summit Project
		Date:	September 22, 2022

Re: Response to Supplemental Information Request – C. *Environmental Protection and Enhancement Act*, Code of Practice Application Requirements

SIR No. C1:

Statements within the report "Code of Practice for Pits in Alberta Application, dated Dec 2021" (COP) indicate that impacts are mitigated by best management practices under the Code of Practice for Pits (Alberta 2004). Examples include, (not an exhaustive list) pg. 218, Section 5.3, pg. 18, pg. 195, pg. 218, Section 5.3. The Code of Practice for Pits was not designed as a best management practice tool. Any statement within the application that uses this reference requires revisiting. Mitigative measures are required to be site specific, definitive in relation to science (rather than opinion), provided within the application, and address potential impacts to all receptors. Monitoring can be part of the mitigative plan but are not considered adequate mitigative measures alone.

Response:

SLR referenced the COP, or the guide to the COP in five instances in the application documentation. The relevant sections are as follows (where the COP is referenced with respect to mitigation):

- Section 5.3 of the main document.
- Appendix I – Hydrogeological Assessment Report[1]
    - Executive summary - here the reference is general and SLR has stated that other mitigation measures including those contained in the following report are used in addition to the best management practices outlined in the code of practice for pits.
    - Section 1.4 - this refers to the objectives of the Hydrogeological assessment report and is specific to the requirements in the COP.
    - Section 5.3 Potential Impacts on Groundwater and Surface Water Quality.

The intent in both Section 5.3 of the COP and Section 5.3 of Appendix I was to highlight that the COP has been used to develop the minimum requirements but that specific mitigation measures are outlined in the following reports:

- The Erosion and Sedimentation Control Plan (SLR 2021).
- The Stormwater Management Plan (SLR 2021).

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[1] SLR 2020. Hydrogeological Assessment Report prepared for Mountain Ash Limited Partnership. SLR Consulting (Canada) Ltd. January 2020.

- The Groundwater Management Plan (SLR 2021).
- The Stripping and Grade Plan (SLR 2021).
- The Mining and Excavation Plan (SLR 2021).
- Post Mining and Reclamation Plan (SLR 2021).

In general, SLR has not relied on the COP for its mitigation and monitoring requirements. The COP and the associated guide were however used to identify the minimum requirements associated with mitigation, monitoring and reclamation. SLR and Mountain Ash Limited Partnership (MALP) have developed unique mitigation, monitoring and reclamation measures that are Project specific and appended as Appendix A to this response.

Sincerely,

Carolyn Carruthers

Carolyn Carruthers
SLR Project Manager

Statement of Limitations

SLR is relaying information obtained during work conducted for Mountain Ash Limited Partnership. SLR accepts no responsibility or liability for the use of this information for any purpose by any other entity except provincial review agencies. The regulatory agency (or agencies) can rely on the information in this document for the purposes of review, comment, and regulatory approvals.

Appendix A Mitigation Table

Discipline	Mitigation
Wildlife	• Project activities will develop in phases of 8 ha to 16 ha. • Reclamation is progressive (meaning as portion of a phase are depleted, and other portions of the phase is opened or stripped, material from the new portion of the phase or stripping's from this phase, get placed in the previous excavation area which is being reclaimed). • Project clearing and site preparation activities are planned to occur outside the migratory breeding bird nesting period, which is April 14 to August 28 (Nesting Zone B4; ECCC 2018) in this area and the nesting period for raptors, which is March 1 to August 31 depending on the species. If site preparation and stripping activities occur within the migratory breeding bird period or nesting period for raptors, a nest sweep conducted by a qualified biologist will be conducted within seven days prior to these activities specifically pertaining to the portion of the phase to be disturbed or prepared. • Conduct a wildlife sweep before clearing and reclamation activities for each Project Phase or new disturbance to identify new wildlife habitat features (e.g., raptor nests) and update the mitigation plan as needed. Results of these surveys, with updated mitigation measures, as needed, will be provided to Alberta Environment and Parks (AEP) prior to any clearing activity. • If an active nest or den is observed during operations, a qualified biologist will be contacted to discuss setbacks and mitigation measures for the active nest or den. Results and mitigation strategy will be provided to AEP. • Do not harass, hunt, trap, or feed wildlife or livestock on the Project site and surroundings. • Train workers to report wildlife incidents such as presence of wildlife on the construction site or during Project operation, or wildlife mortality via collision with a vehicle. • On-site garbage will be disposed of in appropriate storage containers to not attract wildlife. • Maintain the perimeter fence to deter wildlife accessing the Project site. • Effective access control to restrict unauthorized traffic into the Project. • Sloping of excavation will be done to minimize nesting by bank swallows. Stop excavation work if bank swallows colonize a slope in the excavation area. • Manage on site surface water to limit wildlife habitat, including shorebird and waterfowl nesting habitat. • Internal speed limit is reduced in the Project area to reduce wildlife/vehicle conflicts and fugitive dust emissions • Prohibit any unauthorized harvesting of any natural vegetation on the Project site by workers. • Manage dust and noise emissions (SLR 2021d) to minimize disturbance to wildlife around the Project site, see below.

Discipline	Mitigation
Traffic	• Hauling activities will be monitored to minimize the impact on other road users, with no staging permitted along or immediately adjacent to Highway 567 or RR 40 • The site access intersection will be constructed as a Type IVa intersection to accommodate the acceleration and deceleration properties of large haul vehicles. It is important to note that previous studies indicate a Type II intersection would support site generated traffic on the opening day; however, MALP has committed to a Type IVa intersection to provide longer acceleration and deceleration lanes and turning lanes to maintain traffic operations along Hwy 567 for local traffic and passenger vehicles • Safety protocols provided by MALP to ensure driver behavior is acceptable to the given site context, with complaints regarding driver behavior investigated and mitigated in an appropriate manner. • Track-out debris onto municipal and provincial will be monitored and inspected daily. If required, street sweeping will be completed.
Erosion and Sediment	• Permanent control • 60 m Buffer from north property line/boundary containing a berm and landscaped buffer • 15m buffer from east property line/boundary will containing a vegetated temporary berm. • Temporary control measures include: • Perimeter silt fence primarily along south and east boundaries of Phase 1 • Silt fence along haul route adjacent to wetland preservation area • V-ditch/berm with check dams to provide some runoff storage in unprotected areas • Run-off control (diversion ditch) along west and north boundaries to intercept drainage from upslope areas • Scour matting will be used, if required • Stormwater controls (conveyance ditches, sumps and settlement ponds) to convey surface runoff to ponds to allow sediments to settle adequately before re-entering the local groundwater system. • Rolled erosion control product in diversion and conveyance ditches to prevent erosion and reduce potential for downslope sedimentation, as required • Check dams in diversion and conveyance ditches to reduce runoff velocity, as required. • Daily inspections of stormwater infrastructure during operating periods will be performed by site personnel • Hydro-mulch/tackifier on all overburden areas and other disturbed areas that need to be stabilized beyond the short-term • Good housekeeping (gravel access pad) to reduce dirt/mud tracking onto adjacent paved roadways • Halt operations during significant or severe rains/snowfall events. • Conduct cleaning, fueling, and servicing of all equipment at a safe distance (preferably 100 m) on fine-grained glacial till, away from watercourses, wetlands or environmentally sensitive areas.

Discipline	Mitigation
	• Ensure all vehicles and equipment brought onsite are free of debris, grease, oil, mud or leaks. • dust control applications, includes watering and the application of Calcium Chloride Calcium used on internal haul routes and other gravel surfaces that accommodate common vehicle movements and traffic during operations
Weeds	• Environmental professionals supporting the site will assess and monitor vegetated area for invasive weeds. This includes the list of invasive species provided by RVC and species listed under the Weed Control Act. • Onsite staff during the initial stripping and grading phases will identify different types of weeds, no spray zones (i.e., water including a buffer area), and different control methods. • Weed control methods may include a combination of or any one of the following: • Chemical (e.g., herbicides) • Mechanical (e.g., mowing prior to flowering) • Manual (e.g., hand pulling prior to seed set) • Grazing and/or cultivation (may be limited due to land use) • Phases will be reclaimed to equivalent land capability using only certified weed free seed mix where seeding is required. • Monitor re-vegetation of the Project site and re-seed where necessary.
Surface Water Quality and Quantity	• The site will be developed in phases to minimize the working area and allow for progressive site restoration, with each working area being between 8 to 16 ha in size. These factors will reduce the potential for suspended solid generation. Settlement ponds commissioned at the start of the development in combination with infiltration sumps will manage all surface runoff generated during operations offsite and collect the suspended solids before any water is infiltrated back into the ground. • Incident rainfall onto the extraction areas within the glacial till horizon will be locally managed (due to limited permeability / infiltration capacity of the till) to convey rainfall to a temporary stormwater ponding areas. • The exposure of the till during excavations will be temporary until the underlying sands and gravels are reached. Once the excavation enters the sand and gravel, incident rainfall is readily infiltrated thus no management of precipitation within the extraction areas is required. Within the extraction area there will be very little fine particulate, as the site is clean sand and gravel. • The overburden removal areas border on the active extraction area. Very fine particulate has the potential to contribute to turbidity of water; however, overburden removal areas will be separated from the extraction area by silt fencing to permit overburden removal. Should the occasional breach occur, which will be repaired based on daily inspections, calculations show that the slow movement of groundwater allows any fines to settle/filter in the order of a few tens of meters from the extraction (pit) area. • Progressive reclamation following exhaustion of each aggregate extraction phase will involve recontouring, soil placement and revegetation, and will promote the formation of a temporary low-lying wet area which intercepts surface water drainage during periods of heavy precipitation in the southeast corner of the Phase 1 extraction area.

Discipline	Mitigation
	• Surface runoff intercepted within the Project boundary will be managed through infiltration. There will not be surface discharge of stormwater, thus removing the risk of adverse effects to water quality in surface water bodies of the surrounding environment. • Install perimeter (grassed / lightly vegetated) ditches (swales) at the outer foot of the screening berms / overburden stockpiles to route 'dirty' runoff (initial treatment) from the berms to appropriately sized settlement / attenuation ponds (secondary treatment). Shallower longitudinal gradients in the swales would encourage longer residence times, lower velocities and thus improve treatment effectiveness. • Interception ditches are proposed upslope of the Surface Water Management Phases to prevent stormwater runoff from the up-gradient catchment entering the extraction areas. This water is considered 'clean' and therefore does not require treatment; instead, it is routed around the Surface Water Management Phases via diversion ditches and allowed to disperse overland (via a series of shallow excavated diffusion channels). This provides hydrological continuity between the upslope and downslope of the relevant Surface Water Management Phases. • A temporary locally created sump excavated within the extraction area to collect clean runoff upslope of the Surface Water Management Phases during the development of Phases 2, 3 and 4. The temporary sump will also collect water from Pond C during the Phase 3 extraction operation. The temporary sump is to be located in a low topographic spot within the extraction area and is required due to topographic constraints that impede gravity flow of clean water away from the extraction area. Water collected in the temporary sump will either infiltrate or be pumped to the temporary diversion ditch located east of Phase 1, which conveys clean water to the perimeter of the extraction area for direct release through infiltration. Surface water management features (i.e., swales / settlement ponds / sumps) have been designed to accommodate the design 1:100-year rainfall event.
Groundwater Quality and Quantity	• Restrict the excavation to no less than 1 metre (m) above the high-water table. This ensures no stirring up of the groundwater. Progressive temporary groundwater monitors (piezometers) will be used to monitor actual water table position as excavation begins to encroach on the 1m above GWT. • Use external settlement ponds for those stormwaters that cross the fine-grained overburden. The decant water is introduced to infiltration lagoons, which maintains and temporarily enhances groundwater recharge, thereby ensuring no adverse water quantity impacts (i.e., depletion). • Equipment maintenance and refueling will be undertaken on existing overburden areas (4 m to 6 m of fine-grained till) and will be located by the scale on Phase 4. When equipment is not being used it will have drip trays located beneath it to prevent leakage to the ground. • Fuel will be stored in Phase 4 in double-walled above ground storage tanks which are certified by the Petroleum Tank Management Association of Alberta (PTMAA). • The operational area will be kept to a minimum to reduce potential impacts, so no more than 16 ha of disturbance, i.e., active mining or reclamation, will occur at any time as per the approved development authority.

Discipline	Mitigation
	• As each phase of the planned excavation area is depleted, it will be progressively rehabilitated with the replacement of the overburden, subsoil and topsoil. • A Groundwater monitoring program will continue during the life of the Project
Wetlands	• Wetland avoidance: MALP is avoiding 2 wetlands in the northwest corner of the Site Location, Water bodies 19 and 20, and the entire southern portion of the Property Boundary, as shown Figure 1. Water bodies 19 and 20, comprise 1.393ha of the total 1.880 ha wetland area, or 74%, within the Site Location and are B value wetlands. These wetlands comprise 5.572 ha of wetland replacement area within the Site Location. • Wetland minimization: Impacts to Water body 1 are minimized by removing a portion, 0.199 ha, of the wetland within the Site Location. Water body 1 is hydrologically isolated and the remaining 32% of the total wetland area retained is expected to function as a wetland post construction. In accordance with the Alberta Wetland Mitigation Directive7, the above proposed minimization is anticipated to maintain the natural conditions and function of the wetland. • Wetland replacement: In accordance with the Alberta Wetland Mitigation Directive7, an in-lieu replacement fee is proposed for the permanent impacts to Wetlands 1, 13, 17, and 18.
Landscape Plan	• A permanent buffer and berm area will run along the north boundary of the Project. The buffer will run the length of the north boundary until reaching the NE corner of the wetland avoidance area. This permanent berm will be constructed entirely within the 60m buffer. • A temporary wetland screening berm will be constructed around the wetland avoidance area in the NW corner of the Property boundary. Exact geometry subject to available material at time of construction. This berm will remain in place until Phase 4 mining, at which time the scale / laydown area will be relocated within a portion of the depleted Phase 3 • East side of the Project will include a temporary, vegetated topsoil berm.
Air Quality / Dust Management	• Calcium Chloride ($CaCl_2$) will be applied to unpaved roads for dust suppression • Project Access road and a portion of scale area will be paved • Conveyor drop heights will be reduced • Crusher will be enclosed with a shroud • Surface watering on active pit surfaces • No crushing zone 190 m from the east boundary and 140 m from the north boundary of the Project during Phases 1,2, 3, and 4 • 60 m buffer with a permanent screening berm along the north boundary of the Project.
Noise	• Daytime operations only. Monday to Friday 7 am to 7 pm, Saturday 7 am to 5pm, and no activity on Sunday or statutory holidays. • Excavation will occur below grade (18 – 26 m) and into the face of the aggregate deposit. This includes depth of the overburden. • Sight and sound berms will be constructed on the north and east boundaries of the Project. • The crusher will be offset by 190 m from the east boundary and 140 m from the north boundary.

Discipline	Mitigation
	• An acoustic shroud will be utilized around the crusher to control sound. • Minimal conveyor drop heights used to minimize impulsive sound. • Low sound level and broadband reverse alarms meeting applicable safety regulations will be used on all equipment. • Staff will be trained on low sound generating techniques. • Equipment will be maintained regularly to ensure that it does not increase in sound level due to wear and tear. • Regular and continuous sound monitoring will be conducted. • There will be a variation in the direction that traffic arrives and leaves the Project site.

Appendix S

Wetland Impact Assessment Report & Wetland Replacement Fee

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Wetland Assessment and Impact Report

NW AND SW 31-026-3 W5M

Mountain Ash Limited Partnership

1945 Briar Crescent NW
Calgary, AB T2N 3V6

Prepared by:

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SLR Project No:

212.06650.00003

May 10, 2023

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Appendices

1.0 Project Information

Mountain Ash Limited Partnership (MALP) is planning to develop the Summit Project (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County, Alberta (Figure 1, Appendix A). The Project Boundary encompasses approximately 91 ha excluding existing road rights-of-way, with an extraction area of approximately 80 ha. This land is currently owned by 1410266 Alberta Ltd. (a general partner of MALP). MALP received land use and a master site development plan approval for the Project on March 2, 2021 (Land Use Bylaw C-8051-2020).

SLR Consulting (Canada) Ltd. (SLR) was retained by MALP to complete a Wetland Assessment and Impact Report (WAIR) for the Project.

2.0 Wetland Assessment Overview and Results

The wetlands were classified in accordance with the *Alberta Wetland Classification System* (GoA 2015a) and identified and delineated using methods provided in the *Alberta Wetland Identification and Delineation Directive* (GoA 2015b). This WAIR was prepared following the *Alberta Wetland Assessment and Impact Report Directive* (GoA 2017).

Since the original *Water Act* Application submission, the Project Boundary has been refined and Supplemental Information Requests (SIRs) from Alberta Environment and Protected Areas (EPA) have been provided. As a result, additional water bodies have been included, some have been reclassified, one has been re-delineated, and some water bodies are now outside of the Project Boundary, but within the Area Assessed.

A total of 23 water bodies were assessed as part of this WAIR. Nineteen water bodies were identified partially or fully within the Project Boundary, including 7 wetlands. Four water bodies fall outside of the Project Boundary but are within the Area Assessed, including 3 wetlands. MALP proposes to partially or fully remove 15 of these 23 water bodies, including 7 wetlands and avoid 8 of these 23 water bodies, including 3 wetlands. These 23 water bodies, and proposed impacts are described in Table 1 and

Table 2 below, and shown in Figure 2, Appendix A

The 19 water bodies identified within the Project Boundary are described in Table 1.

Table 1: Water Bodies Located within the Project Boundary

Water body ID	Classification	Area (ha)	Permanent Impact (ha)
Water body 1	Seasonal Graminoid Marsh	0.291	0.199
Water body 4	Ephemeral Water body	0.028	0
Water body 5	Dugout	0.067	0
Water body 6	Ephemeral Water body	0.048	0.048
Water body 7	Ephemeral Water body	0.055	0
Water body 8	Ephemeral Water body	0.058	0.058
Water body 9	Ephemeral Water body	0.028	0.028
Water body 10	Ephemeral Water body	0.063	0.063

Water body ID	Classification	Area (ha)	Permanent Impact (ha)
Water body 11[1]	Temporary Graminoid Marsh	0.009	0.009
Water body 12	Ephemeral Water body	0.014	0.014
Water body 13	Temporary Graminoid Marsh	0.023	0.023
Water body 14[1]	Temporary Graminoid Marsh	0.028	0.028
Water body 15	Ephemeral Water body	0.017	0.017
Water body 16[1,2]	Temporary Graminoid Marsh	0.046	0.046
Water body 17	Temporary Graminoid Marsh	0.118	0.118
Water body 18	Temporary Graminoid Marsh	0.050	0.050
Water body 21[3]	Ephemeral Water body	0.020	0.020
Water body 22[3]	Ephemeral Water body	0.041	0.041
Water body 23[3]	Ephemeral Water body	0.143	0

Notes:

[1] Water bodies reclassified to meet the requirements of the SIRs.

[2] Water body re-delineated to meet the requirements of the SIRs.

[3] Water bodies added based on the refined Project Boundary and to meet the requirements of the SIRs.

Table 2: Water Bodies Located outside of the Project Boundary

Water body ID	Classification	Area (ha)[1]
Water body 2	Ephemeral Water body	0.008
Water body 3	Temporary Graminoid Marsh	0.045
Water body 19	Temporary Graminoid Marsh	0.676
Water body 20	Temporary Graminoid Marsh	0.722

Notes:

[1] The water body area is proposed to be avoided.

3.0 Wetland Desktop Data Review

A comprehensive desktop delineation with field verification (Pathway 5) was conducted due to the historical agricultural disturbance (GoA 2015b) within the Project Boundary since 1953.

A preliminary desktop review was conducted prior to field surveys in accordance with the *Alberta Wetland Identification and Delineation Directive* (GoA 2015a).

3.1 Natural Subregion

The Project is located within the Foothills Parkland Natural Subregion which is characterized by short, cool summers where hay or feed crops are the dominant main crops. Where seepage zones or low areas are present, aspen forests with understories of snowberry (*Symphoricarpos albus*), silverberry (*Elaeagnus commutata*), white meadowsweet (*Spiraea alba*), prickly rose (*Rosa acicularis*), saskatoon (*Amelanchier alnifolia*) and a diverse array of herbs on well to imperfectly drained Black and Dark Gray Chernozems can be found (Natural Resources Committee 2006).

3.2 Soils

The underlying parent material of the region is moderately to strongly calcareous, mixed Continental and Cordilleran till (Alberta Soil Information Centre 2016). Fertile loam to clay loam Orthic Black Chernozemic soils are extensive, with Gleysolic soils present in poorly drained and lower slope positions expected (Alberta Agriculture and Forestry 2016). The Dunvegan soil series, a fertile Orthic Black Chernozem formed on glacial till parent material, was identified across the Area Assessed, with the gleyed variant (Dunvegan-GL) identified in depressional areas.

3.3 Alberta Conservation Information Management System

The Alberta Environment and Parks (AEP) Alberta Conservation Information Management System (ACIMS; GoA 2019a) database was also used to determine if any sensitive species had been recorded in the area.

ACIMS was searched for parks or protected areas within the area of the Project. No Parks, Protected Areas or Crown Reservations were identified (GoA 2019a).

3.4 Wildlife and Wildlife Habitat

Wildlife composition within the Foothills Parkland Natural Region closely resembles species found in the Rocky Mountain Natural Region. Birds include dusky flycatcher, white crowned sparrow, clay-colored sparrow, blue grouse, yellow warbler, alder flycatcher, MacGillivray's warbler (Alberta Wilderness Association 2015). Habitat is excellent for elk and moose, and where watercourses are present, bull trout habitat can also be found (Alberta Wilderness Association 2015)

A review of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the *Species at Risk Act* (SARA; GoC 2021) was conducted to determine if any federally listed species at risk (SAR) may be present within or near the Project. The AEP Fisheries and Wildlife Management Information System (FWMIS) Fish and Wildlife Internet Mapping Tool (FWIMT; GoA 2019b) was accessed to determine if any provincially listed SAR and other inventory data were available for the area.

A review of the FWMIS database indicated that five provincially Sensitive species (GoA 2021) have been observed in the area of the Project (Appendix C) including:

- Great blue heron;
- Sora;
- Least flycatcher;

- Eastern kingbird; and
- Barn swallow.

Of these five bird SAR, the barn swallow is also federally listed as Threatened by COSEWIC and SARA (GoC 2021).

3.5 Watercourses

No mapped watercourses were identified within the Project Boundary (GoA 2019b).

3.6 Historical Aerial Photograph Review

Historical precipitation data was assessed to aid in selection of representative historical aerial images (Alberta Agriculture and Forestry 2019). The images provide historical information on water levels or wetland permanence across years and across variable climatic conditions. Precipitation trends are identified in Table 3. Air photos selected included:

- August 14, 1953
- September 19, 1962
- May 31, 1974
- April 26, 1980
- May 7, 1994
- September 28, 2008
- Mid-Summer 2016

Climate data was accessed using the *Interpolated Weather Data Since 1961 for Alberta Townships* (Alberta Agriculture and Forestry 2019) to determine monthly precipitation and the total annual precipitation for the corresponding years. This information was used to determine permanence by determining if a wetland only had evidence of water temporarily, seasonally, semi-permanently or permanently. Corresponding climate data is as follows:

- 1953 – no data available
- 1964 – 473.68 mm
- 1974 – 387.42 mm
- 1980 – 471.41 mm
- 1994 – 506.88 mm
- 2008 – 662.5 mm
- 2016 – 441.54 mm

Rainfall was consistent over each decade with the 2000s being slightly wetter. Where drier years occurred, correlated historical air photos which were reviewed, showed no standing water, and in some cases, cultivation.

Review of the available air photos between 1954 and 2016 and corresponding climate data revealed that water bodies 1, 2, 3, 4, 11, 17, 18, 19, and 20 show historical seasonal water presence. Of note, wetland

5, which was assessed in 2019 as a dugout, may have previously been a temporary or seasonal graminoid marsh. The excavation of the wetland likely occurred between 2008 and 2016 as determined from the available air photos.

Temporary wetlands typically dry out by late spring and have a hydroperiod that is flooded every year for a short period of time (one to four weeks) after snowmelt or a heavy rainfall, but otherwise lacks surface water (GoA 2015a, 2015b, 2016). Seasonal wetlands typically dry out by the end of the summer and have a hydroperiod that is flooded every year for most of the growing season (GoA 2015a, 2015b, 2016). Temporary and seasonal wetlands may both be dry year-round during periods of drought and are sometimes tilled and seeded for agricultural purposes (GoA 2015a, 2016). This is consistent with what is observed in the historical arial images.

The shape, size, and permanence of the water bodies are largely inconsistent over time, except for Water bodies 1, 5, 19 and 20. Additionally, there is obvious drainage on the 1974 and 1980 aerial photographs. This feature is less obvious on the 1994 aerial photograph and appears to have an altered path.
The drainage is not evident on the 2008 and 2016 aerial photographs. These inconsistencies are likely the result of the persistent agricultural activities since at least 1953. Changes to the hydrology within the Project Boundary is expected due to the persistent anthropogenic disturbances. Discing, tilling, and harvesting activities all lead to soil erosion and sediment deposit, which in turn changes the hydrology of the landscape.

Table 3: Precipitation Trends Associated with Available Air Photo Imagery

Photo Date[1]	Season	Yearly Precipitation (mm)[2]	Monthly Precipitation (mm)[2]	Daily Precipitation (mm)[2]	Comments
1953 Figure 3[3]	Late summer	No data	No data	No data	Water bodies 1-6, 11, 17-20, and 23 appear to contain water. Water body 7 is indistinct from the surrounding landscape. The remaining water bodies are distinct and/or slightly distinct from surrounding cultivation.
1962 Figure 4	Late summer	473.68	August –wettest (89.61) November – driest (9.01)	Driest – 0 Wettest – 36.42	Water bodies 2, 3, 5, 12, and 17-20 appear to contain water. Water body 7 is indistinct from the surrounding landscape. The remaining water bodies are distinct and/or slightly distinct from surrounding cultivation.
1974 Figure 5	Early spring	387.42	May –wettest (85.07) February – driest (6.86)	Driest – 0 Wettest – 39.16	Water bodies 1-5, 8 12-20, and 22-23 appear to contain water. Water body 7 is indistinct from the surrounding landscape. The remaining water bodies are distinct and/or slightly distinct from surrounding cultivation
1980 Figure 6	Late spring	471.41	May –wettest (101.38) February – driest (12.85)	Driest – 0 Wettest – 46.24	All water bodies appear to contain water except for water bodies 6,7 18 and 21.
1994 Figure 7	Mid-summer	506.88	June –wettest (123.69) December – driest (13.16)	Driest – 0 Wettest – 33.13	Water bodies 1-5, 8-11, 13-14, 17, 19-23 appear to contain water. Water bodies 6 and 7 are indistinct from the surrounding landscape. The remaining water bodies are distinct and/or slightly distinct from surrounding cultivation.
2008 Figure 8	Early fall	662.5	May –wettest (183.41) March – driest (7.42)	Driest – 0 Wettest – 49.82	All water bodies appear dry, and most are indistinct from the surrounding landscape.
2016[4] Figure 9	Late summer	441.54	July –wettest (153.9) February – driest (1.58)	Driest – 0 Wettest – 28.28	All water bodies appear dry and most are indistinct from the surrounding landscape with the exception of water body 5, which has been excavated as a dugout.

Notes:

[1] Air Photo Distribution Services (AEP 2019b) | [2] Alberta Agriculture and Forestry (2019) | [3] Figures in Appendix A 4ESRI (2016)

4.0 Field Surveys

Field surveys were conducted on June 3-5, 2019, and August 16, 2022, to confirm the presence of water bodies identified within the Project Boundary during the desktop review. Wetland classification, identification, and delineation was completed in accordance with the *Alberta Wetland Classification System* (GoA 2015a) and the *Alberta Wetland Identification and Delineation Directive* (GoA 2015b). The boundaries of the wetlands were delineated on foot during field surveys through observing hydrophytic vegetation, wetland soil indicators, and hydrological indicators, in accordance with the *Alberta Wetland Identification and Delineation Directive* (GoA 2015b).

In addition to the wetland field surveys, incidental wildlife observations were recorded.

4.1 Identified Wetlands

A total of 23 water bodies were assessed for the Project, as described in Table 1 and

Table 2 above, and shown in Figure 2, Appendix A. Of these 23 water bodies, 10 are wetlands and 13 are non-wetlands, as follows:

- 1 was classified as a Seasonal Graminoid Marsh (M-G-III);
- 9 were classified as Temporary Graminoid Marshes (M-G-II);
- 12 were classified as Ephemeral Water bodies that do not meet the criteria to be considered wetlands; and,
- 1 was identified as a dugout.

The 10 wetlands are hydrologically isolated and receive water input from stormwater within their catchment areas (Figure 3, Appendix A). The wetlands have been directly modified by agricultural activities resulting in disturbed soil structure and modifications both to natural hydrology and vegetation.

Vegetation was utilized as the primary wetland indicator and were supplemented with soil indicators. No rare plants were found onsite. Results of vegetation and soil indicators for each of the wetlands are provided in Appendix B.

4.2 Alberta Wetland Rapid Evaluation Tool – Actual

The Alberta Wetland Rapid Evaluation Tool-Actual (ABWRET-A) functional value for wetlands was submitted to AEP on June 23, 2019. The evaluation form submission and assessment scores are provided in Appendix E.

The ABWRET-A values for each of the wetlands identified within the Assessed Area are described in Table 4.

Table 4: ABWRET-A Values

Water body ID	Classification	ABWRET-A Value	Total Area (ha)	Replacement Area (ha)
Water body 1	Seasonal Graminoid Marsh	B	0.291	1.164
Water body 3	Temporary Graminoid Marsh	B	0.045	0.180
Water body 11	Temporary Graminoid Marsh	D	0.009	0.009
Water body 13	Temporary Graminoid Marsh	C	0.023	0.046
Water body 14	Temporary Graminoid Marsh	C	0.028	0.056
Water body 16	Temporary Graminoid Marsh	B	0.046	0.184
Water body 17	Temporary Graminoid Marsh	B	0.118	0.472
Water body 18	Temporary Graminoid Marsh	D	0.050	0.050
Water body 19	Temporary Graminoid Marsh	B	0.676	2.704
Water body 20	Temporary Graminoid Marsh	B	0.722	2.888
		Total	**2.008**	**7.753**

4.3 Use of Wetlands by Wildlife

No obvious use of wetlands by larger wildlife was observed during field surveys. Cliff swallows and northern rough-winged swallows were observed around Water body 5, which is not a wetland. Cliff swallows were observed collecting mud from the dugout walls and transporting it back to mud nests under the eavestroughs of one of the dwellings onsite. Water bodies 19 and 20 have been heavily used by cattle and hoof shear was very prominent. No indication of other hoofed mammals was observed, although deer and elk scat and a red fox were observed in the Project Boundary. These mammals may be using water from water bodies when present. Four of the five SAR species identified in the desktop data review were observed. A single great blue heron was observed flying over the Project Boundary; however, no evidence of nesting was found. The least flycatcher and eastern kingbird were heard singing in aspen stands at a few locations in the Project Boundary. Two barn swallow nests were observed under the eavestroughs of two of the dwellings present in the Project Boundary.

5.0 Wetland Mitigation Hierarchy

The *Alberta Wetland Mitigation Directive* (GoA 2018) outlines a mitigation hierarchy where wetland avoidance must be a primary consideration for proposed development. If it is determined that wetlands cannot be avoided, options to minimize or reduce impacts to wetlands must be considered. If constraints imposed on the proposed development limit wetland avoidance and minimization options, replacement options for unavoidable wetland loss can be considered.

A total of 23 water bodies were assessed for the Project, of which 10 are wetlands. Wetland mitigation considerations for these 10 wetlands, Water bodies 1, 3, 11, 13, 14, 16, and 17-20 are discussed in the sections below.

5.1 Wetland Mitigation Considerations

Avoidance options considered for the wetlands are as follows:

1. Mine aggregate around wetlands and avoid temporary disturbances in wetlands from temporary disturbances (i.e., stockpiling).
2. Avoid wetlands with the largest areas and highest values; minimize impacts due temporary disturbances (i.e., stockpiling), and permanently remove wetlands of smaller areas and lower values in areas of aggregate mining.
3. Do not mine aggregate.

Option 1 – Mining aggregate around the wetlands would create a drop in the landscape that would result in erosion due to exposed subsurface materials and create a safety hazard due to the high potential of subsurface instability. Minimizing impacts as the result of temporary disturbances (i.e., stockpiling) outside of the Extraction Phase Boundary would reduce indirect wetland impacts. Option 1 is not technically feasible for safety reasons. As such it was not chosen.

Option 2 – Wetlands 19 and 20 are B-value wetlands and the largest wetlands assessed as part of this WAIR. Avoiding these wetlands would result in reduced aggregate extraction but still meet the overall objectives of the Project. Minimizing impacts as the result of temporary disturbances (i.e., stockpiling) outside of the aggregate mining area would also reduce indirect wetland impacts. Option 2 was chosen as the preferable option. This meets the objectives of the *Alberta Wetland Policy* to minimize the loss of the wetlands while allowing for the Proposed Project to proceed, as the policy identifies the need for continued growth and economic development in the Province (GoA 2013). *Alberta Wetland Policy* outcomes include those wetlands of the highest value be protected, and the wetlands with permanent impacts be replaced via an in-lieu replacement fee as necessary (GoA 2013). In-lieu replacements fees are utilized by the Province to restore wetlands on the landscape. Further details are provided in the Avoidance, Minimization and Replacement sections below.

Option 3 – This option would not meet the objectives of the Project. As such it was not chosen.

5.2 Wetland Avoidance and Minimization

Impacts to Water body 1 are minimized by removing a portion, 0.199 ha, of the wetland within the Project Boundary. The area of wetland that will be retained is 0.093 ha, or 32% of the total wetland area. The total contributing catchment area to Water body 1 is 4.975 ha. The area of catchment that will be retained is 0.233 ha, or 5% of the total catchment area. The 95% reduction in overall catchment area pre- versus post-construction is anticipated to negatively impact wetland function. As such, wetland replacement for the retained portion of this wetland is proposed, as described in the section below.

MALP has proposed to avoid water bodies 3, 19 and 20. These B value wetlands comprise 5.772 ha of the of the 7.753 ha wetland replacement area, or 74%.

The total contributing catchment area to Water body 3 will be completely avoided.

The total contributing catchment area to Water body 19 is 5.631 ha. The area of catchment that will be retained is 4.655 ha, or 83% of the total catchment area. The 17% reduction in overall catchment area pre- versus post-construction is not anticipated to negatively impact wetland function, as the catchment area receives inputs from impervious road surfaces, which will contribute greater water inputs through reduced permeable surfaces.

The total contributing catchment area to Water body 20 is 2.755 ha. The area of catchment that will be retained is 2.044 ha, or 74% of the total catchment area. The 26% reduction in overall catchment area pre- versus post-construction is not anticipated to negatively impact wetland function, as the catchment area receives inputs from impervious road surfaces, which will contribute greater water inputs through reduced permeable surfaces.

Water bodies 19 and 20 will be protected by an earthen berm constructed at a distance of at least 10 m set back, between the wetlands and the Extraction Phase Boundary. This 10 m setback is identified in Provincial guidance as an effective width of vegetation (GoA 2012). Hydrology will be maintained through breaks and/or culverts in the berm as required. Additionally, there is a reclamation requirement for the Project, which will include the avoided areas.

A Wetland Monitoring Plan prepared in accordance with the *Alberta Wetland Mitigation Directive* (GoA 2018) will monitor natural conditions and function of the wetlands are maintained throughout the lifespan of the Project (SLR 2023).

5.3 Wetland Replacement

In accordance with the *Alberta Wetland Mitigation Directive* (GoA 2018), an in-lieu replacement fee is proposed for the permanent impacts to Wetlands 1, 11, 13, 14, 16, 17, and 18.

Table 5 below shows the total wetland replacement area of 1.981 ha for the proposed permanent wetland impacts for a total in lieu replacement fee of $35,063.70 plus GST.

Table 5: Replacement Areas and Fees for Proposed Permanent Wetland Impacts

Water body ID	ABWRET-A Value	Area to be Removed (ha)	Replacement Ratio	Replacement Area (ha)	Replacement Fee
Water body 1	B	0.291	4:1	1.164	$20,602.80
Water body 11	D	0.009	1:1	0.009	$159.30
Water body 13	C	0.023	2:1	0.046	$814.20
Waterbody 14	C	0.028	2:1	0.056	$991.20
Water body 16	B	0.046	4:1	0.184	$3,256.80
Water body 17	B	0.118	4:1	0.472	$8,354.40
Water body 18	D	0.050	1:1	0.050	$885.00
				Wetland Replacement Fee (before GST)	**$35,063.70**
				GST	**$1,753.19**
				Total Wetland Replacement Fee (after GST)	**$36,816.89**

6.0 Wildlife Mitigations

To comply with the *Migratory Birds Convention Act* and *Alberta Wildlife Act*, disturbance to migratory and/or breeding birds and their habitat during restricted activity periods (RAP) will be avoided or mitigated appropriately (GoC 1994; GoA 2000). The recommended RAP of April 1 – August 17 takes into consideration the migratory bird Primary Nesting Period for nesting zone B4: April 14 to August 17 (GoC 2018) and the Alberta Provincial RAP for migratory birds: April 1 to July 15 (GoA 2011).

No Project activities within the Project Boundary will be completed during this period, if possible. If construction during this window is unavoidable, a qualified wildlife biologist will conduct nest searches, and species appropriate setback buffers will be placed around active nests until young have fledged.

7.0 Statement of Limitations

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Sincerely,

SLR Consulting (Canada) Ltd.

Alana-Rose Lynes

Carolyn Carruthers

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Senior Ecologist

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Project Manager

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Appendix A Figures

Wetland Assessment and Impact Report

NW AND SW 31-026-3 W5M

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00003

May 10, 2023

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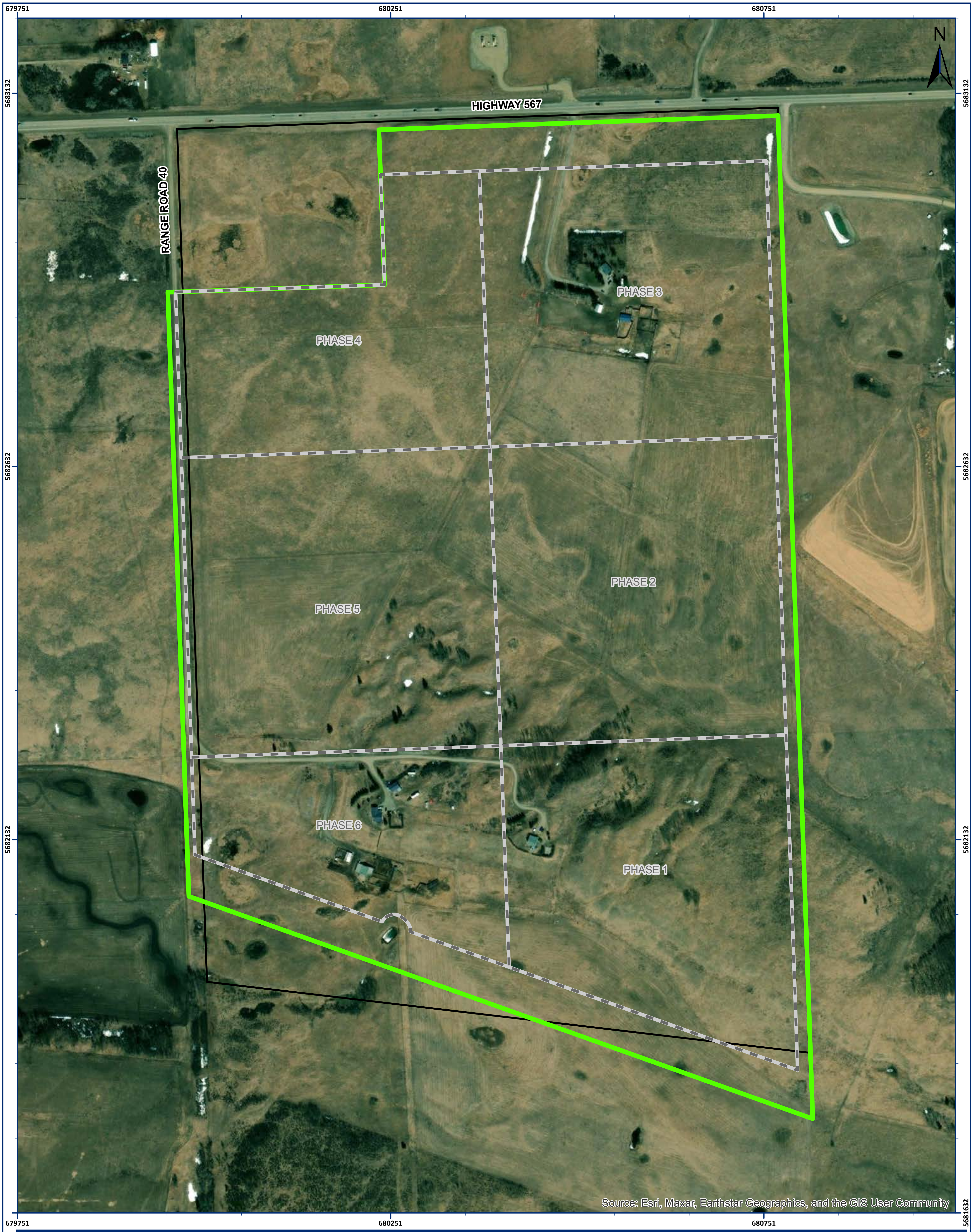

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

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▭	AREA ASSESSED
🟩	PROJECT BOUNDARY

NOTES:

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SCALE 1:5,000
PAGE SIZE 11 x 17
NAD 1983 UTM Zone 11N
THIS MAP IS FOR CONCEPTUAL PURPOSES ONLY
AND SHOULD NOT BE USED FOR NAVIGATION

MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

PROJECT SITE PLAN

SLR

FIGURE NO:
1

DATE: September 20, 2022

PROJECT NO: 212.06650.00007

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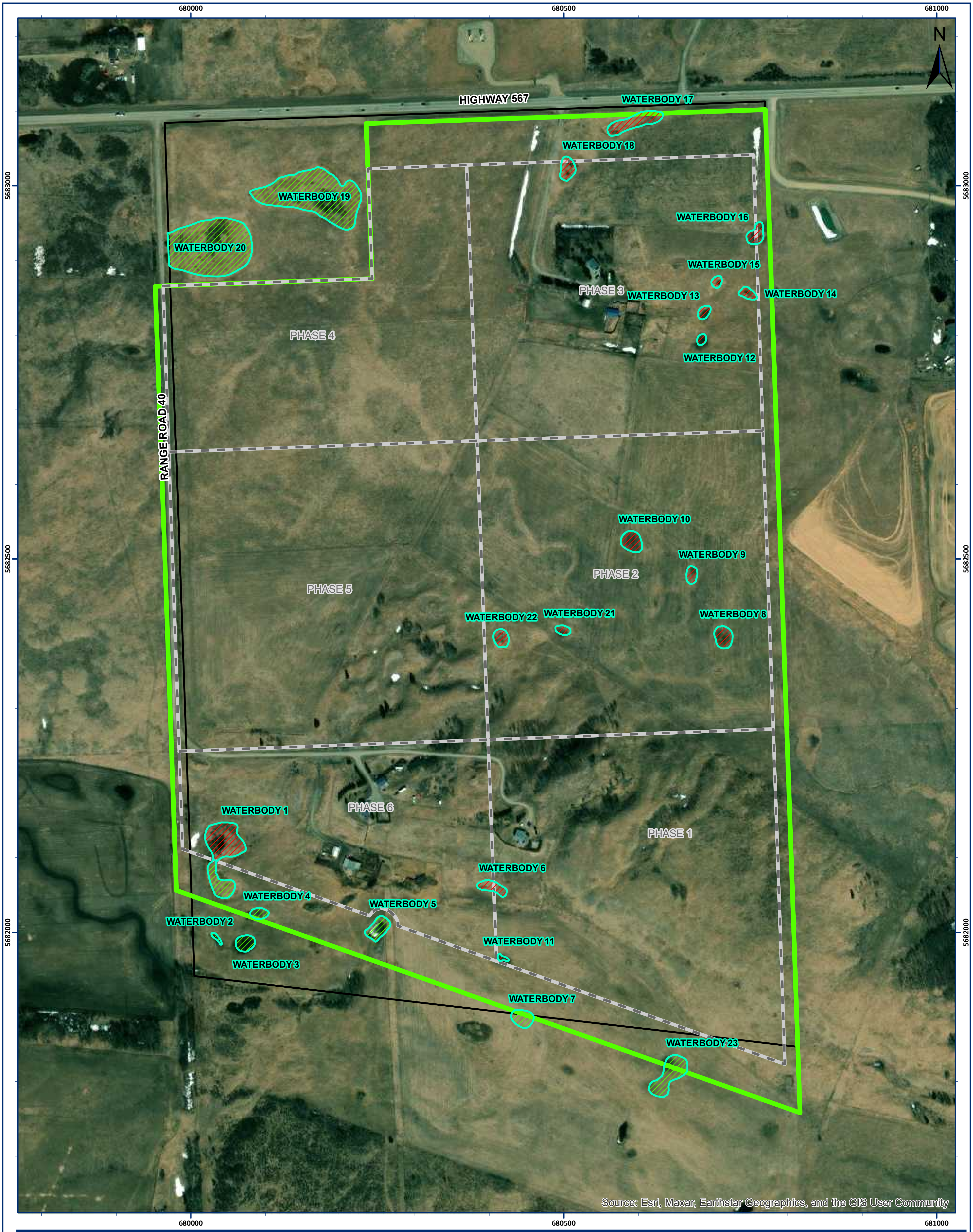

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

LEGEND

☐	AREA ASSESSED
▭	EXTRACTION PHASE BOUNDARY
🟩	PROJECT BOUNDARY
☐	WATERBODY
🟥	INDICATES WATERBODY THAT WILL BE REMOVED
🟩	INDICATES WATERBODY THAT WILL BE LEFT IN PLACE

NOTES:

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SCALE 1:5,000
PAGE SIZE 11 x 17
NAD 1983 UTM Zone 11N
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MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

IDENTIFIED WATERBODIES

SLR

FIGURE NO:
2

DATE: May 8, 2023

PROJECT NO: 212.06650.00007

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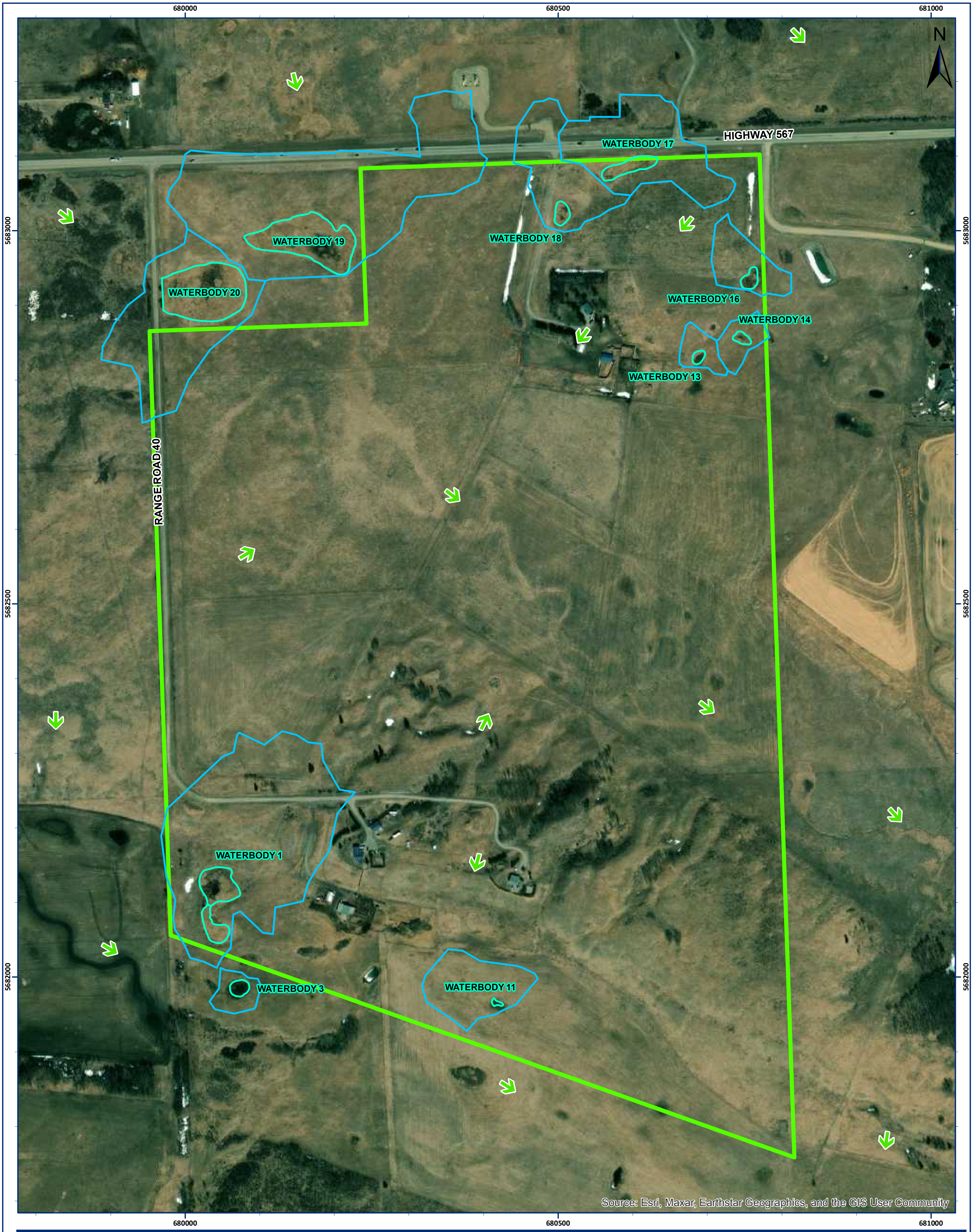

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

LEGEND

🟩	FLOW DIRECTION
▭	CATCHMENT
🟩	PROJECT BOUNDARY
▭	WATERBODY

NOTES:

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MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

WETLAND DRAINAGE AND CATCHMENT

SLR

FIGURE NO:
3

DATE: May 8, 2023

PROJECT NO: 212.06650.00007

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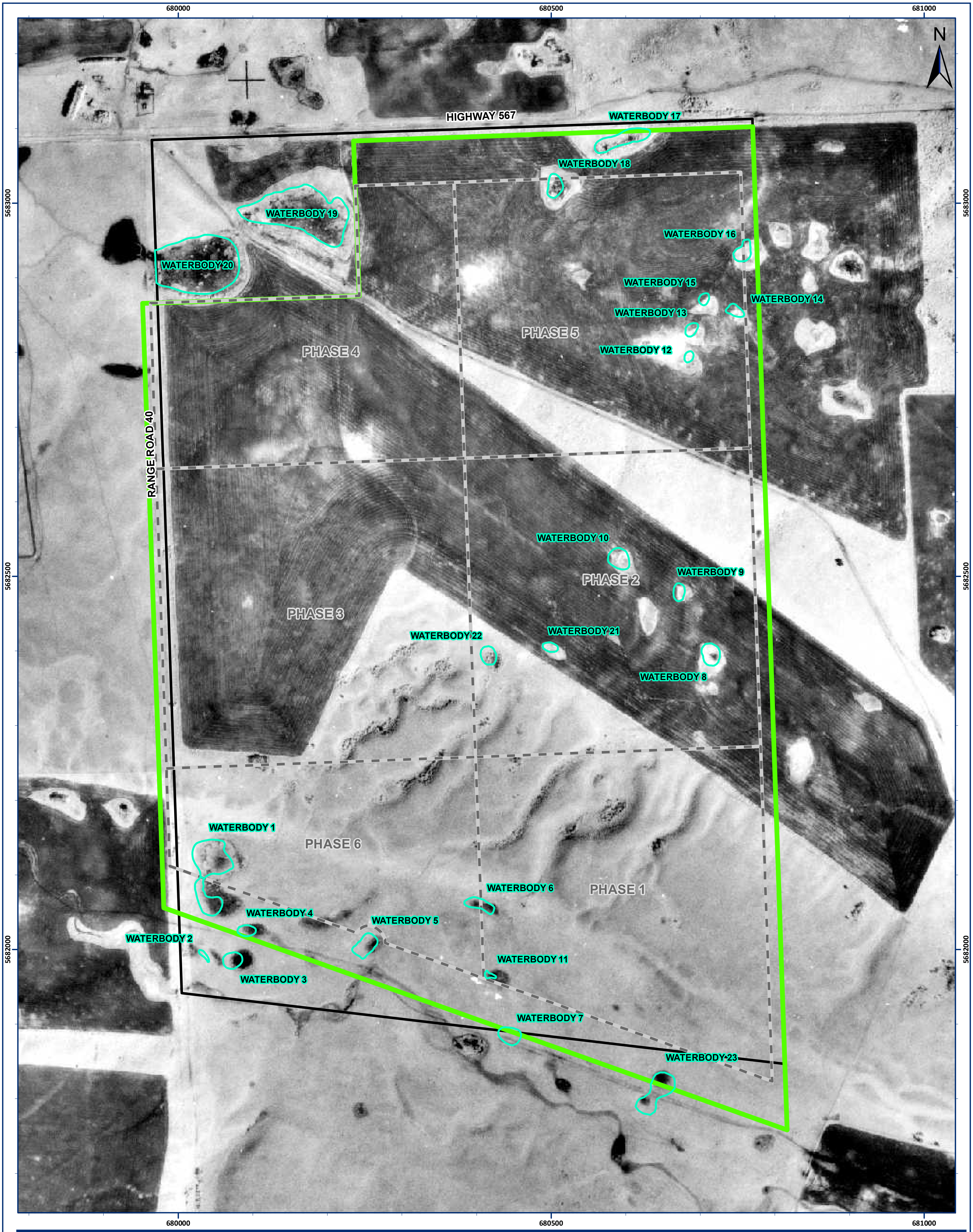

LEGEND

▭ AREA ASSESSED
▭ EXTRACTION PHASE BOUNDARY
🟩 PROJECT BOUNDARY
▭ WATERBODY

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MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

AERIAL PHOTOGRAPH (1953)

SLR

FIGURE NO:
4

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PROJECT NO: 212.06650.00007

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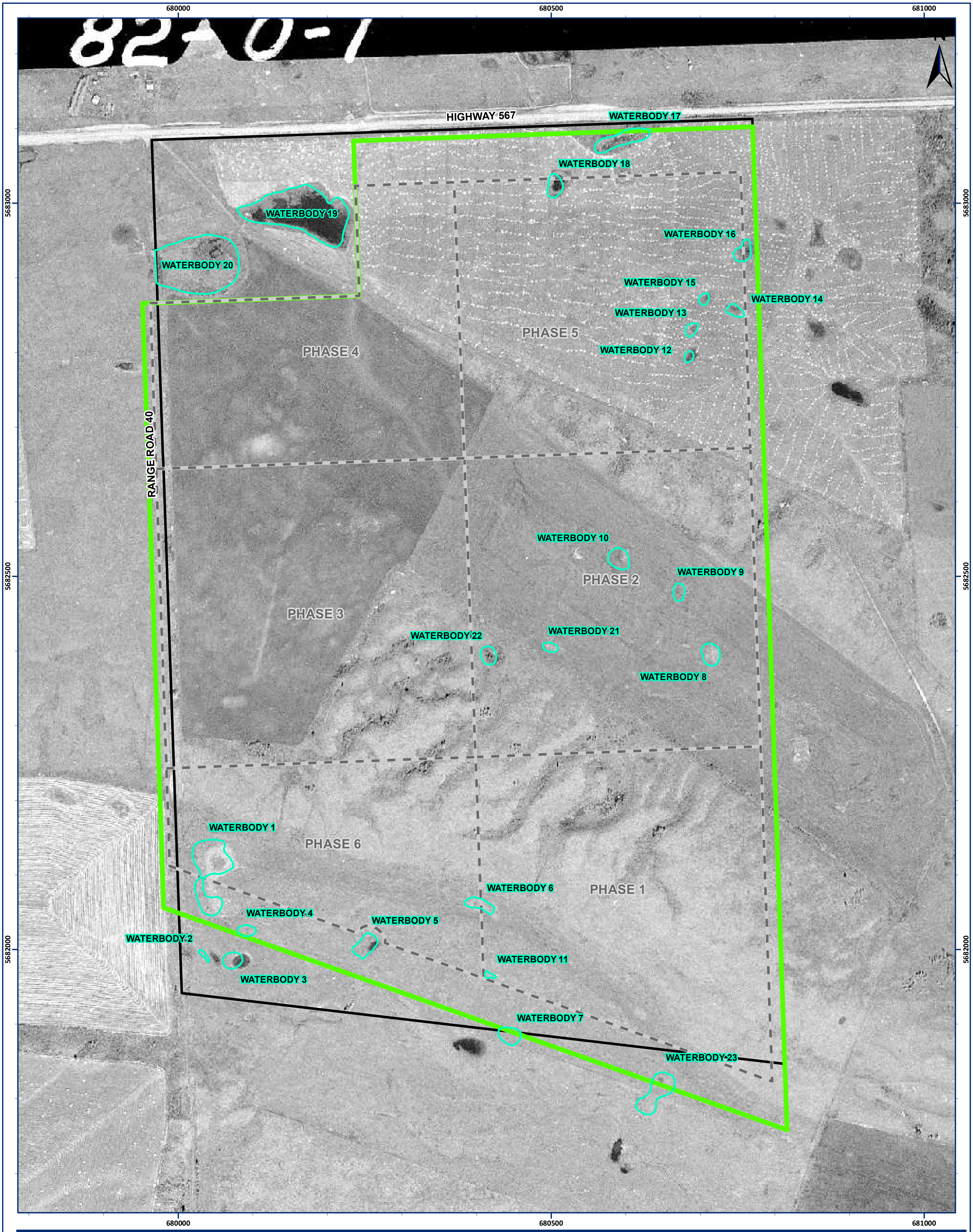

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- ▭ EXTRACTION PHASE BOUNDARY
- 🟩 PROJECT BOUNDARY
- ▭ WATERBODY

NOTES:

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MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

AERIAL PHOTOGRAPH (1962)

SLR

FIGURE NO:
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DATE: May 9, 2023

PROJECT NO: 212.06650.00007

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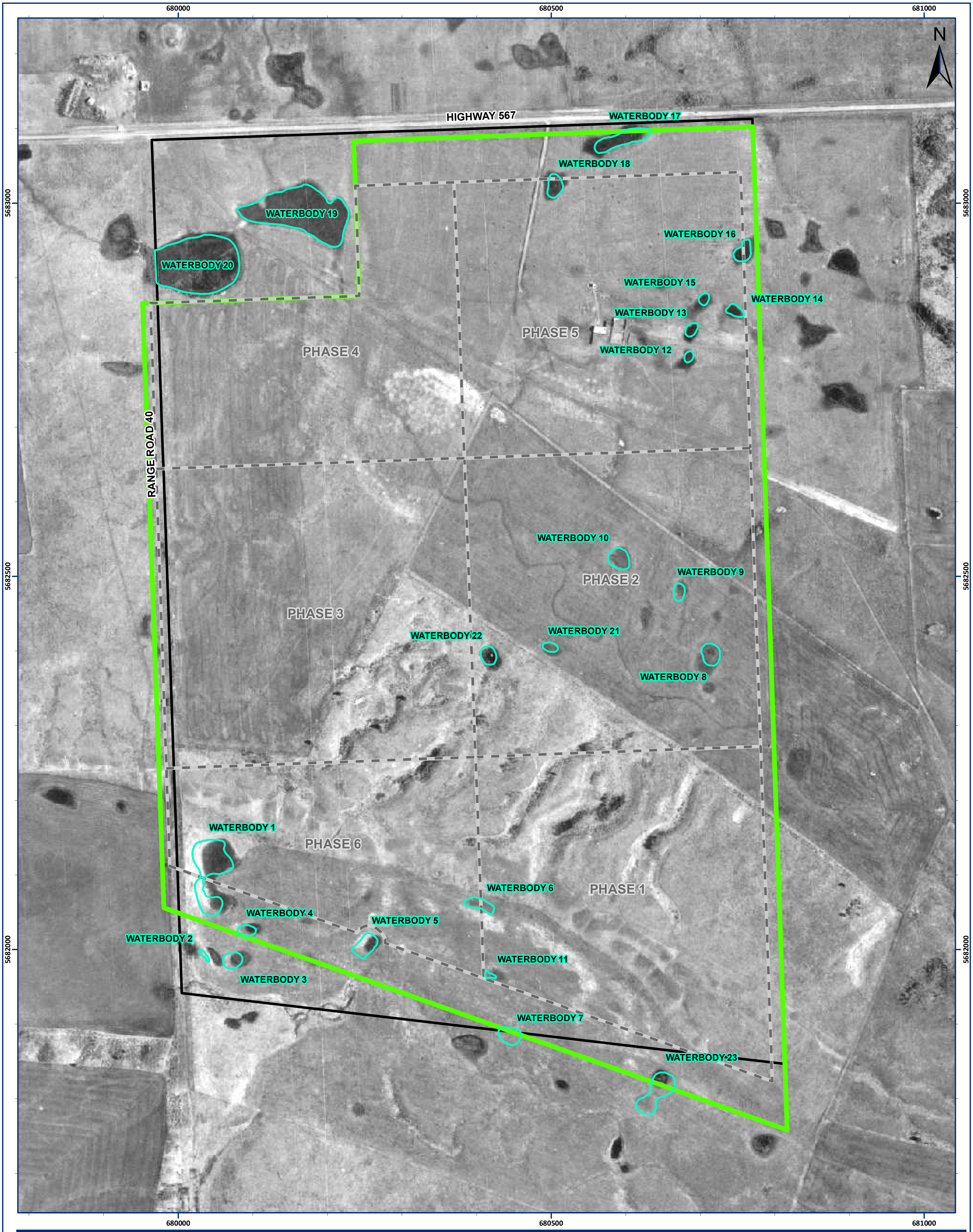

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- ▭ EXTRACTION PHASE BOUNDARY
- 🟩 PROJECT BOUNDARY
- ▭ WATERBODY

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MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

AERIAL PHOTOGRAPH (1974)

SLR

FIGURE NO:
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DATE: May 9, 2023

PROJECT NO: 212.06650.00007

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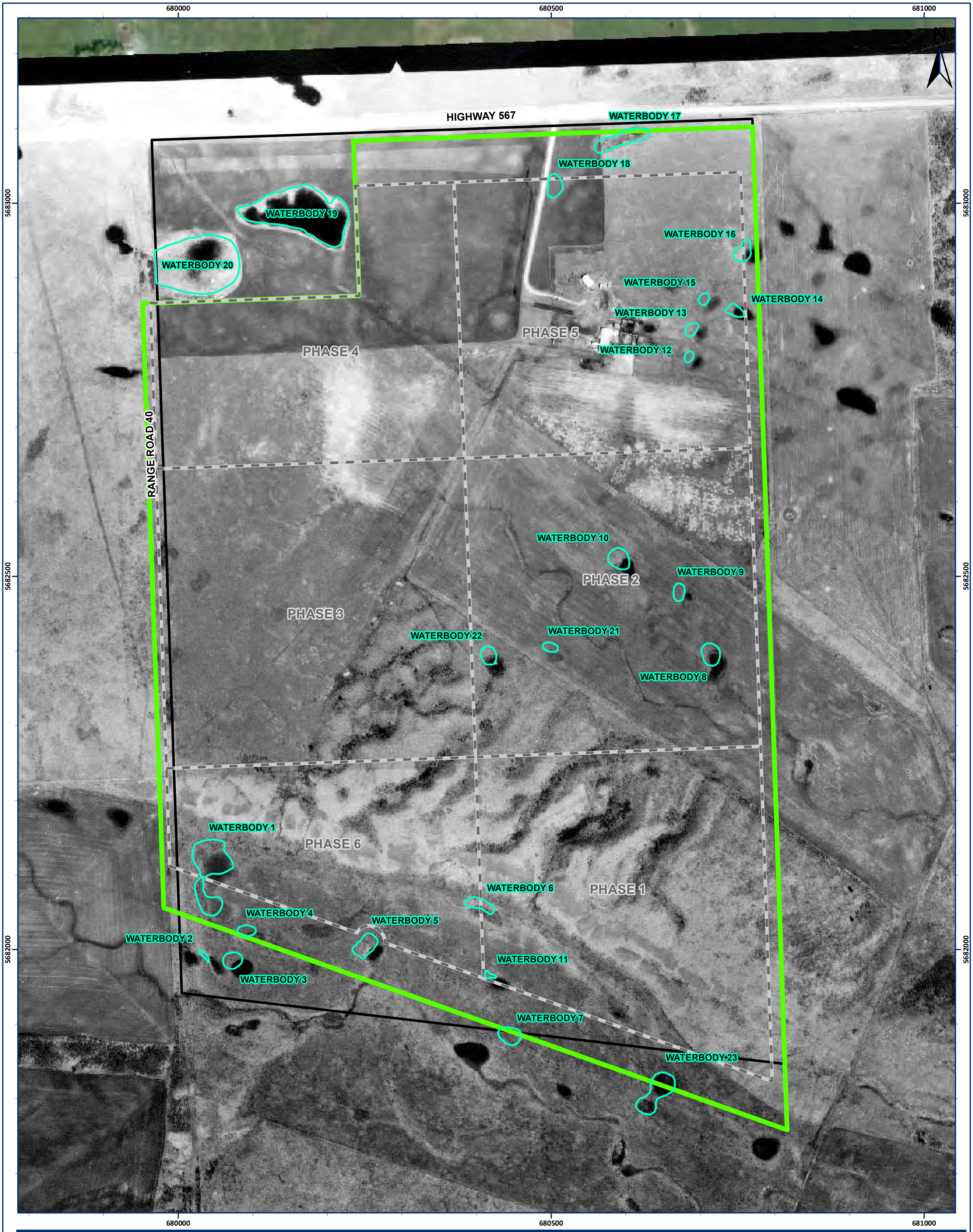

LEGEND

- AREA ASSESSED
- EXTRACTION PHASE BOUNDARY
- PROJECT BOUNDARY
- WATERBODY

NOTES:

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MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

AERIAL PHOTOGRAPH (1980)

SLR

FIGURE NO:
7

DATE: May 9, 2023

PROJECT NO: 212.06650.00007

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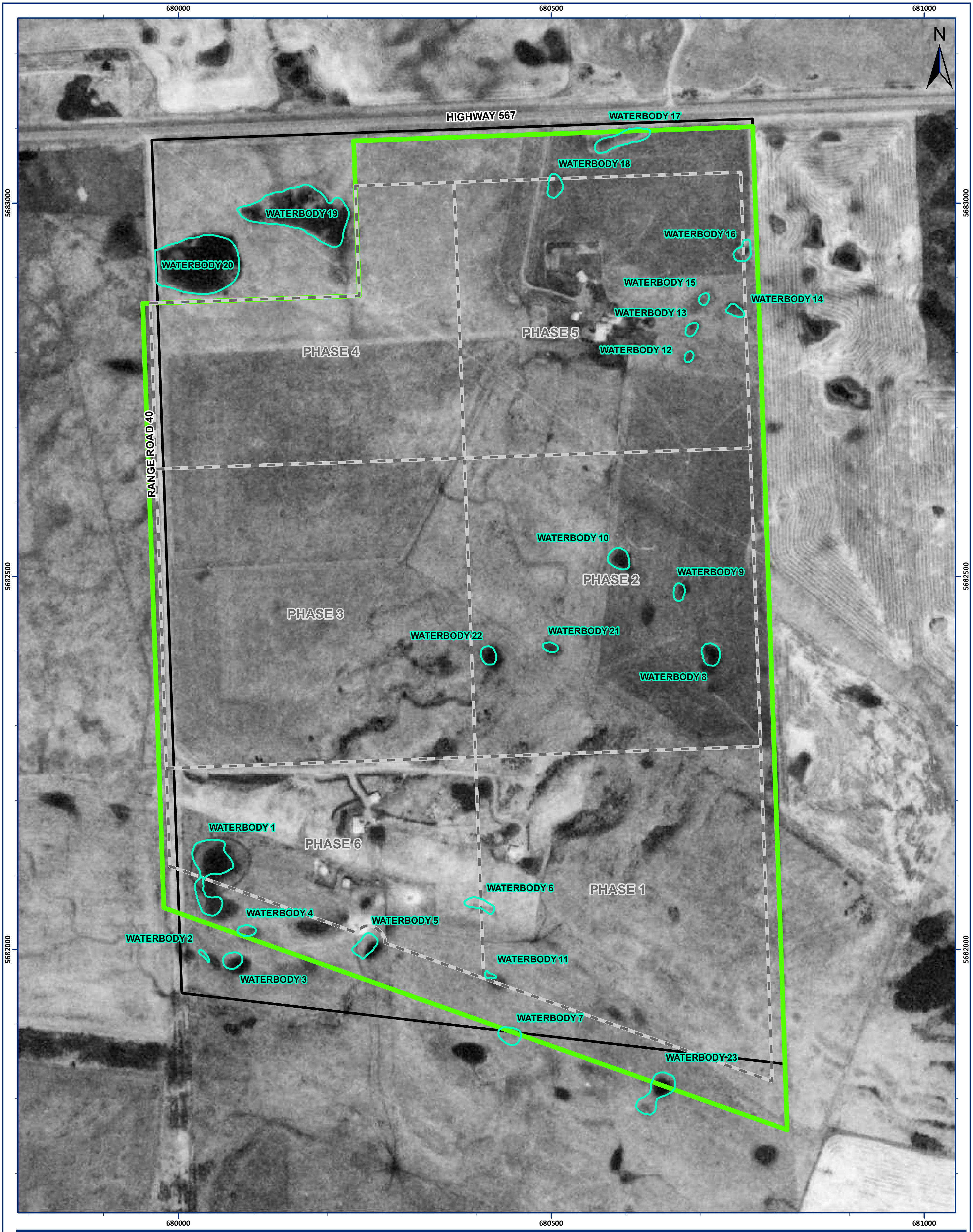

LEGEND

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▭ EXTRACTION PHASE BOUNDARY

🟩 PROJECT BOUNDARY

▭ WATERBODY

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MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

AERIAL PHOTOGRAPH (1994)

SLR

FIGURE NO:
8

DATE: May 9, 2023

PROJECT NO: 212.06650.00007

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LEGEND

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▭	EXTRACTION PHASE BOUNDARY
🟩	PROJECT BOUNDARY
▭	WATERBODY

NOTES:

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MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

AERIAL PHOTOGRAPH (2008)

SLR

FIGURE NO:
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DATE: May 9, 2023

PROJECT NO: 212.06650.00007

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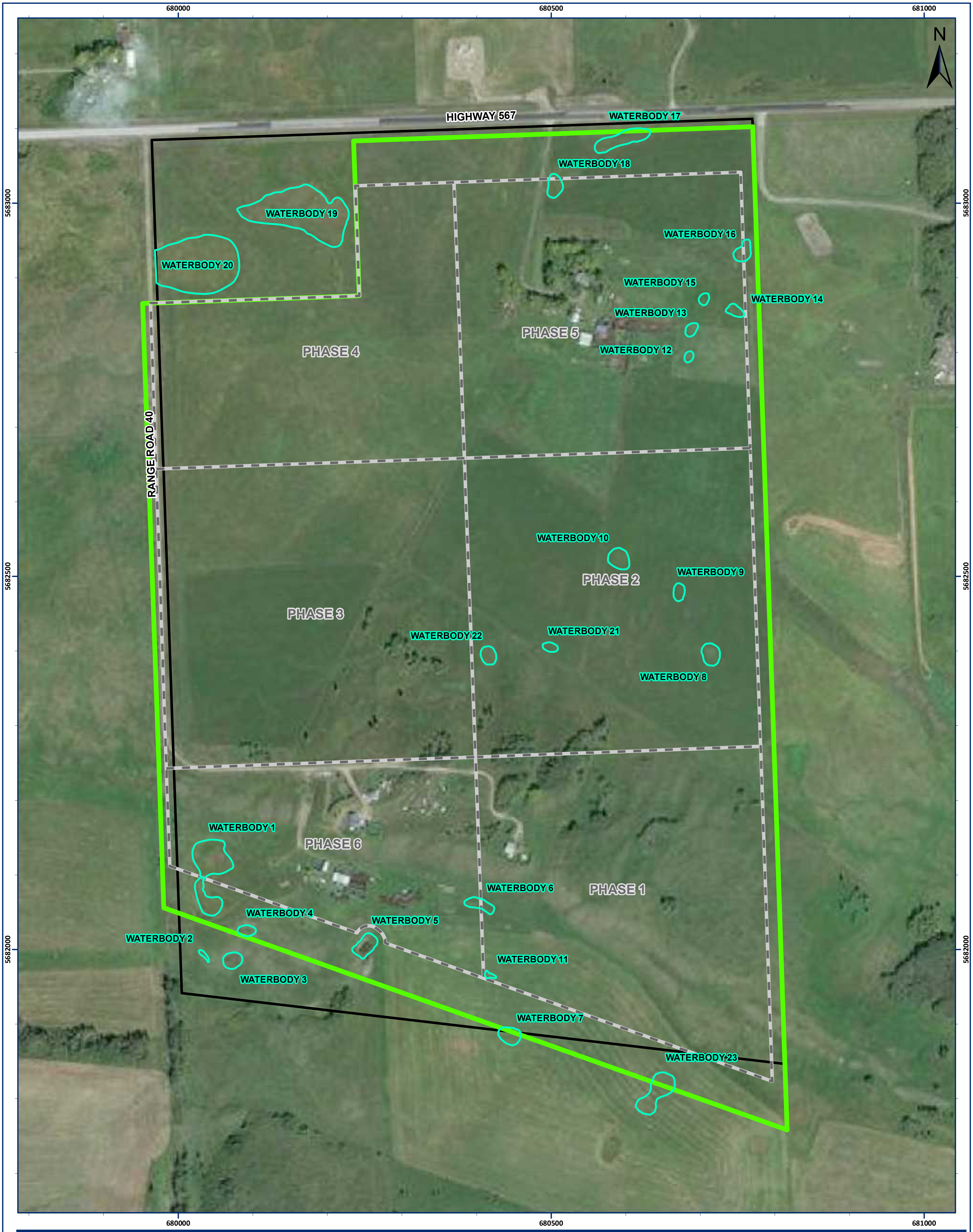

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▭ AREA ASSESSED
▭ EXTRACTION PHASE BOUNDARY
▭ PROJECT BOUNDARY
▭ WATERBODY

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MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

AERIAL PHOTOGRAPH (2016)

SLR

FIGURE NO:
10

DATE: May 9, 2023

PROJECT NO: 212.06650.00007

Appendix B Vegetation and Soil Data

Wetland Assessment and Impact Report

NW AND SW 31-026-3 W5M

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00003

May 10, 2023

Water Body Assessments - Vegetation and Soil Indicators

Water body ID	Classification	Predominant species present	Scientific Names and Indicator Status[1]	Soil Indicators
1	Seasonal Graminiod Marsh (M-G-III)	Needle spikerush, water sedge, wild mint , smooth brome, western dock and hair grass	*Eleocharis acicularis* (OBL), *Carex aquatilis* (OBL), *Mentha arvensis* (FACW), *Rumex occidentalis* (OBL), *Deschampsia cespitosa* (FAWC)	Topsoil 0-25cm. Subsoil 25-30+ cm. Clay loam, gleyed with mottles. Surface water cracks. Snails.
2	Ephemeral Water body	Dandelion, silverweed and common plantain	*Taraxacum officinale* (FACU), *Potentilla anseria* (FACW), *Plantago major* (FAC)	No soil pit.
3	Temporay Graminiod Marsh (M-G-II)	Dandelion, silverweed, common plantain, hair grass, kentucky bluegrass and clover sp.	*Taraxacum officinale* (FACU), *Potentilla anseria* (FACW), *Plantago major* (FAC), *Deschampsia cespitosa* (FACW), *Poa pratensis* (FACU), *Trifolium sp.*	No soil pit.
4	Ephemeral Water body	Dandelion, silverweed and common plantain	*Taraxacum officinale* (FACU), *Potentilla anseria* (FACW), *Plantago major* (FAC)	No soil pit.
5	Ephemeral Water body	Smooth brome and slender wheatgrass	*Bromus inermis* (UPL) *and Elymus trachycaulum* (FACU)	No soil pit.
6	Ephemeral Water body	Kentucky bluegrass, smooth brome, Canada thistle and western dock	*Poa pratensis* (FACU), *Bromus inermis* (UPL), *Cirsium arvense* (FACU), *Rumex occidentalis* (OBL)	Topsoil 0-27 cm. Subsoil 27+ cm. No gleying, no mottles.
7	Ephemeral Water body	Hay crop	N/A	Topsoil 0-30+ cm. No gleying, no mottles.
8	Ephemeral Water body	Hay crop, dandelion	*Taraxacum officinale* (FACU)	Topsoil 0-30+ cm. No gleying, no mottles.
9	Ephemeral Water body	Hay crop	N/A	No soil pit.
10	Ephemeral Water body	Hay crop	N/A	No soil pit.
11	Temporay Graminiod Marsh (M-G-II)	Hay crop, western dock	*Rumex occidentalis* (OBL)	No soil pit.
12	Ephemeral Water body	Hay crop	N/A	No soil pit.
13	Temporay Graminiod Marsh (M-G-II)	Tame pasture - fowl bluegrass, slender wheatgrass, smooth brome, timothy grass, common plantain	*Poa palustris* (FACW), *Rumex occidentalis* (OBL), *Bromus inermis* (UPL), *Phleum pratense* (FACU), *Plantago major (FAC)*	Topsoil 0-25 cm. Subsoil 25-30+ cm. Clay loam, mottles.
14	Temporay Graminiod Marsh (M-G-II)	Kentucky bluegrass, smooth brome, Canada thistle, western dock	*Poa pratensis* (FACW), *Bromus inermis* (UPL), *Cirsium arvense* (FACU), *Rumex occidentalis* (OBL)	No soil pit.
15	Ephemeral Water body	Kentucky bluegrass, smooth brome, Canada thistle, western dock	*Poa pratensis* (FACU), *Bromus inermis* (UPL), *Cirsium arvense* (FACU), *Rumex occidentalis* (OBL)	No soil pit.
16	Temporay Graminiod Marsh (M-G-II)	Smooth brome, slender wheatgrasss, water sedge	*Bromus inermis* (UPL), *Elymus trachycaulum* (FACU), *Carex aquatilis* (OBL)	No soil pit.
17	Temporay Graminiod Marsh (M-G-II)	Hay crop, dandelion, western dock, water sedge	*Taraxacum officinale* (FACU), *Rumex occidentalis* (OBL), *Carex aquatilis* (OBL)	No soil pit.
18	Temporay Graminiod Marsh (M-G-II)	Hay crop, dandelion, sedge	*Taraxacum officinale* (FACU), *Carex aquatilis* (OBL)	Topsoil 0-27 cm. Subsoil 27-30+ cm. Clay loam, mottles. Snail.
19	Temporay Graminiod Marsh (M-G-II)	Tame pasture - clover, dandelion, water sedge, western dock	*Trifolium sp., Taraxacum officinale* (FACU), *Carex aquatilis* (OBL), *Rumex occidentalis* (OBL)	Topsoil 0-25 cm. Subsoil 25-30+ cm. Mottles.
20	Temporay Graminiod Marsh (M-G-II)	Tame pasture - clover, dandelion, water sedge, western dock	*Trifolium sp., Taraxacum officinale* (FACU), *Carex aquatilis* (OBL), *Rumex occidentalis* (OBL)	No soil pit.
21	Ephemeral Water body	Hay crop	N/A	No soil pit.
22	Ephemeral Water body	Clover sp., dandelion, Canada thistle	*Trifolium sp., Taraxacum officinale* (FACU), *Cirsium arvense* (FACU)	No soil pit.
23	Ephemeral Water body	No observations, desktop delineation only.	N/A	No soil pit.

Indicator status from the 2021 Alberta Wetland Plant List produced by the Alberta Native Plant Council.

Appendix C FWMIS Search Results

Wetland Assessment and Impact Report

NW AND SW 31-026-3 W5M

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00003

May 10, 2023

Fish and Wildlife Internet Mapping Tool (FWIMT)

(source database: Fish and Wildlife Management Information System (FWMIS))

Species Summary Report

Report Created: 29-May-2019 08:03

Species present within the current extent :

Fish Inventory	Wildlife Inventory	Stocked Inventory
	BARN SWALLOW	No Species Found in Search Extent
	EASTERN KINGBIRD	
	GREAT BLUE HERON	
	LEAST FLYCATCHER	
	SORA	

Map Extent

Projection
10-TM AEP Forest

Northwest (X,Y)
539826, 5678051

Northeast (X,Y)
542126, 5678051

Centroid (X,Y)
540976, 5677330

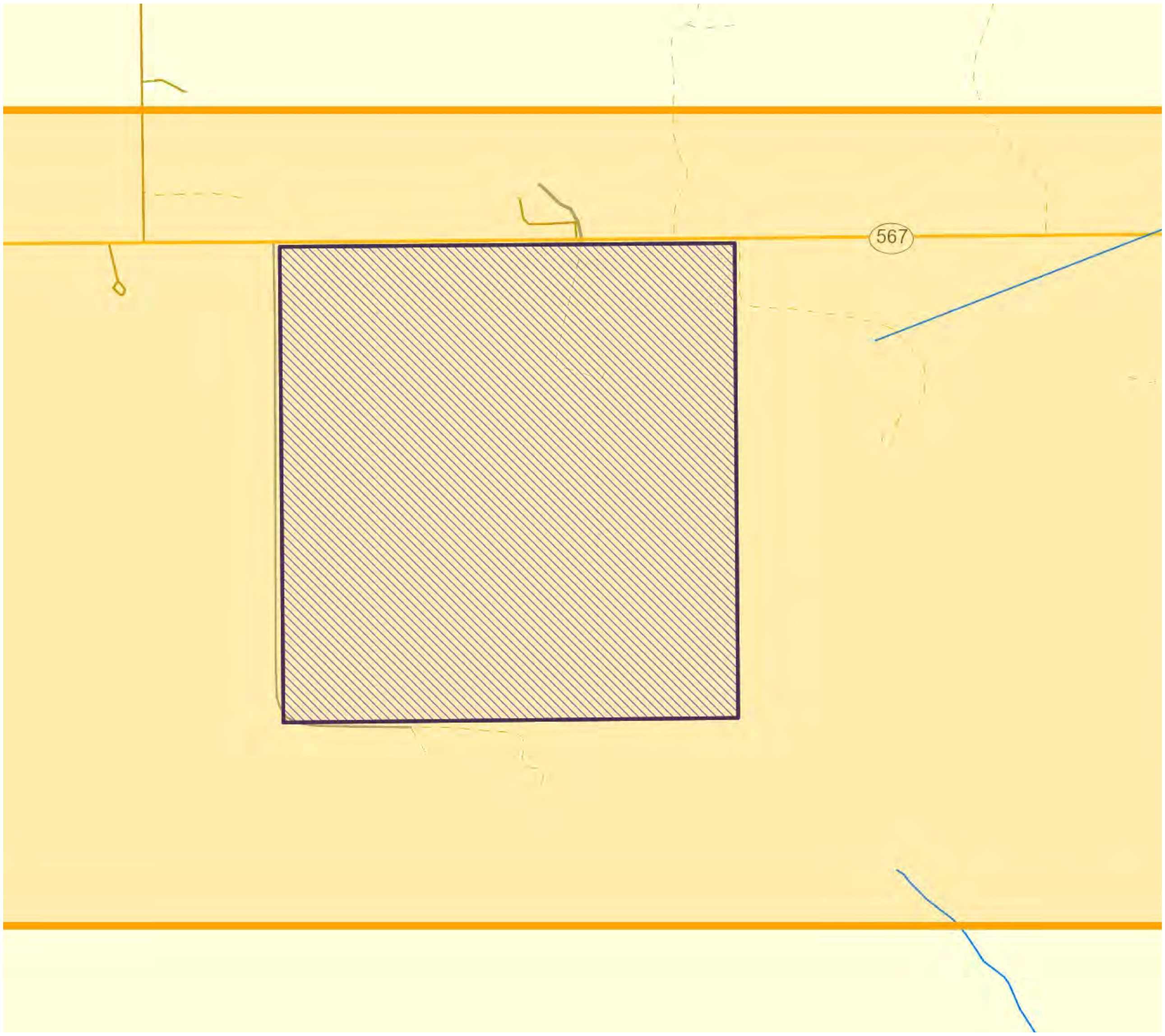
Southwest (X,Y)
539826, 5676608

Southeast (X,Y)
542126, 5676608

Contact Information

For contact information, please visit:
http://aep.alberta.ca/about-us/contact-us/fisheries-wildlife-management-area-contacts.aspx

29-May-2019 08:03 **Map Results**



Appendix D ABWRET-A Results

Wetland Assessment and Impact Report

NW AND SW 31-026-3 W5M

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00003

May 10, 2023

Function (ABWRET-A Raw Score)	Wetland 19	Wetland 20	Wetland 18	Wetland 17	Wetland 16	Wetland 15	Wetland 14	Wetland 13	Wetland 12	Wetland 10	Wetland 9	Wetland 8	Wetland 4	Wetland 3	Wetland 2	Wetland 11	Wetland 1	Wetland 6	Wetland 7	Wetland 5
Surface Water Storage (WS)	6.12	6.11	2.75	6.20	6.20	2.75	2.74	2.74	2.74	5.85	5.84	5.84	6.16	6.16	6.16	2.64	6.17	5.84	5.82	5.47
Stream Flow Support (SFS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Streamwater Cooling (WC)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sediment & Toxicant Retention & Stabilization (SR)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Phosphorus Retention (PR)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Nitrate Removal & Retention (NR)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Organic Nutrient Export (OE)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fish Habitat (FH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aquatic Invertebrate Habitat (INV)	5.35	5.36	4.26	4.76	4.78	4.31	4.36	4.31	4.35	4.76	4.73	4.77	4.92	4.89	4.83	4.22	5.20	4.80	4.94	4.51
Amphibian Habitat (AM)	2.74	2.76	2.28	2.52	2.47	2.29	2.29	2.29	2.29	2.50	2.46	2.52	4.15	4.13	2.94	2.31	2.98	2.47	2.59	3.79
Waterbird Habitat (WB)	4.83	4.85	3.94	4.68	4.28	3.93	3.59	3.93	3.59	4.55	4.18	4.59	5.30	5.34	4.89	3.93	5.04	4.29	4.26	4.68
Songbird, Raptor, & Mammal Habitat (SBM)	3.39	3.30	2.70	2.95	2.91	2.75	2.76	2.75	2.75	2.90	2.90	2.93	3.56	3.46	3.32	2.60	3.51	2.55	2.89	3.38
Pollinator & Native Plant Habitat (PH)	3.14	3.11	1.75	2.90	3.09	1.83	1.83	1.83	1.82	2.27	2.81	2.75	3.09	3.00	2.89	1.72	3.11	2.42	2.80	3.06
Human Use & Recognition (HU)	3.20	3.28	2.54	3.01	3.01	2.74	2.74	2.74	2.74	2.52	3.02	3.02	3.64	3.56	3.56	2.97	3.65	3.72	3.27	2.97
Function (ABWRET-A Normalized Score)	Wetland 19	Wetland 20	Wetland 18	Wetland 17	Wetland 16	Wetland 15	Wetland 14	Wetland 13	Wetland 12	Wetland 10	Wetland 9	Wetland 8	Wetland 4	Wetland 3	Wetland 2	Wetland 11	Wetland 1	Wetland 6	Wetland 7	Wetland 5
Surface Water Storage (WS)	0.84	0.84	0.25	0.86	0.86	0.25	0.25	0.25	0.25	0.79	0.79	0.79	0.85	0.85	0.85	0.23	0.85	0.79	0.79	0.73
Stream Flow Support (SFS)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Streamwater Cooling (WC)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sediment & Toxicant Retention & Stabilization (SR)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Phosphorus Retention (PR)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Nitrate Removal & Retention (NR)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Organic Nutrient Export (OE)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fish Habitat (FH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aquatic Invertebrate Habitat (INV)	0.54	0.54	0.40	0.46	0.47	0.41	0.41	0.41	0.41	0.47	0.46	0.47	0.49	0.48	0.47	0.39	0.52	0.47	0.49	0.43
Amphibian Habitat (AM)	0.35	0.35	0.28	0.32	0.31	0.28	0.28	0.28	0.28	0.31	0.31	0.32	0.58	0.58	0.38	0.28	0.39	0.31	0.33	0.52
Waterbird Habitat (WB)	0.36	0.36	0.25	0.34	0.29	0.25	0.21	0.25	0.21	0.33	0.28	0.33	0.42	0.42	0.37	0.25	0.39	0.29	0.29	0.34
Songbird, Raptor, & Mammal Habitat (SBM)	0.34	0.32	0.21	0.26	0.25	0.22	0.22	0.22	0.22	0.25	0.25	0.25	0.37	0.35	0.32	0.19	0.36	0.18	0.24	0.34
Pollinator & Native Plant Habitat (PH)	0.25	0.24	0.00	0.20	0.24	0.02	0.02	0.02	0.02	0.10	0.19	0.18	0.24	0.22	0.20	0.00	0.24	0.12	0.19	0.23
Human Use & Recognition (HU)	0.42	0.44	0.29	0.39	0.39	0.33	0.33	0.33	0.33	0.29	0.39	0.39	0.51	0.49	0.49	0.38	0.51	0.53	0.44	0.38
Normalized Score (ABWRET_A) Based on Wetlands in RWVAU	Wetland 19	Wetland 20	Wetland 18	Wetland 17	Wetland 16	Wetland 15	Wetland 14	Wetland 13	Wetland 12	Wetland 10	Wetland 9	Wetland 8	Wetland 4	Wetland 3	Wetland 2	Wetland 11	Wetland 1	Wetland 6	Wetland 7	Wetland 5
Normalized Hydrological Health (HH)	0.84	0.84	0.25	0.86	0.86	0.25	0.25	0.25	0.25	0.79	0.79	0.79	0.85	0.85	0.85	0.23	0.85	0.79	0.79	0.73
Normalized Water Quality (WQ)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Normalized Ecological Health (EH)	0.54	0.54	0.40	0.46	0.47	0.41	0.41	0.41	0.41	0.47	0.46	0.47	0.58	0.58	0.47	0.39	0.52	0.47	0.49	0.52
Normalized Human Use (HU)	0.42	0.44	0.29	0.39	0.39	0.33	0.33	0.33	0.33	0.29	0.39	0.39	0.51	0.49	0.49	0.38	0.51	0.53	0.44	0.38
RWVAU #	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Normalized Value Score (ABWRET_a)	0.76	0.76	0.52	0.73	0.74	0.53	0.53	0.53	0.53	0.71	0.72	0.72	0.78	0.78	0.75	0.53	0.76	0.73	0.73	0.71
Value Category (a, b, c, d)	c	c	d	c	c	d	d	d	d	d	c	c	c	c	c	d	c	c	c	c
Abundance Factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Final Score(A, B, C, D)	B	B	D	B	B	C	C	C	C	C	B	B	B	B	B	D	B	B	B	B

Appendix E Photographs

Wetland Assessment and Impact Report

NW AND SW 31-026-3 W5M

Mountain Ash Limited Partnership

SLR Project No. 212.06650.00003

May 10, 2023

Photo 1: Water body 1 – Southwest corner of Project Area (June 3, 2019).

Photo 2: Water body 3 – Southwest corner of Project Area (June 3, 2019)

Photo 3: Water body 17 – North end of Project Area (June 4, 2019).

Photo 4: Water body 19 – Northwest corner of Project Area (June 4, 2019).

Photo 5: Water body 20 – Northwest corner of Project Area (June 4, 2019).

Photo 6: Water body 19 – Hoof sheer within wetland (June 4, 2019).

Photo 7: Water body 20 – Hoof sheer within wetland (June 4, 2019).

Photo 8: Water body 7 – South end of Project Area (June 3, 2019).

Photo 9: Water body 11 – South end of Project site (June 3, 2019)

Photo 10: Water body 18 – North end of Project Area (June 4, 2019).

Photo 11: Water body 5 – Excavated dugout (June 4, 2019).

Photo 12: Water body 8 – Located with Water bodies 9 and 10 within hay field (June 5, 2019).

Photo 13: Water body 21 – Middle of Project Area (August 2, 2022).

Photo 14 Water body 22 – Middle of Project Area (August 2, 2022).

Wetland Replacement Fee Form

*Alberta Environment and Parks (AEP) and Alberta Energy Regulator (AER)

A. Water Act Applicant Information

After payment has been received a receipt will be sent to the applicant's email below.

Contact Name Tige Brady

Company Name (If applicable) Mountain Ash Limited Partnership

Mailing Address

Contact Email tige.brady@telus.net

City

Prov.

Postal

B. Project Information

Municipality Rocky View County

Legal Land Description
Qtr SW Sec 31 Twp 26 Rg 3 Mer 5

Name Authenticating Professional Alana-Rose Lynes

Authenticating Company SLR Consulting (Canada) Ltd.

Name of Lead Reviewer (AER or AEP)

Administrative Region Calgary

D. Water Act Application Information

Please fill the applicable Water Act Application Number

AEP Water Act or DRAS Case Number **DAPP0001717** (Leave blank if AER)

AER Water Act Application Number (Leave blank if AEP)

C. Fees for Wetland Loss

Please complete "*Wetland Replacement Details*" sheet to auto-populate this section.

Sum of Wetland Area Removed (ha)		**0.56500000**
Wetland Replacement Area Owed (ha)		**1.98100000**
Wetland Replacement Fee	**$**	35,063.70
GST	**$**	1,753.19
Total Wetland Replacement Fee	**$**	**36,816.89**

E. Wetland Replacement Payment Methods

See complete instructions on making the Replacement Fee payment on the yellow tab below

Payment Receipt Stamped by
Alberta Environment and Parks - Finance and Administration

Receipt Number:

Date:

December 2018

Classification: Public

					DO NOT FILL				
Wetland ID	Public Land In Green Area (Y or N)*	RWVAU	Lost Wetland Area (ha)	ABWRET Relative Value	Replacement Ratio	Replacement Area (ha)	Replacement Rate ($/ha)	Replacement Cost	
1	N	13	0.291	B	4	1.164	17700	$	20,602.80
11	N	13	0.009	D	1	0.009	17700	$	159.30
13	N	13	0.023	C	2	0.046	17700	$	814.20
14	N	13	0.028	C	2	0.056	17700	$	991.20
16	N	13	0.046	B	4	0.184	17700	$	3,256.80
17	N	13	0.118	B	4	0.472	17700	$	8,354.40
18	N	13	0.05	D	1	0.05	17700	$	885.00

Appendix T

Wetland Monitoring Program

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Wetland Monitoring Plan

Summit Pit

Mountain Ash Limited Partnership

1945 Briar Crescent NW
Calgary, AB   T2N 3V6

Prepared by:

SLR Consulting (Canada) Ltd.

200, 708 – 11th Avenue SW
Calgary, AB   T2R 0E4

SLR Project No:

212.06650.00006

May 10, 2023

Table of Contents

1.0 Project Information

Mountain Ash Limited Partnership (MALP) is planning to develop the Summit Pit (the Project) along Highway 567 within NW and SW 31-026-03 W5M, northeast of the Town of Cochrane, in Rocky View County, Alberta (Figure 1, Appendix A).

SLR Consulting (Canada) Ltd. (SLR) was retained by MALP to complete a Wetland Assessment and Impact Report (WAIR) for the Project. A total of 23 water bodies were assessed as part of the WAIR, of which MALP has proposed to avoid two wetlands, Water bodies 19 and 20 (SLR 2023). These wetlands are described in Table 1 below and shown in Figure 1 (attached).

Alberta Environment and Protected Areas (EPA) has requested this monitoring plan include Water body 54, which is outside of the Project Boundary but within the Property Boundary, as shown in Figure 1. This wetland is described in Table 1 below and shown in Figure 1 (attached).

In addition, EPA has requested the wetland monitoring plan include two offsite wetlands, Water bodies 61 and 75, which will be monitored using remote desktop methods. These wetlands are described in Table 1 below and shown in Figure 1 (attached).

Table 1: Summary of Water Bodies included in the Wetland Monitoring Plan

Water Body ID	Wetland Classification	Delineated Area (ha)	Monitoring Method
Water Body 19	Temporary Graminoid Marsh	0.676	Onsite field assessment
Water Body 20	Temporary Graminoid Marsh	0.722	Onsite field assessment
Water Body 54	Temporary Graminoid Marsh	0.132[1]	Onsite field assessment
Water Body 61	Temporary Graminoid Marsh	0.294[1]	Offsite remote assessment
Water Body 75	Temporary Graminoid Marsh	0.054[1]	Offsite remote assessment

[1] Wetland areas based on desktop delineation only (i.e., no field surveys conducted).

2.0 Wetland Protection

Water bodies 19 and 20 are located adjacent to the Phase 4 extraction boundary of the Project, as shown in Figure 1. The material within Phase 4 is expected to be extracted over a period of five to seven years. These wetlands will be protected by an earthen berm constructed at a distance of at least 10 m set back, between the wetlands and the extraction boundary (SLR 2023). This 10 m setback is identified in Provincial guidance as an effective width of vegetation (Government of Alberta (GoA) 2012), and as such no indirect effects are anticipated. Hydrology will be maintained through breaks and/or culverts in the berm as required (SLR 2023).

Water body 54 is located approximately 100 m south of the Phase 6 extraction boundary of the Project as shown in the Figure 1. The material within Phase 6 is expected to be extracted over a period of five to seven years. This setback far exceeds the 10 m effective width of vegetation identified in Provincial guidance (GoA 2012), and as such no indirect effects are anticipated.

Water body 61 is located is located approximately 250 m east of the Phase 1 extraction boundary of the Project as shown in Figure 1. The material within Phase 1 is expected to be extracted over a period of five to seven years. This setback far exceeds the 10 m effective width of vegetation identified in Provincial guidance (GoA 2012), and as such no indirect effects are anticipated.

Water body 75 is located is located approximately 50 m east of the Phase 3 extraction boundary of the Project as shown in Figure 1. The material within Phase 3 is expected to be extracted over a period of five to seven years. This setback far exceeds the 10 m effective width of vegetation identified in Provincial guidance (GoA 2012), and as such no indirect effects are anticipated.

3.0 Wetland Monitoring Plan

In accordance with the Alberta Wetland Mitigation Directive (GoA 2018), this Wetland Monitoring Plan (the Plan) ensures that the natural conditions and function of the wetlands are maintained throughout the lifespan of the Project. Specifically, the Plan provides a comparison of pre-Project and post-reclamation characteristics, including wetland area, class, vegetation, soils, hydrology, and habitat. These characteristics will be evaluated prior to Project activities (i.e., excavation) within the wetland catchment areas, in accordance with the Alberta Wetland Identification and Delineation Directive (GoA 2015a). This evaluation will provide the baseline conditions in which to compare the post-reclamation characteristics throughout the monitoring period.

3.1 Wetland Monitoring Timeframe

A pre-Project evaluation will be conducted during the growing season within one year prior to the commencement of Project activities (i.e., excavation) the wetland catchment areas. The wetland boundaries for Water bodies 19, 20 and 54 will be delineated and flagged during this evaluation. The wetland boundaries for the offsite wetlands, Water bodies 61 and 75, will be determined using drone imagery.

The post-excavation evaluations will be conducted during the growing season for Water bodies 19, 20, 54, 61 and 75 as follows:

- One year post-excavation within the wetland catchment areas;
- Three years post-excavation within the wetland catchment areas;
- Five years post-excavation within the wetland catchment areas;
- Seven years post-excavation within the wetland catchment areas, if Project activities continue past six years; and
- Two years post-reclamation activities within the wetland catchment areas.

Note: Post-reclamation activities means the work to recontour, replace materials, including topsoil and subsoil, and revegetate has been complete. This does not mean that there is a ‘reclamation certificate’.

3.2 Wetland Evaluation

Wetland area and classification: The wetland area will be classified and delineated in accordance with the Alberta Wetland Classification System (GoA 2015b) and the Alberta Wetland Identification and Delineation Directive (GoA 2015a). For all post-excavation evaluations, any changes in wetland area and/or class compared to pre-Project will be identified.

Wetland vegetation function: Wetland vegetation function for Water bodies 19, 20 and 54 will be evaluated by locating and marking five 1 m x 1 m vegetation plots distributed throughout each wetland. The plots will be photographed, and geo-referenced with GPS to ensure the same plots are sampled in each evaluation. The results will be recorded on the Field form for wetland delineation procedures in Alberta (wetland field form) provided in the Alberta Wetland Identification and Delineation Directive (GoA 2015a).

The wetland vegetation function for the offsite wetlands, Water bodies 61 and 75, will be assessed using drone imagery. The total area of vegetation in the wetland versus bare soil will be documented. An assessment regarding the presence of non-native versus native vegetation will be provided. Offsite disturbances to the wetlands that may impact vegetation function (e.g., agriculture) will be documented.

Wetland soil function: Wetland soil function for Water bodies 19, 20 and 54 will be evaluated by locating and digging one soil plot in the centre of each wetland. Plots will be geo-referenced with GPS to ensure the same plots are sampled in each evaluation. The results will be recorded on the wetland field form.

The wetland soil function for the offsite wetlands, Water bodies 61 and 75, will be assessed using drone imagery. The area of vegetation versus bare soil will be documented. Offsite disturbances to the wetlands that may impact soil function (e.g., agriculture) will be documented.

Wetland hydrological function: Wetland hydrological function for Water bodies 19, 20 and 54 will be evaluated by surveying hydrological features as described in the wetland field form throughout the entirety of each wetland. Results will be recorded on the wetland field form.

The wetland hydrological function for the offsite wetlands, Water bodies 61 and 75, will be assessed using drone imagery. Hydrological indicators (e.g., standing water) will be documented. Offsite disturbances to the wetlands that may impact hydrological function (e.g., agriculture) will be documented.

Wetland habitat: Wetland vegetation, soils, and hydrology are all important aspects of wetland habitat; therefore, a change in wetland vegetation, soils, or hydrological function are expected to impact habitat. In addition to the information collected for these functions, all incidental wildlife and invertebrate observations will be recorded.

3.3 Reporting and Adaptive Management

Results of the evaluations will be provided to EPA in a letter report within one month of field sampling. Post-excavation evaluations will compare the results to the pre-Project evaluation and identify any changes that indicate unexpected negative wetland impacts or a trajectory for wetland loss. If there are any unexpected negative wetland impacts or wetland loss, the reports will provide a management plan to address these impacts (e.g., weed control, vegetation planting, etc.) in consultation with the EPA Wetland Specialist.

4.0 Closure

If you should have any questions, please contact Alana-Rose Lynes at alynes@slrconsulting.com.

Sincerely,

SLR Consulting (Canada) Ltd.

Alana-Rose Lynes

Alana-Rose Lynes, M.Sc., P. Biol.
Senior Wetland Ecologist

Attachment: Figure 1: Waterbody Catchment

5.0 References

Government of Alberta (GoA). 2012. Stepping Back from the Water: A Beneficial Management Practices Guide for New Development Near Water Bodies in Alberta's Settled Region. Environment and Sustainable Resource Development.

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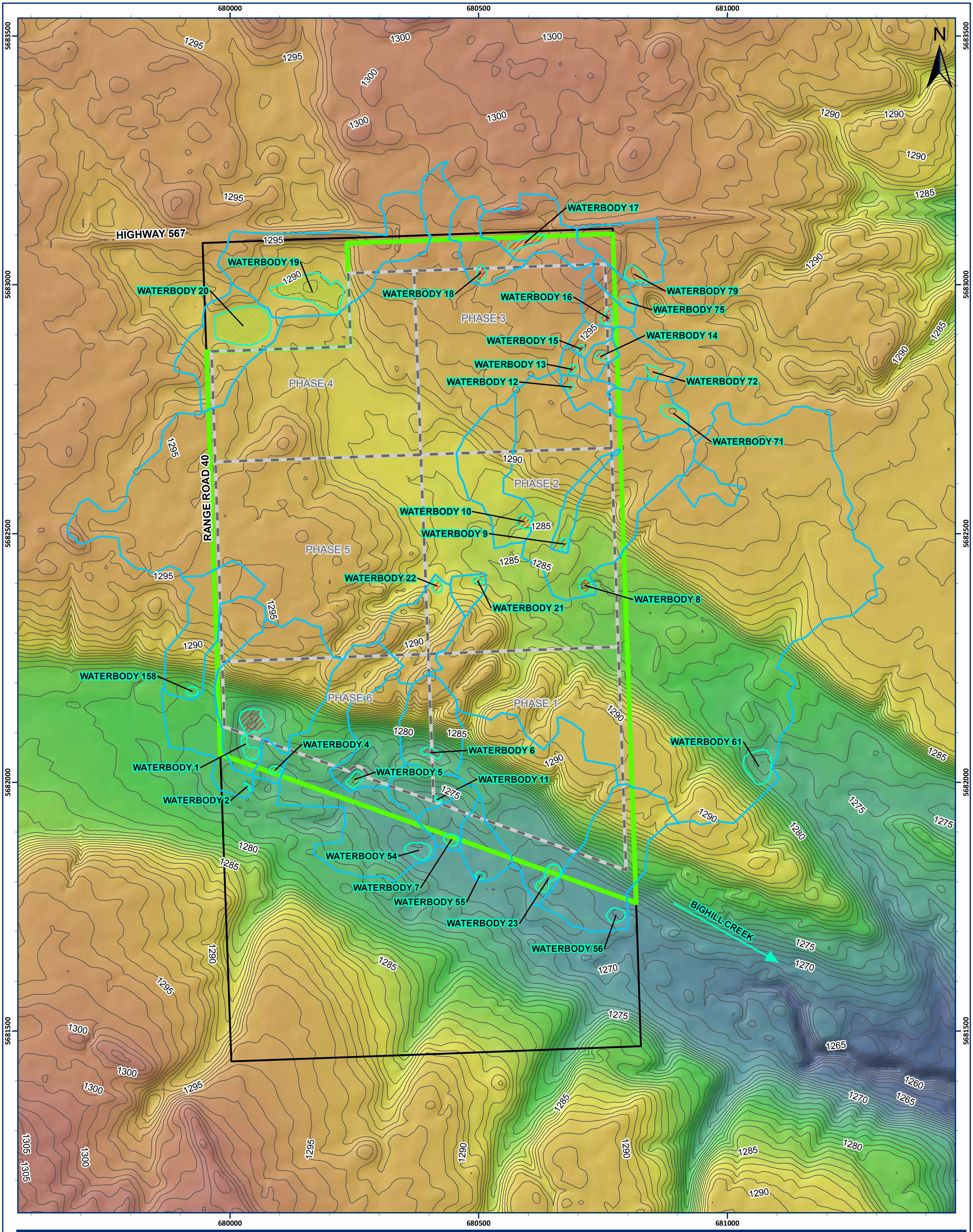

LEGEND

───	CONTOUR (1m)
▭	CATCHMENT
▭	EXTRACTION PHASE BOUNDARY
▭	PROJECT BOUNDARY
▭	PROPERTY BOUNDARY
▭	WATERBODY
▨	INDICATES WATERBODY THAT WILL BE REMOVED
▨	INDICATES WATERBODY THAT WILL BE LEFT IN PLACE

ELEVATION

High : 1306.29

Low : 1256.18

0 50 100 200 300 m

SCALE 1:7,500
PAGE SIZE 11 x 17
NAD 1983 UTM Zone 11N

MOUNTAIN ASH LIMITED PARTNERSHIP

SUMMIT PROJECT

WATERBODY CATCHMENTS

SLR

FIGURE NO:
1

DATE: May 9, 2023

PROJECT NO: 212.06650.00007

Appendix U

Wildlife Protection Plan

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8

Technical Memorandum

To:	Alberta Environment and Parks Terrina Perley, CET Senior Land and Water Specialist	From:	SLR Consulting (Canada) Ltd.
AEP File Nos:	DAPP0001717 ECM 00481044 EPEA 00478753	Project:	Mountain Ash Limited Partnership Summit Project
		Date:	September 22, 2022

Re: Response to Supplemental Information Request – D. *Wildlife Act* (Alberta) and Wildlife Regulations

SIR No. D3:

As this project will occur over a long period of time, it is recommended the development include a Wildlife Protection plan, as the phase are developed. Wildlife features may be determined over time and developing a set of strategies on how wildlife will be managed as phases are developed, would more adequately manage that risk. For example, how will habitat such as a den or nest be dealt with as the project moves to a next phase.

Response:

The Wildlife Protection Plan described in this response collates the various Mountain Ash Limited Partnership (MALP) mitigation measures regarding their ongoing commitment to best management practices and strategies pertaining to the Summit Project (the Project). The Project will be developed in six phases of eight to 16 ha over a period of 30 to 40 years. Once a phase has been completed (approximately six to eight years), it will be reclaimed as the next phase is developed. MALP will reclaim each phase in accordance with the best industry practices to ensure equivalent land capability can be achieved. Appropriate vegetation species mix, seeding rates, and composition will be based on reclamation criteria/requirements, seed availability, and landowner specifications likely consistent with current land use at the time which currently is primarily tame pasture and hay. Reclamation of mined areas will occur concurrently with mining operations. This will limit the inactive excavation (pit) area at any given time. Concurrent excavation (pit) area reclamation will also limit any additional soil handling and placement.

A full description of the biophysical environment is provided in the Biophysical Impact Assessment (SLR 2020). As stated in the response to SIR D1, there were no sensitive wildlife habitat features identified in 2019 or 2022 that require additional mitigation measures. Barn swallows were nesting on the residences in 2019 and no nesting was observed in 2022. As the clearing activities are expected to occur outside the migratory breeding bird period, no additional mitigation for barn swallows, or other migratory bird species, is required. If site preparation and stripping activities must occur within the migratory breeding bird period or nesting period for raptors, a nest sweep conducted by a qualified biologist will be conducted within seven days prior to construction activities. MALP will conduct wildlife sweeps for each new phase of development to identify new wildlife habitat features that may require additional mitigation.

The following mitigation measures will be implemented during the development and operation of the Project. Industrial standards, guidelines, recommendations, and best management practices will be followed to ensure impacts on wildlife are reduced or eliminated (GOA 2021, 2018, 2017, 2015, 2013, 2012, 2010; GOC 2021a, and 2021b).

- Limit the area of disturbance as far as practically possible.
- Conduct a wildlife sweep before clearing and reclamation activities for each Project Phase to identify new wildlife habitat features (e.g., raptor nests) and update the mitigation plan as needed. Results of these surveys, with updated mitigation measures, as needed, will be provided to Alberta Environment and Parks (AEP) prior to any clearing activity.
- Site preparation and stripping activities will avoid the migratory breeding bird period which is April 14 to August 28 in this area (Nesting Zone B4; ECCC 2018), and the nesting period for raptors March 1 to August 31 (GOA 2021).
- If site preparation and stripping activities must occur within the migratory breeding bird period or nesting period for raptors, a nest sweep conducted by a qualified biologist will be conducted within seven days prior to construction activities.
    - If nests are observed during the nest sweep, a setback distance and mitigation measures will be provided based on the species.
    - Mitigation measures will be provided, and strategies will be discussed with AEP as needed.
- Comply with federal and provincial legislation relating to migratory birds and designated species at risk (if presence is identified onsite) during Project construction.
- If an active nest or den is observed during operations, a qualified biologist will be contacted to discuss setbacks and mitigation measures for the active nest or den.
- Do not harass, hunt, trap, or feed wildlife or livestock on the Project site and surroundings.
- Train workers to report wildlife incidents such as presence of wildlife on the construction site or during Project operation, or wildlife mortality via collision with a vehicle.
- On-site garbage will be disposed of in appropriate storage containers to not attract wildlife.
- Maintain the perimeter fence to deter wildlife accessing the Project site.
- Effective access control to restrict unauthorized traffic into the Project.
- MALP will implement a weed control plan to comply with the requirements of the *Alberta Weed Control Act* as part of their regular operating practices that will cover construction, operation and reclamation (SLR 2021a).
- Disturbed areas will be progressively reclaimed.
- Phases will be reclaimed to equivalent land capability using only certified weed free seed mix where seeding is required.
- Monitor re-vegetation of the Project area and re-seed where necessary.
- Sloping of excavation (SLR 2021b) will be done to minimize nesting by bank swallows.
Stop excavation work if bank swallows colonize a slope in the excavation (pit) area.
- Manage on site surface water (SLR 2021c) to limit wildlife habitat, including shorebird and waterfowl nesting habitat.

- Prevent vegetation from becoming established around the edges and perimeter of the stormwater ponds. This will prevent the development of suitable habitat for birds and other wildlife.
- Internal speed limit is reduced in the Project area to reduce wildlife/vehicle conflicts and fugitive dust emissions.
- Prohibit the harvesting of any natural vegetation in the Project area by workers.
- Manage dust and noise emissions (SLR 2021d) to minimize disturbance to wildlife around the Project area.

Sincerely,

Tessa Giroux, P.Biol., R.P.Bio.
Environmental Scientist

Rick Lauzon, P.Biol., R.P.Bio.
Senior Wildlife Biologist

Statement of Limitations

SLR and AECOM are relaying information obtained during work conducted for Mountain Ash Limited Partnership. SLR and AECOM accept no responsibility or liability for the use of this information for any purpose by any other entity except provincial review agencies. The regulatory agency (or agencies) can rely on the information in this document for the purposes of review, comment, and regulatory approvals.

References

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SLR. 2021c. Stormwater Management Plan, Appendix I of the COP for pits. SLR Consulting (Canada) Ltd.

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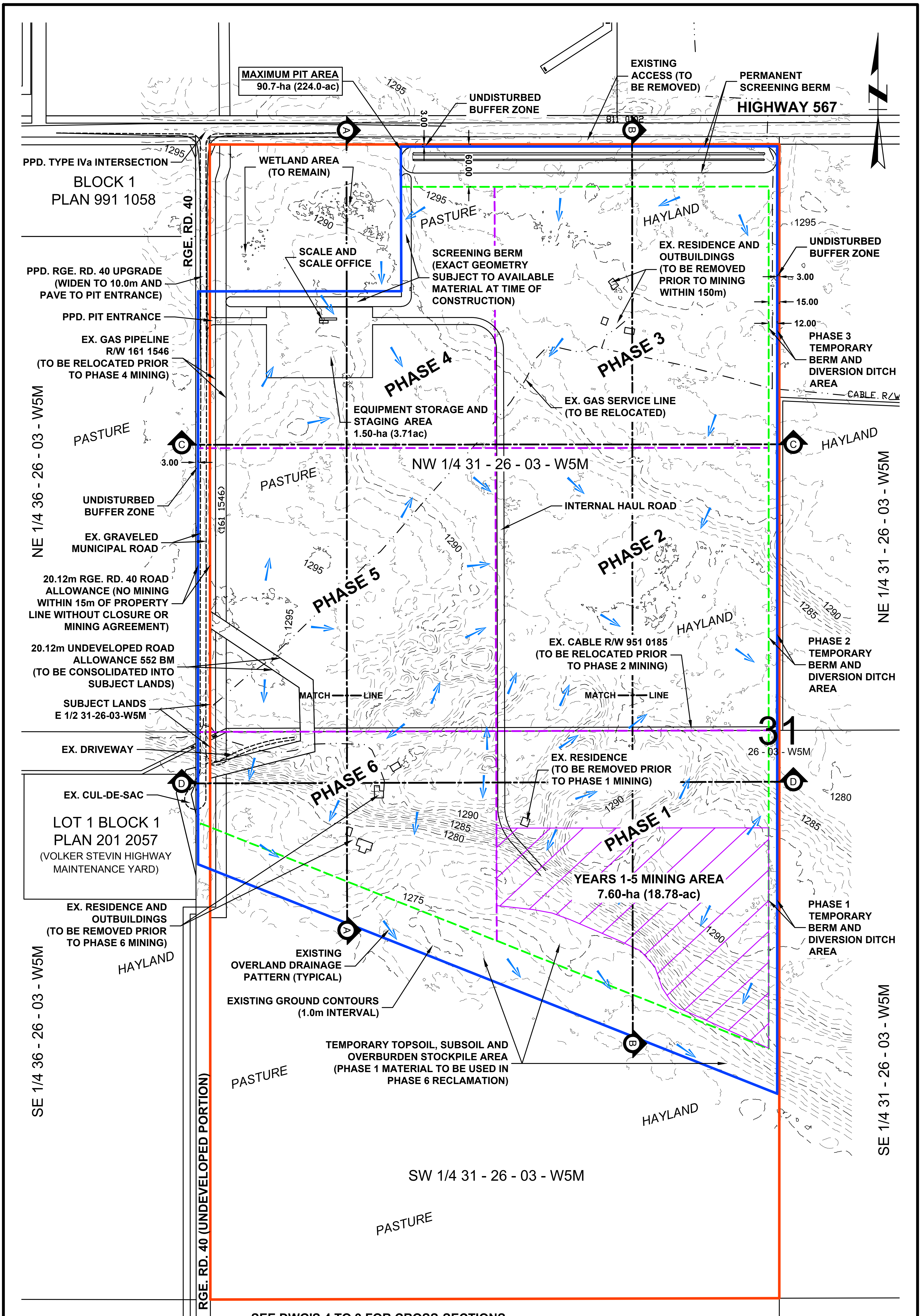
Appendix V

Supplemental Drawings

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8



SEE DWG'S 4 TO 9 FOR CROSS-SECTIONS

PLAN LEGEND

—	MAXIMUM PIT AREA
- -	CURRENT ACTIVE PIT AREA
- -	EXTRACTION SETBACK
- -	MINING PHASE BOUNDARY
TS	TOPSOIL STOCKPILE
SS	SUBSOIL STOCKPILE
OB	OVERBURDEN STOCKPILE

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:5000
0 25 50 100 200 300 m

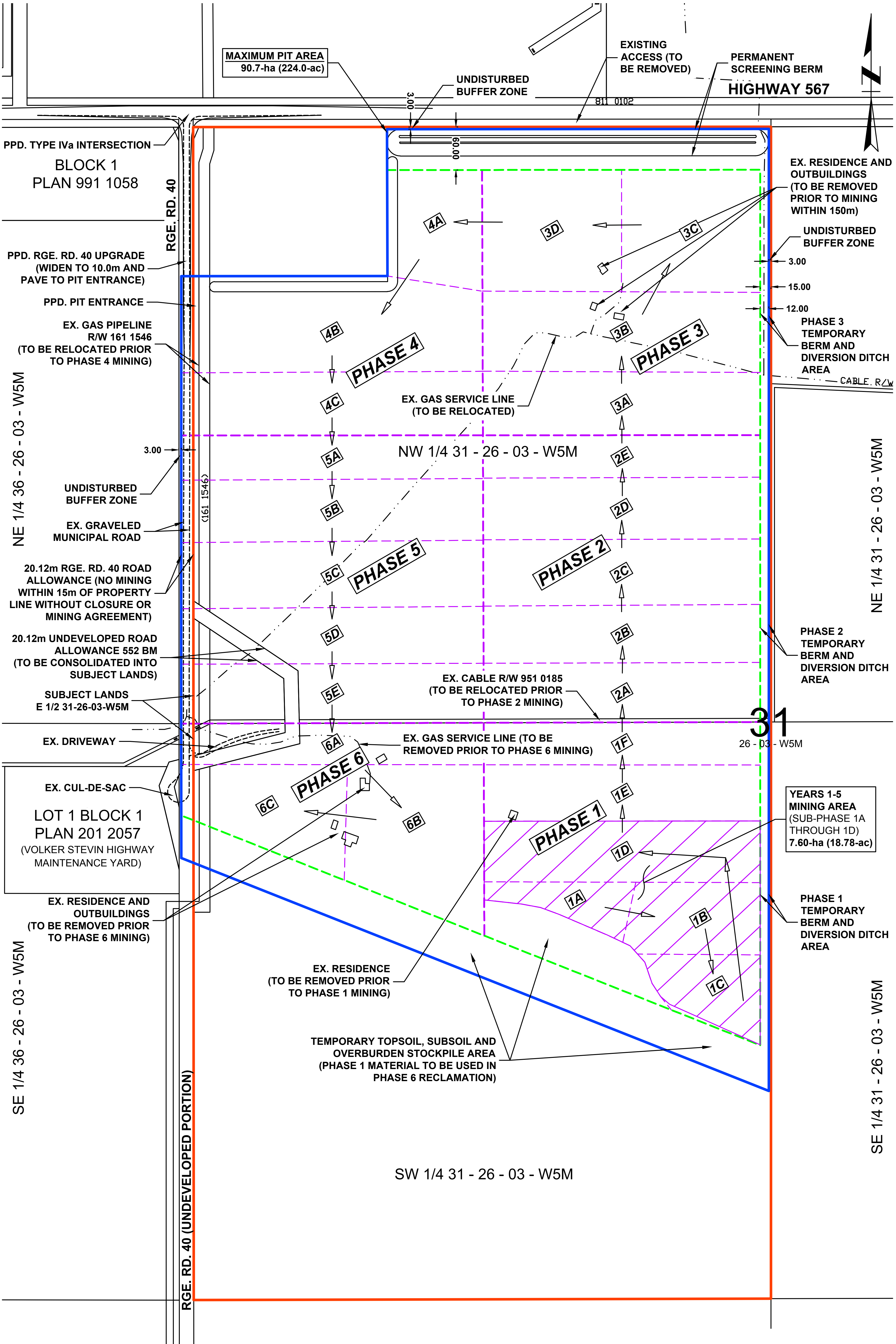
1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

EXISTING GROUND

BADKE CONSULTING LTD.
(403)982-7773

DRAWN: BCD
CHK'D: JDB
FILE #: 1638.M1
DATE: NOV. 2021
DWG. 2
REV. 23/01/05 1



PLAN LEGEND

- MAXIMUM PIT AREA
- CURRENT ACTIVE PIT AREA
- EXTRACTION SETBACK
- MINING PHASE BOUNDARY

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:5000
0 25 50 100 200 300 m

1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

MINING PHASES

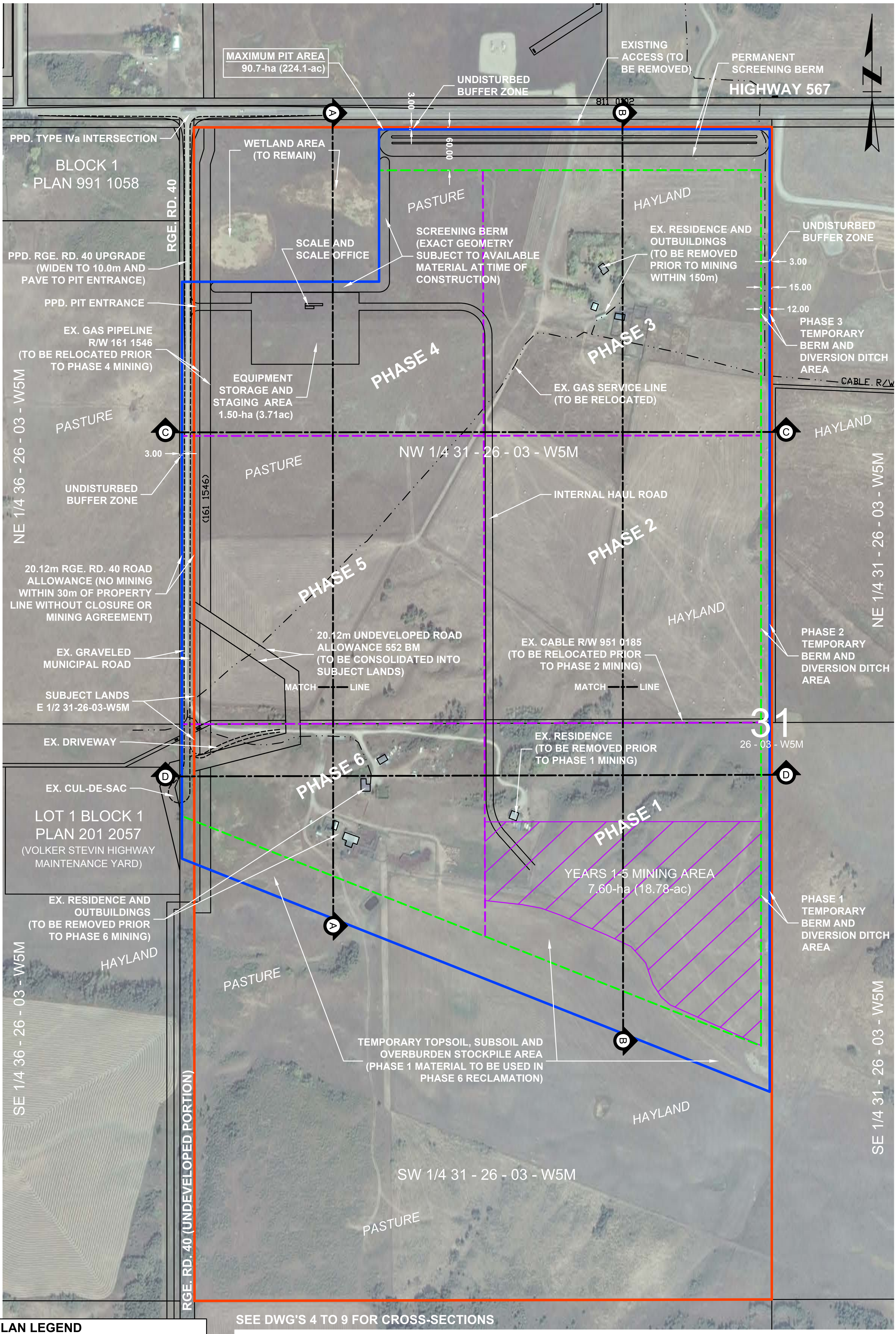
BADKE CONSULTING LTD.
(403)982-7773

DRAWN: BCD	DATE: NOV. 2021
CHK'D: JDB	DWG. 10
FILE #: 1638.M1	REV. 23/01/05 1

Appendix W
Original Code of Practice Drawing Set

Code of Practice for Pits in Alberta Application
Mountain Ash Limited Partnership

SLR Project No: 212.06650.00007/8



SEE DWG'S 4 TO 9 FOR CROSS-SECTIONS

PLAN LEGEND

▬	MAXIMUM PIT AREA
‒ ‒	CURRENT ACTIVE PIT AREA
‒ ‒	EXTRACTION SETBACK
‒ ‒	MINING PHASE BOUNDARY
TS	TOPSOIL STOCKPILE
SS	SUBSOIL STOCKPILE
OB	OVERBURDEN STOCKPILE

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:5000
0 25 50 100 200 300 m

1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

ACTIVITIES PLAN

BADKE CONSULTING LTD.
(403)982–7773

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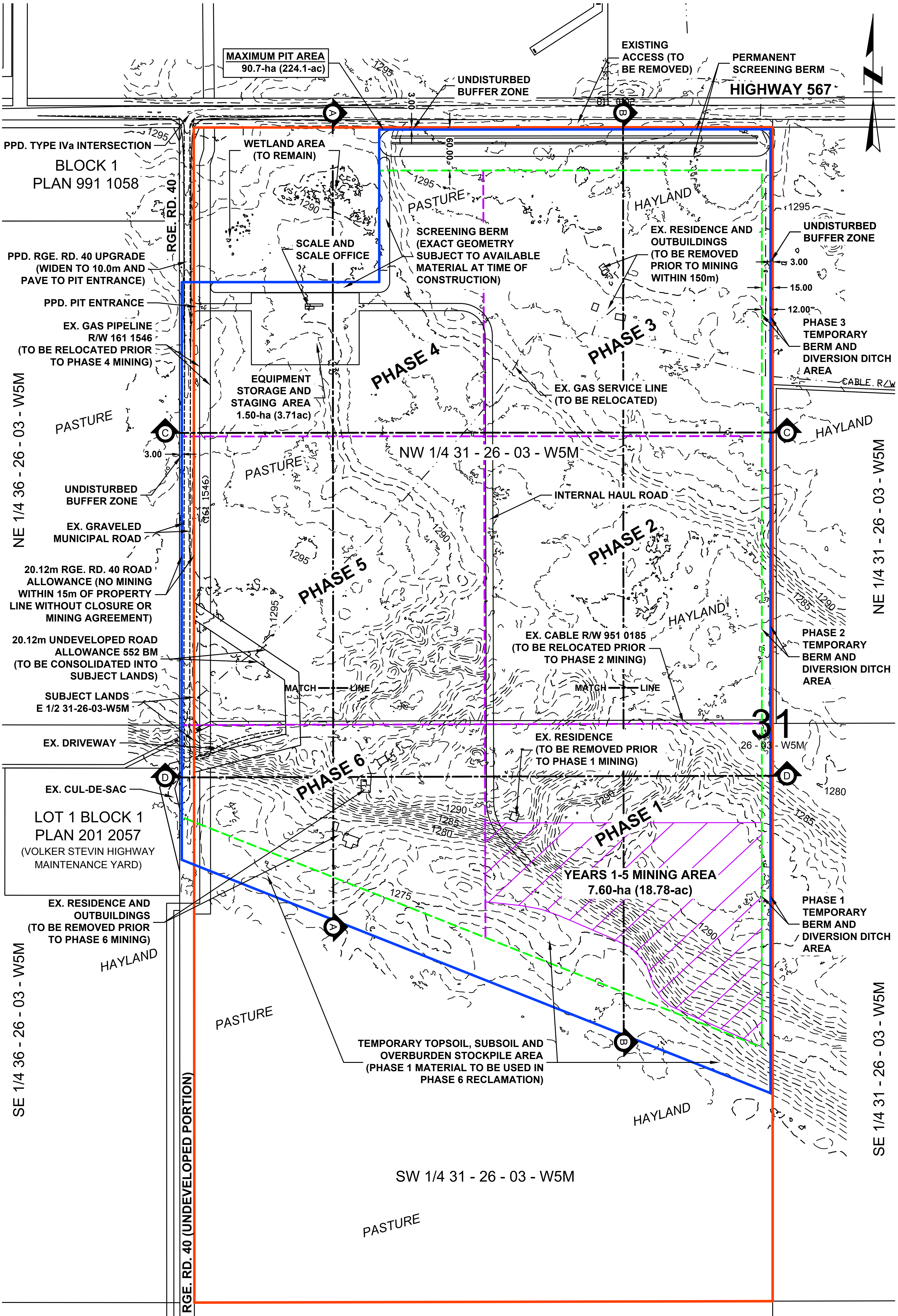
CHK'D: JDB	DWG. 1
FILE #: 1638.M1	REV. 0



SEE DWG'S 4 TO 9 FOR CROSS-SECTIONS

PLAN LEGEND

—	MAXIMUM PIT AREA
— —	CURRENT ACTIVE PIT AREA
— —	EXTRACTION SETBACK
— —	MINING PHASE BOUNDARY
TS	TOPSOIL STOCKPILE
SS	SUBSOIL STOCKPILE
OB	OVERBURDEN STOCKPILE

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:5000
0 25 50 100 200 300 m

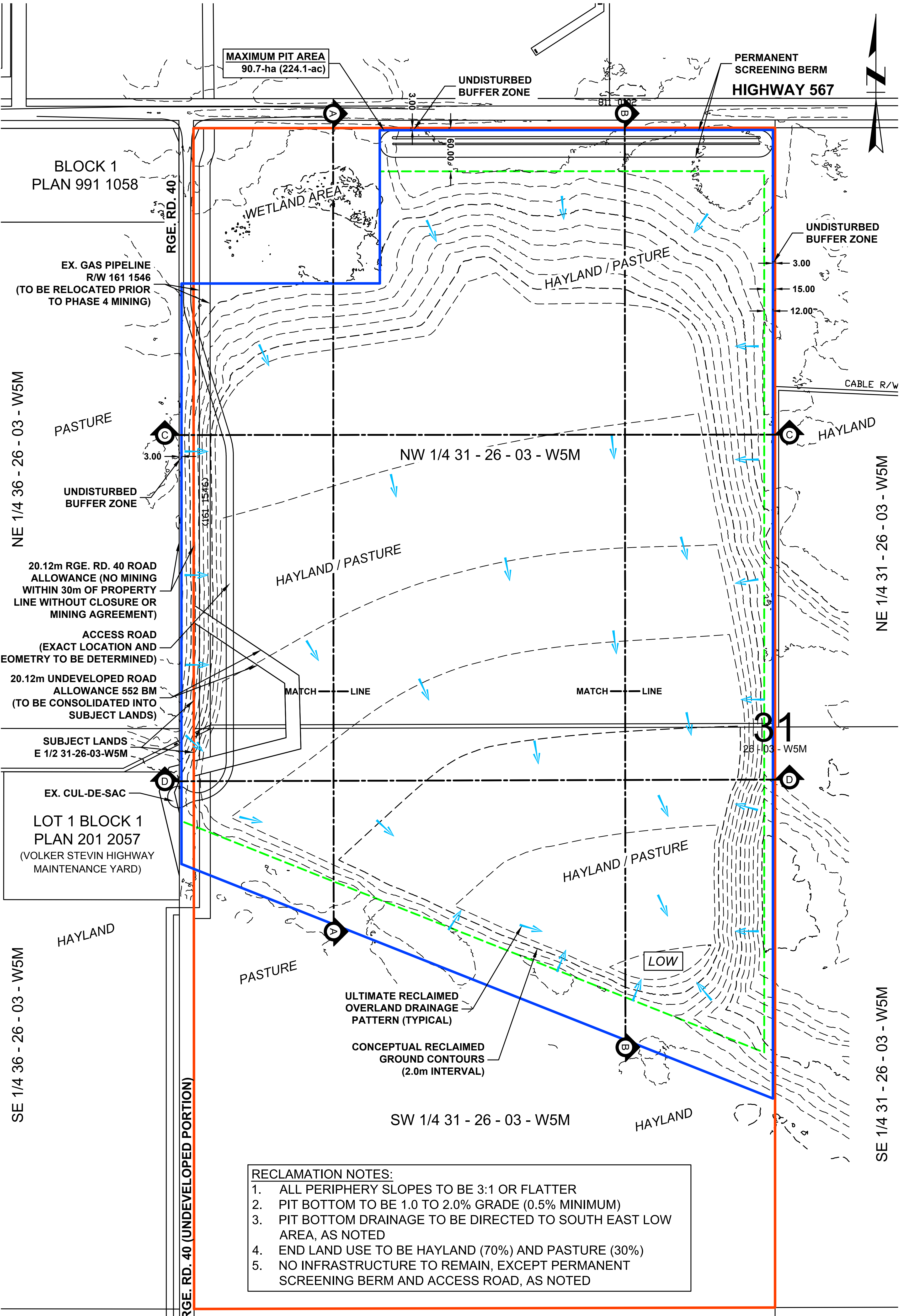
1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

EXISTING GROUND

BADKE CONSULTING LTD.
(403)982-7773

DRAWN: BCD
DATE: NOV. 2021
CHK'D: JDB
DWG. 2
REV. 0
FILE #: 1638.M1



RECLAMATION NOTES:

1. ALL PERIPHERY SLOPES TO BE 3:1 OR FLATTER
2. PIT BOTTOM TO BE 1.0 TO 2.0% GRADE (0.5% MINIMUM)
3. PIT BOTTOM DRAINAGE TO BE DIRECTED TO SOUTH EAST LOW AREA, AS NOTED
4. END LAND USE TO BE HAYLAND (70%) AND PASTURE (30%)
5. NO INFRASTRUCTURE TO REMAIN, EXCEPT PERMANENT SCREENING BERM AND ACCESS ROAD, AS NOTED

SEE DWG'S 4 TO 9 FOR CROSS-SECTIONS

PLAN LEGEND

━	MAXIMUM PIT AREA
╌	EXTRACTION SETBACK

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:5000
0 25 50 100 200 300 m

1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

RECLAMATION PLAN

BADKE CONSULTING LTD.
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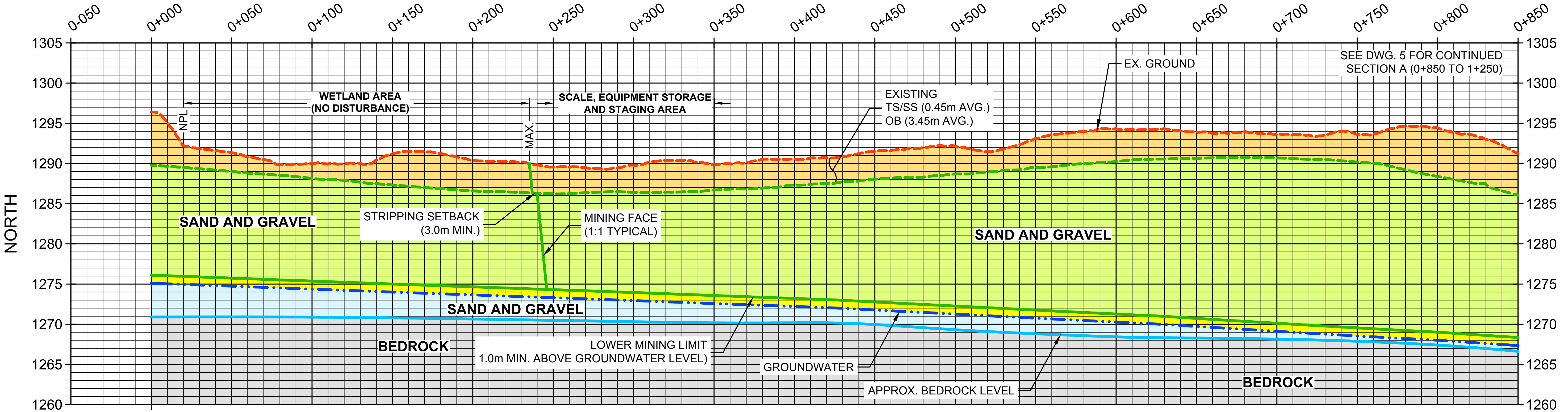
REV. 0



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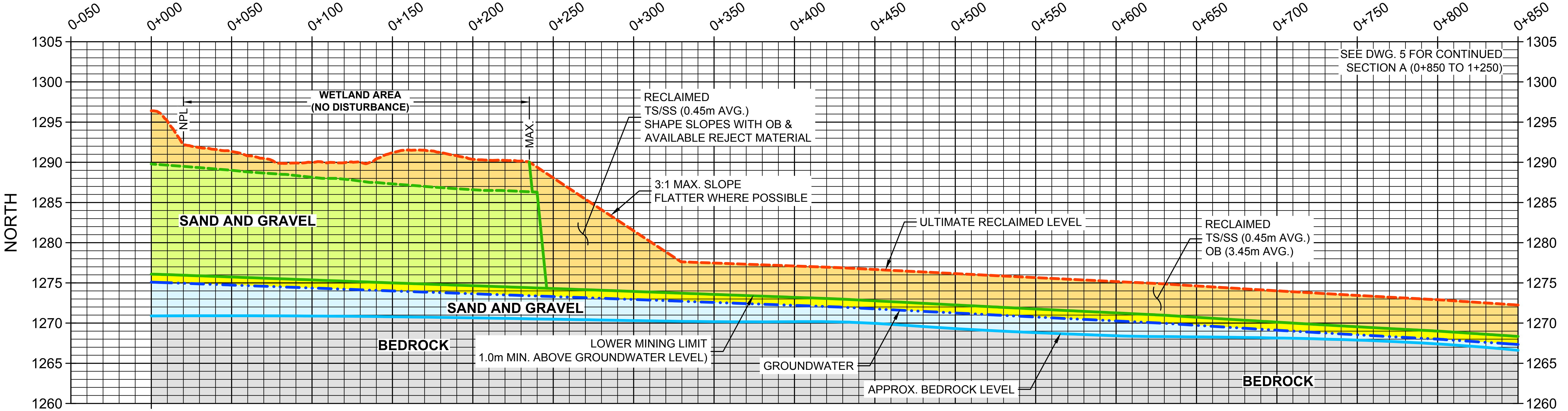

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PLAN LEGEND

MAX.:	MAXIMUM PIT AREA
EXT.:	EXTRACTION LIMIT
PL:	PROPERTY LINE
TS/SS:	TOPSOIL / SUBSOIL
OB:	OVERBURDEN

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:2500
0 10 20 40 80 120 160 m
0 2 4 8 16 24 32 m
VERTICAL SCALE: 1:500 (5x)

1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

SECTION A - NORTH

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DRAWN: BCD
DATE: NOV. 2021
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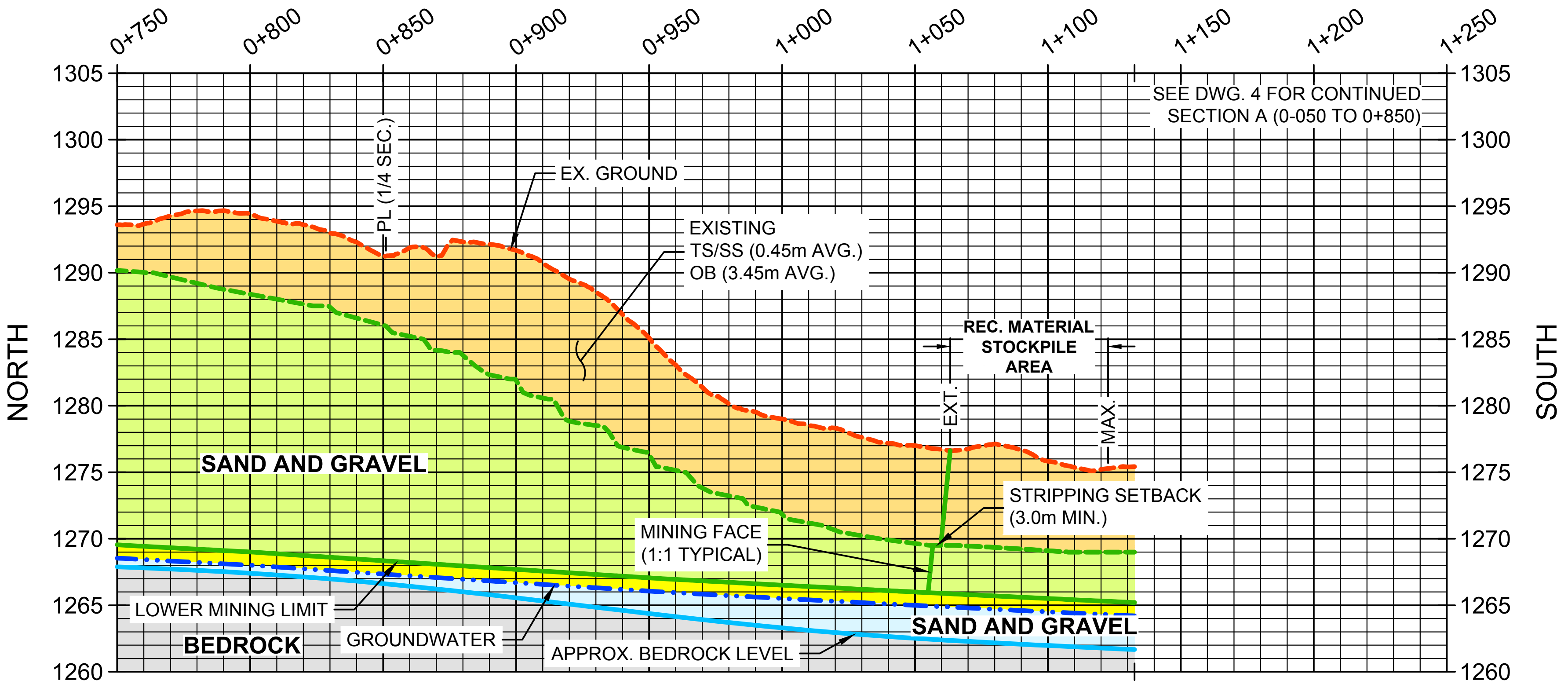

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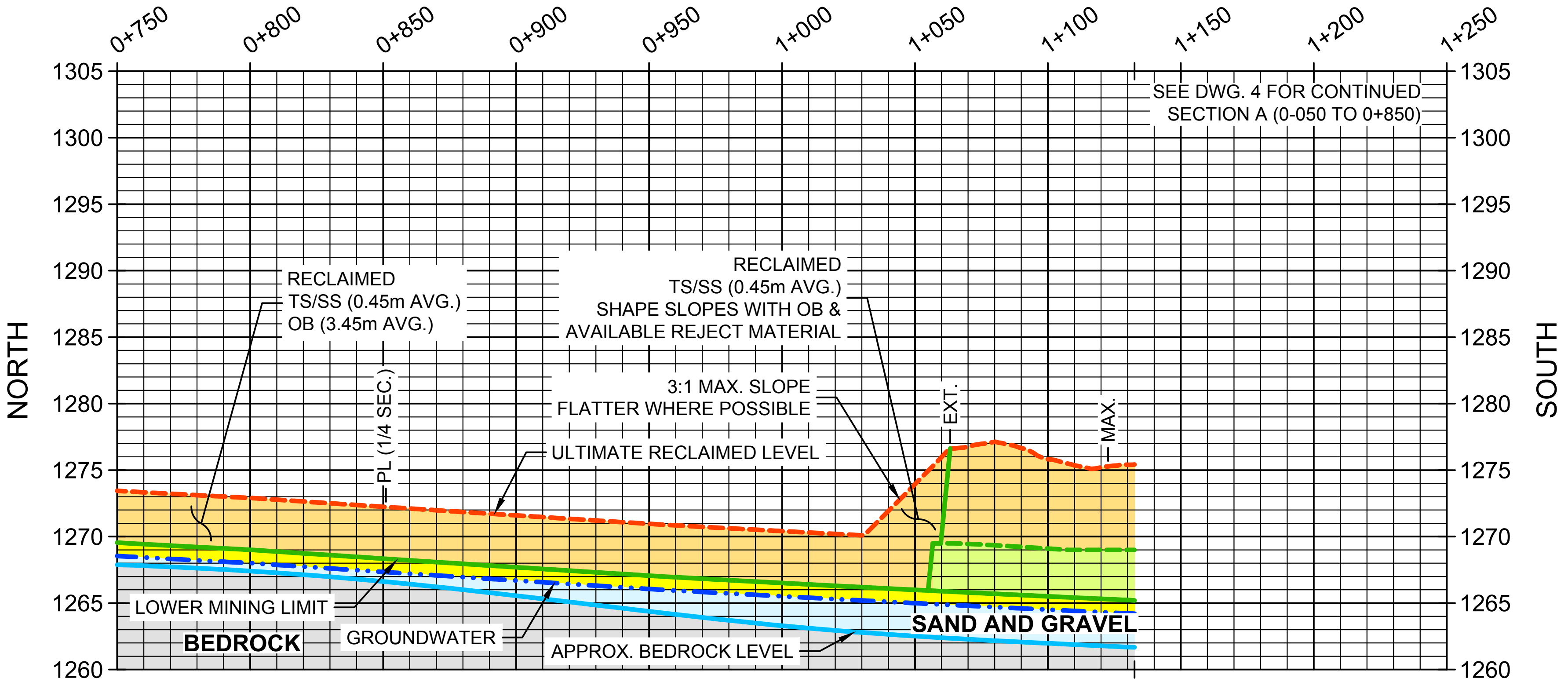

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PLAN LEGEND

MAX.:	MAXIMUM PIT AREA
EXT.:	EXTRACTION LIMIT
PL:	PROPERTY LINE
TS/SS:	TOPSOIL / SUBSOIL
OB:	OVERBURDEN

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:2500
0 10 20 40 80 120 160 m
0 2 4 8 16 24 32 m
VERTICAL SCALE: 1:500 (5x)

1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

SECTION A - SOUTH

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DRAWN: BCD
DATE: NOV. 2021
CHK'D: JDB
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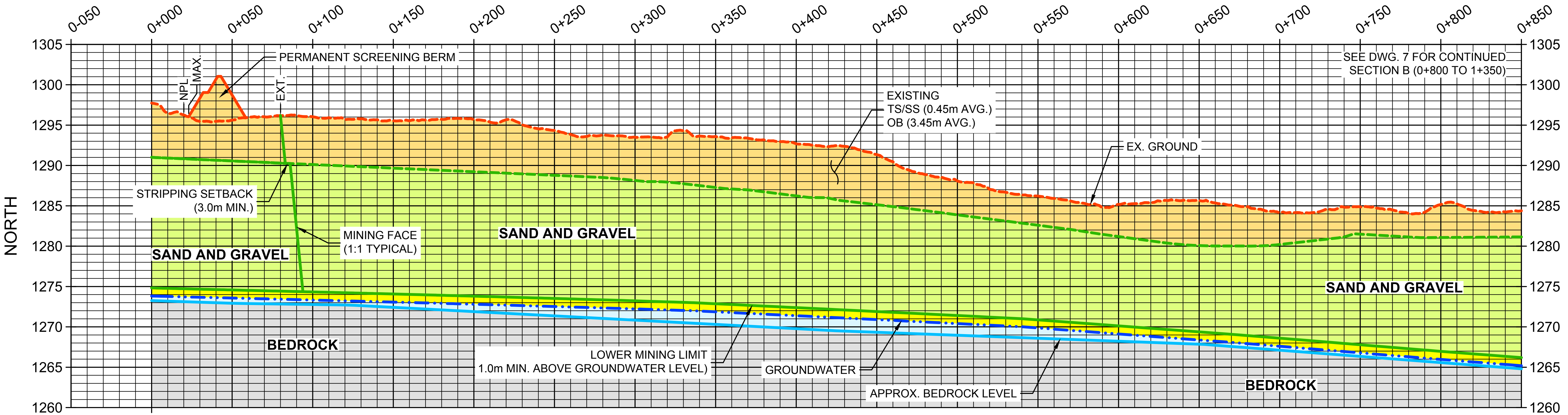
REV. 0
FILE #: 1638.M1



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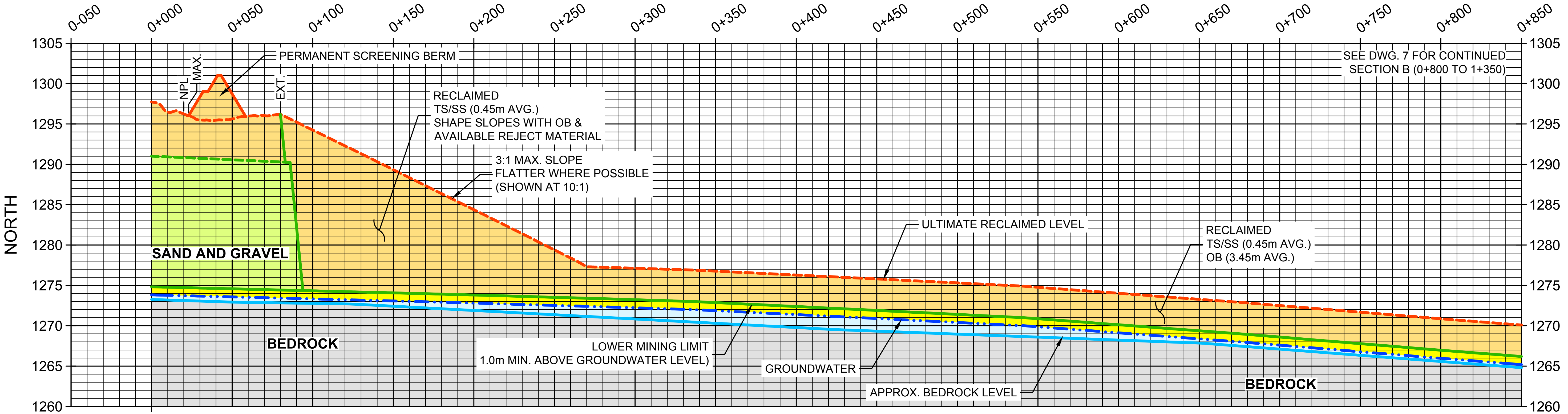

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PLAN LEGEND

MAX.:	MAXIMUM PIT AREA
EXT.:	EXTRACTION LIMIT
PL:	PROPERTY LINE
TS/SS:	TOPSOIL / SUBSOIL
OB:	OVERBURDEN

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:2500
0 10 20 40 80 120 160 m
0 2 4 8 16 24 32 m
VERTICAL SCALE: 1:500 (5x)

1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

SECTION B - NORTH

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(403)982-7773

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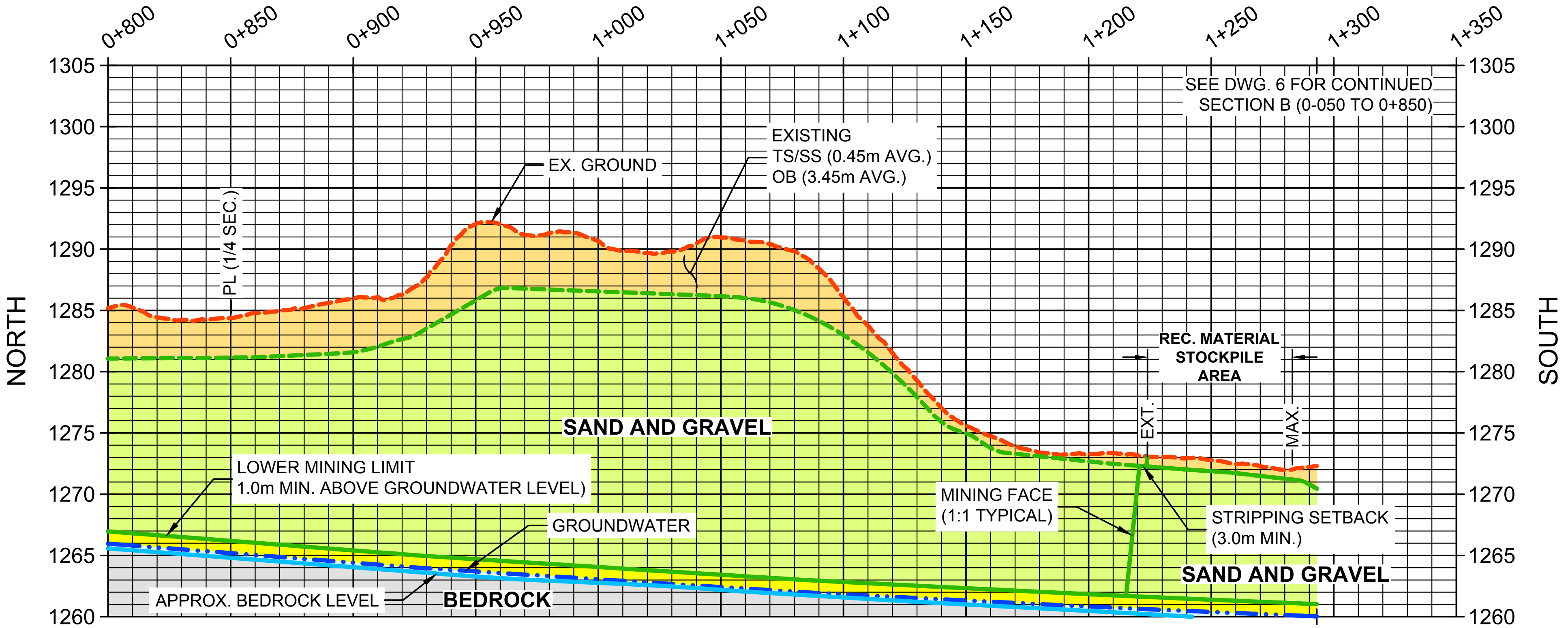
REV. 0
FILE #: 1638.M1



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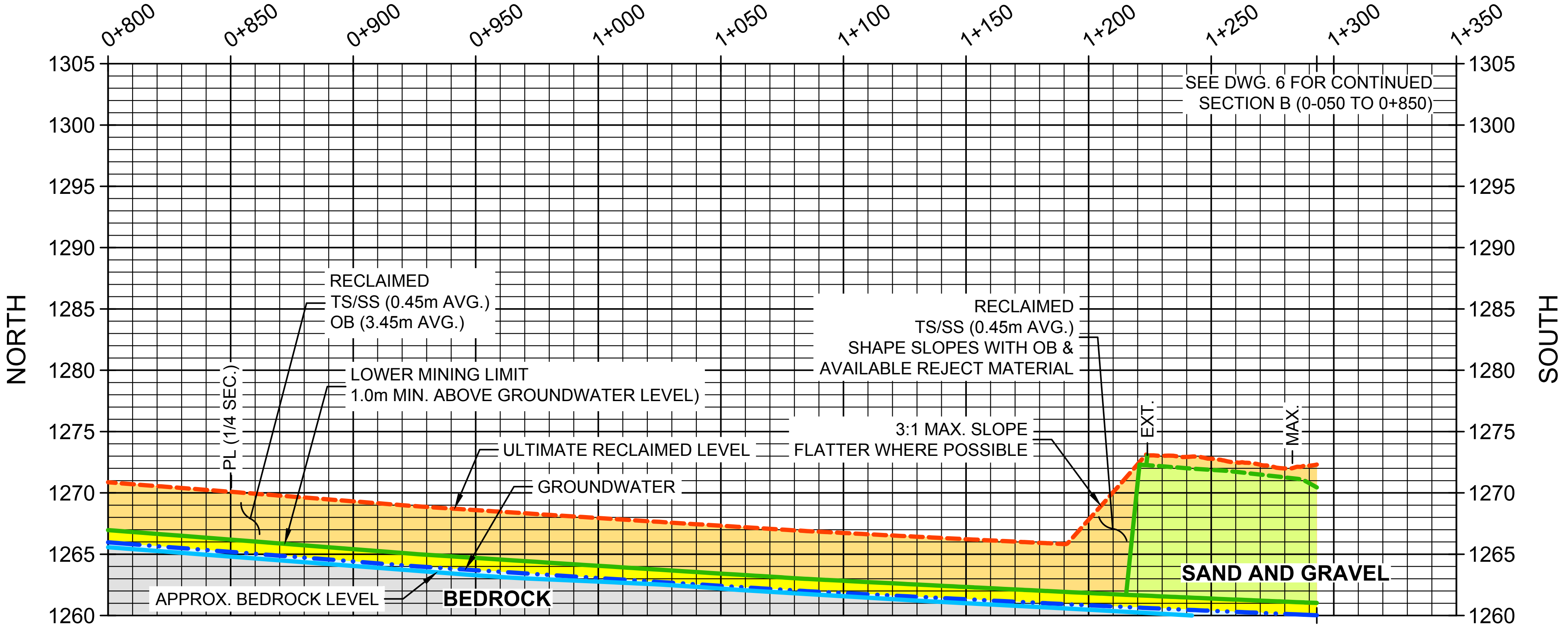

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PLAN LEGEND

MAX.:	MAXIMUM PIT AREA
EXT.:	EXTRACTION LIMIT
PL:	PROPERTY LINE
TS/SS:	TOPSOIL / SUBSOIL
OB:	OVERBURDEN

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:2500
0 10 20 40 80 120 160 m
0 2 4 8 16 24 32 m
VERTICAL SCALE: 1:500 (5x)

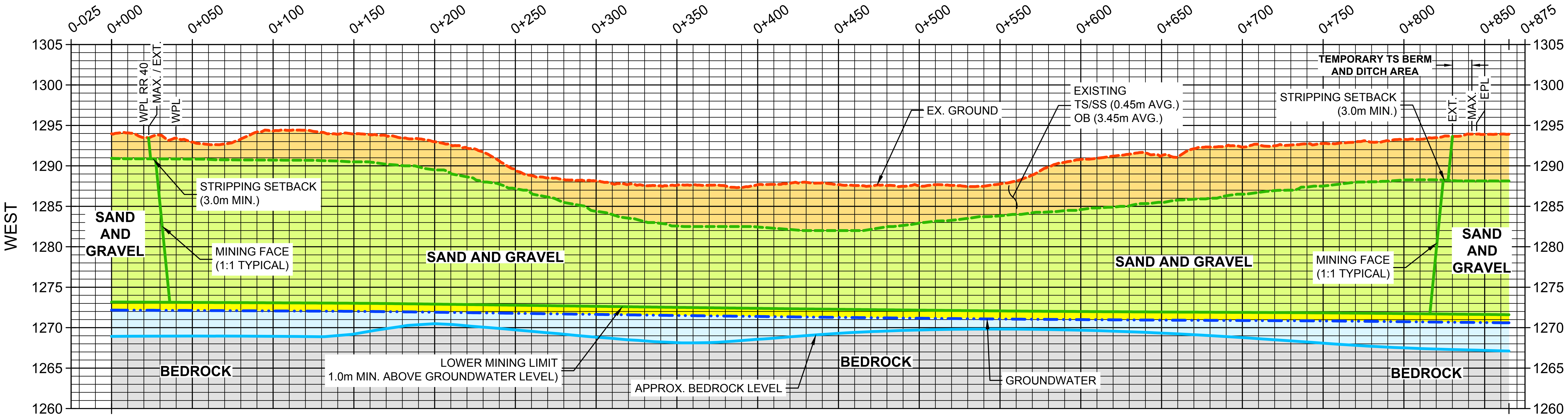
1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

SECTION B - SOUTH

BADKE CONSULTING LTD.
(403)982-7773

DRAWN: BCD
DATE: NOV. 2021
CHK'D: JDB
DWG. 7
REV. 0
FILE #: 1638.M1



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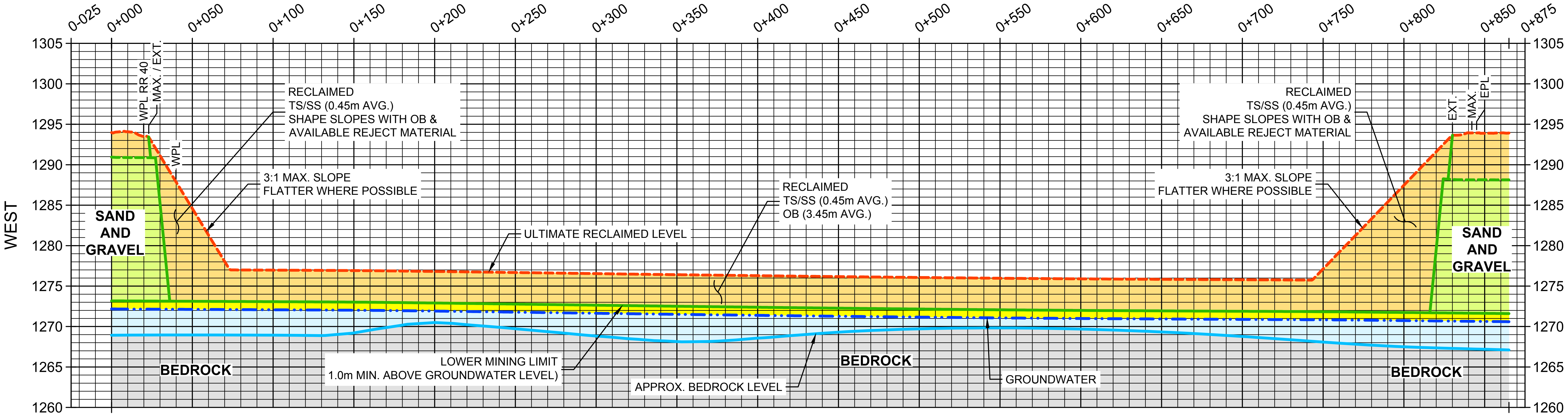

SECTION C - RECLAIMED

PLAN LEGEND

MAX.:	MAXIMUM PIT AREA
EXT.:	EXTRACTION LIMIT
PL:	PROPERTY LINE
TS/SS:	TOPSOIL / SUBSOIL
OB:	OVERBURDEN

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:2500
0 10 20 40 80 120 160 m
0 2 4 8 16 24 32 m
VERTICAL SCALE: 1:500 (5x)

1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

SECTION C

BADKE CONSULTING LTD.
(403)982-7773

DRAWN: BCD
DATE: NOV. 2021
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DWG. 8
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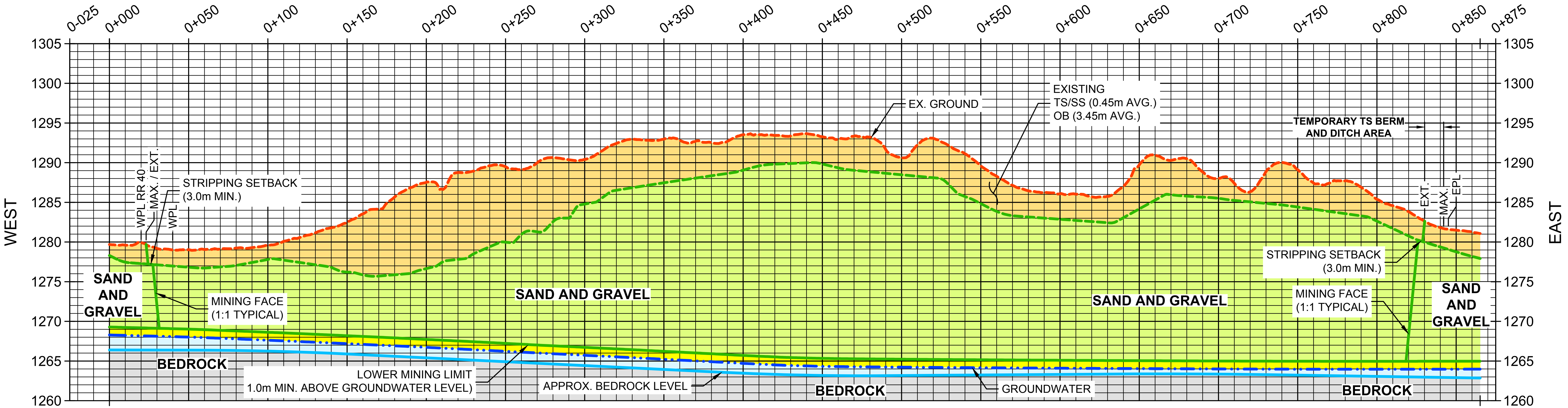
FILE #: 1638.M1



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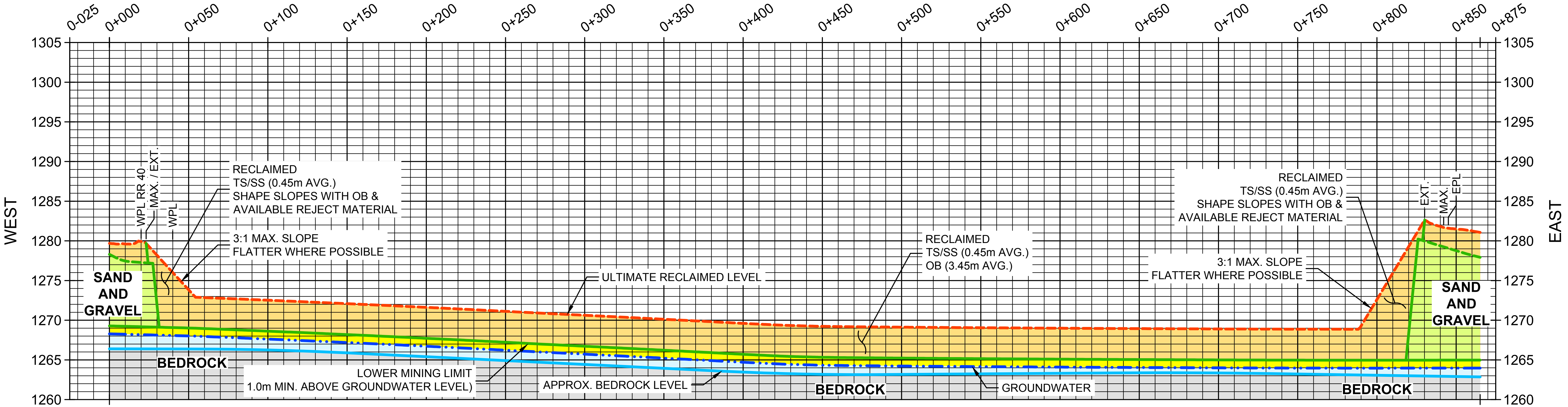

SECTION D - RECLAIMED

PLAN LEGEND

MAX.:	MAXIMUM PIT AREA
EXT.:	EXTRACTION LIMIT
PL:	PROPERTY LINE
TS/SS:	TOPSOIL / SUBSOIL
OB:	OVERBURDEN

ROCKY VIEW
COUNTY

HORIZONTAL SCALE: 1:2500
0 10 20 40 80 120 160 m
0 2 4 8 16 24 32 m
VERTICAL SCALE: 1:500 (5x)

1410266 ALBERTA LTD.
SUMMIT PIT

W 1/2 SEC. 31 - 26 - 03 - W5M

SECTION D

BADKE CONSULTING LTD.
(403)982-7773

DRAWN: BCD
DATE: NOV. 2021
CHK'D: JDB
DWG. 9
REV. 0
FILE #: 1638.M1

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