TETRA TECH

Tlicho All Season Road (TASR) 2017 Geotechnical Investigation of Granular & Bedrock Prospects

PRESENTED TO

Government of the Northwest Territories Department of Infrastructure

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ISSUED FOR REVIEW
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Tetra Tech Canada Inc.
Box 2244, 201, 4916 - 49 Street
Yellowknife, NT X1A 2P7 CANADA
Tel 867.920.2287 Fax 867.873.3324

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EXECUTIVE SUMMARY

Tetra Tech Canada Inc. (Tetra Tech) is pleased to submit this data report presenting the results of a geotechnical and geophysical investigation program conducted to evaluate 13 material prospect sites along the proposed 94 km Tlicho All Season Road (TASR), which aligns from Hwy 3, about 34 km west of the community of Behchoko, to the community of Whati on the south shore of Lac La Martre, Northwest Territories. This data report presents findings from 8 granular material prospects and 5 bedrock quarry prospects, which are being considered for construction of the proposed road. Geophysical surveys were completed at six sites to complement the subsurface data. A hydrotechnical survey was also undertaken at Crossing 10 under the scope of work. The summer 2017 investigation program was conducted for the Government of the Northwest Territories, Department of Infrastructure (GNWT-INF), under INF Contract No. SC02690 issued June 12, 2017.

The fieldwork commenced on June 24 and was completed July 27, 2017. Eight prospect sites were only accessible by helicopter. Prospects 1, 13B, 13C, 13D and 116 were accessed by ground with testpit equipment. An initial helicopter reconnaissance was undertaken prior to the start of field program with the drilling contractor, Department of Infrastructure representative, and a Tlicho representative.

Different investigation methods and techniques were used at the various prospects, to best suit the expected material types and conditions present at each site. The bedrock quarry prospect sites were investigated using a heli-portable diamond drill operated by Northtech Drilling. The granular borrow prospect sites, which were ground accessible, were investigated undertaking testpitting programs using an excavator operated by the Tlicho General Services Contractor, and those granular sites not accessible by ground were investigated using the same heli-portable drill operated by Northtech configured to solid stem auger drilling.

Non-intrusive geophysical surveys were undertaken at 6 sites to complement the borehole and testpit results. The geophysical investigations employed two different geophysical instruments; a Ground Penetrating Radar, and an OhmMapper. The GPR system was used to collect data that would allow estimation of the site stratigraphy, specifically the interface between overburden and bedrock. The OhmMapper system was used to supplement the GPR by providing additional stratigraphic information and detail of the overburden.

A hydrotechnical survey was completed at Crossing 10a (km 48+200). The hydrotechnical survey was not related to the material prospect investigations, but because equipment and labour were in the field, then the hydrotechnical data was collected efficiently. The hydrotechnical findings are presented in herein.

Detailed geotechnical logs, interpreted geophysical profiles, and laboratory index testing and metal leaching/acid rock drainage results are presented in this report.

Site specific Pit and Quarry Development Plans will be presented under separate cover. Preliminary development observations are presented herein.

Table I below summarizes the geotechnical and geophysical field investigation activities undertaken at each prospect and general subsurface conditions encountered.

Table I: Summary of Geotechnical and Geophysical Investigations Summer 2017 Geotechnical Investigation Program, Tlicho All Season Road, NT

Prospect			Geotechnical Activity			Geophysical Activity		Generalized Subsurface Conditions
Number	**Type**	**KM[1]**	**Auger Boreholes**	**Rock Core Boreholes**	**Testpits**	**Ohm-Mapper[2]**	**GPR[2]**	
Prospect 1	Granular	1+300	0	0	24			Fine grained, trace silt (Beach)
Prospect 13B	Granular	17+000	0	0	9			Fine grained, trace silt (Beach)
Prospect 13C	Granular	19+700	0	0	9			Fine grained, trace silt (Beach)
Prospect 13D	Bedrock	18+500	0	5	1			Limestone bedrock with patchy overburden
Prospect 29	Bedrock	31+500	0	7	0			Exposed limestone bedrock
Prospect 33A	Bedrock	36+700	0	9	0		3,330	Limestone bedrock, variable overburden (up to 7.4 m)
Prospect 68A	Granular	63+700	0	0	0		1,210	Mixed gravels and cobbles, sub-angular to sub-rounded (Esker)
Prospect 69	Granular	64+500	5	1	4		1,130	Gravel, sand, cobbles and boulders (Esker)
Prospect 76	Granular	69+000	9	1	1		1,400	Fluvial modified - silt, sand, gravel and cobbles, heterogeneous
Prospect 86	Bedrock	76+500	0	4	0		800	Limestone/Dolomite, weathered bedrock sands
Prospect 98	Granular	83+000	5		1	680	1,230	Sand, gravel, cobbles, and boulders (Esker)
Prospect 105	Bedrock	89+000	0	2	0			Exposed granite bedrock
Prospect 116	Granular	Whati Access Road	0	0	22			Sand and gravel, Esker complex
Totals			19	30	71	680	9,100	

1. Approximate Kilometre marker along proposed alignment Tlicho All Season Road, provided by GNWT – INF.
2. Linear metres, length of data collected using geophysical instrument.

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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the Government of the Northwest Territories, Department of Infrastructure (GNWT-INF) and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the Government of the Northwest Territories, Department of Transportation, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech Canada Inc.'s Services Agreement. Tetra Tech's General Conditions are provided in Appendix A of this report.

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) were retained to undertake geotechnical and geophysical investigations of 13 material prospect sites along the proposed Tlicho All Season Road (TASR) alignment, which extends from approximately km 197 of NWT Hwy No. 3 (near the community of Behchoko, NT) northward to the community of Whati, NT on the south shore of Lac La Martre, NT, as presented on Figure 1.

This data report presents Tetra Tech's findings of the investigations conducted at 8 granular material prospects and 5 bedrock quarry prospects, which are being considered for construction of the proposed road. Geophysical surveys were completed at six prospect sites to complement the subsurface borehole data. A hydrotechnical survey was also undertaken at Crossing 10 under the terms of contract.

The investigation program was undertaken for the Government of the Northwest Territories, Department of Infrastructure (GNWT-INF). The work was conducted under INF Contract No. SC02690 issued June 12, 2017. The program was conducted in general accordance with the terms of reference outlined in the contract, and within the conditions of the project Land Use Permit # W2016S0009).The work was authorized by Alexander Murray, Project Officer.

2.0 OBJECTIVES

The objective of the summer 2017 investigation program was to obtain subsurface and surface information at the prospect sites and assess the quantity and quality of materials encountered.

The investigations provide site-specific information obtained from excavating testpits, drilling auger holes, and coring bedrock holes, accompanied by geophysical surveys at six sites.

Reporting results include testpit and drill hole logs, location plans, geologic site descriptions, geophysical interpreted cross sections, laboratory index testing, petrographic analysis, metal leaching/acid rock drainage (ML/ARD) results, material quality/quantity assessments, and preliminary development observations.

Most prospect sites were only accessible by helicopter. Sites 1, 13B, 13C, 13D and 116 were accessed with testpitting equipment from the ground.

A pre-fieldwork site reconnaissance was undertaken on June 20, 2017 with a representative from Tetra Tech, GNWT-INF, Tlicho, and Northtech Drilling.

3.0 DEVIATIONS FROM THE SCOPE OF WORK

Based on conditions encountered during the execution of the program, the following deviations to the scope of work were implemented. These deviations were discussed with the Project Officer in advance of undertaking, and the work was managed through two change order requisitions.

Deviations included:

- Rock core drilling two boreholes at Prospect 105 was completed. The site had been planned for only a visual assessment, but subsurface information was obtained;
- No drilling was possible at Prospect P68a due to the irregular ground conditions and coarseness of the material; no samples were collected from this site, however, geophysical data was collected;
- A geophysical survey was completed on Prospect 76 (an additional site, 6 sites in total), to complement the borehole drilling data; and

- Rock coring boreholes were advanced at Prospects P69, P76 and P98 (one borehole per site) to obtain subsurface data at each site to support the geophysical findings, because the auger drill could not penetrate the coarse gravel/cobble materials encountered at these sites.

4.0 PROJECT TEAM

Tetra Tech was responsible for the overall coordination and operation of the investigation program, and provided all geotechnical, geophysical, bird survey and hydrotechnical consulting services. Table 4.1 summarizes the organizations and senior personnel that were responsible for the successful execution of the field program.

The Tlicho Engineering and Environmental Services Inc. (Tlicho) was the general services contractor that provided a variety of services, including establishing a work camp for field staff at the Nichicon yard west of Behchoko, supplying excavator equipment for field investigations at granular Prospects 1, 13B, 13C, 13D, and 116, responsible for site access and clearing/slashing crews, and supplied wildlife monitors for field crews.

Northtech Drilling Ltd. (Northtech) provided a heli-portable rig and operators capable of both geotechnical auger drilling and diamond coring. The rig was a modified Hydracore Prospector on a small tracked skid steer, which provided flexibility to drill both granular and bedrock prospect sites with the same drill. The drill and support equipment was transported by helicopter, typically in five to nine loads (depending on diamond or auger drilling configuration), with maximum weight of about 2,350 lbs. per load, and could be quickly and easily broken down and re-assembled for transport between sites. The drill was operated by a lead driller and 1 to 2 laborers as required. The drill was versatile and productive, but its limitation was its light weight, which did not have sufficient reaction force to allow it to auger penetrate coarser granular materials.

Acasta HeliFlight Inc. provided an Astar 350 B3 helicopter, sufficient for lifting power (maximum sling load of about 2,400 lbs.) to move the required equipment and was suitably sized to move crews between sites.

Table 4-1: Field Organization

Organization	Position	Representative
Tetra Tech **(Project Prime)**	Program Manager Assistant Program Manager Field Geologist – Rock Coring Field Engineer – Auger Drilling and Testpitting Bird Surveys Hydrotechnical Survey Senior Geophysicist Field Geophysicists Surficial Geologist	Ed Grozic Rob Girvan Scott Kingston Tim Schaap Steve Moore and Karla Langlois Mauricio Herrera and Mark AylwardNally Neil Parry James Mickle and Rob Winter Shirley McCuaig
Acasta HeliFlight Inc.(Acasta)	Pilot	Rob Girard and Donald Campbell
Northtech Drilling Ltd. (Northtech)	Office General Manager Lead Driller Alternate Driller Driller Labour	Stan Cochrane Mark Fairweather John Paquin Braden Mernickle
Tlicho Engineering and Environmental Services Inc.(General Services Contractor)	Superintendent	Chris Babkirk and Andy Young

5.0 BACKGROUND INFORMATION

Aerial imagery, bedrock and surficial geology mapping was reviewed, and preliminary maps were prepared for each prospective site prior to mobilizing equipment and personnel. Air photo interpretation and terrain analysis was undertaken to identify target areas, such as areas of exposed bedrock or with minimal overburden above bedrock, areas where granular deposits appear to be thickest and easily accessible, tree clearing requirements and proposed geophysical survey line locations. Tetra Tech reviewed available geotechnical/geological information and identified localized target areas within each prospect to optimize the field program execution.

The proposed borehole and testpit locations and geophysical profiles were confirmed with the GNWT prior to undertaking the subsurface investigations.

The GNWT was responsible for securing a Land Use Permit (W2016S0009) for this project and for completing archaeological assessments at each site prior to the start of the field program.

5.1 Bedrock Geology

Bedrock geology in the region has been mapped by Douglas et al. (1975). The following is summarized from this map, a selected portion of which is shown on Figure 2. The kilometer reference markers are based on the proposed all-season road alignment.

From the junction with Highway 3 to Yellowknife (km 0+000) to about 37+800, the alignment overlies the Middle Devonian Lonely Bay Formation. This formation consists of dark brown bituminous, argillaceous, nodular, fine-grained limestone.

From approximately km 37+800 to 73+000, it crosses white and grey gypsum, grey and brown interbedded limestone and dolostone, limestone and dolostone breccia of the Chinchaga Formation. This rock formation is also Middle Devonian in age, but is slightly older as it underlies the Lonely Bay formation.

From km 73+000 to the town of Whati, the route is underlain by bedrock of the Ordovician Chedabucto Lake Formation, which is made up of fine-grained brown, cherty or sandy dolostone and grey shale.

Between km 87+000 and 90+600, along and on either side of the alignment, small igneous intrusions of Proterozoic (Aphebian) age poke through the overlying Paleozoic rocks. These are made up of feldspar porphyry and quartz feldspar porphyry.

5.2 Surficial geology

The area from km 0+000 to 72+500 has been mapped by Kerr (2016). However, the area north of this, up to Whati, was mapped using remote predictive methods based on Landsat information (Kerr et al. 2014). It is therefore less reliable than Kerr (2016), but it is the only available surficial geology map for this region. The following is summarized from these two maps, which are shown on Figure 3.

From km 7+750 to 44+500, and from km 64+000 to Whati, till is the dominant deposit, with some incursions of fine-grained glaciolacustrine sediment in a few locations. Till forms a poorly sorted deposit ranging from silt to cobbles and boulders. The till is both heterogeneous and variable in depth and spatial distribution. Thickness varies but is usually greater than 2 m and the till may be covered locally by glaciolacustrine veneer (less than 1 m thick). Streamlined landforms consisting of till are present locally.

Thin to thick glaciolacustrine sediment is found at km 1+700 to 2+700, 20+500 to 21+400, 32+200 to 33+200, 44+500 to 64+000, 65+700 to 66+300 and 69+200 to 70+500. It consists of silty clay to fine sand up to 2 m thick. It may include marl and organic deposits of variable thickness, as well as thermokarst features.

From km 0+000 to 0+900, eolian deposits and glaciolacustrine beaches are found. The eolian deposits comprise fine to medium sand of variable thickness. An eolian deposit is also found between km 26+100 and 27+400.

A small meltwater channel crosses the route at 40.4.

Glaciolacustrine beaches that formed at the margins of Glacial Lake McConnell are found locally at various locations along the alignment. A few of these make up the granular aggregate prospects for this study (Prospects 1, 13B and 13C). They consist of sandy gravel of variable thickness that may contain cobbles and boulders, and may form shingle beaches if located near exposed bedrock.

Glaciofluvial deposits are too small to map at the scale of the government mapping. However, Prospect 68A is shown to be an esker ridge with beach strandlines. The esker is coarse grained and rocky at surface.

Large organic deposits (wetlands) are evident on the less reliable Kerr et al. (2014) map, and may be overrepresented at the scale of the map. The fact that Prospects 105 (bedrock) and 116 (esker complex) are mapped as mainly organic deposits and some till, rather than the esker and bedrock landforms that they are, supports this suggestion. Few organic deposits are mapped on Kerr (2016), which is taken to mean that those that exist are too small to map at 1:500,000 scale. As this is the more accurate map, it appears that glaciofluvial deposits and bedrock exposures have very likely been mapped as wetlands and till on the Kerr et al. (2014) map.

A look at a Google Maps image shows that the large esker, of which Prospect 116 is a part, continues westward from the prospect in a west-southwestward direction and then a southwestward direction, leading into the community of Whati. The existing gravel road is on top of the esker, which represents the driest possible location for it.

5.3 Climate

Climate data is available for Whatì from 1996 to present, with some notable gaps in the data in 2012 and 2013 (Environment Canada 2012). Since 1996, the mean annual air temperature is -4.9°C.

Climate Normals are not available for Whatì, but Environment Canada maintains a weather station in Yellowknife, with records dating back to 1942 (Environment Canada 2017). The climate at Whatì is similar to that at Yellowknife given their proximity.

The mean annual air temperature for Yellowknife has averaged -3.9°C over the last 30 years, (1987-2016 average). This is warmer than the average of -4.8°C observed over the period of record (1942-2016). The warmest and coldest months are July and January and have mean monthly air temperatures of 17.2°C and -25.4°C respectively.

Mean annual air temperatures in Yellowknife have increased over the period of record, by approximately 0.03°C per year. The warming trend has been much steeper over the past 30 years (1987-2016) than it was in the preceding 43 years (1943-1986): 0.04°C per year as compared to 0.01°C per year.

This trend is reflected in the mean annual freezing and thawing indices. The mean annual (1987-2016) freezing and thawing indices are about 3206 C°-days and 1803 C°-days, respectively. The freezing and thawing indices from 1943-1986 were 3563 and 1679 C°-days, respectively. The freezing index has thus decreased by 10%, indicating warmer winters, while the thawing index has increased by 7%, indicating warmer summers.

The mean annual total precipitation for Yellowknife is 271 mm, about 40% of which falls as snow (1943-2016). The 30 year moving average precipitation is 289 mm (1987-2016). The percentage of the precipitation that falls as snow has remained relatively stable over the period of record (1942-2016). Total precipitation, on the other hand, has shown a general increase over the years, with a 5% increase from the 1957-1986 intervals to the 1987-2016 intervals, and appears to have been gradually increasing over the period of record (1942-2016).

5.4 Permafrost

The TASR alignment lies within the extensive discontinuous permafrost zone (Heginbottom et al 1995). The extensive continuous zone indicates that permafrost is commonly present over 50% to 90% of the area. Permafrost in this zone is regularly found in undisturbed forested and poorly-drained areas with organic cover. When present, the average temperature is expected to be between 0°C and -1°C. Ground temperature monitoring on Highway 3 (EBA 2003) ranged from +0.4°C to -1.7°C in 2003.

Permafrost (or seasonally frozen ground) was observed in testpits and auger drilling sites along the length of the alignment where investigative work took place. Ground temperature monitoring installations were not part of the granular and bedrock prospects scope of work.

6.0 SITE INVESTIGATION OPERATIONS

6.1 General

The field program was staged from the Tlicho camp in the Nichicon yard west of Behchoko. The field work was carried out between June 24 and July 27, 2017. A combination of testpit excavations, auger and rock core drilling, and geophysical surveys were undertaken at the prospect sites.

A total of 19 auger boreholes and 30 rock core boreholes were completed. Total drill depth was about 276 m in 49 boreholes. Several auger borings also met shallow refusal. A total 70 testpits were excavated with a total testpit depth of 236 m. Six testpits were hand dug shallow excavations.

The Geophysical program commenced in July. Five sites were surveyed between July 5 and 10, 2017 with a further sixth site being surveyed on July 24, 2017. Ground Penetrating Radar (GPR) data was collected at all sites. OhmMapper resistivity data was collected at Prospect P98 along the main profile line to provide additional information as to the quality of the granular deposit and potential presence and distribution of permafrost soils based on resistivity values. A total of 9100 m of GPR data and 680 m of OhmMapper resistivity data was collected from all six sites investigated.

6.2 Safety

Personnel safety is of prime importance on all Tetra Tech projects. Understanding the work requirements, the use of safe operating methods and practices, providing effective supervision of work execution, and returning consistent and regular feedback are all important factors in conducting a safe field program.

The field engineers were responsible for site orientations for everyone they were working with. The orientation included safety, communications, and emergency procedures. Daily on-site meetings were held at the beginning of each work day to review the work plan and provide instruction to prepare everyone for performing the day's tasks safely. Any potential hazards of the drilling, testpitting, and geophysical work being used on the project were discussed, including safety concerns associated with working remotely, near heavy equipment, site access and clearing requirements. The drilling crew and clearing crews completed separate daily safety meetings.

A satellite phone was available on site for use during all field activities. Wildlife monitors were supplied by Tlicho and accompanied the crews during field activities to document wildlife sightings and manage potential wildlife encounters (e.g., bears).

Any safety issues arising in the field were documented and addressed throughout the project, and communicated to GNWT along with other routine reporting documents, including job observations; hazard identifications, near miss incidents, and spill reporting.

Two small spills occurred on June 28 and July 1 during drilling operations. In one case a hydraulic hose developed a leak and in the other case a hydraulic pump seal began to leak and was replaced. Both spills were below reportable quantities; however spill reports were prepared and submitted.

No buried utility checks were necessary as all sites were within undeveloped forest regions and over half a kilometer from the fibre optic line that travels adjacent to Highway 3.

6.3 Mobilization and Transportation

Field staff were mobilized from Tetra Tech offices in Yellowknife, Edmonton, Calgary and Vancouver. Northtech, Tlicho and Acasta were mobilized from Yellowknife and Behchoko.

Equipment was mobilized to the prospect sites and moved from one prospect to the next using the helicopter for the rock core drilling, auger drill program, geophysical surveys and clearing work. Field staff were mobilized into the drill sites daily via helicopter from the Behchoko airstrip.

Testpitting field equipment, including the excavator, operator and support truck, were mobilized into the prospect sites from the south end of the TASR alignment at the Highway 3 intersection, and for Prospect 116, were mobilized from Whati.

6.4 Minimizing Environmental Impacts

Tetra Tech worked with project team members and stakeholders to eliminate or minimize environmental impacts. All field work was carried out in a manner that recognized the sensitivity of the northern environment and reduced the impact of planned activities. The requirements of the land use permit and water license issued by the regulatory authority was satisfied.

A helicopter was used to mobilize drill equipment and personnel into the prospect sites to mitigate environmental impacts associated with driving along the cleared TASR alignment. A Kubota all-terrain vehicle was used for crew access to the testpitting prospects at P13B and P13C to minimize rutting along the existing TASR alignment. All geophysical profiles were collected on foot along existing cleared trails and open spaces. Within the prospects that were accessed via helicopter, an ARGO 8x8 all-terrain vehicle on tracks was used to move drill equipment and personnel around between drilling locations.

Two minor spills occurred during the field investigation program; however, these spills were quickly contained, and cleaned-up using on site spill kits and absorbent pads. Spills were reported to the project manager and to the appropriate parties. Spill incident reports were prepared.

Evidence of wildlife was observed at the prospect sites. Multiple Bison were sighted within Prospect 1 and a black bear was observed at a distance at Prospect 98. No Caribou were sighted during the field program. Evidence of wildlife was observed at the prospect sites.

6.5 Initial Site Reconnaissance

A pre-fieldwork site reconnaissance was undertaken on June 20, 2017 with a representative from Tetra Tech, GNWT-INF, Tlicho, and Northtech Drilling to identify target investigation areas and optimize the field program at each prospect site. The reconnaissance was carried out by Ed Grozic (Tetra Tech), Stan Cochrane (Northtech), Chris Babkirk (Tlicho) and Sandy Murray (GNWT-INF). The reconnaissance identified access and clearing requirements for investigation equipment, utilizing existing access wherever possible, and provided cursory level ground truthing following the desktop study and air photo interpretation program. Desktop-based air photo review included preparation of a field mapbook in advance of the site reconnaissance.

6.6 Bird Survey

Bird surveys were completed prior to undertaking any site clearing activities and mobilizing any equipment to a site, in accordance with the Migratory Birds Convention Act (The Government of Canada 1994). A registered biologist from the Yellowknife office completed the surveys within 7 days of commencing site clearing activities. The bird surveys were completed a different times, prior to the start of clearing, by Steve Moore and Karla Langlois.

6.7 Site Preparation and Restoration

Tlicho was responsible for providing slashing crews that opened cutline access routes, drilling pad clearings, and helicopter landing zones where required, within each prospect. Existing cutlines were utilized when available. Several prospects were within regions that had been previously impacted by forest fires.

In general, a new cutline was located centrally over the prime area of each prospect as previously identified in the initial site reconnaissance with smaller clearings accessing the outer edges of the potential source when required. All clearing was completed by hand felling with chainsaws and dispersing into the surrounding forest, in accordance with the provisions of the Land Use Permit.

New cutlines were established using doglegs to provide a visual screen from the TASR alignment, and were oriented to avoid trees or other natural obstacles as much as possible. Clearings were limited to a width of 5 m where excavator access was required, about 3 m width where heli-portable drill access was required, and about 1.5 m width where geophysical survey foot access was needed.

6.8 Prospect locations

The locations of the Prospects investigated is presented on Figure 1, and site Figures 4 to 15. The figures present available topographical data and landform features as well as the investigation program details including the location of cutlines, testpits and boreholes. Testpit and borehole locations were recorded using handheld GPS (using NAD 83 datum). Drilling and testpit location elevations were compared against the 1 m LiDAR contours provided by GNWT, and if there were differences then the LiDAR data was used.

Table 6.1 below summarizes the locations of the prospect site numbers in relation to the kilometer marker along the route.

Table 6-1: Prospect Locations along TASR Alignment

Prospect ID	Prospect Type	Kilometer Mark	Figure Number
Prospect 1	Granular	1+300	4
Prospect 13B	Granular	17+000	5
Prospect 13C	Granular	19+700	6
Prospect 13D	Bedrock	18+500	7
Prospect 29	Bedrock	31+500	8
Prospect 33A	Bedrock	36+700	9
Prospect 68A	Granular	63+700	10
Prospect 69	Granular	64+500	10
Prospect 76	Granular	69+000	11
Prospect 86	Bedrock	76+500	12
Prospect 98	Granular	83+000	13
Prospect 105	Bedrock	89+000	14
Prospect 116	Granular	Whati Access road	15

6.9 Schedule

The field investigation program of the prospective material sources was conducted between June 24 and July 27, 2017. Site access was prepared and cleanup completed during this time.

- Bedrock drilling took place between June 24th and July 18th
- Granular prospect testpitting took place between July 11th and July 18th
- Granular prospect auger drilling took place between July 19th and 26th

- Geophysical Surveys were completed between July 5th to 10th and July 24th.
- Hydrotechnical Survey Crossing 10 took place on June 27th.

7.0 SITE INVESTIGATION

7.1 Geotechnical Program

7.1.1 Testpitting

Where vehicle access was available the granular prospect sites were investigated using a tracked hydraulic excavator. Tlicho provided a Cat 320C excavator to complete testpitting at Prospects 1, 13B and 13C, and access was obtained via Highway 3. A Cat 320D excavator was sourced from the Hamlet of Whati to complete testpitting at Prospect 116 where vehicle access was available via a gravel road from Whati. The Tetra Tech field representative responsible for overseeing testpitting was Tim Schaap, P.Eng.

Testpits were completed along cleared cutlines. Previously selected testpit locations were excavated and logged, and a few extra locations were chosen by the Tetra Tech field engineer while on site. Prime target areas were investigated first, with testpits extending outwards to determine the extents of the deposit. Testpits were numbered sequentially as “Prospect-Testpit Number” (ex. P1-03).

The Tetra Tech field engineer was on site for all testpitting activities to log the testpits and collect samples. A minimum of five samples per 100,000 m^3, up to a maximum ten samples, were collected for gradation purposes (granular sites) and three samples for common borrow material sites were retained. Granular material samples were collected from the back wall of the testpit by giving directions to the excavator operator. The samples were visually classified in the field, bagged separately, labelled and sent to Tetra Tech’s Yellowknife laboratory for analysis.

Testpit field logs included proportions of gravel, sand, cobble, boulders, fines, clast shapes, maximum size, and moisture conditions. As each testpit was excavated, the soil stratigraphy was logged and representative soil samples were obtained for further laboratory analysis. Granular material greater than 20 mm in size was described and estimated in the field, as it could not practically be representatively sampled. The soil profile was described according to the Modified Unified Soil Classification System (USCS), in accordance with Tetra Tech work methods, and the terms of contract. When observed, groundwater seepage was noted along with the depth at which it occurred.

Visual estimates of texture and moisture content (or ice content, for frozen soils) was recorded for every major soil unit. Frozen soil samples were described according ASTM D 4083-89, “Standard Practice for Description of Frozen Soils”, when possible, but it was difficult to with the marginally frozen (near 0°C) sands that were encountered particularly when exposure to the warm air temperature working conditions.

Testpits were advanced to the base of the target deposits or the maximum reach of the excavator (about 5 m below grade). Testpits were photographed with a clearly graduated metric rod as well as the excavated spoil pile.

Testpits were backfilled by replacing the excavated material, nominally compacting by bucket tamping, and shaping to match the original ground surface. In locations where topsoil or other overburden was present, the organic material was stockpiled separately during testpitting, and subsequently replaced over the backfilled testpit. Backfill was mounded over the area of the excavation to compensate for settling of the replaced soil. Testpitting typically took place near the edge of the cutline while the spoil pile was placed within the cutline to allow for a proper backfill. Testpit logs have been prepared in digital and hard copy using gINT software. All testpit logs are presented in Appendix B.

7.1.2 Auger Drilling

At granular prospect sites where vehicle access was not available, then the sites were investigated by using a heli-portable drilling rig to advance solid stem auger holes. Auger drilling was undertaken along previously cleared cutlines. Some cutlines (i.e. Prospect 68a) were too rough to access with the lightweight tracked heli-drill equipment and as a result several proposed drill locations could not be reached. The Tetra Tech field representative responsible for overseeing auger drilling was Tim Schaap, P.Eng.

The Tetra Tech field engineer was on site for all drilling activities to log the boreholes and collect samples. Sample sizes were limited to the returns from the auger and from shallow hand excavated testpits when the drill met shallow refusal. The samples were visually classified in the field, bagged separately, labelled appropriately and sent to Tetra Tech's Yellowknife laboratory for analysis.

Borehole logs included proportions of gravel, sand, fines, clast shapes, maximum size, and moisture conditions. As each testpit was advanced, the soil stratigraphy was logged and representative soil samples were obtained for laboratory analysis. The soil profile was described according to the Modified Unified Soil Classification System (USCS), in accordance with applicable Tetra Tech work methods, and the terms of contract. Visual estimates of texture and moisture content (or ice content, for frozen soils) was recorded for every major soil unit. Groundwater was noted along with the depth at which it occurred when encountered.

Auger drilling using the light weight heli-portable drill was limited due to its inability to penetrate the cobbly and boulder nature of the materials typically encountered at the granular sites. The auger drill was not capable of advancing through these coarse materials, therefore, at the end of the program it was decided to switch the drill back to rock coring (diamond drill) and to advance one borehole at Prospects 69, 76 and 98.

Borehole logs have been prepared in digital and hard copy using gINT software. All auger drill borehole logs are presented in Appendix B.

7.1.3 Rock Coring

The bedrock prospect sites were accessed using helicopter with a heli-portable drilling rig operated by Northtech Drilling to advance diamond drill boreholes. The Tetra Tech representative responsible for overseeing and managing the rock coring program in the field was Scott Kingston, P.Geo.

Boreholes were numbered sequentially as Prospect-Hole Number (ex. P29-03). Final borehole ID's correspond with the proposed borehole numbering and locations. Boreholes were not renumbered if a proposed hole was not drilled, and as such there are gaps in the sequential numbering of the final holes. If a new hole was added, it was given the next sequential number in the series of proposed borehole locations. Boreholes were moved from proposed locations by the site engineer due to site accessibility or to focus on a specific target definition.

Core drilling was completed using the Boart Longyear BQTK™ core system, which produces an outer hole diameter of 60 mm (2-3/8") and a core diameter of 40.7 mm (1-5/8"). The Boart Longyear QTK™ wireline systems consist of the core barrel assembly and the overshot assembly. Both assemblies are integral to the wireline system.

In general, the borehole locations were selected to target the prime area of the bedrock target area identified through the desktop study, and were established in a grid-like pattern to delineate the lateral extents of the bedrock resource. A minimum of four core holes were drilled at each bedrock site, except for Prospect P105 and P68a, with additional holes drilled depending on the size of the potential quarry area and the results of investigation as the boreholes were completed. Note that in many cases the bedrock resource at the prospect areas may be larger than defined by the extents of drilling. The drilling extents were intended to identify a source area for the volume requirements provided by GNWT-INF.

The final borehole collar locations were surveyed by handheld GPS by the Tetra Tech field representative. Boreholes were backfilled with drill cuttings and woody debris.

Boreholes were typically advanced to between 8.0 m and 9.5 m from ground surface. Details of borehole depths and rationale for their lengths are discussed in the investigation program summary sections.

Recovered drill core was placed in wooden core boxes and immediately logged during drilling. Coring depths were recorded and verified by the Tetra Tech representative in communication with the drilling crew. Rock core logging included measurements to determine total core recovery, rock quality expressed as RQD; rock strength as per the ISRM standard, and weathering/alteration grading. The logging also identified various discontinuities in the core including joints, bedding, and faults and recorded their orientation, joint conditions and depths. Lithology and geological parameters was described with depth in each core run, and field logs included a comments section to note additional geological and geotechnical features, and drilling observations including water return and run blocking.

During the borehole logging, notes were made of parameters relevant to the ML/ARD geochemical characterization, including visible sulphide and carbonate occurrences and the presence of weathering and alteration variabilities.

Each core box was labelled with the borehole ID, start and end depths for the box, project ID, and core box number. Photographs were taken of the recovered core in the core boxes. A wet and dry photograph of the core was taken. Core photographs are provided in the Photographs section.

Notes were made during core logging regarding potential sampling locations for the laboratory test programs. Samples for ML/ARD geochemical characterization were collected from the core boxes after the photographs were taken. A record of the sampling location was recorded in the core box. Sample intervals for laboratory index and material testing were recorded. Samples for this testing were sent in the core boxes to the laboratory. Pieces of representative material from the sampling intervals were retained in the core boxes as a supplement to core photos as a record of the recovered bedrock material.

7.2 Laboratory Testing Program

7.2.1 Index and Materials Testing

Laboratory index and materials testing was completed by Tetra Tech at the Yellowknife and Edmonton laboratories. Granular material samples were analysed for soil classification and determination of relevant engineering properties to gauge their suitability for use in highway construction as granular fill and aggregate. Additional testing on select samples included resistance of aggregates to abrasion (Los Angeles Abrasion testing), petrographic analysis as well as fracture face counts and determination of flat and elongated particles on a 20 mm laboratory crush. The petrographic analyses were performed in accordance with Canadian Standards Association (CSA) A23.2-15A, petrographic examination of aggregates.

The granular material laboratory index testing and petrographic results are presented in Appendix C1 and C3.

7.2.2 Geochemical Characterization Testing

Geochemical characterization analysis was completed for all prospect materials, including both granular fill and bedrock material, to identify metal leaching (ML) and acid rock drainage (ARD) potential of the materials. Geochemical testing for metal leaching and acid rock drainage potential was completed by ALS Laboratories in the North Vancouver, BC and Burnaby, BC labs, with support from the Yellowknife ALS lab to prepare samples.

Geochemical characterization methods, including sample collection, analysis, interpretation and classification follow the best practise guidelines presented in the Mine Environment Neutral Drainage (MEND) Program's *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials, MEND Report 1.20.1* (Price, 2009).

The risks associated with ML/ARD will depend on the final excavated and placed material volumes, construction uses, and location of placement. Larger volumes of disturbed rock materials may translate to increased metal loading. The risks to aquatic life associated with metal leaching and acid rock drainage are increased when the disturbed rock materials are placed proximal to surface water receptors. ML/ARD risks can be mitigated by placing construction materials sub-aqueously to limit the reactions and weathering which produce ML/ARD.

7.2.2.1 Sample Collection Methods and Sample Numbers

Bedrock samples for geochemical characterization were collected from fresh drill core during the core drilling program. Granular material samples for geochemical characterization were selected from materials testing intervals selected from the testpit program.

Samples were selected to be representative of the materials encountered in the boreholes and testpits, and were selected to provide a good spatial variability of the material encountered.

The number of samples collected for each prospect area was determined based on site specific observations with respect to material variability, including mineralogy, weathering and alteration, and in consideration of expected material excavation volumes. The sample numbers were reduced from the proposed scope of work due to observations of material homogeneity, and a low potential for ML/ARD based on visual observations of high carbonate content, low sulphide content, and limited accessory mineral content in the encountered materials.

7.2.2.2 Analysis Program Methods

The samples were submitted to ALS Laboratories for a suite of four static geochemical characterization analyses. Details of the testing methods and purpose of the analysis are provided in the proceeding sections.

- Whole Rock Analysis by X-Ray Fluorescence (XRF)
- Acid-Base Accounting (ABA) Analysis
- Trace Element Analysis by ICP-MS
- Shake Flask Extraction (SFE) Analysis

A brief summary of general findings is provided in the proceeding sections, with complete data presentation and prospect specific results presented in Section 8.0.

The geochemistry testing laboratory certificates are presented in Appendix D1. Lab data summary tables, along with comparison criteria and data statistics, are presented in Appendix D2.

Whole Rock Analysis by Lithium Borate Fusion and XRF

The nature of lithophile elements and the matrices in which they occur require fusion methods for complete dissolution. The samples are prepared using lithium borate fusion and then run on the X-Ray Fluorescence (XRF) machine to provide oxide percentages for the whole rock composition.

The CaO and MgO percentages are normalized to calcite and dolomite proportions, and remaining element oxides normalized to the impurities proportion. Normalized concentrations are plotted on a carbonate ternary plot diagram to determine rock classification and to visualize the compositional variability of the materials within a prospect area and relative to other prospect areas.

General observations:

- Bedrock samples are plotted in the lower zone of the ternary diagram with less than 20% impurities, and variable calcite and dolomite compositions. The granular samples generally plot in the upper zone of the diagram with greater than 60% impurities.

Acid-Base Accounting (ABA) Analysis

Acid-Base Accounting (ABA) analysis was conducted to assess the potential for ARD to be produced from the sampled rock. ABA analysis includes whole rock paste pH, total sulphur and carbonate carbon (CO2) by LECO furnace analysis, sulphate sulphur by HCl leach, neutralization potential (NP) by Standard Sobek method, and fizz rating. The sulphide sulphur is calculated by subtracting the measured sulphate sulphur from the measured total sulphur. Total sulphur is used to calculate the maximum potential acidity (MPA). The net neutralization potential (NNP) is determined by subtracting the AP from the Sobek NP (NNP = Sobek NP – AP). The Sobek neutralization potential ratio (Sobek NPR) is the ratio of neutralization potential to the maximum potential acidity (Sobek NP:MPA). Carbonate NP is calculated from carbonate carbon (CO2%) and used to calculate a carbonate NPR value (Carbonate NP:AP).

The NPR value is used for material classification in accordance with the MEND Guidelines (Price, 2009). The guidelines state that a sample with a NPR value of less than one is classified as potentially acid generating (PAG) and as non-acid generating (NAG) if the NPR is greater than two. Material characterized by an NPR of between one and two is classified as “Uncertain”, and requires additional information to determine the acid rock drainage potential.

General observations:

- All samples analyzed are classified as non-acid generating (NAG).
- Total sulphur is low and variable in the bedrock samples. Total sulphur is uniformly low in the granular materials. The sulphur balance indicates that sulphide sulphur is the dominant form.
- The Carbonate NP tracks well across the majority of samples with the Sobek NP and indicates that the primary form of neutralization potential in the encountered materials is from carbonate sources.

Trace Element Analysis by ICP-MS

The results of the trace elemental analysis on bedrock samples were compared against average crustal abundance values for “Sedimentary rocks – Carbonates” (Price, 1997). The results of the trace elemental analysis on granular material samples were compared against average crustal abundance values in earth’s crust for all material types (Multiple sources, https://en.wikipedia.org/wiki/Abundance_of_elements_in_Earth's_crust). Elemental concentrations exceeding the respective average crustal abundance values by greater than an order of magnitude are flagged for further consideration.

General observations:

- Trace element concentrations are low, and typically fall within an order of magnitude within the respective average crustal abundance comparison values.
- Selenium concentrations in all bedrock samples and the majority of granular material samples are greater than the average crustal abundance value by greater than order of magnitude. This is a function of the limitation of testing and not highlighted as an elevated concentration.
- Cobalt concentrations in a majority of bedrock samples are greater than the average crustal abundance value by greater than an order of magnitude. Bismuth concentrations in a majority of granular material samples are greater than the average crustal abundance value by greater than an order of magnitude. These observations are commonly noted across multiple geologic regions, and appear to be a function of a low average crustal abundance rather than an identification of elevated concentrations in the analyzed samples.

Shake Flask Extraction (SFE) Analysis

The Shake Flask Extraction (SFE) analysis is a short term leachate analysis method used to determine the dissolved parameters of readily soluble components in the rock samples. The test is completed using a 100 g sample of minus 6.35 mm mixed with 300 ml of de-ionized water of known chemical composition. This represents a 3:1 water to solids ratio by weight. The sample is gently agitated on a shake table or gyrator shaker for 24 hours to ensure continuous exposure of all surfaces and mixing of the rinse solution. The resulting supernatant water is submitted for multi-element chemical analysis by ICP-MS.

The results of the SFE analysis were compared against the CCME freshwater aquatic life guidelines (CCME, 2017) and the BC Ministry of the Environment approved water quality (BCAWQ) guidelines (BC MEM, 2017) as a reference points for dissolved concentrations in the leachate from the test samples. Elevated concentrations of dissolved metals in the SFE analysis do not necessarily result in elevated constituents in a field setting; however it can be used to identify which leachable constituents may be of future concern. This test work and analysis does not take into account the receiving water chemistry, dilution volumes or long term metal dissolution for evaluating the impact of metal leaching potential on surface water receptors.

General observations:

- Trace element concentrations are low and typically fall within an order of magnitude the guideline values.

7.3 Geophysical Program

Geophysical data was collected at six prospect sites. Table 7-1 lists the sites surveyed along with the type and quantity of geophysical data collected.

Table 7-1: Geophysical Survey Locations along TASR Alignment

Prospect ID	Prospect Type	Kilometer Mark	Geophysical Data Collected	Approximate Quantity Collected, (linear meters)	Figure Number
Prospect 33A	Bedrock	36+700	GPR	3330	9
Prospect 68A	Granular	63+700	GPR	1210	10
Prospect 69	Granular	64+500	GPR	1130	10
Prospect 76	Granular	69+000	GPR	1400	11
Prospect 86	Bedrock	76+500	GPR	800	12
Prospect 98	Granular	83+000	GPR and OhmMapper	1230 (GPR) / 680 (OhmMapper)	13

The Geophysical program was generally focused on sites with more difficult access requiring helicopter support. At these sites testpitting using an excavator was not possible and practical operational and mobility issues with the heli portable drill limited both the number of drill holes achievable as well as the possible drill depth in coarser material.

At granular sites, the intent was to collect geophysical profiles that provided interpreted stratigraphic cross sections tying collected borehole information together as well as providing qualitative information on the variability of the granular resource, quality and quantitative information on the depth and nature of the underlying lithological contact.

OhmMapper data was collected at site P98 to provide additional insight into the granular material data quality, variability and potential presence of permafrost soils based on measured resistivity values. It also served to back check the granular deposit thickness by providing a second source of information to compare with the GPR data interpretation.

At the bedrock sites, the primary interest was confirming the rock type, rock quality, overburden thickness and the variation of the bedrock surface between borehole locations.

Where additional information has been inferred from the geophysical data, such as significant granular material at bedrock sites, or the presence of likely frozen material, this has been noted.

7.3.1 Geophysical Equipment

Two different geophysical instruments were used:

- A Ground Penetrating Radar (GPR). Malå CuII System, using 100 MHz Rough Terrain Antennas (RTA); and,
- A Capacitively Coupled Resistivity (CCR) System (Geometrics TR5 OhmMapper);

Ground penetrating radar (GPR) surveys were conducted to map site stratigraphy and characterize the permafrost soils present at all six sites where geophysical data was collected. GPR is time domain Electromagnetic (EM) pulse reflection system. Measurements are made by generating a high frequency, short duration EM pulse and then measuring the amount of time taken for reflections, or echoes of that pulse to be detected by a receiver. The reflections are created at lithological boundaries below the ground surface where an abrupt change in the charge capacity of the soil or bedrock layers is present. By transmitting EM pulses and then recording any detected echoes over a fixed time period (sample window) in a repetitive fashion as the antennas are moved along a profile on the ground surface, a cross section showing coherent reflections representative of lithological boundaries can be collected.

The resistivity of the ground controls the depth penetration of the GPR profile collected. In resistive material such as sands and gravels, and most bedrock, penetration depths can exceed 15 m to 20 m with a 100 MHz antenna such as the one used for this program. In more conductive soils with a higher fines content, penetration depth is dramatically decreased to as little as 1 m in lacustrine clays. By reviewing GPR data and interpreting the pattern of coherent reflections along the geophysical profile, as well as the depth of penetration, interpretations can be made as to the site lithology and type of material present.

The OhmMapper system was used at P98 to collect resistivity data that would allow accurate estimation of the site stratigraphy, variability and nature of the permafrost soils on the basis of changes in the resistive properties of the overburden soils and underlying bedrock. The system is operated by towing a number of receiver pods with specific dipole cable lengths with a transmitter pod at a series of different pod separations. The larger the pod separation, the deeper the geophysical data is representative of. For this program, OhmMapper resistivity data was collected in the top 12 m using a one transmitter and two receiver pod configuration with two different dipole and separation lengths (10 m and 15 m dipoles and 10 m and 15 m transmitter and receiver separations). All OhmMapper data was collected on foot with x,y,z positioning information being collected concurrently using an Topcon Hiper RTK GPS system.

By using two different techniques that are sensitive to different physical properties and comparing and combining the results a more complete picture of the site can often be obtained. This was indeed the case at the granular prospects due to similarities in the resistive properties of some of the overlying stratigraphic units. An overview of geophysical fundamentals describing how of the different techniques are used in permafrost soils is included in Appendix F.

7.3.2 Geophysical Methodologies

GPR data provided information on the qualitative nature of the granular resources, guidance on the consistency of the resource, and whether some areas were likely to contain a higher fines content. OhmMapper resistivity data was collected to better define the limits of the granular deposit. Each site was surveyed over one day, and preliminary results were interpreted and provided to the geotechnical drilling crew during the course of the drilling program.

Geophysical profiles were located using an RTK precision GPS system. A local GPS base station was established at each site to provide real-time differential corrections to allow real-time collection of x, y, and topographic data to approximately decimeter accuracy.

The interpreted geophysical profiles for the sites investigated are presented in Appendix E.

7.4 Hydrotechnical Survey Crossing 10a

Tetra Tech undertook a hydrological and hydraulic analysis of Crossing 10a along the TASR alignment as part of this Scope of Work. The hydrotechnical survey was undertaken during the geotechnical drilling program because, resources and equipment were in the field and available for the survey. The hydrotechnical survey results are presented as a technical memo in Appendix G.

8.0 PROSPECT SUMMARIES

This data report has been organized so that geotechnical and geophysical data collected for each prospective site are presented in respective sections and includes the following components:

- Site Description;
- Geotechnical and Geophysical Investigation Activities;
- Site Plan, with Borehole and Testpit Locations;
- General Soil and Rock Conditions,
- Borehole/Testpit Logs;
- Interpreted Geophysical Results and Profiles (where collected);
- Sample Inventory, including laboratory index testing, petrographic analysis and geochemical summaries; and
- Select Photographs.

8.1 Prospect 1

8.1.1 Site Description

Prospect 1 is located at approximately km 1+300 along the proposed alignment. The permitted area shown is 147.2 ha. The prospect straddles the alignment to the southwest and northeast. The site was accessed by excavator from Highway 3. Two archaeological buffer areas (sites 4 and 6) have been previously identified as shown on Figure 4. The site generally slopes to the northwest.

The prospect is situated on a series of raised beach ridges extending southwest from the north end and the location of the old airstrip. The beach ridges are parallel in the areas of the boreholes, and trend southwest. This is also where the deposits are thickest. Southwest of this location, south of the proposed alignment, the beach ridges become more widely separated, less parallel, less distinct, and curve southward. The beaches in the area adjacent to the old airstrip are not distinct, but appear to represent a series of beach ridges or one large ridge that curves gently to the south as they cross the alignment. There are wet areas to the northwest and south that have not been mapped as beach ridges. These are likely areas with a veneer of beach deposits over thicker glaciolacustrine sediments. Bedrock (limestone of the Lonely Bay Formation) outcrops about 62 m northeast of the prospect.

Testpits were excavated along the proposed alignment and in the east part of the prospect. The test locations were accessed by following cutlines that were cleared for the work as shown in Figure 4.

Vegetation cover is variable. Black spruce and jack pine trees are denser in the central and northern parts of the prospect. The region recently experienced a forest fire, so many of the trees have been burnt (Photo 1). The typical vegetation of well drained sites, such as beach ridges, is well spaced trees with a moss/low shrub and sometimes lichen (caribou moss) ground cover.

8.1.2 Geotechnical Investigation Activities

Testpitting took place at Prospect 1 between July 12 and 14, 2017. A total of 24 testpits were excavated with six along the existing alignment cutline, 15 along a new set of cutlines to the northeast and the remaining three located on the old airstrip further to the east and parallel to Highway 3. The area and region show as raised beach deposits of fine sand. Bedrock was not encountered in any of the testpits, nor were any till materials noted underlying the sand within the extent of the testpitting activities. All testpits terminated in the sand. The average testpit depth was 3.4 m. Table 8-1 summaries the testpits completed at the site.

Table 8-1: Prospect 1 Testpit Summary

Testpit ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Water Table (m)	Soil Description
P1-01	6,928,010	525,963	268	2.4	2.0	Sand & Gravel
P1-02	6,927,983	525,936	268	2.4	2.0	Sand & Gravel
P1-03	6,928,053	525,620	266	3.2	-	Sand
P1-04	6,928,118	525,332	268	3.1	-	Sand
P1-05	6,928,163	525,086	266	3.4	-	Sand
P1-06	6,928,190	524,922	263	3.0	-	Sand
P1-07	6,928,,212	525,658	266	3.4	-	Sand
P1-08	6,928,328	525,545	268	4.4	-	Sand
P1-09	6,928,431	525,445	265	3.4	-	Sand
P1-10	6,928,354	525,800	266	3.0	-	Sand
P1-11	6,928,456	525,699	268	4.0	-	Sand
P1-12	6,928,583	525,573	263	3.4	2.7	Sand
P1-13	6,928,525	525,919	267	4.1	-	Sand
P1-14	6,928,592	525,859	268	3.9	-	Sand
P1-15	6,928,700	525,756	263	3.5	2.1	Sand
P1-16	6,928,646	525,807	267	4.3	-	Sand
P1-17	6,928,516	525,638	267	4.0	-	Sand
P1-18	6,928,401	525,753	268	3.5	3.4	Sand
P1-19	6,928,379	525,495	267	4.0	-	Sand
P1-20	6,928,260	525,612	267	3.5	-	Sand
P1-21	6,928,230	525,429	268	4.3	-	Sand
P1-22	6,928,599	526,290	269	2.5	-	Sand
P1-23	6,928,489	526,298	269	2.9	-	Sand
P1-24	6,928,318	526,277	269	3.0	-	Sand

Note: "-"Groundwater table not encountered.
Coordinates listed in NAD 83, Zone 11

8.1.3 General Subsurface Conditions

The soil is defined as a sand, trace silt, grey to tan in colour, and dry to damp (Photos 3, 4, 5). The surface of the prospect comprised a thin layer of organic soils and rootlets that extended typically 100 mm deep. The upper 0.5 to 1.0 m of sandy soil was usually red to brown and had some medium to coarse sand grains. With the exception of Testpits P1-01 and P1-02 which contained gravel (Photo 2), all testpits terminated in sandy soils. Testpits P-01 and P1-02 also contained a shallow ground water table of 2.0 m. The groundwater table was observed at depths of 2.1 m (Photo 4) and 2.7 m along the northwestern boundary of the raised beach and at 3.4 m depth at P1-18. No till soils were encountered during the investigation of Prospect 1.

8.1.4 Materials Testing Program and Results

Laboratory gradation testing showed the sandy soil to be typically 91% to 100% sand with trace silt and gravel particles. The sand was mostly fine grained with limited medium and coarse particle sizes observed. Typically, the upper metre of sand was well graded and with depth it was mostly fine sand. The moisture content ranged from 2% to 12%.

No Los Angeles Abrasion laboratory testing or other aggregate testing was undertaken due to the lack of gravel sized particles during testpitting efforts.

8.1.5 Geochemical Characterization Program and Results

Three overburden samples were submitted for geochemical characterization, including two sand samples and one sand/gravel sample.

XRF analysis indicates a high content of impurities in all samples, with the normalized concentrations ranging from 79.0% to 95.6%.

All samples analyzed are classified as non-acid generating (NAG) based on Sobek NPR values which range from 285 to 1,117 with a median value of 365. Total sulphur is consistently measured at 0.01 S% in all samples. Sobek NP ranges from 89 to 349 $tCaCO_3$/1Kt, with a median value of 114 $tCaCO_3$/1Kt. The Carbonate NP tracks well against the Sobek NP, and has a median value of 111 $tCaCO_3$/1Kt.

Trace element analysis identified select elements at concentrations greater than the average crustal abundance. No concentrations, except bismuth and selenium, were noted at concentrations greater than 10x the average crustal abundance.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in all samples. The guideline value is 0.100 mg/L and measured concentrations range from 0.415 to 0.597 mg/L. No other metals were noted at concentrations above the guideline values.

8.1.6 Development Potential

Prospect 1 is located at the south-end of the proposed road alignment. A material source at this location is preferred; however, he materials encountered at this site are generally fine grained and not ideally suited for road embankment fill. An alternate material source along Highway 3 might be considered.

The prospect is located within an old forest fire area. Damaged and dead trees and new growth vegetation will require clearing for development. The present proposed development plan for the site is for the supply of about 390,000 m^3 pit run material. With a focus on developing the beach ridge trending to the northeast from the TASR alignment, which consists of primarily poorly graded sandy soils, an estimated 550,000 m^3 of sand could be available.

Testpit results indicate that the material targeted for extraction is not well suited for general pit run because the material is generally fine to medium grained sand with trace fines. The material might be suitable for other fill applications, but the material is susceptible to erosion and will require protection

An undefined smaller volume of well graded sandy gravel exists along the TASR alignment to the east in a lower elevation region (P1-01 and 02). Testpitting terminated within the shallow water table due to sloughing of the testpit walls (Photo 2). As the gravel is at or below the water table, this area may be less feasible to develop. Further sand deposits exist to the northeast along the old airstrip and to the south of the TASR alignment.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

8.2 Prospect 13B

8.2.1 Site Description

Prospect 13B is located at approximately km 17+000 along the proposed alignment and was identified as a granular site. The permitted area shown is 83.5 ha. Most of the permitted box lies to the northeast of the TASR alignment. The northwest corner of the site is mapped as shallow and exposed bedrock; with a thin cover of sediments. The bedrock is an extension of the rock from Prospect 13D to the northwest. Bedrock consists of limestone of the Lonely Bay Formation.

Prospect 13B is located within the southeastern portion of a large beach ridge deposit. Beach ridges trend northwest at this location and are thickest to the south, becoming thinner to the north and northeast. The northern portion of the prospect is slightly wetter in the north and much wetter in the northeast, from the borehole locations to the northeast edge of the prospect boundary. The rest of the deposit is relatively dry. A large wetland is present northeast of the prospect; parts of it impinge on the prospect area and are not mapped as part of the deposit. Additional beach ridges are found south and north of the prospect.

Vegetation is more typical of beach ridges in the area. Forest fire burned stands of stunted jack pine dominate the landscape, with moss, low shrubs and young pine trees making up the ground cover (Photos 6-7). There may be a few vegetation-free areas as well. Trees are denser and taller in the wet areas.

Testpits were excavated along the alignment and to the east of the alignment along cutlines cleared for the work. One testpit was advanced in the south part of the permitted area, west of the alignment.

8.2.2 Geotechnical Investigation Activities

Testpitting took place at Prospect 13B on July 11, 2017. Nine testpits were excavated with four along the existing alignment cutline and the remaining five located on newly established cutlines towards the east and southwest. The region is mapped as a beach deposit of fine sand overlying limestone bedrock at depth. A silty till soil overlies the bedrock and was observed in half of the testpits at a depth of 1.3 m to 4.7 m below ground, where present. Bedrock was encountered at depths between 1.9 m and 4.0 m. The average thickness of sandy soil was 3.4 m.

Where bedrock or till was not encountered in the testpit, the excavation was limited by dry sloughing of upper sandy soil into the testpits and the limit of the excavator with a maximum depth achieved of 5.3 m and an average depth of 4.9 m.

The local topography slopes to the northeast and a creek bounds the permitted area to the east-southeast. The deeper sandy soils were found around the south corner of the prospect. To the west and northwest, bedrock becomes shallow and daylights at Prospect 13D.

Table 8-2: Prospect 13B Testpit Summary

Testpit ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Bedrock Depth (m)	Soil Description
P13B-01	6,933,213	511,536	272	5.3	-	Sand
P13B-02	6,933,298	511,572	271	4.6	-	Sand
P13B-03	6,933,139	511,434	276	5.0	-	Sand
P13B-04	6,933,312	511,394	275	5.2	-	Sand
P13B-05	6,933,404	511,274	276	4.0	4.0	Sand
P13B-06	6,933,566	511,378	271	1.9	1.9	Sand
P13B-07	6,933,517	511,109	275	2.6	2.6	Sand
P13B-08	6,933,721	511,197	272	2.6	2.6	Sand
P13B-09	6,933,689	511,043	274	4.0	4.0	Sand

Coordinates listed in NAD 83, Zone 11

8.2.1 General Subsurface Conditions

The soil is described as a sand, with trace to some silt, grey to tan in colour, and dry to damp in moisture. Three of the nine testpits did not intersect till or bedrock (Photos 8-9), or note changes to the soil stratigraphy with depth, and were terminated due to dry sloughing of the upper sandy soils. The six testpits that did not terminate in sand, terminated either in till (P13- 01, till at 4.7 m) or on bedrock with between 0.1 m and 0.9 m of till (Photo 10) overlying the bedrock below.

The surface of the prospect consisted on a thin layer of organic soils and rootlets that extended typically 100 mm deep. The upper 0.5 m to 1.0 m of sandy soil was usually red to brown and had some medium to coarse sand grains (Photo 11). With depth, the sand was predominantly fined grained and grey to tan in colour. Bedrock fragments were noted in P13B-08 (Photo 12).

8.2.2 Materials Testing Program and Results

Laboratory gradation testing showed the sandy soil to be typically 89% to 100% sand with only 1% to 11% silt. The sand was typically a fine grained sand with very little medium sized particles. The moisture content ranged from 2% to 12% for the sandy soils. Where silty soils were present, the moisture contents ranged from 12% to 19%.

No Los Angeles Abrasion laboratory testing or other aggregate testing was undertaken due to the lack of gravel sized particles during testpitting efforts. No petrographic analysis was completed.

8.2.3 Geochemical Characterization Program and Results

Six samples were submitted for geochemical characterization from the Prospect 13B and 13C sites, including two clay samples, three sand sample and one rock fragment sample. Due to these two prospects proximity to one another and similarity in materials the combined results are discussed together.

XRF analysis indicates a high content of impurities in sand and clay samples, with the normalized concentrations ranging from 91.8% to 96.7%. The rock fragments sample, P13B-07.2_2.5-2.6, has a normalized calcite concentration of 50.4% and a normalized dolomite concentration of 32.2%, and classifies as a dolomitic limestone.

All samples analyzed are classified as non-acid generating (NAG) based on Sobek NPR values which range from 275 to 1,552, with a median value of 472. Total sulphur ranges from the detection limit of testing at <0.01 S% to 0.02 S%. Sobek NP for the sand samples ranges from 59 to 86 t$CaCO_3$/1Kt and from 157 to 167 t$CaCO_3$/1Kt for the clay samples. The Sobek NP for the rock fragments sample is 970 t$CaCO_3$/1Kt. The Carbonate NP tracks well against the Sobek NP in all samples.

Trace element analysis identified select elements at concentrations greater than the average crustal abundance. No concentrations, except bismuth and selenium, were noted at concentrations greater than 10x the average crustal abundance.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in four of five samples. The guideline value is 0.100 mg/L and measured concentrations range from 0.100 to 0.624 mg/L. Leachable copper was measured within an order of magnitude above both the CCME and BCAWQ guideline values in two of five samples (one clay sample, one sand sample). The guideline value is 0.002 mg/L and measured concentrations range from <0.001 to 0.004 mg/L in the samples.

8.2.4 Development Potential

Prospect 13 sites (13B, 13C and 13D) are located between km 17+000 and 20+000 along the proposed alignment as potential sources of road construction material. Prospect 13B is located at approximately km 17+000 along the proposed alignment.

Prospect 13B is covered with damaged and dead trees from an old forest fire event, which has since re-vegetated with new growth, and will require clearing for development. The proposed extraction volume for the site is for supply of about 570,000 m^3 pit run material.

The land slopes gently to the northeast and deeper deposits of poorly graded sandy soils are available towards the southeast portion of the prospect. An estimated 480,000 m^3 of sand is available along the TASR alignment and to the northeast within the extent of the test holes.

As with Prospect 1, the granular resources at Prospect 13B are primarily poorly graded fine sands as observed during testpitting. The sand will not likely be well suited for general pit run. The material might be suitable for other fill applications but the material will be susceptible to erosion and will require protection.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

8.3 Prospect 13C

8.3.1 Site Description

Prospect 13C is located at approximately km 19+700 along the proposed alignment. The permitted area shown is about 109.8 ha. The site was identified as a granular prospect. The permitted box straddles the alignment to the east and west. An archaeological buffer area (sites 1) was previously identified in the southeast part of the permitted area, as shown on Figure 6.

The prospect spans the northern end of a prominent beach ridge series that extends to Prospect 13B. The group of raised beach deposits appear thickest and driest in the central and eastern portions of the prospect. A curving meltwater channel cuts through the prospect in the south, which has resulted in steeper slopes on the north side of the channel. The channel bottom is poorly drained, and contains one small wetland and a small misfit stream (term s used for a stream with meanders that are not proportional in size to the meanders of the valley) in its eastern portion. Other parts of the prospect are moderately to imperfectly drained, i.e. the area south of the channel and much of the western portion that is west of the alignment. In the north, another meltwater channel marks the boundary of the deposit. It is also poorly drained and contains a larger wetland. North of this channel, exists bedrock (Lonely Bay Formation) covered with a thin veneer of glaciolacustrine sediments (or till) appears to be present. Possible beach deposits (with no ridges) are present east and west of the prospect. They appear to be thinner based on their surface expression. A large wetland complex is present northeast of the deposit.

Beach ridge vegetation consists of burnt jack pine, low shrubs, grasses and a few vegetation-free areas (Photo 13). Wetter areas support denser vegetation, as does the glaciolacustrine veneer area in the north. The meltwater channels host common wetland vegetation in the wetlands and low shrubs elsewhere.

Testpits were excavated along the alignment and to the east of the alignment along cutlines cleared for the work.

8.3.2 Geotechnical Investigation Activities

Testpitting took place at Prospect 13C on July 11 and 12, 2017. Nine testpits were excavated with three along the existing alignment cutline and the remaining six located on newly established cutlines towards the east. The region appears to be a beach deposit of fine sand overlying a limestone bedrock at depth. A clay till soil type overlies the bedrock and was observed in two of the testpits at a depth 3.0 m and 3.5 m. In general, the testpits did not show a limit to the depth of sand but digging was limited by dry sloughing of upper sandy soil into the testpits and the limit of the excavator.

The southern testpits (P13C-01 to 05, 08, and 09) averaged 4.5 m deep with no bedrock or clay till encountered. Moving north, bedrock was observed to be shallower. To the south, a small creek crosses east to west.

Table 8-3: Prospect 13C Testpit Summary

Testpit ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Bedrock Depth (m)	Soil Description
P13C-01	6,935,394	509,935	274	4.5	-	Sand
P13C-02	6,935,420	510,029	276	4.5	-	Sand
P13C-03	6,935,421	510,136	274	4.4	-	Sand

Table 8-3: Prospect 13C Testpit Summary

Testpit ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Bedrock Depth (m)	Soil Description
P13C-04	6,935,495	509,898	275	4.3	-	Sand
P13C-05	6,935,529	510,006	275	4.6	-	Sand
P13C-06	6,935,621	509,,854	275	3.9	3.9	Sand
P13C-07	6,935,654	509,952	274	3.7	3.7	Sand
P13C-08	6,935,591	510,222	273	4.7	-	Sand
P13C-09	6,935,466	510,354	274	4.3	-	Sand

Coordinates listed in NAD 83, Zone 11

8.3.1 General Subsurface Conditions

The soil is defined as a sand with trace silt, grey to tan in colour, and dry to damp in moisture. Seven of the nine testpits did not encounter bedrock or changes to the soil stratigraphy with depth and were terminated due to dry sloughing of the upper sandy soils (Photos 14-16). The average thickness of the sand was 4.2 m. The remaining testpits encountered a silty clay till prior to terminating on bedrock.

The surface of the prospect was a very thin layer of organic soils and rootlets that extended typically 100 mm deep. The upper 0.5 m to 1.0 m of sandy soil was usually red to brown and had some medium to coarse sand grains.

8.3.2 Materials Testing Program and Results

Laboratory gradation testing showed the sandy soil to be typically 98% to 100% sand with only 0 to 2% silt. The sand was mostly fine grained. The moisture content ranged from 2% to 7%.

No Los Angeles Abrasion laboratory testing or other aggregate testing was undertaken due to the lack of gravel sized particles during testpitting efforts. No petrographic analysis was completed.

8.3.3 Geochemical Characterization Program and Results

Samples from Prospect 13B and 13C are discussed together due to the proximity of the two prospects, refer to discussion in Section 8.2.3.

8.3.4 Development Potential

The prospect is covered with old forest fire damaged trees and vegetated with new growth and will require clearing for development. The site was identified as an alternate for Prospect 13C.

In general the site is relatively level, and grades towards small water crossings along the north and south extents. The granular soil encountered is largely a poorly graded sand, but large quantities are present with an estimated 350,000 m^3 of sand available along the TASR alignment and to the east. There appear to be more volume of material within the permitted prospect boundary beyond what was investigated during the testpitting program.

As with Prospect 1 and 13B, the granular resources at Prospect 13C are primarily poorly graded fine sands as observed during testpitting. The sand will not likely be well suited for general pit run. The material might be suitable for other fill applications but the material will be susceptible to erosion and will require protection.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

8.4 Prospect 13D

8.4.1 Site Description

Prospect 13D is located at approximately km 18+500 along the proposed alignment. The site was identified as a bedrock prospect. The permitted area shown is 27.7 ha. The permitted box straddles the alignment to the east and west, as shown on Figure 7.

The prospect is situated on a local topographic high, with about 15% of the area consisting of exposed bedrock (Lonely Bay Formation). The rest of the area appears to be covered with a veneer of glaciolacustrine sediment or possibly till. The old winter road traversed the site. Bedrock was visibly exposed on the old winter road at 510,361E, 6,934,147N. Generally, bedrock is not obviously visible, but is very shallow or lightly covered by vegetation and woody debris.

Beach ridges that are part of the large complex containing Prospects 13B and 13C are found to the east and northwest and bedrock with a thin cover of sediment is present to the south and west.

Vegetation, where present, consists of fire-burned stunted jack pine, low shrubs, and moss (Photos 17-21).

8.4.2 Geotechnical Investigation Activities

Rock core drilling took place at Prospect 13D between July 1 and 5, 2017. Five boreholes were completed at Prospect 13D. Boreholes P13D-01, P13D-03 and P13D-04 were located along the existing TASR alignment road, and P13D-02 and P13D-05 were located to the east of the alignment and accessed via cutlines. There is a roughly north-south trending bedrock ridge to the east of the alignment, on top of which these two boreholes were located. Borehole depths ranged from 5.0 m to 9.5 m. A testpit was added to the program and excavated on July 12, 2017 at P13D-01 to provide a representative characterization of the overburden material (Photos 22-23). Table 8-4 presents a summary of the boreholes and testpit completed for the investigation program.

The depth to bedrock in the five boreholes indicates that the bedrock surface is closest to surface at P13D-05 in the northeast of the investigation area, and deepens towards P13D-01 in the southwest portion of the investigation area.

Table 8-4: Prospect P13D Borehole and Testpit Summary

Borehole/Testpit ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Bedrock Depth (m)	Bedrock Type
P13D-01TP	6,934,231	510,341	283	2.2	N/A	--
P13D-01	6,934,213	510,341	285	5.0	4.72	Limestone
P13D-02	6,934,246	510,436	282	9.5	0.50	Limestone
P13D-03	6,934,325	510,305	285	8.0	0.75	Limestone
P13D-04	6,934,423	510,228	284	9.5	0.15	Limestone
P13D-05	6,934,539	510,414	280	9.5	0.10	Limestone

Coordinates listed in NAD 83, Zone 11

8.4.1 General Subsurface Conditions

Bedrock was generally intercepted between 0.15 m and 0.75 m below ground surface, with the exception of P13D-01 where depth to bedrock is 4.72 m. Based on the series of three boreholes along the TASR alignment, there appears to be a deepening bedrock contact to the southwest corner. Bedrock is near surface at P13D-04, and dips gently towards the south at P13D-03, before steeply dipping at P13D-01. The depth to bedrock between P13D-01 and P13D-03 is unknown but may approach 3 m assuming a linear bedrock surface between these two holes.

The top 0.10 m to 0.25 m of overburden consists of brown organic silty-sand, with trace gravels. In boreholes P13D-02 and P13D-03, sub-angular to sub-rounded cobbles and pebbles of mixed lithologies were recovered during drilling to a depth of 0.75 m

P13D-01 intercepted an overburden layer of 4.7 m during rock core drilling. The recovered overburden contained sandy and gravelly, trace cobbles, and trace clay. The gravels are sub-angular to rounded and dominantly of limestone and granitic compositions. These results suggest a till deposit overlying bedrock. Testpit P13D-01 was completed to a depth of 2.2 m and was useful in determining the matrix composition. The testpit identified poorly graded silt soil which is sandy and gravelly, with trace clay. The material is damp. A 400 mm boulder and cobbles up to 300 mm diameter were identified.

Bedrock in all boreholes consists of a relatively homogenous limestone. The limestone is medium gray, fine grained, moderately strong, with trace to moderate fossils and calcite veining. Weathering is minor to moderate with some discoloration and iron alteration on joint surfaces. Calcite and calcitic silts are common on joint surfaces, with lesser clay on partial joint coatings. The limestone has a strong reaction to addition of hydrochloric acid.

8.4.2 Materials Testing Program and Results

Samples were submitted for Los Angles Abrasion, flat and elongation particles, and petrographic analysis. Los Angles Abrasion losses were between 22% and 23% while flat and elongation analysis ranged from 7.2% to 11.9%.

Petrographic analysis was completed on the sample from P13D-05 (0-9.0m). The sample was crushed to 20mm minus, and consists of an equal 50-50 split of the 20-14mm and 14-10mm fraction size. The dominant sample composition is high strength limestone with minor calcite (weighted average = 95.2%). The remaining sample composition is medium strength limestone (weighted average = 2.0%) and medium strength, weathered limestone (weighted average = 2.8%). The weighted average petrographic number (PN) is 110.

8.4.3 Geochemical Characterization Program and Results

Eight samples were analyzed from Prospect 13D. The eight samples represent minor variations in limestone composition with depth identified in the five boreholes.

XRF analysis indicates a high content of calcite in all samples, with low concentrations of impurities and dolomite with the normalized concentrations ranging from 82.6% to 96.7%. All samples contain less than 20% normalized concentration of impurities, and less than 10% normalized concentration of dolomite. The samples are classified as calcitic limestone and high calcium limestone based on the XRF analysis.

All samples analyzed are classified as non-acid generating (NAG) based on Sobek NPR values of greater than 2, which range from 149 to 3171 with a median value of 519. Total sulphur ranges from 0.01 S% to 0.28 S%, with a median value of 0.08 S%. Sobek NP ranges from 933 to 1000 $tCaCO_3$/1Kt, with a median value of 968 $tCaCO_3$/1Kt. The Carbonate NP tracks well against the Sobek NP, and has a median value of 894 $tCaCO_3$/1Kt.

Trace element analysis identifies select elements at concentrations greater than the average crustal abundance. Concentrations of cobalt are noted at greater than 10x the average crustal abundance in seven of the eight samples. Concentration of barium is noted at greater than 10x average crustal abundance in sample P13D-04_6.50-6.70.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in six of eight samples. The guideline value is 0.100 mg/L and measured concentrations range from 0.081 to 0.228 mg/L. No other metals were noted at concentrations above the guideline values.

8.4.4 Development Potential

The area is well vegetated with dense tree cover and will require clearing for development. The area coincident with the existing TASR alignment is relatively flat lying. The terrain slopes down to the east of the existing alignment into a series of benches defined by northwest-southeast trending contour lines. There are consistent rock outcroppings along strike of the benched slope at the investigated areas around P13D-05 and P13D-02.

A quarry could potentially be developed sloping down and away from the proposed TASR alignment to the east. The alignment occupies part of the ridge and limits the availability of a quarry but an estimated 200,000 m^3 of material is anticipated as recoverable. The site is presently identified as an alternate for Prospect 13C; however, based on the findings of this report, might be considered the best suited of the three sites (13B, 13C and 13D) along this section of the alignment.

The southwest corner of the prospect area might be avoided for quarry development due to evidence of thick (4 m to 5 m) till-like overburden cover in this area as observed at P13D-01. Or perhaps, the overburden material could be used as general fill.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

8.5 Prospect 29

8.5.1 Site Description

Prospect 29 is located at approximately km 31+500 along the proposed alignment. The site was identified as a bedrock prospect. The permitted area shown is about 376.6 ha. The permitted box crosses the alignment, but the majority of the prospect is to the east of the alignment.

The prospect sits mainly atop a large topographic high with bedrock exposures visible over about 30% of the area (Photo 24-25). There appears to be a thin cover of sediment elsewhere that supports a moderately dense to dense cover of black spruce. Lower elevation areas along the prospect's southeastern edge contain more trees and appear to be wetter. Higher areas are well drained. The western tip of the prospect, in the area west of the alignment, appears to contain some poorly drained areas that may be covered with moss/sedge associations. The Lonely Bay Formation limestone appears to be flat-lying in this location, as the northern and eastern boundaries of the upland show bedrock layering.

A large wetland/pond complex is present east and northeast of the prospect and moderately to poorly drained till/glaciolacustrine/minor beach ridge deposits elsewhere.

8.5.2 Geotechnical Investigation Activities

Rock core drilling took place at Prospect 29 from June 24 to 28, 2017. Seven boreholes were completed at Prospect 29. Minimal clearing was required for the helicopter to safely access P29-08 and for the helicopter landing zone, no clearing was required to access the other seven boreholes. Table 8-5 presents a summary of the boreholes completed for the investigation program. Borehole P29-02 was not drilled.

All boreholes, except P29-08, intercepted bedrock limestone at surface, and were drilled on or proximal to bedrock outcrops. There is a significant amount of bedrock exposure visible on the air photos for the prospect site. Drilling targeted bedrock outcrops near the center of the prospect area in a "U-shape" exposure, with the top of the "U" open to the north. The area central to this shape is characterized by a sparsely treed area, with pockets of outcrops visible on surface, and minor amounts of frost heaved rock material.

Boreholes P29-03, P29-05, and P29-06 are located on a 1 m to 2 m high bedrock outcrop ridge that runs roughly north-south.

Borehole P29-08 was added to the program to estimate the approximate depth to bedrock within the vegetated area in the center of the prospect area. This hole was placed approximately 20 m into the vegetated area. The depth to overburden noted at this location cannot be applied to depth to bedrock for the entire vegetated area, but provides a reasonable estimate for overburden thickness where trees are present.

Table 8-5: Prospect 29 Borehole Summary

Borehole ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Bedrock Depth (m)	Bedrock Type
P29-01	6,946,345	508,730	293	9.5	0	Limestone
P29-03	6,946,396	508,975	293	8.0	0	Limestone
P29-04	6,946,225	508,754	295	9.5	0	Limestone
P29-05	6,946,214	508,960	295	9.5	0	Limestone
P29-06	6,946,226	509,054	291	8.0	0	Limestone
P29-07	6,946,203	508,855	295	9.5	0	Limestone
P29-08	6,946,248	508,898	297	4.3	0.25	Limestone

Coordinates listed in NAD 83, Zone 11

8.5.1 General Subsurface Conditions

Bedrock encountered is a consistent limestone across all boreholes. The limestone is grey-brown, fine grained, and medium strong, with abundant crinoid and other fossils. There are minor to moderate calcite veining throughout. Stylolites typically increase with depth in the holes. RQD and recovery are good, with both increasing with depth.

8.5.2 Materials Testing Program and Results

Samples were submitted for Los Angles Abrasion, flat and elongation particles, and petrographic analysis. Los Angles Abrasion losses were between 22% and 25% while flat and elongation analysis ranged from 4.7% to 7.7%.

Petrographic analysis was completed on the sample from P29-04 (0-9.5m). The sample was crushed to 20mm minus, and consists of an equal 50-50 split of the 20-14mm and 14-10mm fraction size. The dominant sample composition is high strength, grey limestone with trace calcite (weighted average = 91.5%). The remaining sample composition is medium strength, grey, weathered limestone (weighted average = 8.5%). The weighted average petrographic number (PN) is 117.

8.5.3 Geochemical Characterization Program and Results

Nine samples were analyzed from Prospect 29. The nine samples represent the minor variations in limestone composition with depth identified in the five boreholes.

XRF analysis indicates a high content of calcite in all samples, with limited impurity and dolomite concentrations. Normalized concentrations of calcite range from 85.1% to 96.5%. All samples contain less than 20% normalized concentration of impurities, and less than 5% normalized concentration of dolomite. The samples are classified as calcitic limestone and high calcium limestone based on the XRF analysis.

All samples analyzed are classified as non-acid generating (NAG) based on Sobek NPR values of greater than 2, which range from 33 to 1,558 with a median value of 623. Total sulphur ranges from 0.02 S% to 0.93 S%, with a median value of 0.05 S%. Sobek NP ranges from 955 to 988 $tCaCO_3$/1Kt, with a median value of 974 $tCaCO_3$/1Kt. The Carbonate NP tracks well against the Sobek NP, and has a median value of 914 $tCaCO_3$/1Kt.

Trace element analysis identifies select elements at concentrations greater than the average crustal abundance. Concentrations of cobalt are noted at greater than 10x the average crustal abundance in four of the nine samples. Concentration of barium is noted at greater than 10x average in four of the nine samples.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in seven of nine samples. The guideline value is 0.100 mg/L and measured concentrations range from 0.093 to 0.167 mg/L. Leachable silver was measured within an order of magnitude above the CCME and guideline value in one of nine samples. The guideline value is 0.0001 mg/L and measured concentration in sample P29-05_4.34-4.57 is 0.0002 mg/L. Leachable silver in seven of the nine samples report as less than the detection limit of testing at <0.00005 mg/L.

8.5.4 Development Potential

The proposed development plan for Prospect 29 is for supply of 750,000 m^3 rock quarry material. Outcrop exposures are prevalent at Prospect 29, and the drilling delineated a "U-shape" alignment of exposed bedrock material. Central to this "U-shape" delineation is a moderately treed area that would need to be cleared for development. Depth to bedrock within the treed area is uncertain, but small bedrock exposures in this area and drilling at P29-08 indicates that bedrock is likely within a meter or less of ground surface.

The drilling identified a uniform limestone material which is consistent with depth and based on materials testing exhibits favourable abrasion resistance results and particle shape. Prospect 29 is considered to be a very good rock quarry location.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

An access road would need to be developed from the existing TASR alignment to the delineated resource.

8.6 Prospect 33A

8.6.1 Site Description

Prospect 33A is located at approximately km 36+700 along the proposed alignment. The site was identified as a bedrock prospect. The permitted area shown is 194.4 ha. The permitted area is located to the east of the proposed alignment. The Duport River crossing is to the north at about km 40+400, so this site will be an important material source for constructing the bridge crossing.

This prospect is located on another prominent topographic high consisting of Lonely Bay Formation limestones. It also displays horizontal bedrock layering along the northeastern margin and in the areas immediately southeast of the prospect. Jack pine, minor black spruce and shrubs cover most of the rest of it, while some wetland vegetation with scattered stunted trees appears to be present in localized depressions (Photo 26-29).

The prospect appears to have a thin cover of glaciolacustrine sediment and/or till. Borehole P33A-08 was drilled on the northern knob, which has the highest elevation. The rest of the upland is lower and forms undulating topography. A small arc of beach ridges is present where P33A-01 was drilled. A second group of beach ridges is present along the eastern boundary of the prospect.

The bedrock ridge continues to the south and southwest of the prospect, with thicker till overlying it and forming streamlined landforms in the west. A wetland/pond complex is present to the north and northeast.

8.6.2 Geotechnical Investigation Activities

Rock core drilling took place at Prospect 33A from July 6-9, 2017. Nine boreholes were completed at Prospect 33A. All holes were completed to a depth of 9.5 m, depth to bedrock varied from 0.35 m to 7.6 m. Geophysical data was collected at the site and is described below. Table 8-6 presents a summary of the boreholes completed for the investigation program.

Boreholes P33A-02, P33A-03, P33A-04, and P33A-05 were located along the existing TASR alignment. Boreholes P33A-06, P33A-07, and P33A-08 were located along the northern boundary of the prospect area and were accessed along a clearing line. Boreholes P33A-01 and P33A-10 were located in southern portion of the prospect and were also accessed via a clearing line.

Borehole P33A-09 was cut from the program due to availability of data from nearby holes and the observations of significant overburden cover at P33A-06 and P33A-08. Additionally the decision was due to the availability of geophysics data at this location to corroborate the depth to bedrock this location. Borehole P33A-10 was added as infill hole in the southern portion of the prospect area, primarily to obtain sufficient material from this portion of the prospect for testing. Borehole P33A-01 was moved towards the northwest from the proposed location. There is a beach sand ridge to the east of the P33A-01 site which the proposed hole originally was situated on top of.

Table 8-6: Prospect 33A Borehole Summary

Borehole ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Bedrock Depth (m)	Bedrock Type
P33A-01	6,951,539	507,867	288	9.5	0.60	Limestone
P33A-02	6,951,487	507,572	286	9.5	0.70	Limestone
P33A-03	6,951,769	507,535	287	9.5	0.50	Limestone
P33A-04	6,952,125	507,485	280	9.5	2.80	Limestone
P33A-05	6,952,337	507,456	285	9.5	3.60	Limestone
P33A-06	6,952,399	507,644	288	9.5	7.60	Limestone
P33A-07	6,952,458	507,881	289	9.5	4.90	Limestone
P33A-08	6,952,423	508,041	292	9.5	7.40	Limestone
P33A-10	6951490	507778	289	9.5	0.35	Limestone

Coordinates listed in NAD 83, Zone 11

8.6.3 Geophysical Survey Activities

A total of approximately 3330 metres of GPR data was collected at site P33A. The four Geophysical profiles collected form an irregular rectangle with the sides approximately oriented north-south (Line 2 and Line 4), east-west (Line 1 and Line 3). The Northernmost line (Line 1) follows the northern edge of topographic high mentioned in the site description while the West line (Line 4) follows the current road alignment cut line. All of the collected GPR data was with the 100 MHz RTA antenna with the exception of the westernmost geophysical profile which was also collected with the 50 MHz RTA antenna. The 50 MHz data has not been presented as it closely resembles the data collected with the 100MHz RTA antennas and does not materially add further information to the discussion.

The GPR data for the most part shows a few horizontally coherent reflectors representing lithological or possibly water/temperature related interfaces. Where these reflectors are present they are distinct and do not vary greatly in depth over short distances indicating that locally, the reflectors are planar and roughly parallel to the ground surface. Interpreted profile sections are included in Appendix E. Generally, the bedrock contact identified in the geotechnical discussion as the overburden bedrock contact correlates with reflectors that have been identified as other miscellaneous reflectors (labelled as blue) on the interpreted geophysical profiles. A deeper, stronger, coherent reflector has been interpreted in the geophysical data as the bedrock contact (labelled as red). However, it is possible that this contact is within the bedrock and represents a material change, or the depth at which competent un-fractured rock is present. At some locations, for example along Line 3 between 40 and 110 m, the GPR data is very quiet with relatively few reflections. These areas likely represent locations where competent rock is present at or very near (less than 0.5 m) to surface. The bedrock appears to typically vary from near surface to up to 10 m deep at the along the westernmost geophysical profile line.

The northernmost geophysical profile (Line 1) along the northern edge of the topographic high shows considerably more structure with evidence of lithological layering in the overburden material and bedrock depths of between 3 to 8 m. The thickest overburden material is present in the middle section of the profile. Considerable localised reflections are seen below the interpreted bedrock interface suggesting that there is likely a further transition zone of fractured rock up to 5 m or 6 m thick before unfractured bedrock is reached.

The southernmost geophysical profile (Line 3) shows a number of strong dipping reflectors running from near surface towards the west. Between these reflectors are areas with relatively few GPR reflections. Given indications from surficial observations and the geotechnical discussions it would appear that the majority of these reflectors must be associated with either significant bedding planes in the bedrock that may be fractured or changes in rock type. Towards the east end of the geophysical profile there is more stratigraphic structure. The easternmost geophysical profile (Line 2) is similar to the westernmost profile line in that a number of largely horizontal reflectors are seen with some near surface overburden lithology stratigraphy. Taken together the GPR profiles appear to confirm the geotechnical conclusion that overburden thicknesses are greater at the north end of this side. The presence of angled reflectors, likely within bedrock on the north-south lines (Line 2 and Line 4) and largely flat reflectors of the east-west lines (Line 1 and Line 3) seems to suggest an inclined layered bedrock system with the dipping planes getting deeper as one goes from east to west.

8.6.4 General Subsurface Conditions

The area defined by Prospect 33A varies considerably in terms of rock and soil conditions from north to south, based on the drilling observations. The southern zone is generally flat with limited topographic relief, and is defined by a shallow (0.35 m to 0.70 m) flat-lying bedrock contact. The bedrock surface deepens moving to the north, while topographical elevation also rises to the north. The northern portion of the prospect is defined by a roughly east-west trending ridge, with an irregular (up to 3 m high undulations) surface expression. Drilling along this ridge identified a deeper bedrock surface varying between 3.6 m and 7.4 m.

Overburden materials consist of gravels and cobbles of mixed lithology, dominantly limestone and lesser granitic material. Recovered clasts are dominantly sub-angular to sub-rounded, fresh to moderately weathered. A silt-sand matrix with some clay is assumed, based on minimal core recovery.

Bedrock consists of a variable limestone, distinguished by differences in colour, texture and mineralogy. Variations in limestone occur on the scale of between centimeter to meter scale partings. There does not appear to be a distinct stratigraphic distribution, with subtle variations in compositions occurring with depth in the borehole. In terms of rock strength and geotechnical parameters, the limestone units do not appear to be significantly different and were grouped together for materials testing. RQD, rock strength and recovery typically increased with depth in the bedrock unit.

8.6.5 Materials Testing Program and Results

Samples were submitted for Los Angles Abrasion, flat and elongation particles, and petrographic analysis. Los Angles Abrasion losses were between 23% and 30% while flat and elongation analysis ranged from 5.8% to 13.0%.

Petrographic analyses were completed on two samples of crushed material from Boreholes P33A-02 and P33A-07. The samples were crushed to 20 mm minus, and consist of an equal 50-50 split of the 20-14 mm and 14-10 mm fraction size.

For Sample P33A-02 (2.0-9.5 m), the dominant sample composition is high strength grey limestone with trace calcite (weighted average = 67.7%). The remaining sample composition is high strength, grey, sandy limestone with trace calcite (weighted average = 10.9%), medium strength, tan limestone (weighted average = 14.9%), and medium strength, tan, weathered limestone with some slickensides (weighted average = 6.5%). The weighted average petrographic number (PN) is 143.

For sample P33A-07 (0-9.5 m), the dominant sample composition is high strength, grey-tan limestone with trace calcite (weighted average = 75.9%). The remaining sample composition is medium strength, grey-tan, weathered limestone (weighted average = 15.6%) and medium strength, tan limestone (weighted average = 8.5%). The weighted average petrographic number is 148.

8.6.6 Geochemical Characterization Program and Results

Fourteen samples were analyzed from Prospect 33A. The higher number of samples for this prospect is necessary due to the increased variability of limestone material encountered in the boreholes, both in terms of texture, grains size and composition.

XRF analysis results demonstrate the variabilities in limestone compositions intercepted within the boreholes. All samples return normalized concentrations of impurities of below 20%. Normalized calcite concentrations range from 44.0% to 93.6%, with a median value of 52.5%. Normalized dolomite concentrations range from 0.7% to 51.4%, with a median value of 37.4%. The majority of samples, 10 out of 14, classify as Dolomitic Limestone. Two samples classify as Calcitic Limestone, one sample as High Calcium Limestone, and one sample as Calcitic Dolomite. There is not a distinct pattern to the vertical (depth in borehole) or lateral variability (position of borehole) in the limestone variability.

All samples analyzed are classified as non-acid generating (NAG) based on Sobek NPR values of greater than 2, which range from 236 to 3,302 with a median value of 702. Total sulphur ranges from 0.01 S% to 0.13 S%, with a median value of 0.05 S%. Sobek NP ranges from 937 to 1,055 $tCaCO_3/1Kt$, with a median value of 1,020 $tCaCO_3/1Kt$. The Carbonate NP tracks well against the Sobek NP, and has a median value of 948 $tCaCO_3/1Kt$.

Trace element analysis identifies select elements at concentrations greater than the average crustal abundance. Concentrations of cobalt are noted at greater than 10x the average crustal abundance in eight of the fourteen samples. Concentration of barium is noted at greater than 10x average in three of the fourteen samples.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in three of fourteen samples. The guideline value is 0.100 mg/L and measured concentrations range from 0.010 to 0.183 mg/L. No other metals were noted at concentrations above the guideline values. Recommendations for Development

8.6.7 Development Potential

The southern extent of the prospect area is the preferred area for quarry development. Drilling confirms the presence of a shallow bedrock surface and a large bedrock source. Geologic characterization during drilling indicated subtle variations in the composition of limestone, indicating by variations in colour, texture, and mineral composition. Materials testing results indicated positive abrasion resistance and particle shape.

Prospect 33a is presently identified as an alternate site for Prospect 29, however might be considered as a complementary site given the distance to the next northerly site, Prospect 69.

Due to the limited topographical relief in the southern end of the prospect area, the depth of the quarry may be limited by the need to maintain a positive drainage.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

8.7 Prospect 68A

8.7.1 Site Description

Prospect 68A is located at approximately km 63+700 along the proposed alignment. The site is identified as a granular prospect. The permitted area shown is about 140.2 ha, but the deposit is a smaller landform within the permitted area. The permitted box crosses the alignment. An archaeological buffer area (site 3) was previously identified to the west of the alignment as shown on Figure 10.

No drilling was undertaken at Prospect 68A because the ground surface and topography was too rough and irregular for the self-propelled heli-portable auger drill to advance. However, a geophysical survey was completed to develop an understanding of the subsurface conditions on site.

This prospect, along with Prospect 69, is made up of a series of three ridges, all of which extend beyond the boundaries of the prospects. One follows the alignment more or less, curving westward away from it in the north and leading to a smaller, almost perpendicular ridge (north of the prospect) that trends east/west. The second one trends approximately east-southeast and forms Prospect 69, east of the alignment, and third is a sinuous, sharp-crested ridge that crosses the alignment in the south, trending east/west. It bisects the first ridge at the south end of the prospect and the old winter road crosses it. Bedrock (Chinchaga Formation) may be close to surface at its eastern end. The first ridge is double-crested north of the prospect.

The geomorphology suggests that the east/west ridges are recessional moraines (including the one within Prospect 68A), and the other two are eskers. The two east/west trending ridges (including the one in north of the prospect area) support a denser shrub/tree cover (commonly with open stands of jack pine/black spruce) than the other two, and have reasonably sharp crests. The other two have more subdued crests, are treeless in the air photos but now appear to support an open jack pine/lichen/moss forest and minor shrubs. The double crested ridge that follows the alignment is perpendicular to both moraines and crosses right through the moraine at prospect 68A, which suggests that it is an esker and the two moraines are recessional moraines. The similar vegetation at Prospect 69 (Photos 33-34) and the fact that it terminates at the moraine suggests that it too is an esker, but a slightly younger one that formed when the ice margin was at the moraine's position.

Geophysical Profiles were collected in the vicinity of the intersection point of ridge following the road alignment and the sinuous, sharp crested ridge to the south. In this area the ground surface of the ridges in the area is typically rough and boulder covered, and easily traversed.

Lighter coloured areas on the air photos and flutings in the north suggest that till is present north of the prospect, while the rest of the area is covered with poorly drained glaciolacustrine material. Wetlands and ponds are abundant to the south and there is a large pond present to the northeast. A few beach ridges are present on the southwest side of the pond.

8.7.2 Geophysical Survey Activities

A total of three geophysical profiles were collected at P68A consisting of one main profile along the crest of the sinuous, sharp crested ridge to the south where it intersects the ridge following the road alignment, and two cross lines totalling approximately 1,210 metres in total length. Only GPR data was collected using the 100 MHz RTA antennas. The main geophysical profile runs east-west and shows an irregular reflection interface that varies in depth from near surface to approximately 5 to 6 metres in depth. The reflection interface varies in strength and in some locations is ill-defined suggesting that the reflecting boundary is irregular and rough. The overburden material above this reflector contains numerous chaotic and point reflections indicating that it is likely poorly sorted and has little lithological structure. Some sections show lower detected signal levels, which in general indicate the likely presence of increased concentrations of fine grained materials in those areas. As a general statement more overburden material is present on the eastern end of the primary geophysical profile.

The two geophysical profiles that cross the main east–west line (Line 1) are oriented north–south. They are similar in nature to that seen and described above. There is little noticeable increase in overburden thickness seen as the crosslines intersect the east–west profile (Line 1) except for a 40 section of Line 2 immediately south of Line 1 where bedrock may be near surface.

Based on the characteristics of the GPR data and the lack of layered lithological features seen, it is felt that it is more likely that site P68A is a moraine deposit rather than an esker.

Interpreted profiles are included in Appendix E.

8.7.3 General Subsurface Conditions

Based on the geophysical data collected at the site and subsequent interpretation, combined with air photo terrain mapping, the subsurface conditions in the area surveyed consist of a poorly sorted granular material of variable thickness (till), overlying bedrock. The geophysical lines cover the east-west ridge interpreted to be a moraine, and a sediment composition of till is consistent with this interpretation. The bedrock contact is poorly defined in some areas suggesting that the transition from overburden to bedrock may be graded with the initial bedrock being highly fractured and weathered. There are potentially large boulders present in the overlying overburden material based on diffraction reflections and there may also be localized pockets of finer grained silty material. It is possible that what has been interpreted as the bedrock contact may alternatively, be a contact with a denser surficial sediment underlying the till.

8.7.4 Geochemical Characterization Program and Results

No sampling was completed for the Prospect 68A site. A geochemical characterization program is recommended if the prospect is identified for development. Testing was completed at adjacent site Prospect 69,

8.7.5 Development Potential

The proposed development of the site is for supply of 750,000 m^3 pit run material. Prospects 69 and 76 were identified as alternatives sites to 68A.

Developing the ridge of Prospect 68A, which runs parallel to the TASR alignment, to a depth of 4 m, could generate about 160,000 m^3 of material. This north running ridge has been identified as an esker deposit.

The longer west to east ridge which crosses the TASR alignment has been identified as a moraine ridge deposit, and could potentially provide an additional 500,000 m^3 of pit run.

Neither the esker of moraine deposits could be investigated using the heli-portable drill because the ground surface was too rough for the drill to self-propel travel along and the subsurface materials were too coarse for the light weight drill to penetrate. No subsurface investigation took place at Prospect 68A.

Prospect 69 to the north, adjacent to site 68A, was investigated and is described in Section 8.8.

8.8 Prospect 69

8.8.1 Site Description

Prospect 69 is located at approximately km 64+500 along the proposed alignment. The site was identified as a granular prospect. The permitted area shown is about 23.9 ha. The permitted box is located to the east of the alignment.

Prospect 69 is part of the ridge complex containing Prospect 68A. The ridge making up Prospect 69 trends approximately east-southeast and is located east of the alignment. As noted above, the geomorphology suggests that this ridge is an esker, with a subdued crest. It is treeless in the air photos but now supports an open jack pine/lichen/moss forest and minor shrubs.

8.8.2 Geotechnical Investigation Activities

Solid stem auger drilling was undertaken at Prospect 69 on July 23, 2017. Five drilling locations were attempted with the heli-portable auger drill, but drilling met refusal on probable cobble and boulder materials. No penetration could be achieved and limited data was collected (Photos 30-31). Following the auger drilling, a diamond drill hole (P69-05d) was advanced at the site near P69-05 (Photo 31). Bedrock was encountered at a depth of 7.2 m and the overburden was found to be gravel, cobble and sand. The drill cuttings showed the material to be a granular till. Geophysical data was collected at the site and is presented below.

Four very shallow testpits were hand excavated as part of a ground truthing exercise along the transect cutlines to the north and south of the main west to east baseline.

Table 8-8: Prospect 69 Borehole Summary

Borehole ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Bedrock Depth (m)	Soil Type
P69-01	6,97,7999	508,190	271	0.6	-	Gravel
P69-02	6,978,070	507,930	273	0.3	-	Gravel
P69-03	6,978,140	507,704	274	0.3	-	Gravel
P69-04	6,978,213	507,499	274	0.3	-	Gravel
P69-05	6,978,275	507,367	274	0.3	-	Gravel
P69-05d	6,978,275	507,367	274	11.0	7.2	Sand & Gravel
P69-06	6,978,247	507,573	273	0.3	-	Gravel
P69-07	6,978,116	507,529	271	0.4	-	Gravel
P69-08	6,978,094	508,075	270	0.2	-	Gravel
P69-09	6,977,970	508,040	270	0.2	-	Gravel

Coordinates listed in NAD 83, Zone 11

8.8.3 Geophysical Survey Activities

A total of three geophysical profiles were collected at P69 consisting of one main east – west profile (Line 1) along the crest of an esker feature and two north – south cross lines (Line 2 and Line 3) totalling approximately 1,130 m in total length. Only GPR data was collected using the 100 MHz RTA antennas. The main geophysical profile (Line 1) running east-west and shows an irregular reflection interface, interpreted as bedrock that varies in depth from near surface to approximately 5 to 8 metres in depth. The reflection interface varies in strength and in some locations is ill-defined suggesting that the reflecting boundary is irregular and rough. There is a further faint coherent reflector another 3 to 7 metres below this that is either a change in bedrock type or a structural feature within the bedrock below which there is minimal fracturing. The overburden material above this reflector contains numerous chaotic and point reflections indicating areas of poorly sorted material, but also shows some areas with layering evident indicating more sorted material. These layered features increase as one proceeds east along Line 1. Localised sections typically 10 m to 15 m long, show lower detected signal levels indicating the likely presence of increased concentrations of fine grained materials in overburden soil matrix.

The two geophysical profiles that cross Line 1 (Line 2 and 3) are oriented approximately north – south. They are similar in nature to that seen and described above. There is little noticeable increase in overburden thickness seen as the crosslines intersect the east – west profile. Reflections indicating lithological layering in the overburden material show a consistent dipping trend going from the ground surface trending deeper to the south.

Interpreted Geophysical profiles are presented in Appendix E.

8.8.4 General Subsurface Conditions

The prospect was described as an esker deposit from surficial geological mapping and aerial photo review. With the exception of the diamond drilling, the site investigation was limited to the upper 0.6 m of soil which was found to be largely made up of fine to coarse gravel and cobbles with trace to some sand and trace silt. Some boulders were noted at or near the surface (Photo 35-36) and may be present at depth as well. The deposit presents itself more as an esker than a moraine.

Diamond drilling showed near surface cobbles and coarse gravel while between about 1.0 m and 7.0 m the soil was largely considered to be fine gravel with lesser volumes of coarse gravel and sand with the exception of between 3.5 m and 5.0 m where several cobbles were cored. The sand and silt content of the subsurface could not be accurately estimated as they were not recovered in the core barrel, however, drill cutting fluids returned to the surface appeared to contain largely sand sized particles and did not appear very dirty leading to the observation that the silt fraction of the soil is trace.

8.8.5 Materials Testing Program and Results

Laboratory testing showed 52% to 67% coarse gravel, 42% to 14% fine gravel, 2% to 11% sand and 4% to 8% silt. Moisture contents were low ranging from 0.9% to 2.7%. As the soil samples were limited to shallow drilling and testpitting, we cannot confirm that this is representative of the overburden within the prospect. No petrographic analysis was completed.

8.8.6 Geochemical Characterization Program and Results

Two gravel samples were submitted for geochemical characterization from the Prospect 69 site.

XRF analysis classifies the gravel samples as Calcitic Dolomite with greater than 20% impurities. The normalized calcite concentrations are 34.9% and 35.4%. The normalized dolomite concentrations are 41.5% and 40.7%.The normalized impurities concentrations are 23.5% and 23.8%.

Both samples analyzed are classified as non-acid generating (NAG) based on Sobek NPR values of 3,014 and 6,042. Total sulphur is measured at measured at or less than the detection limit of testing of 0.01 S%. Sobek NP is 942 and 944 $tCaCO_3$/1Kt for the two samples. The Carbonate NP tracks well against the Sobek NP, and has a median value of 915 $tCaCO_3$/1Kt.

Trace element analysis identified select elements at concentrations greater than the average crustal abundance. No concentrations, except bismuth and selenium, were noted at concentrations greater than 10x the average crustal abundance.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in both samples. The guideline value is 0.100 mg/L and measured concentrations range from 0.149 to 0.187 mg/L.

8.8.7 Development Potential

The proposed development of the site is for supply of 750,000 m^3 pit run material. Prospects 68A and 76 were identified as alternatives sites to 69.

The surface conditions and near shallow exploratory drilling and testpitting noted during the site investigation back up the prospect classification of a gravel/sand esker with variable cobble and boulder content. Diamond drilling showed bedrock likely beyond an economical quarry depth with sandy drill cuttings washed away and evidence of coarse gravel to boulders making up the overburden. The silt and clay content of the overburden is unknown but appears to be trace considering the minimal dirty drill cutting fluids washing out of the deep borehole.

Developing the ridge of Prospect 69 running east southeast from the TASR alignment to a depth of 4 m could generate about 370,000 m^3 of potentially well graded gravel and sand.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

The office based review and site investigation provided more confidence in Prospect 69 as a source of granular material than with the neighbouring Prospect 68a site which is considered to be partially a moraine and likely containing poorly sorted soils and with Prospect 76 which appears to contain more silts and poorly sorted soils with lower quantities of gravel and cobble sized material.

8.9 Prospect 76

8.9.1 Site Description

Prospect 76 is located at approximately km 69+000 along the proposed alignment. The site was identified as a granular prospect. The permitted area shown is about 71.9 ha. The majority of the permitted box is located on the east of the alignment, and is bound to the northwest by the James River where new bridge or large culvert will be required to cross the river.

This prospect is located on a till plain that is cut west and northwest of the prospect by a large meltwater channel that forms its own valley. The till to the east is vaguely streamlined in a west-southwest direction. A dark sinuous feature to the south may be a moraine or an esker. Its dense forest cover suggests the former. The valley appears to contain a small esker or possibly eroded glaciolacustrine material (the government surficial mapping shows it to be floored with glaciolacustrine sediments).

The deposit appears to consist of ice-contact material, which is commonly a laterally and vertically variable mix of till and water-sorted sediments. The deposit is thickest in southwest and north-central areas, and thinnest in the west, where Borehole P76-06 is located. This borehole, and Boreholes P76-05, P76-07 and P76-08 are located within a depression that may have formed by ice melt beneath the deposits. The depression forms a bowl shape that dips toward the valley. A north-northeast trending ridge of material bounds the depression in the west, within the prospect. It forms the valley wall at this location. In the north, the valley wall crosses the prospect and trends slightly more eastward. East of the boreholes exists a shallow linear depression, which is a wetter area supporting shrubs and tall pine and spruce trees. The rest of the deposit supports more widely spaced shorter trees and intervening areas of lichen/moss/shrubs (Photos 37-43).

Bedrock is not visible, but is mapped as the Chinchaga Formation.

8.9.2 Geotechnical Investigation Activities

Prospect 76 was identified from the surficial geology review as a probable ice contact site with a complex heterogeneous mix of material types and particle sizes. The prospect is covered by mature forest and is part of a series of prominent rises and hills with a curving rise of land extending east and north from the TASR alignment.

Nine auger boreholes and a hand dug testpit were completed at the site on July 21 and 22, 2017, and a diamond drill borehole was completed at P76-3d on July 25, 2017. Auger drilling met refusal on cobble and boulder materials. Table 8-9 presents a summary of the investigation program. All boreholes were advanced with the heli-portable tracked drill. Geophysical data was collected at the site and is presented below.

Table 8-9: Prospect 76 Borehole Summary

Testpit ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Water Table (m)	Soil Description
P76-01	6,982,107	504,790	277	0.2	-	Sand
P76-02	6,982,192	504,954	274	0.3	-	Gravel
P76-03	6,982,279	505,138	275	0.3	-	Gravel
P76-03d	6,982,279	505,138	275	18.5	-	Sand, Gravel, Cobbles
P76-04	6,982,463	505,172	275	0.5	-	Gravel
P76-05	6,982,603	505,045	268	3.9	-	Silt
P76-06	6,982,603	504,936	264	1.1	-	Silt
P76-07	6,982,281	504,700	273	1.6	-	Sand
P76-07a	6,982,281	504,700	273	0.7	-	Gravel
P76-08	6,982,341	504,815	269	0.6	-	Gravel
P76-09	6,982,421	504,980	268	1.8	-	Silt

Note: “-“Groundwater table not encountered.
Coordinates listed in NAD 83, Zone 11

8.9.3 Geophysical Survey Activities

A total of three geophysical profiles were collected at P76 using the GPR system with a 100 MHz RTA antenna. Line 1 is a geophysical profile running east – west along a south edge of the survey area keeping to the higher ground then curving to the north and terminating facing west on the north site of the investigation area. Line 2 is a geophysical profile running east – west along the middle of the site and Line 3 runs north – south following the existing cleared road alignment joining Lines 1 and 2. An approximate total of approximately 1,400 metres of geophysical data was collected. A reflector as much as 15 metres below ground surface has been interpreted as the bedrock contact (red line) on Line 1, with the contact being strong in some places and irregular in others. It appears to trend towards the surface getting shallower as Line 1 curves north. Overburden thickens again at the northern end with bedrock estimated at a depth of up to 8 metres below ground surface. This area also corresponds to the highest elevations along Line 1. Locations where the bedrock contact has not been identified along Line 1 are likely a result of areas of high concentrations of fine grained material attenuating the GPR signal and masking the underlying bedrock. A number of linear stratigraphic features are evident within the overburden material suggesting possible fluvial layering and sorting of overburden material.

Line 2 runs east – west and shows very similar features to those discussed with Line 1 with overburden thicknesses of 8 to 10 metres. Line 3 runs north – south and also shows the same features with the interpreted bedrock contact being greater than 10 metres along the majority of its length.

A number of very bright localised reflections can be seen on all three geophysical profiles that potentially represent high ice content material or massive ice. These reflectors are less than 50 metres in extent horizontally and are at least 3 metres below the ground surface. Examples of these features can be seen in Appendix E, Figure P76-L1-01.1, chainages 125 to160 and 175 to 190, Figure P76-L1-03, chainage 125 to 145, Figure P76-L2.1, chainage 70 to 110 and Figure P76-L3 chainages 130 to 150 and 175 to 190.

Interpreted Geophysical Profiles are contained in Appendix E.

8.9.4 General Subsurface Conditions

Drilling results confirmed an inconsistent mix of soil types. Some boulders were present at the surface throughout the site. The helicopter landing zone at P76-07 was largely sandy soils at the surface (Photo 40) with coarse gravel or cobbles at depth and a silty layer in-between. Elsewhere, silt and fine sand were observed near the surface. The rise of land to the east contained sands and gravels near the surface.

In general, drilling could only penetrate the upper 0.5 m to 0.7 m of overburden as the drill met refusal on gravels and cobbles. Where deeper drilling was possible, the soils were silts, clays and fine sands, and the borehole terminated in permafrost and/or on coarse gravels and cobbles. A hand excavated testpit was dug to a depth of 0.7 m using a shovel and pinch point bar (Photo 42).

Following the auger drilling, a diamond drill was mobilized to site and advanced one borehole at P76-03d. The drill advanced through gravel, cobble and boulder overburden and encountered limestone bedrock at 11.8 m below grade and the borehole was terminated at 18.5 m. Drill fluid cuttings washed to the surface were largely sand with only trace quantities of silt and clay particles estimated. The low quantities of core barrel returns leads to the observation that the overburden is largely sandy soil with some gravels and cobbles present.

8.9.5 Materials Testing Program and Results

Subsurface soils varied greatly across the prospect. With the exception of the near surface soils at P76-07 which were 86% sand, the rest of the borehole sites contained silt and clay contents ranging from 13% and 77% with the remainder being largely fine sand. Moisture contents ranged from 8% to 15% with the near surface sandy soils at P76-07 being only 4%. A low plastic clayey material was observed at P76-05 and P76-06. Since the soil samples were typically limited to shallow drilling and testpitting, it cannot be confirmed where these results are representative of the overburden within the prospect. No petrographic analysis was completed.

8.9.6 Geochemical Characterization Program and Results

Three samples were submitted for geochemical characterization from the Prospect 76 site. Two samples described as silt and one sample described as sand. The sand sample was not submitted for SFE analysis due to insufficient sample quantity.

XRF analysis provides normalized calcite concentrations ranging from 0.95% to 17.4%. The normalized dolomite concentrations range from 0.9% to 16.8%. The normalized impurities concentrations range from 65.8% to 98.2%.

The three samples analyzed are classified as non-acid generating (NAG) based on Sobek NPR values ranging from 166 to 1,853, with a median value of 1206. Total sulphur is measured at measured at or less than the detection limit of testing of 0.01 S%. Sobek NP ranges from 26 to 579 $tCaCO_3$/1Kt, with a median value of 377 $tCaCO_3$/1Kt. The Carbonate NP tracks well against the Sobek NP, and has a median value of 366 $tCaCO_3$/1Kt.

Trace element analysis identified select elements at concentrations greater than the average crustal abundance. No concentrations, except bismuth and selenium, were noted at concentrations greater than 10x the average crustal abundance.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in one of the two samples. The guideline value is 0.100 mg/L and measured concentrations were 0.088 mg/L and 0.125 mg/L. Leachable copper was measured within an order of magnitude above both the CCME and BCAWQ guideline values in one of the two samples. The guideline value is 0.002 mg/L and measured concentrations were 0.002 mg/L and 0.005 mg/L.

8.9.7 Development Potential

The proposed development of the site is for supply of 750,000 m^3 pit run material. Prospects 68A and 69 were identified as alternative sites to 68a.

Prospect 76 was not found to contain significant quantities of gravel. The subsurface stratigraphy that could be investigated with the solid stem auger drill identified dominantly sandy silt soils and poorly sorted soils with lower quantities of gravel and cobble sized material. Below what could be drilled likely contains sand with trace quantities of gravels and cobbles as noted in the diamond drill hole. Drill fluid cuttings generally washed out the smaller sand sized particles.

As a general pit run or embankment fill source, an estimated 448,000 m^3 of sandy soil is believed to be available. Further subsurface investigation could identify quantities of gravel and cobble and depth.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

8.10 Prospect 86

8.10.1 Site Description

Prospect 86 is located at approximately km 76+500 along the proposed alignment. The site was identified as a bedrock prospect. The permitted area shown is about 28.2 ha. The permitted box extends to the east and west of the proposed alignment, with a larger portion being on the west side.

The prospect is situated on a local topographic high with plenty of exposed bedrock (dolostone and shale of the Chedabucto Lake Formation). The surrounding area has rugged topography, with bedrock-controlled ridges, and discontinuous thin to thick surficial cover that has been mapped as till. Bedrock exposures are common. The south and east, fine-grained fluvial sediments and wetlands are present within ephemeral stream channels at low elevations.

Within the prospect, bedrock exposure is abundant, especially in the central and northeastern potions (Photos 44, 46). The ground surface is irregular with small hills and depressions. It is covered with till veneer containing boulders. The western portion is lower in elevation and moderately well drained. The higher elevation areas appear well to rapidly drained. The former support shrubs and moss and scattered jack pine, while the latter supports fewer trees and more moss/shrubs.

8.10.2 Geotechnical Investigation Activities

Four boreholes were completed at Prospect 86. Table 8-10 presents a summary of the boreholes completed for the investigation program. Geophysical data was collected at the site and is presented below.

Table 8-10: Prospect 86 Borehole Summary

Borehole ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Bedrock Depth (m)	Bedrock Type
P86-01A/B	6,989,031	503,408	289	5.00/3.50	0/0	Limestone/Dolomite, Limestone Sands
P86-02	6,988,795	503,407	280	9.50	0	Limestone/Dolomite, Limestone Sands
P86-04	6,988,958	503,188	285	8.80	0.15	Limestone/Dolomite, Limestone Sands
P86-06	6,989,192	503,263	283	8.00	2.0	Limestone/Dolomite, Limestone Sands

Coordinates listed in NAD 83, Zone 11

8.10.3 Geophysical Survey Activities

The Geophysical Data collected at site P86 consisted of two profiles. Line 1 is a short profile oriented northwest – southeast and Line 2 is a much longer profile following higher ground and existing cutline generally running north to south with an east –west oriented loop at the southern end. All data was collected using the GPR system with a total approximate length of 800 linear metres of geophysical data was collected.

A large number of relatively short, randomly oriented linear coherent reflections are seen on both profile lines. These reflections are typically present down to a depth of 6 to 8 metres below the ground surface and are then underlain by a horizontal reflector that has been identified as competent bedrock. On the basis of the geotechnical information it is believed that the randomly oriented linear reflections at shallower depths are for the most part caused by fractures and dissolution cavities and channels within the dolomite rock present on site. There is little evidence of till pockets being present at surface along the geophysical profiles collected except in areas where attenuated signal levels suggests fine grained surficial material (clays and silts) masking any deeper reflection information.

8.10.4 General Subsurface Conditions

Bedrock was dominantly intercepted at or near surface. Bedrock was intercepted at 2.0 m in borehole P86-06. The overburden material recovered at P86-06 consisted of coarse sub-rounded gravels and boulders, and dominantly composed of calcitic dolomite. The dolomite varies from tan to grey in colour, fine grained, partially weathered, and contains slight dissolution cavities. The dissolution cavities contain fine calcitic sand infill. Two granite cobbles between 150 mm and 200 mm in diameter were recovered between 1.7 m and 2.0 m in P86-06.

There are two zones of bedrock material encountered, with a weathered upper zone characterized by frequent dissolution cavities and weathered bedrock sands, and a lower slightly weathered zone. The contact occurs at 6.3 meters in P86-02, at 5.5 m in P86-04, and at 4.3 m in P86-06. Borehole P86-01 was completed to 5 m and did not encounter the lower zone.

The bedrock within the upper zone is a weathered vuggy calcitic dolomite. The dolomite is tan-grey-brown in colour, fine grained and crystalline. It contains frequent and continuous dissolution cavities (vugs), and is highly fractured. The dissolution cavities are generally empty in the recovered core, however trace to minor amounts of calcitic sands can be seen lining the cavities. The sands are not recovered in the drill core, but are returned in the water recovery and deposited around the drill collar (Photos 45, 47). Both the host rock dolomite and weathered bedrock sands are moderately to strongly reactive with the addition of HCl acid. Geochemical characterization results, presented below, demonstrate the compositional similarity between the host rock and weathered sands. Core recovery and RQD are poor in the upper weathered zone and drill runs frequently blocked due to fragmented fractured core (Photo 48).

The bedrock in the lower zone transitions to a light grey, fine grained, calcitic dolomite with a crystalline texture. Trace to minor amounts of crinoid and bivalve fossils are observed. The rock is slightly weathered and contains trace to minor amounts of dissolution cavities, with an absence of weathered sands. The rock has a minor to moderate reaction to the addition of HCl acid. Rock strength, core recovery and RQD increase when compared to the more highly fractured upper zone.

The average core recovery in the upper weathered bedrock zone is 58%, and average RQD is 19%. The average core recovery in the lower bedrock zone is 92%, and the average RQD is 69%. The core loss in the upper weathered zone is attributed to the unrecovered weathered sands.

8.10.5 Materials Testing Program and Results

Samples were submitted for Los Angles Abrasion, flat and elongation particles, and petrographic analysis. Sample intervals from two boreholes were combined where required to source sufficient volume for the testing and to group similar materials from the upper and lower bedrock zones together. The unrecovered weathered bedrock sands did not undergo materials testing.

Recovered core from P86-02 (entire hole, 0-9.5 m) and P86-01A (entire hole, 0-5 m) was combined to create a composite sample representative of the bedrock unit as a whole, upper and lower zones, with sufficient volume for testing.

Recovered core from the top 0-5 m of P86-04 and P86-06 were combined to create a sample representative of the upper bedrock zone. Recovered core from 5.0-8.8 m in P86-04 and 5.0-8.0 m in P86-06 were combined to create a sample representative of the lower bedrock zone.

Los Angles Abrasion losses were between 18% and 20%, and demonstrate that the recovered core from the upper and lower bedrock zones do not exhibit significantly different abrasion resistance characteristics. Flat and elongation analysis ranged from 4.1% to 7.6%, with the upper weathered bedrock zone at 7.6%, the lower zone at 4.1% and the composite sample at 5.7%.

Petrographic analysis was completed on a composite sample from P86-01A (0-5.0m) and P86-02 (0-9.5m) and. The sample was crushed to 20mm minus, and consists of an equal 50-50 split of the 20-14mm and 14-10mm fraction size. The dominant sample composition is high strength, dolostone with some vugs (weighted average = 84.7%). The remaining sample composition is medium strength, very vuggy, dolostone (weighted average = 15.3%). The weighted average petrographic number (PN) is 131.

Petrographic analysis was completed on a composite sample from P86-04 (5.0-8.8m) and P86-06 (5.0-8.0m). The sample was crushed to 20mm minus, and consists of an equal 50-50 split of the 20-14mm and 14-10mm fraction size. The dominant sample composition is high strength, dolostone with minor calcite (weighted average = 96.8%). The remaining sample composition is medium strength, dolostone (weighted average = 3.2%). The weighted average petrographic number (PN) is 106.

8.10.6 Geochemical Characterization Program and Results

Nine samples were analyzed from Prospect 86. This includes eight samples of bedrock material, and one sample of weathered bedrock sand material collected from the water return at the borehole annulus. Three of the bedrock samples were collected from the weathered, vuggy material over the top 0-5m of the boreholes, the other five bedrock samples were collected from the variably weathered lower zone of the boreholes below 5m depth. In addition to the variability in weathering between these two zones, it was noted during logging that they potentially represented different compositions.

XRF analysis indicates that all samples are compositionally similar, with near uniform values of calcite and dolomite and limited impurities. Normalized calcite concentrations range from 36.7% to 44.1%, with a median value of 40.9%. Normalized dolomite concentrations range from 44.2% to 53.2%, with a median value of 49.9%. Normalized impurity concentrations range from 3.1% to 19.5%, with a median value of 9.3%. All samples classify near the boundary of the Calcitic Dolomite and Dolomitic Limestone division, with the elevated dolomite concentration relative to calcite placing all samples in the Calcitic Dolomite Category. The compositional similarity between the weathered sand and the bedrock material confirms the field observation that the sands are weathered bedrock material.

All three samples in the weathered zone (above 5m) and the weathered sand sample are classified as non-acid generating (NAG), based on Sobek NPR values which range from 5,888 to 6,810 with a median value of 6,784.

All five samples in the lower zone (below 5m) are classified as NAG, based on Sobek NPR values which range from 125 to 820, with a median value of 329.

The key compositional difference between the samples in the upper and lower zones is the Sulphur concentrations, which accounts for the differences in the range of NPR values. Sobek NP values between the two sample sets is similar. The Sobek NP values for the upper weathered zone range from 920 to 1065 $tCaCO_3$/1Kt, with a median value of 1060 $tCaCO_3$/1Kt. The Sobek NP values for the lower zone samples range from 962 to 1,030 $tCaCO_3$/1Kt, with a median value of 1,015 $tCaCO_3$/1Kt. Total Sulphur in the upper zone samples is less than the detection limit of testing at <0.01S% in all four samples. Total Sulphur in the lower zone samples range from 0.04 S% to 0.26 S%, with a median value of 0.10 S%. This is interpreted to be as a result of weathering in the upper zone.

Trace element analysis identifies select elements at concentrations greater than the average crustal abundance. Only the cobalt concentration in sample P86-04, sand is noted at greater than 10x the average crustal abundance.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in six of nine samples. The guideline value is 0.100 mg/L and measured concentrations range from 0.028 to 0.238 mg/L. The one sand sample (P86-04-SAND) reports leachable copper at 0.008 mg/L, within an order of magnitude of the 0.002 mg/L guideline value, and leachable molybdenum at 0.22 mg/L, within an order of magnitude of the 0.073 mg/L guideline value. Sample P86-04_8.36-8.55 from the lower zone reports leachable selenium at 0.0012 mg/L, slightly elevated above the CCME guideline of 0.001 mg/L. All other samples report less than detection limit values of leachable selenium at <0.0005 mg/L.

8.10.7 Development Potential

The proposed development of Prospect 86 is for supply of 360,000 m^3 quarry rock material.

This prospect may not be entirely suitable for bedrock quarry development due to the low core recoveries observed in the weathered bedrock zone that appears to extend from about 4 m to 6 m below ground surface. The core recoveries indicate that this zone consists of about 50% of recoverable rock core that is weathered and highly fractured, and 50% fine grained weathered bedrock sands. However, it may be possible to treat the upper 4-6 m as a material source with a heterogeneous mix of sand to boulder sized weathered bedrock materials. The lower bedrock zone may be suitable as a bedrock quarry development. It is unlikely the upper layer can simply be excavated and will require a degree of drilling and blasting.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

8.11 Prospect 98

8.11.1 Site Description

Prospect 98 is located at approximately km 83+000 along the proposed alignment. The site was identified as a granular prospect. The permitted area shown is about 30.6 ha. The majority of the permitted box is located on the east side of the alignment. Prospect 98 is located about 2.5 km south of the Lac la Martre River. The river outlets the south end of Lac la Martre Lake and flows eastward. A new bridge will be required to cross the river, so Prospect 98 would be an important material resource.

The prospect is located on a prominent northwest-trending esker ridge about 4 km long (Photos 54, 56). The prospect covers 2.2 km of its length, where the esker is thickest. The proposed TASR alignment crosses the esker approximately in its center. The esker is sharp-crested and uniformly thick within the prospect except for a thinner portion near Borehole P98-06. The esker is sinuous and has a steeper slope on its southwest side.

The esker is connected to other possible glaciofluvial sediments on its northern side and is surrounded by hummocky till, localized glaciofluvial sediments, a few possible but vague beach ridge deposits and till thin over bedrock. South of the northwestern end and both north and south of the southeastern end of the prospect, wetlands, ponds and poorly drained sediments are present. Wetland vegetation and sparse stunted black spruce trees are present in the wetlands, with dense, taller spruce bordering these low areas. The esker supports a dense stunted jack pine forest with low shrubs (Photo 52).

The Chedabucto Lake Formation makes up the bedrock. As this location is close to location of the mapped Aphebian intrusions, feldspar or quartz feldspar porphyry may be present as well.

8.11.2 Geotechnical Investigation Activities

Prospect 98 is defined by an esker that runs northwest-southeast as a prominent ridge. The north-west portion of the prospect that was accessible and could be investigated with the heli-portable drill was about 1,000 m long. The prospect is covered by mature forest and rises between 5 m and 10 m above the surrounding lands. The surrounding low lying lands contain marshes and bodies of water.

The surface of the esker was littered with boulders that made overland travel with the lightweight tracked drill not possible so auger drilling was limited to the northwest end of the prospect near the TASR alignment (Photos 51-53). Auger drilling was marginal and could only penetrate the upper 0.3 m to 0.4 m of overburden at most as the drill continuously met refusal on coarse gravel and cobbles. A hand excavated testpit was dug to about 0.55 m below grade through the use of a shovel and a 1.5 m pinch point bar (Photo 57). Geophysical data was collected at the site and is presented below.

Given the difficulty advancing boreholes with the auger drill, a diamond drill was remobilized to site to advance one boring at P98-01N. The drill advanced through gravel and cobble overburden and encountered bedrock, what appears to be a type of granitic intrusion (monzodiorite) at 6.3 m below grade and terminated at refusal at a depth of 6.5 m due to hard drilling. The lightweight drill could not advance well in the hard basalt and the drill could not be effectively anchored in the overburden soils. Drill cuttings washed to the surface were largely sand with low quantities of silt and clay particles observed.

Five shallow auger boreholes, a hand dug testpit and a diamond drill borehole were completed at Prospect 98. Table 8-11 presents a summary of the investigation program.

Table 8-11: Prospect 98 Borehole Summary

Testpit ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Water Table (m)	Soil Description
P98-01	6,995,237	501,346	280	0.4	Not encountered	Gravel

P98-01d	6,995,357	501,311	280	6.5	Not encountered	Sand, Gravel, Cobbles
P98-07	6,995,269	501,388	278	0.6	Not encountered	Gravel
P98-08	6,995,229	501,292	274	0.3	Not encountered	Gravel
P98-11	6,995,185	501,330	279	0.2	Not encountered	Gravel
P98-12	6,995,311	501,313	274	0.3	Not encountered	Gravel
P98-13	6,995,427	501,301	282	0.55	Not encountered	Gravel

Note: Coordinates listed in NAD 83, Zone 11

8.11.3 Geophysical Survey Activities

Both GPR and OhmMapper resistivity data was collected at site P98. The Geophysical survey consisted of three profile lines, Line 1 along the main crest of the esker and two cross lines, line 2 and 3. The OhmMapper data was collected along a subsection of Line 1. An approximate total of 1230 metres of GPR and 680 metres of OhmMapper data was collected.

An irregular, poorly defined reflector varying in depth between 3 and 8 metres is present on all geophysical profiles collected and has been interpreted as the bedrock contact. Bedrock appears fairly consistent in depth along the entire section of the esker surveyed with slightly thicker overburden material at the northern end of the geophysical profiles. Some localised lithological layering is seen in the data at the south end of Line 1 and Line 3 suggesting that surficial material may be more graded at the south end of the esker than the north.

The OhmMapper data shows resistive material (above 4000 Ohm.metres) in the upper 3 to 4 metres at the north end of the geophysical profile thinning to as little as 2 metres and then thickening again to 3 to 4 metres at the south end of the profile. This surficial material is underlain by a more conductive material (2000 Ohm metres) approximately 2 to 4 metres thick. In places a more resistive material is again present under this conductive layer. The layers with the highest resistivity values are expected to have the lowest fines contents. All material in these first two layers is interpreted to be either sands or gravels, but the resistivity data suggests that there may be two different layers present from a gradation curve perspective with the coarser material being at surface.

Table 8-12 shows typical resistive ranges for overburden materials, basalt and limestone.

Table 8-12: Typical Resistivity Ranges for Overburden Materials and Select Rocks

Material	Resistivity Range (Ohm.metres)
basalt	1000 to 100000
limestone	50 to 3000
Sands and gravels	500 - 10000
Glacial Tills	10 - 2000
Silts	30-1500
Clays	2 - 100

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The most resistive surficial material and therefore, anticipated to be the coarsest material, are located in the region of the topographic high and at the southern end of the resistivity profile. All three materials are sufficiently resistive to likely consist of granular material. The second layer being less resistive may have a high proportion of frozen sand material with some silt.

8.11.1 General Subsurface Conditions

The prospect was described as an esker deposit from desktop surficial geological mapping and aerial photo review. With the exception of the diamond drilling, the site investigation was limited to the upper 0.6 m of soil which was found to be largely made up of fine to coarse gravel and cobbles with trace to some sand and trace silt. Boulders were observed sporadically across the site on the surface and partially buried (Photos 52-55) and may be present at depth as well.

Diamond drilling showed near surface cobbles and coarse gravel while between about 1.5 m and 6.0 m the soil was largely considered to be fine gravel with lesser volumes of coarse gravel and sand. Between 3.0 m and 4.0 m cobbles and/or a 500 mm boulder was cored. The sand and silt content of the subsurface could not be accurately estimated as they were not recovered in the core barrel, however, drill cutting fluids returned to the surface appeared to contain largely sand sized particles and did not appear very dirty leading to the observation that the silt fraction of the soil is trace.

8.11.2 Materials Testing Program and Results

Laboratory testing of samples recovered from the site investigation showed primarily GRAVEL with some to trace sand and silt soils types. Gradation testing showed 71% to 87% being gravel with 5% to 16% sand and 8% to 13% silt. Moisture contents were 4.4% and lower.

As the soil samples were limited to shallow drilling and testpitting, we cannot confirm that this is representative of the overburden within the prospect. No petrographic analysis was completed.

8.11.3 Geochemical Characterization Program and Results

Three samples were submitted for geochemical characterization from the Prospect 98 site. All samples are composed of gravels, and variable sands and silts.

XRF analysis provides normalized calcite concentrations ranging from 16.8% to 31.5%. The normalized dolomite concentrations range from 21.1% to 38.1%. The normalized impurities concentrations range from 30.4% to 62.1%.

The three samples analyzed are classified as non-acid generating (NAG) based on Sobek NPR values ranging from 1,981 to 5,754, with a median value of 5,702. Total sulphur is measured at measured at or less than the detection limit of testing of 0.01 S%. Sobek NP ranges from 619 to 899 $tCaCO_3/1Kt$, with a median value of 891 $tCaCO_3/1Kt$. The Carbonate NP tracks well against the Sobek NP, and has a median value of 869 $tCaCO_3/1Kt$.

Trace element analysis identified select elements at concentrations greater than the average crustal abundance. No concentrations, except bismuth and selenium, were noted at concentrations greater than 10x the average crustal abundance.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in one of the three samples. The guideline value is 0.100 mg/L and measured concentrations range from 0.082 mg/L to 0.215 mg/L. Leachable copper was measured within an order of magnitude above both the CCME and BCAWQ guideline values in all three samples. The guideline value is 0.002 mg/L and measured concentrations range from 0.0021 mg/L to 0.0.004 mg/L. Leachable mercury was measured within an order of magnitude above both the CCME guideline value in one of three samples. The guideline value is 0.000026 mg/L mg/L and measured concentrations in sample P98-01.1_0.0-2.2 is 0.00016 mg/L. The other two samples recorded less than detection limit (<0.000050 mg/L) values for leachable mercury.

8.11.4 Development Potential

The surface conditions and exploratory drilling and testpitting undertaken on the site support the prospect classification of a sand and gravel esker. Diamond drilling showed bedrock at depth with sandy drill cuttings washed away and evidence of coarse gravel to boulders making up the overburden. The silt and clay content of the overburden is unknown but appears to be low considering the minimal dirty drill cutting fluids washing out of the deep borehole.

The proposed development of Prospect 98 is for supply of 140,000 m^3 granular material. Developing the ridge of Prospect 98 running southeast from the TASR alignment to a depth of 4 m could result in 127,000 m^3 of potential well graded gravel and sand.

A further 6 ha of ridge topography continues further to the southeast and could yield another 300,000 m^3 of material, but this area was not investigated during the field program. However, it appears to be a continuation of the esker.

Geochemical characterization results indicate that ARD potential is not a concern at this prospect site. The potential for ML is expected to be low.

8.12 Prospect 105

8.12.1 Site Description

Prospect 105 is located at approximately km 89+000 along the proposed TASR alignment, as shown on Figure 14. The all-weather road travelling to Whati is about 6 km to the north as shown on Figure 1. The site was identified as a bedrock prospect. The permitted area shown is about 176 ha. The permitted box extends west and east of the alignment. An archaeological site and buffer (site 5) were identified at the western edge of the prospect. The site was originally intended to only be ground truthed with no subsurface data collection. However, as the summer investigation program advanced, it was decided to advance two boreholes on exposed rock outcrops in the east part of the prospect where no tree clearing and bird survey was required.

Bedrock outcrops form two hills, one in the northeastern portion and one in the southwestern portion, the latter of which is larger and extends to a greater elevation. Exposed bedrock is common on the two knobs. There are no flat surfaces and no indication of bedding as at other bedrock prospects along the alignment. At Prospect 105, the bedrock appears igneous or metamorphic, with numerous joints and faults. The bedrock mapping shows this area to have either the Chedabucto Lake Formation the Aphebian feldspar or quartz feldspar porphyry intrusions.

In general, the prospect is surrounded by till of varying thickness, wetlands and ponds. Other granitic intrusions forming smaller hills are visible to the south and southwest of the prospect. The central and far northeastern extent of the prospect appear to be covered with till veneer, with thicker till blanket deposits evident elsewhere. The central portion appears to be underlain by sedimentary bedrock, possibly the Chedabucto Lake Formation. A small wetland or seasonally wet area is present in south central and southeastern portions. Trees, moss and lichen are present between the bedrock exposures.

8.12.2 Geotechnical Investigation Activities

Prospect 105 is a defined by two prominent rock outcrops, one in the eastern portion and one in the western portion (Photos 59-60). Each rock outcrop covers an approximately 1,300 m^2 surface area based on air photo imagery. The eastern outcrop is closer to the TASR alignment, within 200 to 300 m at its closest point. The western outcrop has a cabin and archeological site on it in the most western portion. The outcrops rise 5 m to 10 m above the surrounding land.

The outcrops have sparse tree cover, and patches of soil scattered around outcrop surface. The area surrounding Prospect 105 is marshy and partially treed.

The geotechnical investigation focused strictly on the eastern outcrop. The western outcrop was observed from the air during a flyover, but no ground investigation was completed in this area. No geophysical data was collected at the site.

Two boreholes were completed on the eastern outcrop at Prospect 105. The holes were drilled to 8.0 m and 9.0 m, respectively. Geologic and geotechnical conditions were the same in both boreholes. Core photos are not available for P105-01, however the photos for P105-02 provide a representative photo record of the material encountered. Table 8-13 presents a summary of the boreholes completed for the investigation program.

Table 8-13: Prospect P105 Borehole Summary

Borehole ID	Northing (m)	Easting (m)	Elevation (m)	Hole Depth (m)	Bedrock Depth (m)	Bedrock Type
P105-01	7,001,585	502,213	301	8.0	surface	Granite
P105-02	7,001,767	502,074	299	9.0	surface	Granite

Coordinates listed in NAD 83, Zone 11

8.12.1 General Subsurface Conditions

No overburden soil was encountered during the drilling investigation.

The bedrock material is granite. It is fine to medium grained with a crystalline texture, rich in potassium feldspar, and has frequent orange-red iron alteration on joints (Photo 58). No visible sulphides and there was no reaction with the addition of HCl acid. The bedrock is consistent from ground surface to depth (Photo 62).

8.12.2 Materials Testing Program and Results

Samples were submitted for Los Angles Abrasion, flat and elongation particles, and petrographic analysis. Los Angles Abrasion losses were 17% for two different samples while flat and elongation analysis ranged from 10.3% to 12.1 %.

Petrographic analyses were completed on two samples from Boreholes P105-01 and P105-02. The samples were crushed to 20 mm minus, and consist of an equal 50-50 split of the 20-14 mm and 14-10 mm fraction size. The dominant sample composition is high strength, granite with potassium feldspar (~99.5%) and the remaining sample composition is medium strength, weathered, potassium feldspar granite (~0.5%). The weighted average petrographic numbers (PN) for both samples are 101.

8.12.3 . Geochemical Characterization Program and Results

Geochemical characterization results were not available for the IFR report, and will be reported in the IFU report.

8.12.4 Development Potential

The proposed development of Prospect 105 is for supply of 320,000 m^3 quarry rock material.

An access road would be required from the TASR alignment to the potential quarry development area. The area surrounding the Prospect 105 outcrops appeared marshy from the air, and air photos indicate various wetlands and waterbodies. This may make access road development challenging.

The western outcrop was not part of the investigation but would appear to be similar to the eastern outcrop, and as such may also be suitable for development. At a minimum a geologic characterization of the western outcrop should be completed to determine whether the material is similar to the eastern outcrop.

Results of the geochemical characterization will inform the potential for ML/ARD from rock material excavated from this prospect.

8.13 Prospect 116

8.13.1 Site Description

Prospect 116 is located along an existing gravel road about 9 km east of Whati. The prospect is about 6 km northwest of the northern end of the proposed TASR alignment, but was investigated as part of the summer program. The permitted area is 268.8 ha.

The prospect is within a large esker complex that forms a shape of a cross in this location, as shown on Figure 15, with the dominate ridge extending southwest to northeast and perpendicular ridge extending northwest to southeast. The main body of the esker appears to be the northeast trending one, which tapers out beyond the eastern end of the prospect but continues on in a west-southwesterly direction towards Whati. The existing road is situated atop this lengthy ridge (Photo 79-74). The prospect is otherwise surround by hummocky till, streamlined till and till veneer. Low areas are filled with wetland and ponds, both of which are particularly abundant south of the prospect although there is a large pond to the northwest. The streamline till appears to be bedrock-controlled, and suggests regularly bedded sedimentary bedrock, which has been mapped as the Chedabucto Lake Formation.

Within the prospect, the main esker ridge is fairly flat in the west central area, where numerous trails are found. The north side of this area has a steeper slope, and the southeastern side of this area slopes gently to the southwest. The northeastern portion of the main esker has a subdued crest. None of the other esker segments have crests. The northwest-trending esker appears to be a thinner deposit than the main one.

Based on the air photos, the eastern part of the main esker just east of Testpit P116-01 is densely forested, while the rest of the esker complex showed shrubs and scattered trees. During the fieldwork, the esker was found to be covered with mature jack pine/black spruce forest and some stands of dead and fire burnt trees. This suggests that the area experienced a forest fire not long before the photo year.

8.13.2 Geotechnical Investigation Activities

Testpitting took place at Prospect 116 between July 17 and 18, 2017. A total of 22 testpits were excavated within the defined prospect, as shown on Figure 15, along several cross cutlines originating from the existing gravel road to Whati. The average testpit depth was 3.4 m deep with most testpits terminating likely in permafrost or possibly seasonally frozen soils. No geophysical data was collected at the site. The general landform is considered to be an esker deposit. At minimum three gravel pits about 4 m deep have been developed in the past by others and are presently partially overgrown.

Four testpits encountered water at an average depth of 3.3 m. In three cases, the water infiltration was noted underneath a zone of permafrost soil. The existing gravel pit near Testpit P116-14 (Photo 63) contained a few centimeters of water at the bottom of the pit which is believed to have been overland runoff from recent rainfall events. The condition of the groundwater table at this prospect is unconfirmed, but the general topography of the esker is that it rises 10 m to 20 m above the surrounding lands. No bedrock was encountered in the excavations.

Table 8-14 presents a summary of the testpits completed at Prospect 116.

Table 8-14: Prospect 116 Testpit Summary

Testpit ID	Northing (m)	Easting (m)	Elevation (m)	Testpit Depth (m)	Water Table (m)	Soil Description
P116-01	7,006,054	495,937	274	3.5	-	Sand & Gravel
P116-02	7,005,700	495,649	285	4.1	4.0	Sand
P116-03	7,005,547	495,667	284	4.0	-	Sand & Gravel
P116-04	7,005,403	495,673	284	4.3	-	Sand & Gravel
P116-05	7,005,056	495,877	281	3.5	-	Sand & Gravel
P116-06	7,005,709	495,400	284	3.5	-	Sand & Gravel
P116-07	7,006,087	495,517	279	2.9	-	Sand
P116-08	7,005,112	495,021	280	2.5	-	Sand
P116-09	7,005,301	494,710	285	4.2	-	Sand & Gravel
P116-10	7,005,157	494,519	285	4.2	-	Sand
P116-11	7,005,034	494,465	282	4.9	-	Sand & Gravel
P116-12	7,005,233	494,607	285	3.3	-	Gravel & Sand
P116-13	7,005,175	494,781	284	1.9	-	Sand & Silt
P116-14	7,005,262	494,962	283	2.5	-	Sand & Silt
P116-15	7,005,705	495,524	285	2.5	-	Sand & Gravel
P116-16	7006,003	495,594	280	4.0	-	Sand
P116-17	7,005,868	495,666	281	1.8	-	Gravel, sandy
P116-18	7,005,314	495,830	282	3.8	2.8	Sand & Gravel
P116-19	7,005,176	495,882	281	3.8	3.2	Sand
P116-20	7,005,881	495,797	277	3.5	3.3	Sand & Gravel
P116-21	7,004,857	494,448	282	3.2	-	Sand
P116-22	7,005,282	495,719	281	3.2	-	Sand

Note: “-“Groundwater table not encountered.
Coordinates listed in NAD 83, Zone 11

8.13.1 General Subsurface Conditions

The prospect contains dominantly sand with lesser extents of gravel. Excluding the surface organic soils, the upper 0.5 to 0.6 m of soil is consistently a gravelly SAND, with trace silt. Below about a metre, the soil was predominantly sand with trace gravel (Photos 69-72).

A few testpits (P116-01, 05, 09, and 12) contained greater quantities of gravelly soil at depth as well as near surface gravel deposits (Photos 66-68). The ridge running parallel to the all season road between P116-11 to 09 and P116-06 to 01 appears the most promising as a gravel source, along with ridge running from P116-03 to P116-05. These three areas are where the three existing gravel pits are (across the road from P116-14; P116-03 and P116-02). The existing gravel pits displayed the same upper sandy gravelly soils with primarily sand below the upper metre of the top of the pits (Photos 63-65).

8.13.2 Materials Testing Program and Results

Where fine to coarse gravel soils were present, laboratory testing showed 46% to 71% gravel, 26% to 52% sand and 1% to 6% silt. Only few testpits had quantities of gravel in this range. Moisture contents ranged from 2.8% to 26.3% (saturated), with higher moisture contents encountered within frozen sandy and/or silty soils found at depth.

Samples were submitted for Los Angles Abrasion, flat and elongation particles, and petrographic analysis. Los Angles Abrasion losses was 32% for while flat and elongation analysis was 4.7%.

Petrographic analysis was completed on a sample of pit run material which was collected from Testpit P116-03, which is located alongside an existing disturbance/pit. The weighted average petrographic number (PN) for Sample was 164.

8.13.3 Geochemical Characterization Program and Results

Six samples were submitted for geochemical characterization from the Prospect 116 site. Three samples are described as sand, and three samples as sand/gravel. The geochemical characterization results indicate that the two sample sets are not distinctly different in terms of chemical composition, and therefore the six samples are discussed together.

XRF analysis provides normalized calcite concentrations ranging from 2.2% to 9.6%. The normalized dolomite concentrations range from 5.0% to 11.5%. The normalized impurities concentrations range from 79.0% to 92.8%. The high impurities content across all samples indicates that the gravels in the three samples are derived from multiple sources, rather than bedrock derived gravels with higher calcite and dolomite contents as observed at other prospect sites.

All samples analyzed are classified as non-acid generating (NAG) based on Sobek NPR values ranging from 188 to 1,354, with a median value of 324. Total sulphur ranges from less than the detection limit of testing at <0.01 S% to 0.03 S%. Sobek NP ranges from 151 to 423 $tCaCO_3/1Kt$, with a median value of 201 $tCaCO_3/1Kt$. The Carbonate NP tracks well against the Sobek NP, and has a median value of 191 $tCaCO_3/1Kt$.

Trace element analysis identified select elements at concentrations greater than the average crustal abundance. No concentrations, except bismuth and selenium, were noted at concentrations greater than 10x the average crustal abundance.

In the SFE analysis, leachable aluminum was measured within an order of magnitude above both the CCME and BCAWQ guideline values in two samples, and an order of magnitude greater than the guideline value in three samples. The guideline value is 0.100 mg/L and measured concentrations range from 0.083 mg/L to 5.560 mg/L. Leachable copper was measured within an order of magnitude above both the CCME and BCAWQ guideline values in four samples, and an order of magnitude greater than the guideline value in one sample. The guideline value is 0.002 mg/L and measured concentrations range from <0.001 mg/L to 0.0238 mg/L. Leachable iron was measured within an order of magnitude above both the CCME and BCAWQ guideline values in two samples, and an order of magnitude greater than the guideline value in one sample. The guideline values are 0.3 and 0.35 mg/L and measured concentrations range from <0.030 mg/L to 3.430 mg/L. Sample P116-13_1.8-1.9 is the sample for which leachable aluminum, copper and iron exceed the guideline by greater than an order of magnitude.

8.13.4 Development Potential

The prospect is covered with mature forest with some stands of dead and forest fire burnt trees which will require clearing for development. Two existing gravel pits have been developed north of the all season road and could supposedly be further developed to source further materials. A third gravel pit south of the all season road could similarly be extended south to obtain more sand and gravelly soil.

The proposed development of Prospect 116 is for supply of 220,000 m^3 pit run material. Expanding one of the existing pits should provide the required material. Between P116-11, 10, 12 and 09, there is an estimated 290,000 m^3 of well graded SAND and gravelly soil.

Between P116-06, 15, 17, 20 and 01, there is an estimated 261,000 m^3 of SAND and gravelly soil, and between P116-04, 18, 19 and 05, there is an estimated 272,000 m^3 of SAND and gravelly soil.

Geochemical characterization results indicate that ARD is not a concern for this prospect site. However, the presence of elevated copper and aluminum concentrations in the shake flask extraction analysis indicate potential for metal leaching that may pose some risk for impacting aquatic life. The risks will depend on the excavated and placed material volumes, construction uses, and location of placement. Larger volumes of disturbed rock materials translate to increased metal loading potential. The risks associated with metal leaching are increased when the disturbed rock materials are placed proximal to sensitive surface water receptors. ML/ARD risks can be mitigated by placing construction materials sub-aqueously to limit the reactions and weathering which produce ML/ARD.

9.0 MATERIAL AVAILABILITY

Generally the study area comprises thin to thick glaciofluvial deposits and glacial till overlying an irregular bedrock surface, except where the surficial deposits have been removed, revealing the underlying bedrock. Section 5.0 describes regional geology and geomorphology. Glaciofluvial deposits such as beach ridges, ice-contact deposits and eskers provide most of the surface sediments that can be used as granular aggregate resources in the study area. Esker complexes are found in the central and northern portions of the proposed alignment, varying in length and landform continuity. The eskers are well formed and steep sided. Some deposits consist mainly of sand, while others comprise sand and gravel or sand, gravel and cobbles. The ice-contact deposits are a mix of silt, sand, gravel and probable till. Eskers commonly have a bouldery surface due to ice melt from above within the glacier ice.

9.1 Bedrock

Sources of quarried rock material have been identified in the study area. Quarried bedrock has been extensively and successfully used as a source of construction material along sections of Hwy 3. Limestone can be quarried in either winter or summer and with some processing used in various general fill applications. Moisture contents of quarried rock are low, which allows for placement year-round. Such fills are frost stable and relatively durable. This material however will require some crushing, depending on its end use and the in-situ properties of the rock.

The granite rock encountered at Site Prospect 105 is hard and durable. The limestone materials encountered are more variable in consistency and generally less hard, but are a good construction material and preferable to many natural granular deposits. The limestone rock will also require a degree of processing depending on its end use and the in-situ properties of the rock.

9.2 Quality Granular Material

Granular soils generally acceptable for use as sub-base and surface courses for gravel roadways are relatively scarce within the sites investigated. These materials are more prevalent in the north part of the region at Prospect 116, but the haulage distances to the proposed road alignment is very long.

In general these materials are found to be well graded gravel and sand with trace to some cobbles and silt. Cobbles might need to be removed by screening or crushed. A fines content of typically 5% to 10% is desirable for gravel surfacing courses. Compaction to a high density can be achieved in the summer months with a vibratory drum roller and moisture conditioning.

The screened gravel fill is readily adaptable to other construction uses such a constructing foundations and pads. Care should be taken to ensure that the fill is frost stable. High fines contents will results in the material being marginally susceptible and at higher risk to frost action. These problems can generally be overcome by ensuring good drainage and restricting the access of water to the fill pad.

9.3 General Fill

Soil suitable for general fill has been located in the outwash, esker and moraine deposits within the study area. Most materials have a high concentration of sand and silt with a variable coarse fraction. If the moisture content of these materials is sufficiently high, then it will be difficult to handle, place and compact these materials during the winter months. These materials can be readily handled and placed in the summer months. For the most part these materials are sufficiently well graded to allow compaction to a relatively dense state. The finer grained sands encountered at Prospects 1 and 13 are susceptible to erosion thus should be capped with a more resistant protective layer.

Frost stability may be a problem arising from construction with random granular fill. Careful consideration will have to be given to fill section and subgrade design, in order to minimize the risk of frost heave.

9.4 Concrete Aggregates

The findings of the program indicate a severe scarcity of sand and gravel which can readily serve as concrete aggregate within areas investigated.

Petrographic analysis suggests that the bedrock materials sampled at Prospects P13D P29, P86 and P105 show acceptable constituents for concrete production, with the granitic bedrock at P105 indicating the highest quality material with the lowest weighted petrographic number. The highest petrographic numbers were observed at P33A and P116, and these sites are judged non suitable for concrete aggregate production. The petrographic results are presented in Appendix C3. The CSA suggested PN limit (CSA 23.2-14, Table A2.1) for concrete Classes C1, C2, and F1 is a maximum of 125, and for all other concrete, the PN limit is 140.

10.0 LIMITATIONS OF REPORT

This report pertains to the specific geotechnical and geophysical activities described above. The data presented in this report are based on boreholes and testpits at discrete locations. Boreholes were advanced with a heli-portable drill using diamond and auger drill techniques. Geological conditions are innately variable and are seldom spatially uniform. In order to interpret the information presented in this data report, it is necessary to make assumptions concerning the lithology/stratigraphy.

Interpreted geophysical sections are presented for all geophysical profiles collected. It should be noted that all interpreted geophysical sections are, by necessity, simplifications of actual site stratigraphy. Supporting geophysical data are included in Appendix E and should be referred to for detailed evaluation of site conditions. The geophysical interpretations presented are considered reasonable given existing supporting data, including site observations and borehole geotechnical data. It should be noted that alternative interpretations are possible and, where appropriate, this has been noted in the site specific discussion.

Samples for geochemical characterization and materials testing were selected to be representative of the materials encountered during the geotechnical investigation program. The innate variability of geologic conditions must also be acknowledged as a limitation of the sampling.

The geochemical characterization identified the risk for ML/ARD potential from material at the investigated prospects is low. However, the use of this material should be evaluated on a location specific basis with consideration for the proximity of placed material to surface receptors, the method of placement, and volume of material. Project risk needs to be evaluated on a case-by-case basis. Areas along the project alignment with a low tolerance of risk may choose to implement monitoring programs to quickly identify any unexpected changes in leachate chemistry from the rocks and potential impacts on downstream surface receptors. The collection of pH and ORP (reduction potential) data is a fast and low-cost method of evaluating leachate pH and can be used to determine redox states of various elements.

Additional geochemical characterization sampling may be recommended if the proposed excavation development boundary extends beyond the lateral extents of the borehole drilling program, or if the quarry is developed beyond the lowest depth of the borehole drilling.

The risks associated with ML/ARD will depend on the excavated and placed material volumes, construction uses, and location of placement. Larger volumes of disturbed rock materials translate to increased metal loading potential. The risks associated with metal leaching and acid rock drainage are increased when the disturbed rock materials are placed proximal to sensitive surface water receptors. ML/ARD risks can be mitigated by placing construction materials sub-aqueously to limit the reactions and weathering which produce ML/ARD.

This report has been prepared in accordance with generally accepted engineering and geophysical practices. No other warranty is made, either expressed or implied.

11.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

ISSUED FOR REVIEW

Prepared by:
Tim Schaap, P.Eng.
Geotechnical Engineer
Direct Line: 867.766.3728 x224
Tim.Schaap@tetratech.com

ISSUED FOR REVIEW

Prepared by:
Scott Kingston, P.Geo.
Geologist
Direct Line: 604.608.8631
Scott.Kingston@tetratech.com

ISSUED FOR REVIEW

Prepared by:
Neil Parry, P.Geoph., MBA
Principal Specialist, Geophysicist
Engineering & Environmental Geophysics
Direct Line: 587.460.3598
Neil.Parry@tetratech.com

ISSUED FOR REVIEW

Prepared by:
Shirley McCuaig, Ph.D., P.Geol.
Senior Terrain Geologist
Engineering Practice
Direct Line: 587.460.3569
Shirley.McCuaig@tetratech.com

ISSUED FOR REVIEW

Prepared by:
Ed Grozic, M.Eng, P.Eng.
Principal Specialist, Arctic Development
Direct Line: 403.723.6858
Ed.Grozic@tetratech.com

ISSUED FOR REVIEW

Reviewed by:
Rob Girvan, P.Eng.
Manager – Yellowknife Arctic Group
Direct Line: 867.920.2287 x256
Rob.Girvan@tetratech.com

/kla

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TABLES

Table 1: TASR Geotechnical Investigation Program

Borehole/ Testpit ID	Method	Zone	Northing (m)	Easting (m)	Elevation (m)	Status	Date Completed	Dominate Rock or Soil Type	Sample Interval (m)	Geophysical Data Collected	Total Depth (m)	Overburden Thickness (m)	Depth to Rock (m)	Watertable (m)	Overburden Generalized Description (Note 1)
P1-01	Testpitting	11V	6,928,010	525,963	268	Complete	14-Jul	Sand & Gravel	-	No	2.4	2.4	N/A	2.0	Sand, well graded gravel within the watertable
P1-02	Testpitting	11V	6,927,983	525,936	268	Complete	14-Jul	Sand & Gravel	2.0-2.4	No	2.4	2.4	N/A	2.0	Sand, well graded gravel within the watertable
P1-03	Testpitting	11V	6,928,053	525,620	266	Complete	14-Jul	Sand	-	No	3.2	3.2	N/A		fine to medium Sand
P1-04	Testpitting	11V	6,928,118	525,332	268	Complete	14-Jul	Sand	-	No	3.1	3.1	N/A		fine dry Sand
P1-05	Testpitting	11V	6,928,163	525,086	266	Complete	12-Jul	Sand	0.5-0.6	No	3.4	3.4	N/A		fine dry Sand
P1-06	Testpitting	11V	6,928,190	524,922	263	Complete	12-Jul	Sand	2.0-3.0	No	3.0	3.0	N/A		fine dry Sand
P1-07	Testpitting	11V	6,928,212	525,658	266	Complete	14-Jul	Sand	0.7-0.8	No	3.4	3.4	N/A		fine dry Sand
P1-08	Testpitting	11V	6,928,328	525,545	268	Complete	13-Jul	Sand	0.5-0.6	No	4.4	4.4	N/A		fine to medium Sand
P1-09	Testpitting	11V	6,928,431	525,445	265	Complete	14-Jul	Sand	0.2-0.3	No	3.4	3.4	N/A		fine to medium dry Sand
P1-10	Testpitting	11V	6,928,354	525,800	266	Complete	13-Jul	Sand	0.2-0.3;0.9-1.0	No	3.0	3.0	N/A		fine to coarse, dry to damp Sand
P1-11	Testpitting	11V	6,928,456	525,699	268	Complete	13-Jul	Sand	1.0-1.1	No	4.0	4.0	N/A		fine to medium, dry to damp Sand
P1-12	Testpitting	11V	6,928,583	525,573	263	Complete	13-Jul	Sand	0.8-0.9	No	3.4	3.4	N/A	2.7	fine to coarse, dry to damp Sand
P1-13	Testpitting	11V	6,928,525	525,919	267	Complete	13-Jul	Sand	0.5-0.6	No	4.1	4.1	N/A		fine to medium, damp Sand
P1-14	Testpitting	11V	6,928,592	525,859	268	Complete	13-Jul	Sand	1.4-1.5	No	3.9	3.9	N/A		fine to coarse, dry to damp Sand
P1-15	Testpitting	11V	6,928,700	525,756	263	Complete	13-Jul	Sand	0.5-0.6	No	3.5	3.5	N/A	2.1	fine to coarse, damp Sand
P1-16	Testpitting	11V	6,928,646	525,807	267	Complete	13-Jul	Sand	2.5-4.0	No	4.3	4.3	N/A		fine to coarse, dry to damp Sand
P1-17	Testpitting	11V	6,928,516	525,638	267	Complete	13-Jul	Sand	1.2-2.0	No	4.0	4.0	N/A		fine to coarse, dry to damp Sand
P1-18	Testpitting	11V	6,928,402	525,753	268	Complete	14-Jul	Sand	3.0-3.5	No	3.5	3.5	N/A		fine to coarse, dry Sand
P1-19	Testpitting	11V	6,928,380	525,495	267	Complete	14-Jul	Sand	1.1-1.2	No	4.0	4.0	N/A		fine to coarse, dry Sand
P1-20	Testpitting	11V	6,928,260	525,612	267	Complete	14-Jul	Sand	0.7-0.8	No	3.5	3.5	N/A		damp to moist Sand
P1-21	Testpitting	11V	6,928,231	525,429	268	Complete	13-Jul	Sand	3.5-4.0	No	4.3	4.3	N/A		fine to medium, dry Sand
P1-22	Testpitting	11V	6,928,599	526,290	269	Complete	14-Jul	Sand	-	No	2.5	2.5	N/A		fine to medium, dry to damp Sand
P1-23	Testpitting	11V	6,928,489	526,298	269	Complete	14-Jul	Sand	-	No	2.9	2.9	N/A		dry Sand
P1-24	Testpitting	11V	6,928,318	526,277	269	Complete	14-Jul	Sand	-	No	3.0	3.0	N/A		fine to coarse, dry Sand
P13B-01	Testpitting	11V	6,933,213	511,536	272	Complete	11-Jul	Sand	3.5-4.0;4.8-5.0	No	5.3	5.3	N/A		fine Sand; clay till
P13B-02	Testpitting	11V	6,933,298	511,572	271	Complete	11-Jul	Sand	3.0-3.4	No	4.6	4.6	N/A		fine to coarse, dry to damp Sand
P13B-03	Testpitting	11V	6,933,139	511,434	276	Complete	11-Jul	Sand	3.5-4.0	No	5	5.0	N/A		fine to medium, damp Sand
P13B-04	Testpitting	11V	6,933,312	511,394	275	Complete	11-Jul	Sand	2.5-3.5	No	5.2	5.2	N/A		fine to medium, damp Sand
P13B-05	Testpitting	11V	6,933,404	511,274	276	Complete	11-Jul	Sand	2.5-3.0	No	4.0	4.0	4.0		fine to medium Sand; clay till
P13B-06	Testpitting	11V	6,933,566	511,378	271	Complete	11-Jul	Sand	0.8-1.0	No	1.9	1.9	1.9		fine to medium Sand; clay till
P13B-07	Testpitting	11V	6,933,517	511,109	275	Complete	11-Jul	Sand	0.9-1.1	No	2.6	2.5	2.5		fine to medium Sand; clay till
P13B-08	Testpitting	11V	6,933,721	511,197	272	Complete	11-Jul	Sand	1.3-1.4	No	2.6	2.6	2.6		fine Sand; silty
P13B-09	Testpitting	11V	6,933,689	511,043	274	Complete	11-Jul	Sand	3.1-3.3;3.7-3.9	No	4.0	4.0	4.0		fine to medium Sand; silty; clay till
P13C-01	Testpitting	11V	6,935,394	509,935	274	Complete	11-Jul	Sand	2.5-3.5	No	4.5	4.5	N/A		fine to medium, damp Sand
P13C-02	Testpitting	11V	6,935,420	510,030	276	Complete	11-Jul	Sand	3.0-4.0	No	4.5	4.5	N/A		dry to damp Sand
P13C-03	Testpitting	11V	6,935,421	510,136	274	Complete	12-Jul	Sand	0.2-0.30;.4-0.5;2.5-3.5	No	4.4	4.4			fine to coarse, dry to damp Sand
P13C-04	Testpitting	11V	6,935,495	509,899	275	Complete	12-Jul	Sand	0.5-2.0	No	4.3	4.3	N/A		fine Sand
P13C-05	Testpitting	11V	6,935,529	510,006	275	Complete	12-Jul	Sand	1.5-2.5	No	4.6	4.6	N/A		fine Sand
P13C-06	Testpitting	11V	6,935,621	509,854	275	Complete	12-Jul	Sand	3.8-3.9	No	3.9	3.7	3.7		fine to medium Sand; clay till
P13C-07	Testpitting	11V	6,935,654	509,953	274	Complete	12-Jul	Sand	1.2-1.3	No	3.7	3.7	3.7		fine Sand; clay till
P13C-08	Testpitting	11V	6,935,591	510,222	273	Complete	12-Jul	Sand	2.0-2.5	No	4.7	4.7	N/A		fine Sand
P13C-09	Testpitting	11V	6,935,466	510,355	274	Complete	12-Jul	Sand	3.0-3.5	No	4.3	4.3	N/A		fine to medium Sand
P13D-01	Diamond Drill	11V	6,934,213	510,341	285	Complete	4-Jul-17	Limestone		No	5.0	4.72	4.72		Topsoil; gravelly silt
P13D-02	Diamond Drill	11V	6,934,246	510,436	282	Complete	4-Jul-17	Limestone		No	9.5	-	0.00		-
P13D-03	Diamond Drill	11V	6,934,325	510,305	285	Complete	3-Jul-17	Limestone		No	8	0.45	0.45		mixed lithology pebbles and cobbles, sub-angular to sub-rounded
P13D-04	Diamond Drill	11V	6,934,423	510,228	284	Complete	1-Jul-17	Limestone		No	9.5	0.15	0.15		No recovery, based on top surface - brown silty sand
P13D-05	Diamond Drill	11V	6,934,539	510,414	280	Complete	5-Jul-17	Limestone		No	9.5	-	0.00		-
P13D-01t	Testpitting	11V	6,934,231	510,341	283	Complete	12-Jul	Silt till	2.0-2.4	No	2.4	2.4	N/A		sandy, gravelly SILT, trce cobbles and clay (Till-like)
P29-01	Diamond Drill	11V	6,946,345	508,730	293	Complete	27-Jun-17	Limestone		No	9.5	-	0		-
P29-02	-	-	-	-	-	Not Drilled	-	-	-	No	-	-	-	-	-
P29-03	Diamond Drill	11V	6,946,396	508,975	293	Complete	26-Jun-17	Limestone		No	8.0	-	0		-
P29-04	Diamond Drill	11V	6,946,225	508,754	295	Complete	26-Jun-17	Limestone		No	9.5	-	0		-
P29-05	Diamond Drill	11V	6,946,214	508,960	295	Complete	28-Jun-17	Limestone		No	9.5	-	0		-
P29-06	Diamond Drill	11V	6,946,226	509,054	291	Complete	28-Jun-17	Limestone		No	8.0	-	0		-
P29-07	Diamond Drill	11V	6,946,203	508,855	295	Complete	27-Jun-17	Limestone		No	9.5	-	0		-
P29-08	Diamond Drill	11V	6,946,248	508,898	297	Complete	29-Jun-17	Limestone		No	4.3	0.25	0.25		No recovery, based on top surface - brown silty sand

Table 1: TASR Geotechnical Investigation Program

Borehole/ Testpit ID	Method	Zone	Northing (m)	Easting (m)	Elevation (m)	Status	Date Completed	Dominate Rock or Soil Type	Sample Interval (m)	Geophysical Data Collected	Total Depth (m)	Overburden Thickness (m)	Depth to Rock (m)	Watertable (m)	Overburden Generalized Description (Note 1)
P33A-01	Diamond Drill	11V	6,951,539	507,867	288	Complete	9-Jul-17	Limestone		GPR	9.5	0.6	0.6		mixed lithology, dominantly limestone, redrill fragments
P33A-02	Diamond Drill	11V	6,951,487	507,572	286	Complete	8-Jul-17	Limestone		GPR	9.5	0.7	0.7		mixed lithology pebbles and cobbles, sub-angular to sub-rounded, assume core loss of fines in matrix
P33A-03	Diamond Drill	11V	6,951,769	507,535	287	Complete	8-Jul-17	Limestone		GPR	9.5	0.5	0.5		mixed lithology pebbles and cobbles, sub-angular to sub-rounded, assume core loss of fines in matrix
P33A-04	Diamond Drill	11V	6,952,125	507,485	280	Complete	8-Jul-17	Limestone		GPR	9.5	2.82	2.82		mixed lithology pebbles and cobbles, sub-angular to sub-rounded, assume core loss of fines in matrix
P33A-05	Diamond Drill	11V	6,952,337	507,456	285	Complete	6-Jul-17	Limestone		GPR	9.5	3.60	3.60		0.5m: soil, brown silty sand, minor clay; 3.1m: mixed lithology pebbles and cobbles, glacial till, sub-angular to sub-rounded, core loss assumed to be fines supporting clasts
P33A-06	Diamond Drill	11V	6,952,399	507,644	288	Complete	6-Jul-17	Limestone		GPR	9.5	7.57	7.57		dominantly limestone pebbles and cobbles, minor mixed lithology clasts, sub-angular to sub-rounded, driller notes pockets of "sand", no recovery of fines
P33A-07	Diamond Drill	11V	6,952,458	507,881	289	Complete	7-Jul-17	Limestone		GPR	9.5	-	0		-
P33A-08	Diamond Drill	11V	6,952,423	508,041	292	Complete	7-Jul-17	Limestone		GPR	9.5	7.42	7.42		0.20m: soil, brown silty, sand; 7.22m: limestone clasts, <1%mixed lithology clasts, sub-angular to sub-rounded, 50% core reocvery, assumed loss is fines in matrix supproting clasts
P33A-09		-	-	-	-	Not Drilled	-	-		No	-	-	-		-
P33A-10	Diamond Drill	11V	6,951,490	507,778	289	Complete	9-Jul-17	Limestone		GPR	9.5	0.35	0.35		mixed lithology pebbles and cobbles, sub-angular to sub-rounded, assume core loss of fines in matrix
P69-01	4" Auger	11V	6,977,999	508,190	271	Refusal	23-Jul	Gravel	-	GPR	0.6	0.6			Gravel, Cobbles, Sand (Esker)
P69-02	4" Auger	11V	6,978,070	507,930	273	Refusal	23-Jul	Gravel	-	GPR	0.3	0.3			Gravel, Cobbles, Sand (Esker)
P69-03	4" Auger	11V	6,978,140	507,704	274	Refusal	23-Jul	Gravel	0.1-0.2	GPR	0.3	0.3			Gravel, Cobbles, Sand (Esker)
P69-04	4" Auger	11V	6,978,213	507,499	274	Refusal	23-Jul	Gravel	0.0-0.2	GPR	0.3	0.3			Gravel, Cobbles, Sand (Esker)
P69-05	4" Auger	11V	6,978,275	507,367	274	Refusal	23-Jul	Gravel	0.0-0.3	GPR	0.3	0.3			Gravel, Cobbles, Sand (Esker)
P69-05d	Diamond Drill	11V	6,978,275	507,367	274	Complete	24-Jul	Gravel	Corebox	GPR	11.0	7.2	7.2	N/A	Gravel, sandy, trace to some cobbles
P69-06	Hand Dug	11V	6,978,247	507,573	273	Not Drilled	23-Jul	Gravel	-	GPR					Gravel, Cobbles, Sand (Esker)
P69-07	Hand Dug	11V	6,978,116	507,529	271	Not Drilled	23-Jul	Gravel	-	GPR					Gravel, Cobbles, Sand (Esker)
P69-08	Hand Dug	11V	6,978,094	508,075	270	Not Drilled	23-Jul	Gravel	-	GPR					Gravel, Cobbles, Sand (Esker)
P69-09	Hand Dug	11V	6,977,970	508,040	270	Not Drilled	23-Jul	Gravel	-	GPR					Gravel, Cobbles, Sand (Esker)
P76-01	4" Auger	11V	6,982,107	504,790	277	Refusal	22-Jul	Sand	-	GPR	0.2	0.2			Sand , silty
P76-02	4" Auger	11V	6,982,192	504,954	274	Refusal	22-Jul	Gravel	-	GPR	0.3	0.3			Gravel, Sand/Silt, Cobbles
P76-03	4" Auger	11V	6,982,279	505,138	275	Refusal	22-Jul	Gravel	-	GPR	0.3	0.3			Gravel, Sandy, some silt to silty
P76-03d	Diamond Drill	11V	6,982,279	505,138	275	Complete	25-Jul	Limestone	Corebox	GPR	18.5	11.85	11.85		Sand/Silt, Cobbles, gravelly
P76-04	4" Auger	11V	6,982,463	505,172	275	Refusal	22-Jul	Gravel	0.1-0.4	GPR	0.5	0.5			Gravel, Sand/Silt, Cobbles
P76-05	4" Auger	11V	6,982,603	505,045	268	Refusal	22-Jul	Silt	0.3-0.6;2.0-2.5	GPR	3.9	3.9			Silt; Cobbles
P76-06	4" Auger	11V	6,982,603	504,936	264	Refusal	22-Jul	Silt	0.6-1.0	GPR	1.1	1.1			Silt; Sandy, trace to someGravel, Cobbles (Permafrost)
P76-07	4" Auger	11V	6,982,281	504,700	273	Refusal	21-Jul	Sand	0.1-0.4;1.0-1.1;1.4-1.5	GPR	1.6	1.6			Sand; Silt, cobbles
P76-07a	Hand Dug	11V	6,982,281	504,700	273	Not Drilled	21-Jul	Gravel	0.2-0.7	GPR	0.7	0.7			Gravel, Cobbles, sandy, silty
P76-08	4" Auger	11V	6,982,341	504,815	269	Refusal	21-Jul	silty Gravel	0.0-0.2	GPR	0.6	0.6			silty Gravel, cobbly, sandy
P76-09	4" Auger	11V	6,982,421	504,980	268	Refusal	21-Jul	Silt	0.1-0.5	GPR	1.8	1.8			Silt; some sand, some clay
P86-01A/B	Diamond Drill	11V	6,989,031	503,408	289	Complete	13-Jul	Limestone		GPR	5.0	0	0		-
P86-02	Diamond Drill	11V	6,988,795	503,407	280	Complete	15-Jul-17	Limestone		GPR	9.5	0	0		-
P86-03		11V	-	-	-	Not Drilled	-	-		No	-	-	-		-
P86-04	Diamond Drill	11V	6,988,958	503,188	285	Complete	14-Jul-17	Limestone		GPR	8.8	0.15	0.15		brown silty-sand, organic rich, minor fine to coarse gravel of mixed lithology
P86-05		-	-	-	-	Not Drilled	-	-		No		-	-		-
P86-06	Diamond Drill	11V	6,989,192	503,263	283	Complete	15-Jul-17	Limestone		GPR	8	2.0	2.0		Dominantly vuggy limestone, two iron rich granitic boulders (intact core 11-17cm), weathered limestone sands core loss
P86-07	-	-	-	-	-	Not Drilled	-	-	-	No	-	-	-	-	-
P98-01	6" Auger	11V	6,995,237	501,346	280	Refusal	20-Jul	Gravel	0.0-0.2;0.0-0.4	R and OhmMap	0.4	0.4			Gravel, Sand/Silt, Cobbles
P98-01d	Diamond Drill	11V	6,995,357	501,311	280	Complete	25-Jul	Granitoid	Corebox	R and OhmMap	6.5	6.3	6.3		Gravel, Sand, some silt, Cobbles
P98-02	-	-	-	-	-	Not Drilled	-	-	-	No	-	-	-	-	-

Table 1: TASR Geotechnical Investigation Program

Borehole/ Testpit ID	Method	Zone	Northing (m)	Easting (m)	Elevation (m)	Status	Date Completed	Dominate Rock or Soil Type	Sample Interval (m)	Geophysical Data Collected	Total Depth (m)	Overburden Thickness (m)	Depth to Rock (m)	Watertable (m)	Overburden Generalized Description (Note 1)
P98-04	-	-	-	-	-	Not Drilled	-	-	-	No	-	-	-	-	-
P98-05	-	-	-	-	-	Not Drilled	-	-	-	No	-	-	-	-	-
P98-06	-	-	-	-	-	Not Drilled	-	-	-	No	-	-	-	-	-
P98-07	6" Auger	11V	6,995,269	501,388	278	Refusal	20-Jul	Gravel	0.3-0.6	R and OhmMap	0.6	0.6			Gravel, trace Sand/Silt
P98-08	4" Auger	11V	6,995,229	501,292	274	Refusal	20-Jul	Gravel	0.2-0.3	R and OhmMap	0.3	0.3			Gravel, Silt, some sand, Cobbles
P98-09	-	-	-	-	-	Not Drilled	-	-	-	No	-	-	-	-	-
P98-10	-	-	-	-	-	Not Drilled	-	-	-	No	-	-	-	-	-
P98-11	4" Auger	11V	6,995,185	501,330	279	Refusal	20-Jul	Gravel		GPR and OhmMap	0.2	0.2			Silt, gravelly; Gravel, silty
P98-12	4" Auger	11V	6,995,311	501,313	274	Refusal	20-Jul	Gravel	0.1-0.3	R and OhmMap	0.3	0.3			Silt, gravelly; Gravel, silty, some sand
P98-13	Hand Dug	11V	6,995,427	501,301	282	Refusal	21-Jul	Gravel	0.1-0.5	R and OhmMap	0.2	0.2			Silt, gravelly, some sand
P105-01	Diamond Drill	11V	7,001,585	502,213	301	Complete	17-Jul-17	Granite		No	8.0	0	0		n/a
P105-02	Diamond Drill	11V	7,001,767	502,074	299	Complete	19-Jul-17	Granite		No	9.0	0	0		n/a
P116-01	Testpitting	11V	7,006,054	495,937	274	Complete	18-Jul-17	Sand	2.8-3.3	No	3.5	3.5			Sand; permafrost at 3.3 m
P116-02	Testpitting	11V	7,005,700	495,649	285	Complete	17-Jul-17	Sand	3.6-4.0	No	4.1	4.1		4	Sand; permafrost at 1.3 m
P116-03	Testpitting	11V	7,005,547	495,667	284	Complete	18-Jul-17	Sand	Tli Cho	No	4	4			Sand
P116-04	Testpitting	11V	7,005,403	495,673	284	Complete	18-Jul-17	Sand	-	No	4.3	4.3			Sand; permafrost at 1.8 m
P116-05	Testpitting	11V	7,005,056	495,877	281	Complete	18-Jul-17	Sand	3.0-3.5	No	3.5	3.5			Sand, gravelly; permafrost at 1.8 m
P116-06	Testpitting	11V	7,005,709	495,400	284	Complete	18-Jul-17	Sand	-	No	3.5	3.5			Sand; permafrost at 1.8 m
P116-07	Testpitting	11V	7,006,087	495,517	279	Complete	18-Jul-17	Sand	-	No	2.9	2.9			Sand; permafrost at 1.5 m
P116-08	Testpitting	11V	7,005,112	495,021	280	Complete	17-Jul-17	Sand	-	No	2.5	2.5			Sand; permafrost at 1.8 m
P116-09	Testpitting	11V	7,005,301	494,710	285	Complete	17-Jul-17	Sand	3.0-3.5	No	4.2	4.2			Sand, some gravel; permafrost at 2.1 m
P116-10	Testpitting	11V	7,005,157	494,519	285	Complete	17-Jul-17	Sand	3.0-3.5	No	4.2	4.2			Sand, some gravel; permafrost at 2.2 m
P116-11	Testpitting	11V	7,005,034	494,465	282	Complete	17-Jul-17	Sand	2.0-3.5;4.5-4.9	No	4.9	4.9			Sand, some gravel
P116-12	Testpitting	11V	7,005,233	494,607	285	Complete	17-Jul-17	Sand	2.4-2.8	No	3.3	3.3			Sand, some gravel; permafrost at 2.4 m
P116-13	Testpitting	11V	7,005,175	494,781	284	Complete	17-Jul-17	Sand	1.8-1.9	No	1.9	1.9			Sand; permafrost at 1.6 m
P116-14	Testpitting	11V	7,005,262	494,962	283	Complete	17-Jul-17	Sand	-	No	2.5	2.5			Sand, silty; permafrost at 1.6 m
P116-15	Testpitting	11V	7,005,705	495,524	285	Complete	17-Jul-17	Sand	1.0-1.1	No	2.5	2.5			Sand, some gravel; permafrost at 1.4 m
P116-16	Testpitting	11V	7,006,003	495,594	280	Complete	18-Jul-17	Sand	2.0-2.5;3.8-4.0	No	4	4			Sand; gravelly, permafrost at 1.6 m
P116-17	Testpitting	11V	7,005,868	495,666	281	Complete	18-Jul-17	Sand	0.6-0.8	No	1.8	1.8			Sand; permafrost at 1.6 m
P116-18	Testpitting	11V	7,005,314	495,830	282	Complete	18-Jul-17	Sand	3.6-3.8	No	3.8	3.8		3.4	Sand, silty
P116-19	Testpitting	11V	7,005,176	495,882	281	Complete	18-Jul-17	Sand		No	3.8	3.8		3.6	Sand; permafrost at 1.9 m
P116-20	Testpitting	11V	7,005,881	495,797	277	Complete	18-Jul-17	Sand		No	3.5	3.5		3.4	Sand; permafrost at 2.0 m
P116-21	Testpitting	11V	7,004,857	494,448	282	Complete	17-Jul-17	Sand	3.0-3.2	No	3.2	3.2			Sand; permafrost at 1.9 m
P116-22	Testpitting	11V	7,005,282	495,719	281	Complete	18-Jul-17	Sand		No	3.2	3.2			Sand; permafrost at 2.0 m

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Table 2:SOIL SAMPLE INVENTORY AND LABORATORY INDEX TESTING SUMMARY

BOREHOLE or TESTPIT NUMBER		SAMPLE NUMBER	SAMPLE INTERVAL TOP feet	TOP m	BOTTOM feet	BOTTOM m	RECOVERY (Tespit, auger or diamond drill)	SAMPLE TYPE (disturbed grab or rock core)	VISUAL SOIL DESCRIPTION	MOISTURE CONTENT (%)	PARTICLE SIZE DISTRIBUTION (%) Gravel	Sand	Silt	Clay	Fractured Face Count (%)	Flat and Elongation Particles (%)	Los Angeles Abrasion Loss (%)	Petrographic Analysis (weighted average petrographic number)
P1	02		6.6	2	7.9	2.4	excavated	grab	SAND AND GRAVEL, some silt	9.3	36	63	1					
P1	05		1.6	0.5	2.0	0.6	excavated	grab	SAND, trace silt	2.4	0	99	1					
P1	06		6.6	2	9.8	3	excavated	grab	SAND, trace silt, trace gravel	11.5	2	96	2					
P1	07		2.3	0.7	2.6	0.8	excavated	grab		2.2								
P1	08		1.6	0.5	2.0	0.6	excavated	grab		2.3								
P1	09		0.7	0.2	1.0	0.3	excavated	grab		3.7								
P1	10	1	0.7	0.2	1.0	0.3	excavated	grab	SAND, trace silt, trace gravel	3.1	1	97	2					
		2	3.0	0.9	3.3	1	excavated	grab	SAND, trace silt	2.4	0	100	0					
P1	11		3.3	1	3.6	1.1	excavated	grab		2.2								
P1	12		2.6	0.8	3.0	0.9	excavated	grab		3								
P1	13		1.6	0.5	2.0	0.6	excavated	grab		2.4								
P1	14		4.6	1.4	4.9	1.5	excavated	grab		3.1								
P1	15		1.6	0.5	2.0	0.6	excavated	grab		2.5								
P1	16		8.2	2.5	13.1	4	excavated	grab		3.2								
P1	17		3.9	1.2	6.6	2	excavated	grab		3.5								
P1	18		9.8	3	11.5	3.5	excavated	grab	SAND, trace gravel, trace silt	4.3	7	91	2					
P1	19		3.6	1.1	3.9	1.2	excavated	grab		2.6								
P1	20		2.3	0.7	2.6	0.8	excavated	grab										
P1	21		11.5	3.5	13.1	4	excavated	grab										
P13B	01		11.5	3.5	13.1	4	excavated	grab	SAND, some silt	11.8	0	89	11					
			15.7	4.8	16.4	5	excavated	grab		14.7								
P13B	02		9.8	3	11.2	3.4	excavated	grab		12.7								
P13B	03		8.2	2.5	11.5	3.5	excavated	grab		3.8								
P13B	04		8.2	2.5	11.5	3.5	excavated	grab		4.8								
P13B	05		8.2	2.5	9.8	3	excavated	grab		3.1								
P13B	06		2.6	0.8	3.3	1	excavated	grab	SAND	1.8	0	100	0					
P13B	07		3.0	0.9	3.6	1.1	excavated	grab	SAND, trace gravel, trace silt	2.3	1	98	1					
P13B	08		4.3	1.3	4.6	1.4	excavated	grab		13.4								
P13B	09		10.2	3.1	10.8	3.3	excavated	grab		19.1								
			12.1	3.7	12.8	3.9	excavated	grab	SILT/CLAY, some sand	18.7	0	19	81					
P13C	01		8.2	2.5	11.5	3.5	excavated	grab	SAND, trace silt	4.6	0	98	2					
P13C	02		9.8	3	13.1	4	excavated	grab		4.5								

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BOREHOLE or TESTPIT NUMBER		SAMPLE NUMBER	SAMPLE INTERVAL TOP feet	TOP m	BOTTOM feet	BOTTOM m	RECOVERY (Tespit, auger or diamond drill)	SAMPLE TYPE (disturbed grab or rock core)	VISUAL SOIL DESCRIPTION	MOISTURE CONTENT (%)	PARTICLE SIZE DISTRIBUTION (%) Gravel	Sand	Silt	Clay	Fractured Face Count (%)	Flat and Elongation Particles (%)	Los Angeles Abrasion Loss (%)	Petrographic Analysis (weighted average petrographic number)
P13C	03		0.7	0.2	1.0	0.3	excavated	grab	SAND, trace silt	5.2	0	99	1					
			1.3	0.4	1.6	0.5	excavated	grab		2.8								
			8.2	2.5	11.5	3.5	excavated	grab		5								
P13C	04		1.6	0.5	6.6	2	excavated	grab		3.6								
P13C	05		4.9	1.5	8.2	2.5	excavated	grab		4.2								
P13C	06		1.6	0.5	4.9	1.5	excavated	grab		2.5								
			12.5	3.8	12.8	3.9	excavated	grab										
P13C	07		3.9	1.2	4.3	1.3	excavated	grab		5.4								
P13C	08		1.3	0.4	1.6	0.5	excavated	grab	SAND	1.8	0	100	0					
			6.6	2	8.2	2.5	excavated	grab		6.7								
P13C	09		9.8	3	11.5	3.5	excavated	grab	SAND, trace silt	4.4	0	98	2					
P13D	01	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
P13D	02	1	0.0	0	1.6	0.5	BQTX	core								7.2	23	
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P13D	03		0.0	0	1.0	0.3	BQTX	core								10.9	22	
		1	1.0	0.3	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										

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SITE:
TASR Sites

BOREHOLE or TESTPIT NUMBER		SAMPLE NUMBER	SAMPLE INTERVAL TOP feet	TOP m	BOTTOM feet	BOTTOM m	RECOVERY (Tespit, auger or diamond drill)	SAMPLE TYPE (disturbed grab or rock core)	VISUAL SOIL DESCRIPTION	MOISTURE CONTENT (%)	PARTICLE SIZE DISTRIBUTION (%) Gravel	Sand	Silt	Clay	Fractured Face Count (%)	Flat and Elongation Particles (%)	Los Angeles Abrasion Loss (%)	Petrographic Analysis (weighted average petrographic number)
P13D	04	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P13D	05	1	0.0	0.0	1.6	0.5	BQTX	core								11.9	22	111
		2	1.6	0.5	6.6	2.0	BQTX	core										
		3	6.6	2.0	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5.0	BQTX	core										
		5	16.4	5.0	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8.0	BQTX	core										
		7	26.2	8.0	31.2	9.5	BQTX	core										
P13D	01			2		2.4	excavated	grab		14.1								
P29	01	1	0.0	0.0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2.0	BQTX	core										
		3	6.6	2.0	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5.0	BQTX	core										
		5	16.4	5.0	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8.0	BQTX	core										
		7	26.2	8.0	31.2	9.5	BQTX	core										
P29	03	1	0.0	0	1.6	0.5	BQTX	core								6.9	24	
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										

Table 2:SOIL SAMPLE INVENTORY AND LABORATORY INDEX TESTING SUMMARY

SITE: **TASR Sites**

BOREHOLE or TESTPIT NUMBER		SAMPLE NUMBER	SAMPLE INTERVAL TOP feet	TOP m	BOTTOM feet	BOTTOM m	RECOVERY (Tespit, auger or diamond drill)	SAMPLE TYPE (disturbed grab or rock core)	VISUAL SOIL DESCRIPTION	MOISTURE CONTENT (%)	PARTICLE SIZE DISTRIBUTION (%) Gravel	Sand	Silt	Clay	Fractured Face Count (%)	Flat and Elongation Particles (%)	Los Angeles Abrasion Loss (%)	Petrographic Analysis (weighted average petrographic number)
P29	04	1	0.0	0	1.6	0.5	BQTX	core								4.7	22	117
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P29	05	1	0.0	0.0	1.6	0.5	BQTX	core								7.7	25	
		2	1.6	0.5	6.6	2.0	BQTX	core										
		3	6.6	2.0	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5.0	BQTX	core										
		5	16.4	5.0	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8.0	BQTX	core										
		7	26.2	8.0	31.2	9.5	BQTX	core										
P29	06	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
P29	07	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	23.6	7.2	BQTX	core										
		7	23.6	7.2	28.5	8.7	BQTX	core										
		8	28.5	8.7	31.2	9.5	BQTX	core										
P29	08	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	14.1	4.3	BQTX	core										

Table 2:SOIL SAMPLE INVENTORY AND LABORATORY INDEX TESTING SUMMARY

SITE:
TASR Sites

BOREHOLE or TESTPIT NUMBER		SAMPLE NUMBER	SAMPLE INTERVAL TOP		SAMPLE INTERVAL BOTTOM		RECOVERY (Tespit, auger or diamond drill)	SAMPLE TYPE (disturbed grab or rock core)	VISUAL SOIL DESCRIPTION	MOISTURE CONTENT (%)	PARTICLE SIZE DISTRIBUTION (%)				Fractured Face Count (%)	Flat and Elongation Particles (%)	Los Angeles Abrasion Loss (%)	Petrographic Analysis (weighted average petrographic number)
			feet	m	feet	m					Gravel	Sand	Silt	Clay				
P33A	01	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	3.3	1	BQTX	core										
		2	3.3	1	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	12.1	3.7	BQTX	core										
		4	12.1	3.7	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P33A	02	1	0.0	0	1.6	0.5	BQTX	core								12.3	25	143
		2	1.6	0.5	2.3	0.7	BQTX	core										
		2	2.3	0.7	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P33A	03	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P33A	04	1	0.0	0	1.6	0.5	BQTX	core								13.0	23	
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	9.3	2.82	BQTX	core										
		4	9.3	2.82	11.5	3.5	BQTX	core										
		5	11.5	3.5	16.4	5	BQTX	core										
		6	16.4	5	21.3	6.5	BQTX	core										
		7	21.3	6.5	26.2	8	BQTX	core										
		8	26.2	8	31.2	9.5	BQTX	core										

SITE: **TASR Sites**

Table 2:SOIL SAMPLE INVENTORY AND LABORATORY INDEX TESTING SUMMARY

BOREHOLE or TESTPIT NUMBER		SAMPLE NUMBER	SAMPLE INTERVAL TOP feet	TOP m	BOTTOM feet	BOTTOM m	RECOVERY (Tespit, auger or diamond drill)	SAMPLE TYPE (disturbed grab or rock core)	VISUAL SOIL DESCRIPTION	MOISTURE CONTENT (%)	PARTICLE SIZE DISTRIBUTION (%) Gravel	Sand	Silt	Clay	Fractured Face Count (%)	Flat and Elongation Particles (%)	Los Angeles Abrasion Loss (%)	Petrographic Analysis (weighted average petrographic number)
P33A	05	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	11.8	3.6	BQTX	core										
		4	11.8	3.6	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	23.2	7.07	BQTX	core										
		6	23.2	7.07	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P33A	06	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	24.8	7.57	BQTX	core										
		6	24.8	7.57	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P33A	07	1	0.0	0	1.6	0.5	BQTX	core								6.1	30	148
		2	1.6	0.5	4.4	1.33	BQTX	core										
		2	4.4	1.33	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P33A	08	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	24.3	7.42	BQTX	core										
		6	24.3	7.42	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										

SITE: **TASR Sites**

Table 2:SOIL SAMPLE INVENTORY AND LABORATORY INDEX TESTING SUMMARY

BOREHOLE or TESTPIT NUMBER		SAMPLE NUMBER	SAMPLE INTERVAL TOP feet	TOP m	BOTTOM feet	BOTTOM m	RECOVERY (Tespit, auger or diamond drill)	SAMPLE TYPE (disturbed grab or rock core)	VISUAL SOIL DESCRIPTION	MOISTURE CONTENT (%)	PARTICLE SIZE DISTRIBUTION (%) Gravel	Sand	Silt	Clay	Fractured Face Count (%)	Flat and Elongation Particles (%)	Los Angeles Abrasion Loss (%)	Petrographic Analysis (weighted average petrographic number)
P33A	10	1	0.0	0	1.1	0.35	BQTX	core								5.8	27	
		1	1.1	0.35	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P69	05	1	23.6	7.2	26.2	8	BQTX	core										
		2	26.2	8	31.2	9.5	BQTX	core										
		3	31.2	9.5	36.1	11	BQTX	core										
P69	03		0.3	0.1	0.7	0.2	auger	grab	GRAVEL, trace silt, trace sand	0.9	94	2	4					
P69	04		0.0	0	0.7	0.2	auger	grab	GRAVEL, some sand, trace silt	2.3	81	11	8					
P69	05		0.0	0	1.0	0.3	auger	grab	GRAVEL, trace sand, trace silt	2.7	85	7	8					
P76	03	1	38.9	11.85	41.0	12.5	BQTX	core										
		2	41.0	12.5	45.9	14	BQTX	core										
		3	45.9	14	50.9	15.5	BQTX	core										
		4	50.9	15.5	55.8	17	BQTX	core										
		5	55.8	17	60.7	18.5	BQTX	core										
P76	04		0.3	0.1	1.3	0.4	auger	grab	SAND AND SILT	8.1	0	57	43					
P76	05		1.0	0.3	2.0	0.6	auger	grab	SILT, sandy	13.4	0	23	77					
			6.6	2	8.2	2.5	auger	grab	SILT, some clay, trace sand	14.6	0	9	75	16				
P76	06		0.0	0	2.0	0.6	auger	grab										
			2.0	0.6	3.3	1	auger	grab	SILT, sandy, some clay trace gravel	8	9	32	49	10				
P76	07		0.3	0.1	1.3	0.4	auger	grab	SAND, some silt, trace gravel	4.4	1	86	13					
			3.3	1	3.6	1.1	auger	grab		8.6								
			4.6	1.4	4.9	1.5	auger	grab	SILT, sandy, trace gravel	14.4	1	25	74					
P76	08		0.0	0	0.7	0.2	auger	grab	SILT, some sand, trace gravel	12.9	1	20	79					
P76	09		0.3	0.1	1.6	0.5	auger	grab		14.7								
P76	07		0.7	0.2	2.3	0.7	excavated	grab										

SITE:

TASR Sites

Table 2: SOIL SAMPLE INVENTORY AND LABORATORY INDEX TESTING SUMMARY

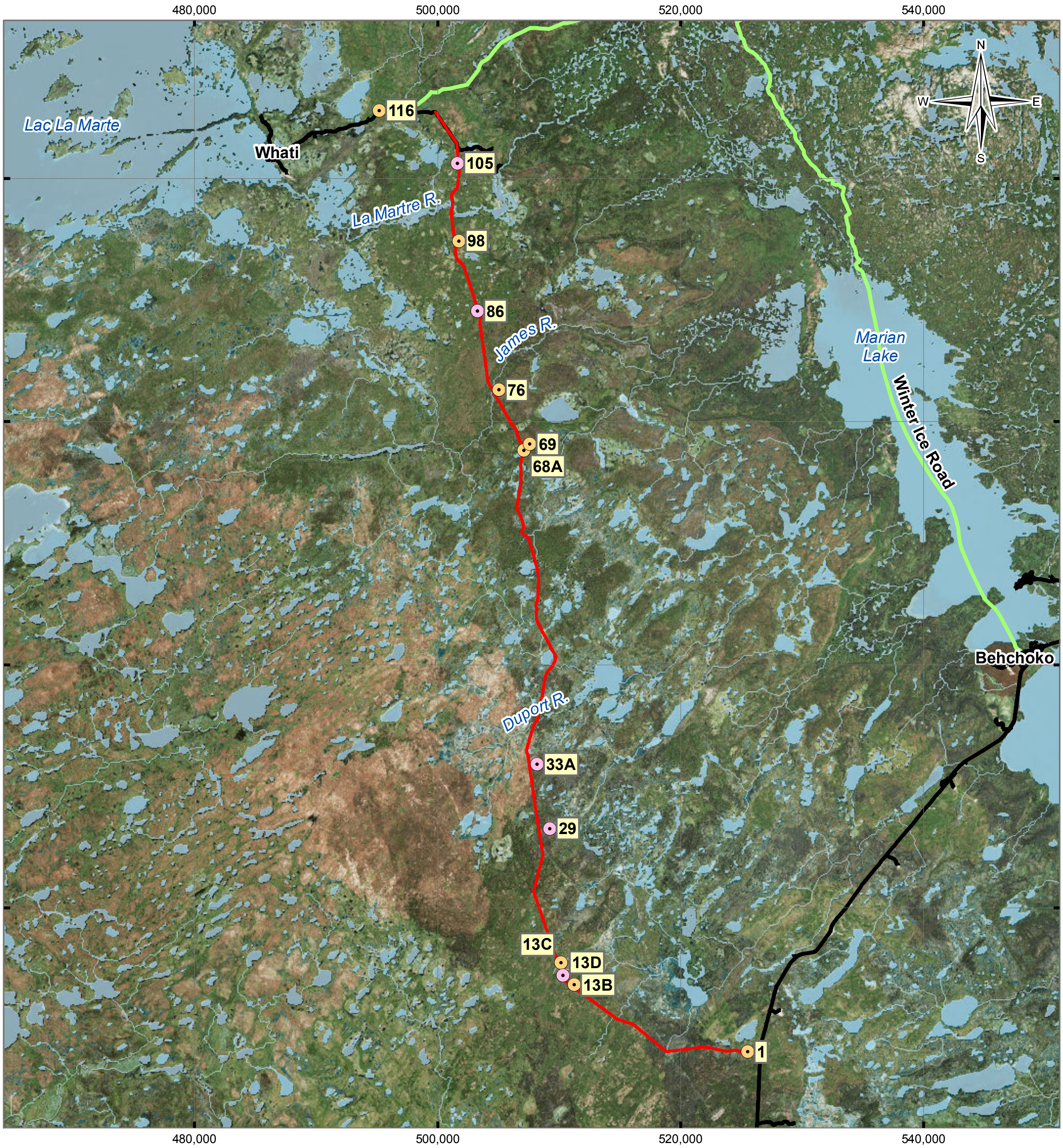
BOREHOLE or TESTPIT NUMBER		SAMPLE NUMBER	SAMPLE INTERVAL				RECOVERY (Tespit, auger or diamond drill)	SAMPLE TYPE (disturbed grab or rock core)	VISUAL SOIL DESCRIPTION	MOISTURE CONTENT (%)	PARTICLE SIZE DISTRIBUTION (%)				Fractured Face Count (%)	Flat and Elongation Particles (%)	Los Angeles Abrasion Loss (%)	Petrographic Analysis (weighted average petrographic number)
			TOP		BOTTOM						Gravel	Sand	Silt	Clay				
			feet	m	feet	m												
P86	01A	1	0.0	0	1.6	0.5	BQTX	core								5.7	20	131
		2	1.6	0.5	6.6	2	BQTX	core										combined sample
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
P86	01B	1	0.0	0	1.6	0.5	BQTX	core										
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
P86	02	1	0.0	0	1.6	0.5	BQTX	core								5.7	20	
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	31.2	9.5	BQTX	core										
P86	04	1	0.0	0	1.6	0.5	BQTX	core								4.1	18	106
		2	1.6	0.5	6.6	2	BQTX	core										combined sample
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	18.1	5.52	BQTX	core								7.6	19	
		5	18.1	5.52	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		7	26.2	8	28.9	8.8	BQTX	core										
P86	06	1	0.0	0	1.6	0.5	BQTX	core								4.1	18	
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core								7.6	19	
		6	21.3	6.5	26.2	8	BQTX	core										
P98	01		0.0	0	1.3	0.4	auger	grab	GRAVEL, some sand, some silt	4.4	71	16	13					
P98	07		1.0	0.3	2.0	0.6	auger	grab	GRAVEL, trace silt, trace sand	1.3	87	5	8					
P98	08		0.7	0.2	1.0	0.3	auger	grab		3.1								
P98	12		0.3	0.1	1.0	0.3	auger	grab		0.8								

Table 2:SOIL SAMPLE INVENTORY AND LABORATORY INDEX TESTING SUMMARY

SITE: **TASR Sites**

BOREHOLE or TESTPIT NUMBER		SAMPLE NUMBER	SAMPLE INTERVAL TOP feet	TOP m	BOTTOM feet	BOTTOM m	RECOVERY (Tespit, auger or diamond drill)	SAMPLE TYPE (disturbed grab or rock core)	VISUAL SOIL DESCRIPTION	MOISTURE CONTENT (%)	PARTICLE SIZE DISTRIBUTION (%) Gravel	Sand	Silt	Clay	Fractured Face Count (%)	Flat and Elongation Particles (%)	Los Angeles Abrasion Loss (%)	Petrographic Analysis (weighted average petrographic number)
P98	13		0.3	0.1	1.6	0.5	excavated	grab										
P105	01	1	0.0	0	1.6	0.5	BQTX	core								12.1	17	101
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8												
P105	02	1	0.0	0	1.6	0.5	BQTX	core								10.3	17	101
		2	1.6	0.5	6.6	2	BQTX	core										
		3	6.6	2	11.5	3.5	BQTX	core										
		4	11.5	3.5	16.4	5	BQTX	core										
		5	16.4	5	21.3	6.5	BQTX	core										
		6	21.3	6.5	26.2	8	BQTX	core										
		5	26.2	8	29.5	9	BQTX	core										
P116	1			2.8		3.3	excavated	grab	GRAVEL and SAND, trace silt	4.5	58	41	1					
P116	2			3.6		4	excavated	grab	SAND, some silt	22		80	20					
P116	3			0		4	existing pit	grab										164
P116	4			0		4	existing pit	grab										
P116	5			3		3.5	excavated	grab	SAND and GRAVEL, trace silt	4.7	46	52	2					
P116	10		9.8	3	11.5	3.5	excavated	grab	SAND, silty, trace gravel	9.1	3	66	31					
P116	11	1	6.6	2	8.2	2.5	excavated	grab		9.2								
		2	14.8	4.5	16.1	4.9	excavated	grab		7.8								
P116	12		7.9	2.4	9.2	2.8	excavated	grab	GRAVEL and SAND, trace silt	4	55	44	1					
P116	13		5.9	1.8	6.2	1.9	excavated	grab		26.3								
P116	15		3.3	1	3.6	1.1	excavated	grab	SAND and GRAVEL, trace silt	8	46	48	6					
P116	16	1	6.6	2	8.2	2.5	excavated	grab		8.1								
		2	12.5	3.8	13.1	4	excavated	grab		14								
P116	17		2.0	0.6	2.6	0.8	excavated	grab	GRAVEL, sandy, trace silt	3.8	71	26	3					
P116	18		11.8	3.6	12.5	3.8	excavated	grab		26.8								
P116	21		9.8	3	10.5	3.2	excavated	grab		16.5								

FIGURES



Q:\Vancouver\GIS\ENGINEERING\YARC\YARC03107-01\Maps\YARC03107-01_Figure01_Overview.mxd modified 9/22/2017 by morgan.zondervan

LEGEND

- Proposed TASR Alignment
- Existing All Season Road
- Existing Winter Road

Material Prospect

- Bedrock Prospect
- Granular Prospect
- Watercourse
- Waterbody

NOTES
Base data source:
CanVec; ESRI Basemap Imagery

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Proposed Tlicho All Season Road Material Prospects

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:475,000
10 5 0 10
Kilometres

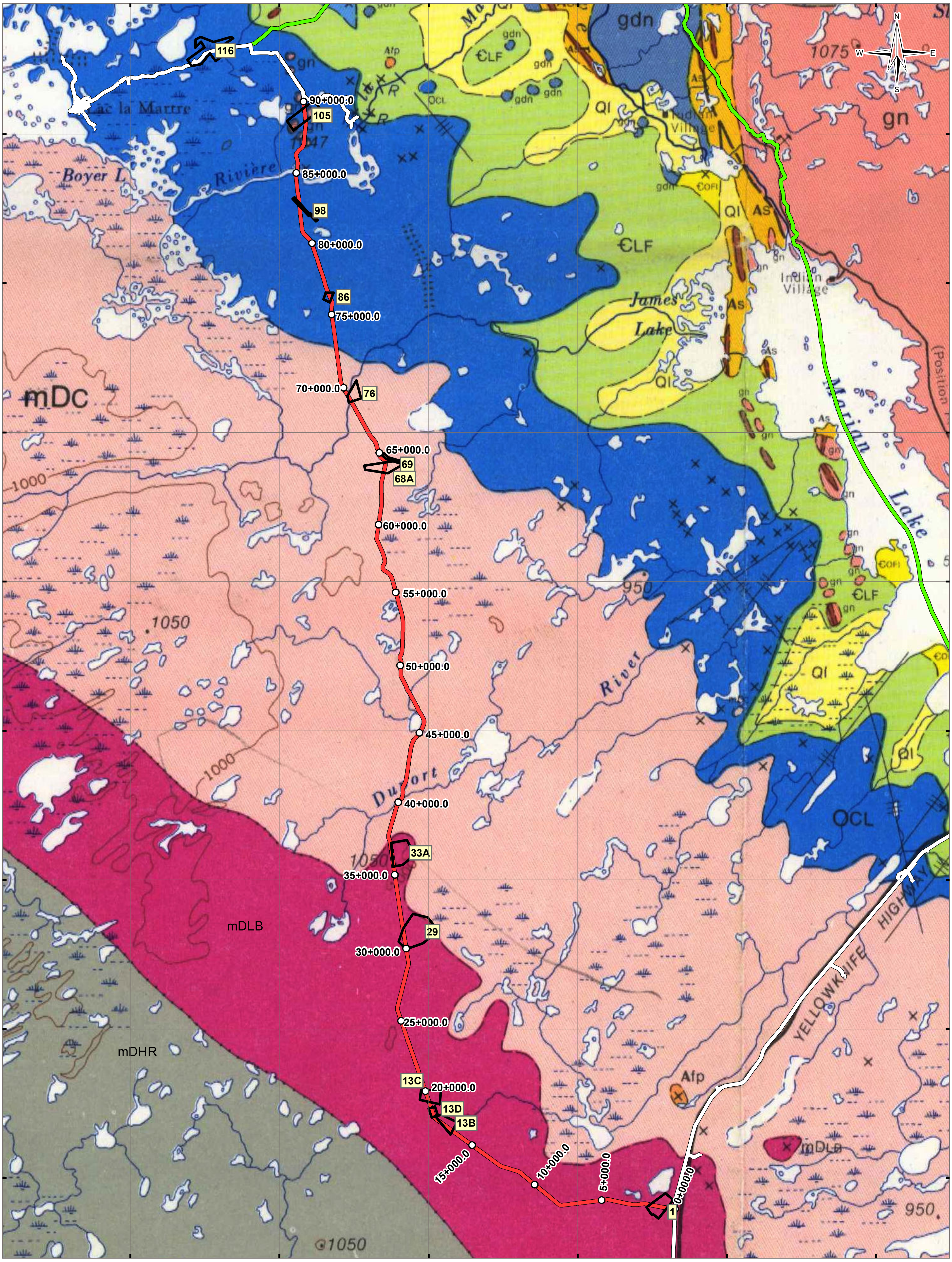
FILE NO.
YARC03107-01_Figure01_Overview.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE	PROJECT NO.
September 22, 2017	ENG.YARC03107-01

Figure 1



LEGEND

Proposed TSAR Alignment
Existing All Season Road
Existing Winter Road
Prospect

Formation Name

- Ql — Glacial Lacustrine Deposits
- mDHR — Horn River Formation
- mDLB — Lonely Bay Formation
- mDC — Chinchaga Formation
- OCL — Chedabucto Lake Formation
- ϾLF — La Martre Falls Formation
- AS — Snare Group
- gdn — Granodioritic Gneiss
- gn — Undifferentiated Granitic Rocks

NOTES
Base data source:
Geological Survey of Canada
Map 1372A Geology Horn River
District of Mackenzie (1974)

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Bedrock Geology

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:250,000
4 2 0 4
Kilometres

FILE NO.
YARC03107-01_Figure02_BedrockGeol.mxd

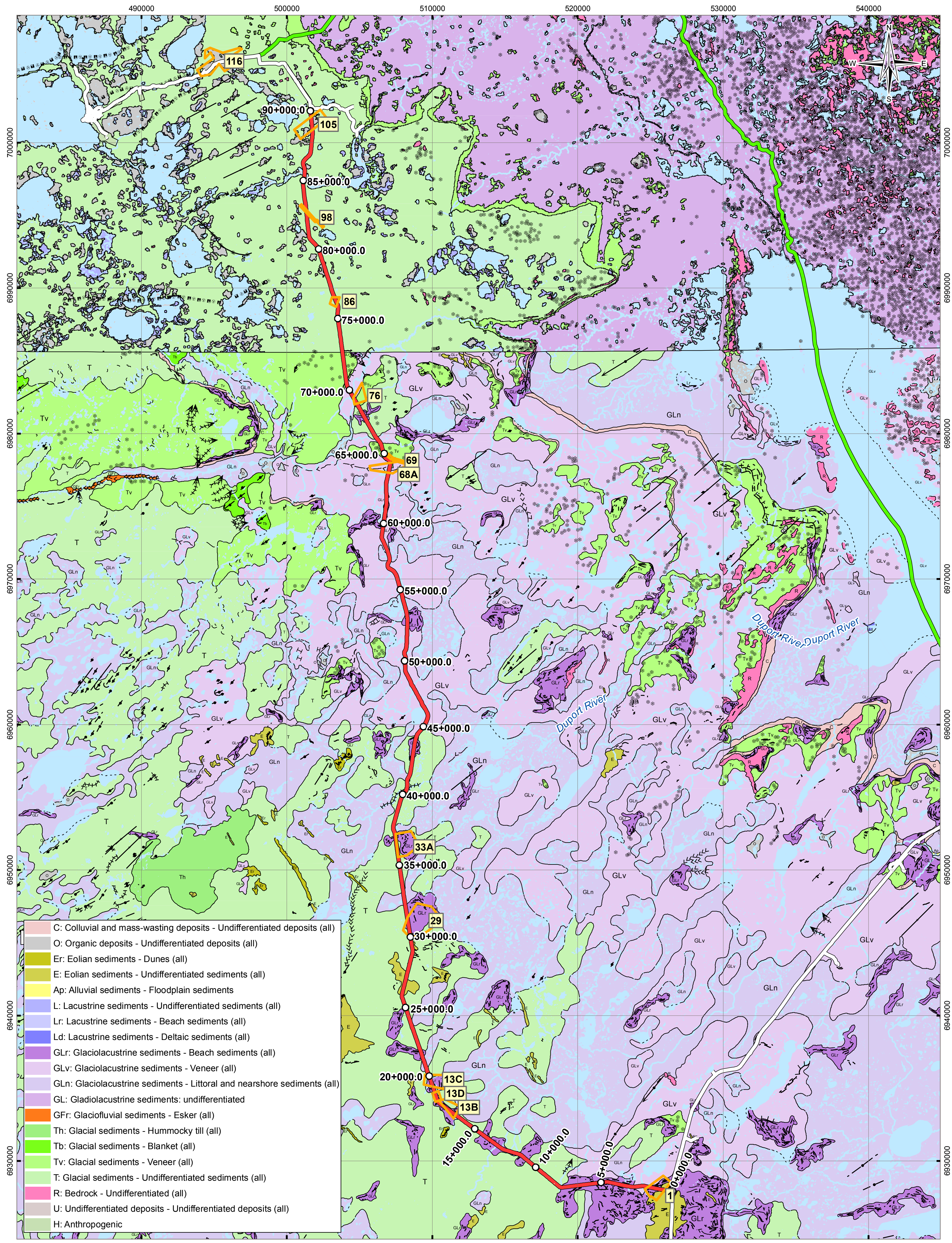
TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	SMC	0

DATE	PROJECT NO.
September 12, 2017	ENG.YARC03107-01

Figure 2

Q:\Vancouver\GIS\ENGINEERING\YARC\YARC03107-01\Maps\YARC03107-01_Figure03_SurfGeo.mxd modified 9/12/2017 by morgan.zondervan



LEGEND

- Prospect
- Proposed TSAR Alignment
- Existing All Season
- Existing Winter Road
- Small outcrop (all)
- Beach crest (all)
- Buried drumlin ridge (all)
- Buried drumlinoid ridge (all)
- Crag-and-tail ridge (all)
- Drumlin ridge (all)
- Drumlinoid ridge (all)
- Dune crest (all)
- Esker ridge (direction known or inferred)
- Esker ridge (direction unknown or unspecified)
- Esker ridge (with beach ridges/strandlines; direction known or inferred)
- Fluted bedrock or drift, central long axis (well defined or unspecified; direction known)
- Iceberg scour central axis (all)
- Minor meltwater channel central axis (lateral, marginal, overflow, subglacial, supraglacial or unspecified; direction unknown or unspecified)
- Minor meltwater channel central axis (marginal, overflow, subglacial, supraglacial or unspecified; direction known)
- Other moraine ridge (minor)
- Terrace scarp (all)
- Major moraine ridge (end, interlobate, or unspecified)
- Geological boundary (confidence concealed)
- Geological boundary (confidence defined)
- Geological boundary coincident with other line feature (confidence concealed)
- Watercourse
- Waterbody

NOTES
Base data source:
Kerr, D.E., Morse, P.D., and Wolfe, S.A., 2016. Reconnaissance surficial geology, Rae, Northwest Territories, NTS 85-K; GSC, Canadian Geoscience Map 290 (preliminary), scale 1:125 000. Doi:10.4095/298838
Ednie, M., Kerr, D.E., Olthof, I., Wolfe, S.A., and Eagles, S., 2014. Predictive surficial geology derived from LANDSAT 7, Marian River, NTS 85-N, Northwest Territories; GSC, Open File 7543. Doi:10.4095/294923

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Surficial Geology

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:250,000
4 2 0 4
Kilometres

TETRA TECH

FILE NO.				
YARC03107-01_Figure03_SurfGeo.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	SMC	0
DATE	PROJECT NO.			
September 12, 2017	ENG.YARC03107-01			

Figure 3

LEGEND

- Testpit
- Proposed TASR Alignment
- Existing All Season Road
- Clearing Line to Testpit (5 m)
- 2 km Swath
- Archaeological Site Buffer
- Granular Prospect

Potential Aggregate Source

- Overburden (Beaches)
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Watercourse
- Wetland

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 1 Testpit Locations

PROJECTION UTM Zone 11
DATUM NAD83
CLIENT Northwest Territories

Scale: 1:10,000
200 100 0 200
Metres

TETRA TECH

FILE NO.
YARC03107-01_Figure04_P1AsBuilt.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE September 27, 2017
PROJECT NO. ENG.YARC03107-01

Figure 4

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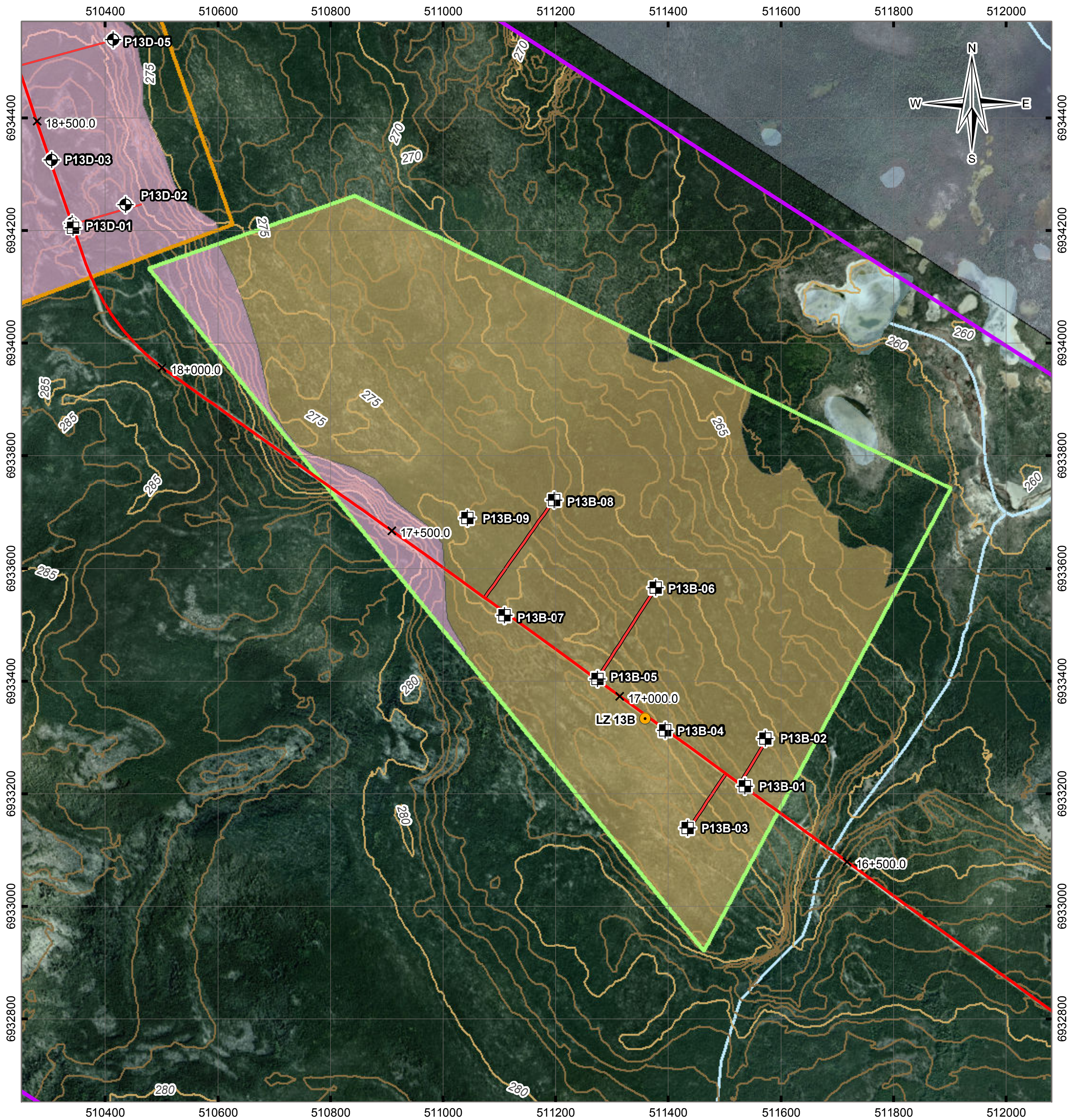

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LEGEND

- Borehole
- Testpit
- Landing Zone
- Proposed TASR Alignment
- Clearing Line to Testpit (5 m)
- Clearing Line to Borehole (3 m)
- 2 km Swath
- Bedrock Prospect
- Granular Prospect

Potential Aggregate Source

- Overburden (Beaches)
- Bedrock
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Watercourse

NOTES

Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 13B Testpit Locations

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:10,000
200 100 0 200
Metres

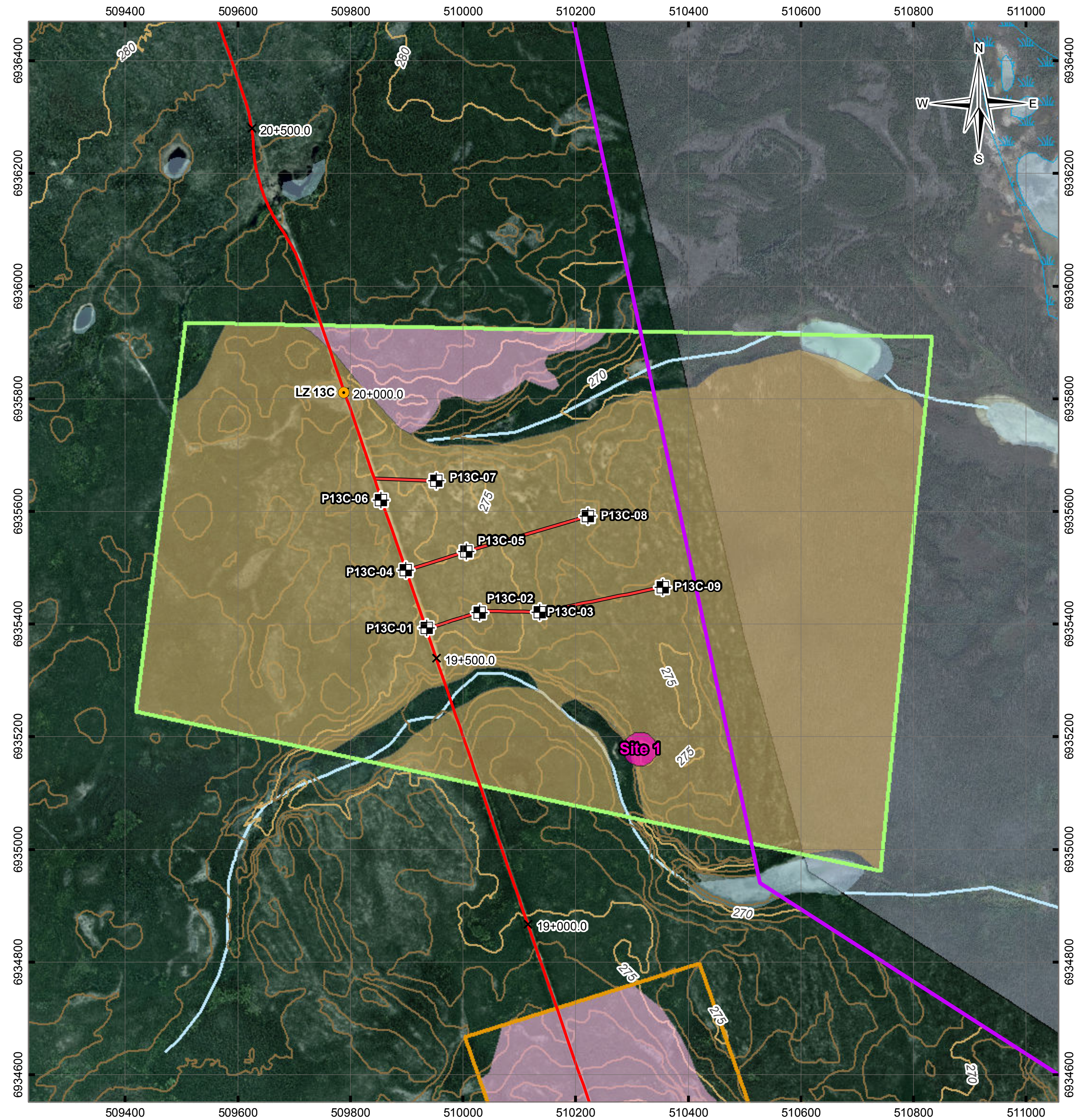
FILE NO.
YARC03107-01_Figure05_P13BAsBuilt.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE	PROJECT NO.
September 27, 2017	ENG.YARC03107-01

Figure 5



LEGEND

- Testpit
- Landing Zone
- Proposed TASR Alignment
- Clearing Line to Testpit (5 m)
- 2 km Swath
- Archaeological Site Buffer
- Bedrock Prospect
- Granular Prospect

Potential Aggregate Source

- Overburden (Beaches)
- Bedrock
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Watercourse
- Wetland

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 13C Testpit Locations

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:10,000
200 100 0 200
Metres

TETRA TECH

FILE NO.
YARC03107-01_Figure06_P13CAsBuilt.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE	PROJECT NO.
September 27, 2017	ENG.YARC03107-01

Figure 6

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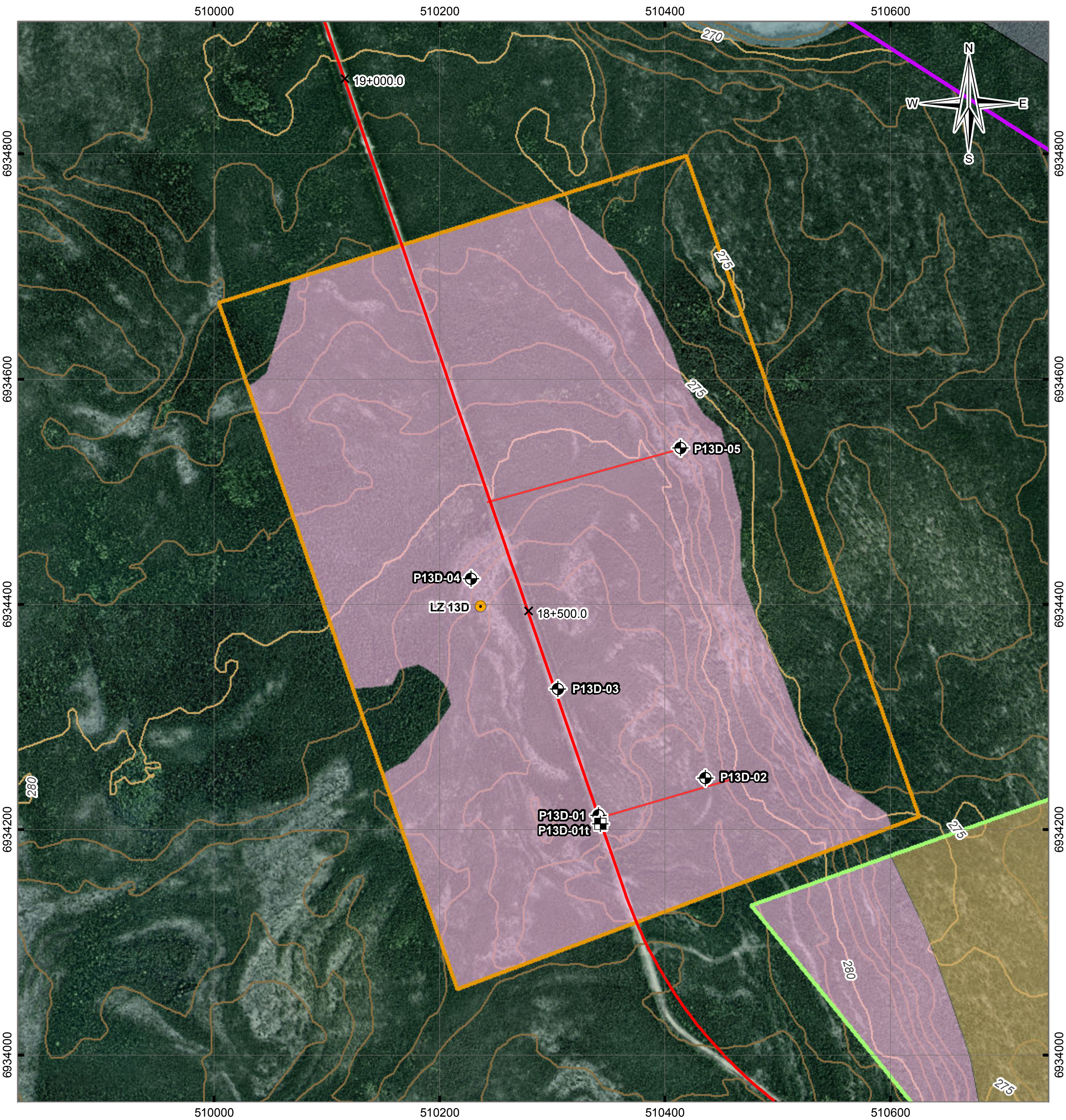

LEGEND

- Borehole
- Testpit
- Landing Zone
- Proposed TASR Alignment
- Clearing Line to Borehole (3 m)
- 2 km Swath
- Bedrock Prospect
- Granular Prospect

Potential Aggregate Source

- Overburden (Beaches)
- Bedrock (Limestone)
- Index Contour (5 m)
- Intermediate Contour (1 m)

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 13D Borehole Locations

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:5,000
100 50 0 100
Metres

TETRA TECH

FILE NO.
YARC03107-01_Figure07_P13DAsBuilt.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE	PROJECT NO.
September 27, 2017	ENG.YARC03107-01

Figure 7

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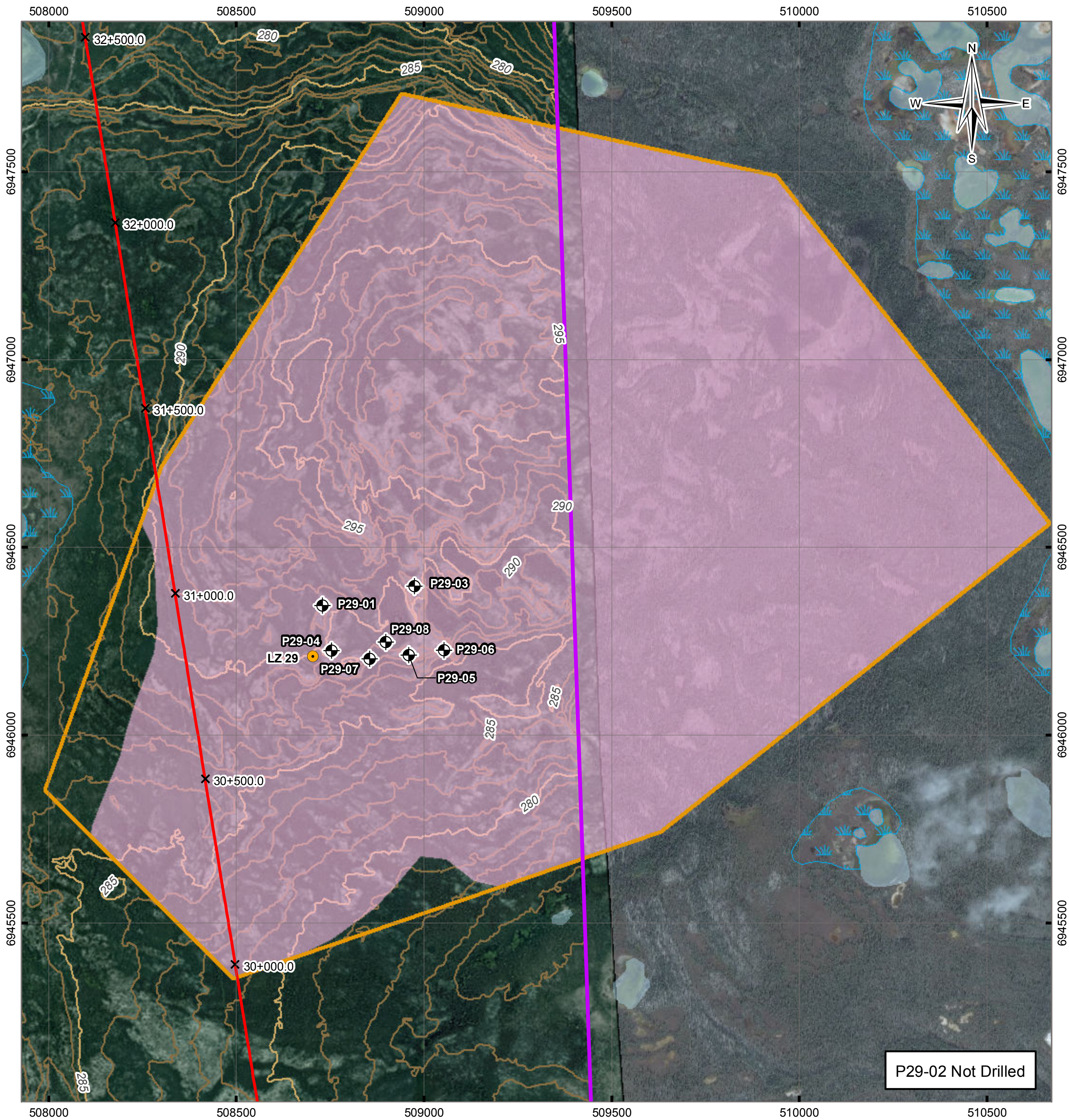

LEGEND

- Borehole
- Landing Zone
- Proposed TASR Alignment
- 2 km Swath
- Bedrock Prospect

Potential Aggregate Source

- Bedrock (Limestone)
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Wetland

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 29 Borehole Locations

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:15,000
200 100 0 200
Metres

FILE NO.
YARC03107-01_Figure08_P29AsBuilt.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE	PROJECT NO.
September 27, 2017	ENG.YARC03107-01

Figure 8

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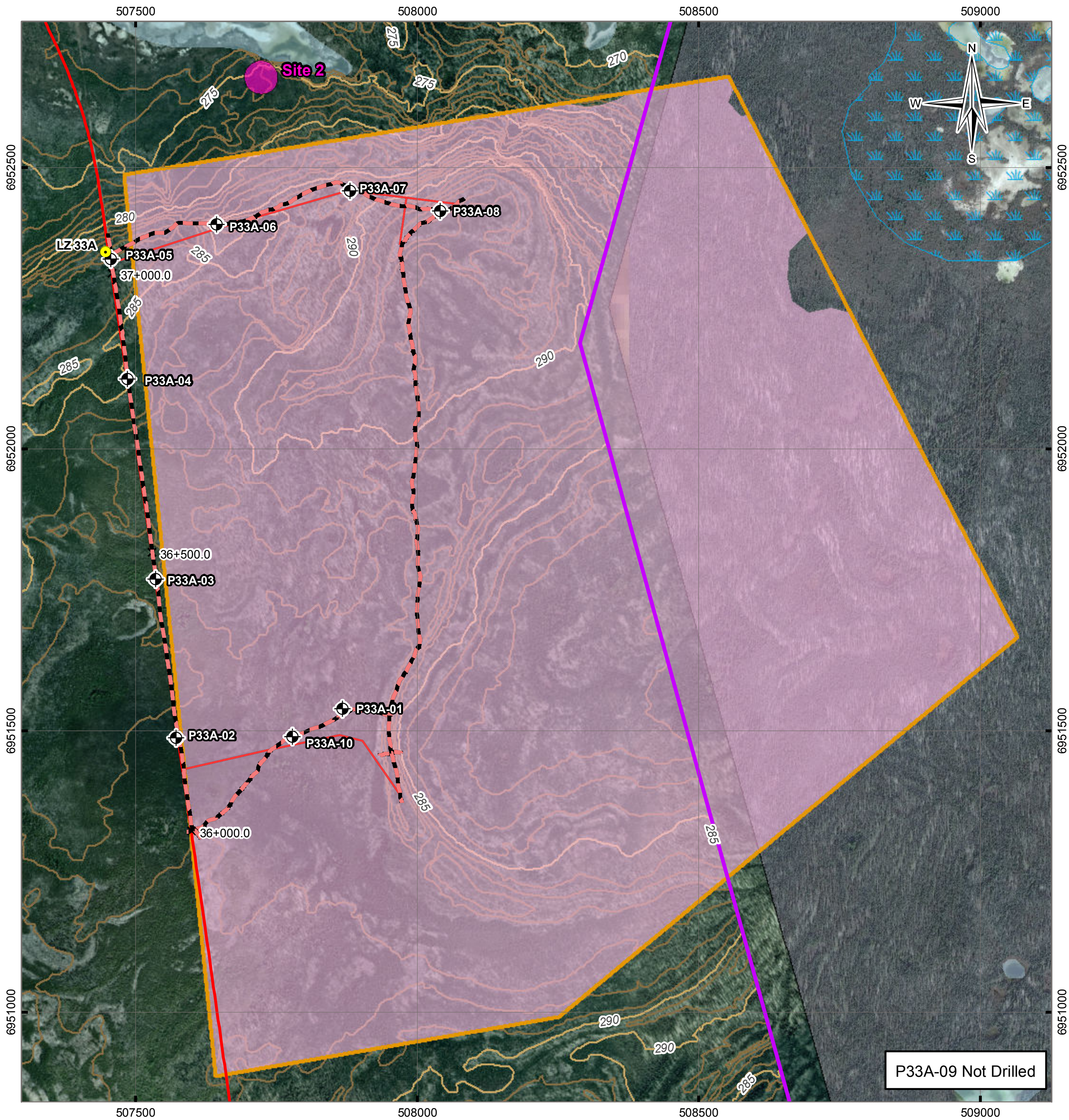

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LEGEND

- Borehole
- Landing Zone with Fuel Cache
- Proposed TASR Alignment
- Ground Penetrating Radar Line/Clearing Line for Geophysical Work (1.5 m)
- Clearing Line to Borehole (3 m)
- 2 km Swath
- Archaeological Site Buffer
- Bedrock Prospect

Potential Aggregate Source

- Bedrock (Limestone, mixed lithology)
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Wetland

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 33A Borehole Locations

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:10,000
200 100 0 200
Metres

FILE NO.
YARC03107-01_Figure09_P33AAsBuilt.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE	PROJECT NO.
September 27, 2017	ENG.YARC03107-01

Figure 9

LEGEND

- Borehole
- Hand Dug Testpit
- Landing Zone
- Landing Zone with Fuel Cache
- Proposed TASR Alignment
- Ground Penetrating Radar Line/ Clearing Line for Geophycial Work (1.5 m)
- Clearing Line to Borehole (3 m)
- 2 km Swath
- Archaeological Site Buffer
- Granular Prospect

Potential Aggregate Source

- Overburden (Esker and Ground Moraine)
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Watercourse
- Wetland

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 68A and 69 Borehole and Testpit Locations

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:20,000
400 200 0 400
Metres

FILE NO.
YARC03107-01_Figure10_P68A_69AsBuilt.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE	PROJECT NO.
September 27, 2017	ENG.YARC03107-01

Figure 10

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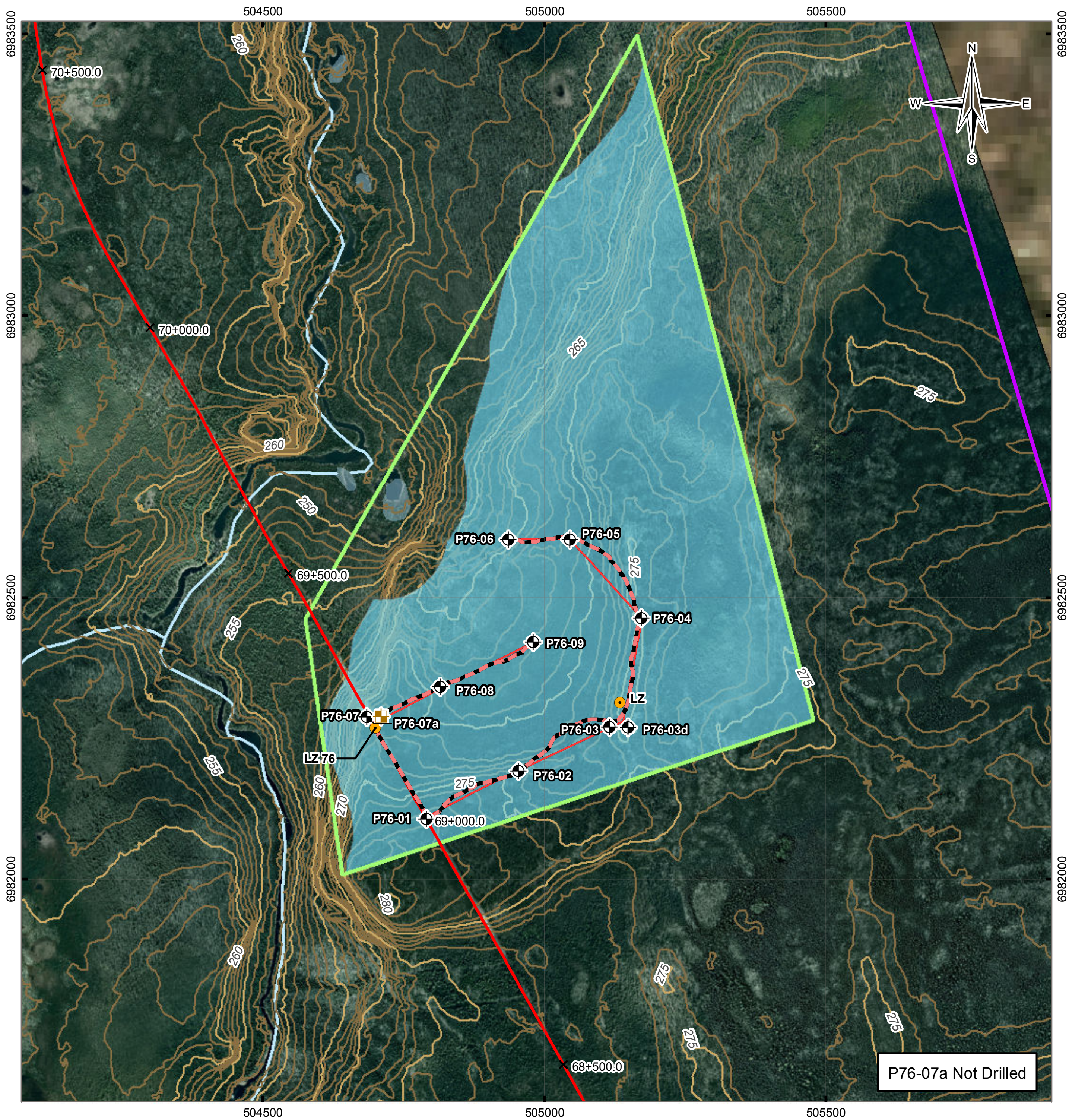

LEGEND

- Borehole
- Hand Dug Testpit
- Landing Zone
- Proposed TASR Alignment
- Ground Penetrating Radar Line/ Clearing Line for Geophycial Work (1.5 m)
- Clearing Line to Borehole (3 m)
- 2 km Swath
- Granular Prospect

Potential Aggregate Source

- Overburden (Ice-Contact)
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Watercourse

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 76 Borehole and Testpit Locations

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:10,000
200 100 0 200
Metres

FILE NO.
YARC03107-01_Figure11_P76AsBuilt.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE	PROJECT NO.
September 27, 2017	ENG.YARC03107-01

Figure 11

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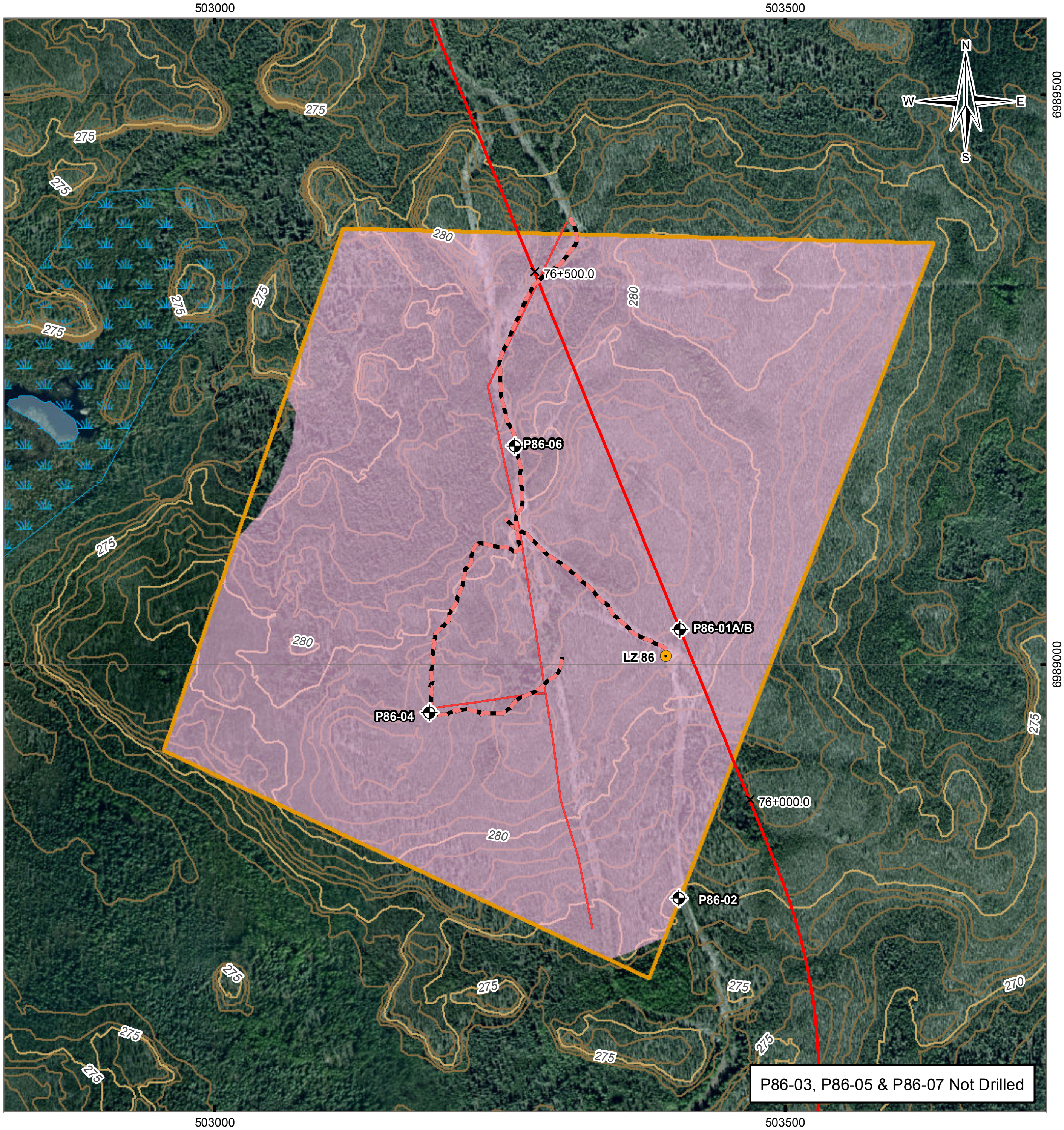

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LEGEND

- Borehole
- Landing Zone
- Proposed TASR
- Ground Penetrating Radar Line/ Clearing Line for Geophycial Work (1.5 m)
- Clearing Line to Borehole (3 m)
- 2 km Swath
- Bedrock Prospect

Potential Aggregate Source

- Bedrock (Limestone)
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Wetland

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 86 Borehole Locations

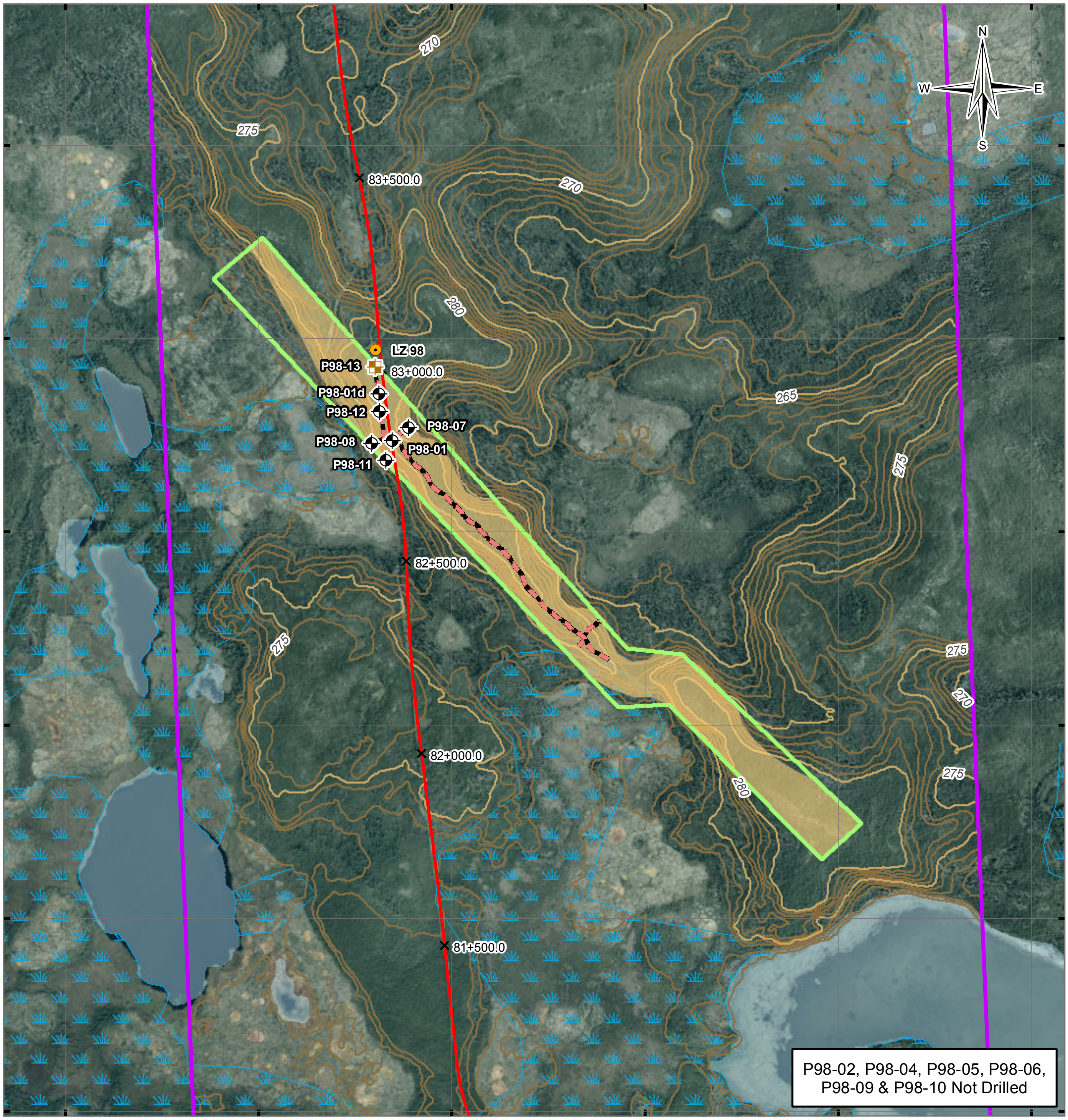
PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:5,000
100 50 0 100
Metres

TETRA TECH

FILE NO.				
YARC03107-01_Figure12_P86AsBuilt.mxd				
OFFICE	**DWN**	**CKD**	**APVD**	**REV**
Tt-VANC	MEZ	SL	EG	0
DATE	**PROJECT NO.**			
September 27, 2017	ENG.YARC03107-01			

Figure 12



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LEGEND

- Borehole
- Hand Dug Testpit
- Landing Zone
- Proposed TASR Alignment
- Ground Penetrating Radar Line/ Clearing Line for Geophycial Work (1.5 m)
- 2 km Swath
- Granular Prospect

Potential Aggregate Source

- Overburden (Esker)
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Wetland

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 98 Borehole and Testpit Locations

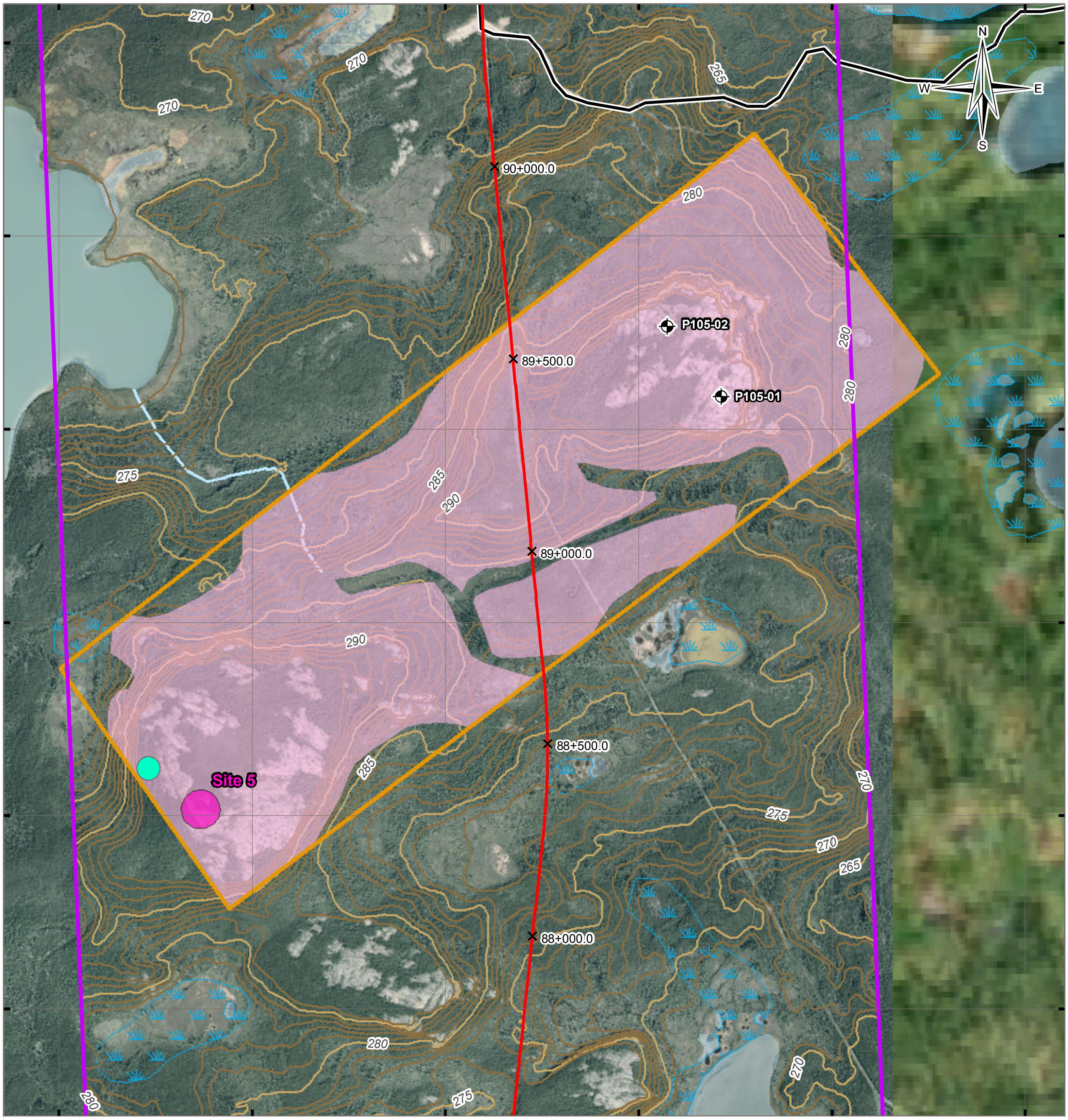
PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:15,000
200 100 0 200
Metres

TETRA TECH

FILE NO.				
YARC03107-01_Figure13_P98AsBuilt.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0
DATE	PROJECT NO.			
September 27, 2017	ENG.YARC03107-01			

Figure 13



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LEGEND

- Borehole
- Proposed TASR Alignment
- Existing All Season Road
- 2 km Swath
- Cabin (30 m Setback)
- Archaeological Site Buffer
- Bedrock Prospect

Potential Aggregate Source

- Bedrock (Granite)
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Watercourse
- Wetland

NOTES
Base data source:
CanVec Topo Data;
ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

STATUS
ISSUED FOR REVIEW

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 105 Borehole Locations

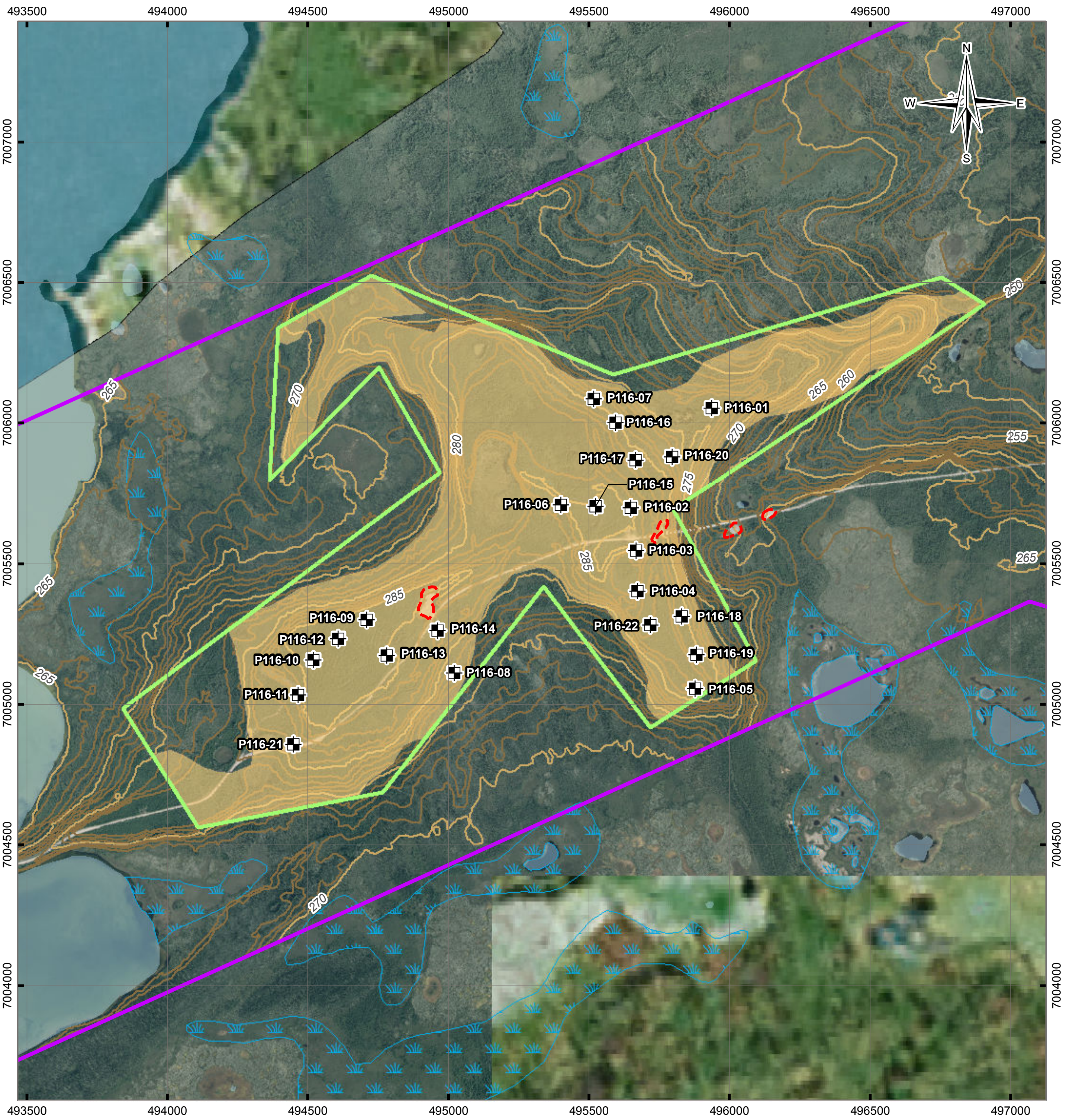
PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:15,000
200 100 0 200
Metres

TETRA TECH

FILE NO.				
YARC03107-01_Figure14_P105AsBuilt.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0
DATE	PROJECT NO.			
September 27, 2017	ENG.YARC03107-01			

Figure 14



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LEGEND

- Testpit
- 2 km Swath
- Granular Prospect
- Approximate Outline of Existing Borrow Pit

Potential Aggregate Source

- Overburden (Esker complex)
- Index Contour (5 m)
- Intermediate Contour (1 m)
- Wetland

NOTES
Base data source: CanVec Topo Data; ESRI Basemap Imagery
Granular and Bedrock prospect boundaries provided by GNWT - INF.

2017 GEOTECHNICAL INVESTIGATION TASR PROSPECTS

Prospect 116 Testpit Locations

PROJECTION	DATUM	CLIENT
UTM Zone 11	NAD83	Northwest Territories

Scale: 1:20,000
400 200 0 400
Metres

FILE NO.
YARC03107-01_Figure15_P116AsBuilt.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	MEZ	SL	EG	0

DATE	PROJECT NO.
September 27, 2017	ENG.YARC03107-01

STATUS
ISSUED FOR REVIEW

Figure 15

PHOTOGRAPHS

Photo 1	Prospect 1 Cutline. Partial forest fire region.
Photo 2	Prospect 1-01. Upper SAND, some gravel to gravelly soils with a well graded sand and gravel at 2.0 m deep which coincided with the ground water table.
Photo 3	Prospect 1-08. Typical dry to damp fine grained sandy overburden encountered over the majority of the prospect.
Photo 4	Prospect 1-15. Water encountered at 2.1 m below grade led to extensive sloughing of the testpit.
Photo 5	Prospect 1-23. Dry to damp fine grained sandy overburden encountered with gravel seams observed near the surface.
Photo 6	Prospect 13B. TASR alignment / old winter road.
Photo 7	Prospect 13B-01. Testpit spoil pile; overburden was largely a fine grained sand overlying a clay till soil just above bedrock.
Photo 8	Prospect 13B-03. Overburden was a fine grained sand. Testpit halted at 5.0 m with no change in soil stratigraphy.
Photo 9	Prospect 13B-04. Overburden was a fine grained sand. Testpit halted at 5.2 m with no change in soil stratigraphy.
Photo 10	Prospect 13B-05. Overburden was a fine grained sand. At 3.1 m, a clay till was observed.
Photo 11	Prospect 13B-07. Close up of the near surface red brown well graded sandy soil. Below a metre, the sand was typically fine and grey in colour.
Photo 12	Prospect 13B-08. Rock fragments were observed in Testpit 08 well above the sand / bedrock interface
Photo 13	Prospect 13C. TASR alignment / old winter road.
Photo 14	Prospect 13C-01. Overburden was a fine grained sand. Testpit halted at 4.5 m due to sloughing sands with no change in soil stratigraphy.
Photo 15	Prospect 13C-06. Spoil pile of fine grained sand.
Photo 16	Prospect 13C-06. Overburden was a fine grained sand. Testpit halted at 4.5 m due to sloughing sands with no change in soil stratigraphy.
Photo 17	Prospect 13D. Vegetation cover on bedrock outcrop bench where P13D-05 was drilled.
Photo 18	Prospect 13D. Bedrock ridge running roughly NW-SE between P13D-05 and P13D-02.
Photo 19	Prospect 13D. Drill set-up for rock coring at P13D-05.
Photo 20	Prospect 13D. Limestone bedrock outcrop at P13D-05.
Photo 21	Prospect 13D. Limestone bedrock outcrop at P13D-05.
Photo 22	Prospect 13D-01. Overburden was a mixed matrix of silt, sand, gravel and cobbles.
Photo 23	Prospect 13D. TASR alignment / old winter road at the site of Testpit 01.
Photo 24	Prospect 29. Looking east from the site of P29-05 towards P29-06 on the right side of the photo.
Photo 25	Prospect 29. Drill rig set-up at borehole P29-07. Limestone outcrop on surface. Photo looking to the east.

PHOTOGRAPHS

Photo 26	Prospect 33A. Looking east along northern cutline at P33A prospect.
Photo 27	Prospect 33A. Photo taken at P33A-07. Typical overburden cover encountered along northern cutline of P33A prospect area, at borehole locations P33A-06, 07, 08.
Photo 28	Prospect 33A. Typical vegetation in the north end of the P33A prospect area. Looking south from site P33A-07.
Photo 29	Prospect 33A. Looking west towards P33A-10. Low topographic relief at south end of P33A prospect area.
Photo 30	Prospect 69-03. Solid stem auger drilling revealed gravels and met refusal at 0.3 m upon probably cobbles.
Photo 31	Prospect 69-07. Near surface cobbles exposed during hand excavating.
Photo 32	Prospect 69-05d. Diamond drill setup. Limestone bedrock observed at 7.2 m depth. Overburden considered to be GRAVEL, sandy, trace to some cobbles, trace silt.
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Photo 34	Prospect 69. Airborne looking east Prospect 69. View looking east over top of the landing zone.
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Photo 41	Prospect 76-03-03d. Looking north over a secondary landing zone.
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Photo 43	Prospect 76-07. Looking south over the TASR alignment / old winter road.
Photo 44	Prospect 86. Looking east from P86-04, typical hummocky limestone boulder outcrop. Weathered, vuggy calcitic dolomite boulders.
Photo 45	Prospect 86. Fine grained limestone/dolomite sands returned at drill collar annulus in water return.
Photo 46	Prospect 86. Photo taken between P86-01 and helicopter landing zone. Weathered, vuggy calcitic dolomite boulders outcropping at surface.
Photo 47	Fine grained calcitic dolomite sands recovered from borehole annulus at P86-04. Fine grained sands are compositionally similar to weathered calcitic dolomite.
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Photo 54	Prospect 98. View looking east over the southeast end of the prospect. The esker continues past the end of the cutline towards the lake.
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Photo 59	Prospect 105. Bedrock exposure above P105-01.
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Photo 62	Prospect 105. Typical of recovered granite drill core.
Photo 63	Prospect 116. Existing gravel pit across the all season road from Testpit 14. Water was present at the bottom of the pit but was likely overland rainfall accumulation and not the water table.
Photo 64	Prospect 116-02. Overgrown existing gravel pit near Testpit 02.
Photo 65	Prospect 116-03. Existing gravel pit near Testpit 03. The upper soil is a sandy gravel while below the soil appears to be largely sandy.
Photo 66	Prospect 116-01. Upper soils were SAND, gravelly and GRAVEL and SAND at depth.
Photo 67	Prospect 116-05. Upper soils were SAND, gravelly and below were SAND and GRAVEL at depth. Permafrost was observed around 1.8 m deep.
Photo 68	Prospect 116-05. Spoil pile for Testpit 05.
Photo 69	Prospect 116-10. Upper and lower soils were primarily sand. A band of gravel was observed between 1.2 and 2.2 m deep. At 2.2 m, permafrost was observed.
Photo 70	Prospect 116-10. Spoil pile for Testpit 10. Frozen pieces of sand are visible.
Photo 71	Prospect 116-19. The soil was largely SAND with trace so some gravel noted near the surface.
Photo 72	Prospect 116-19. Spoil pile for Testpit 19.
Photo 73	Prospect 116-02. Looking east along the Whati all season gravel Road.
Photo 74	Prospect 1162. Looking southeast along the Whati all season gravel Road; west of the prospect.

Photo 1: Prospect 1 Cutline. Partial forest fire region.
Photo taken July 13, 2017

Photo 2: Prospect 1-01. Upper SAND, some gravel to gravelly soils with a well graded sand and gravel at 2.0 m deep which coincided with the ground water table.
Photo taken July 14, 2017

Photo 3: Prospect 1-08. Typical dry to damp fine grained sandy overburden encountered over the majority of the prospect.
Photo taken July 13, 2017

Photo 4: Prospect 1-15. Water encountered at 2.1 m below grade led to extensive sloughing of the testpit. The water table was encountered towards the north/lower elevation of the beach formation. Photo taken July 13, 2017

Photo 5: Prospect 1-23. Dry to damp fine grained sandy overburden encountered with gravel seams observed near the surface.
Photo taken July 14, 2017

Photo 6: Prospect 13B. TASR alignment / old winter road.
Photo taken July 11, 2017

Photo 7: Prospect 13B-01. Testpit spoil pile; overburden was largely a fine grained sand overlying a clay till soil just above bedrock. Photo taken July 11, 2017

Photo 8: Prospect 13B-03. Overburden was a fine grained sand. Testpit halted at 5.0 m with no change in soil stratigraphy. Photo taken July 11, 2017

Photo 9: Prospect 13B-04. Overburden was a fine grained sand. Testpit halted at 5.2 m with no change in soil stratigraphy.
Photo taken July 11, 2017

Photo 10: Prospect 13B-05. Overburden was a fine grained sand. At 3.1 m, a clay till was observed. Probably bedrock inferred at 4.0 m
Photo taken July 11, 2017

Photo 11: Prospect 13B-07. Close up of the near surface red brown well graded sandy soil. Below a metre, the sand was typically fine and grey in colour.
Photo taken July 11, 2017

Photo 12: Prospect 13B-08. Rock fragments were observed in Testpit 08 well above the sand / bedrock interface.
Photo taken July 11, 2017

Photo 13: Prospect 13C. TASR alignment / old winter road.
Photo taken July 11, 2017

Photo 14: Prospect 13C-01. Overburden was a fine grained sand. Testpit halted at 4.5 m due to sloughing sands with no change in soil stratigraphy.
Photo taken July 11, 2017

Photo 15: Prospect 13C-06. Spoil pile of fine grained sand.
Photo taken July 12, 2017

Photo 16: Prospect 13C-06. Overburden was a fine grained sand. Testpit halted at 4.5 m due to sloughing sands with no change in soil stratigraphy.
Photo taken July 11, 2017

Photo 17: Prospect 13D. Vegetation cover on bedrock outcrop bench where P13D-05 was drilled. Photo taken on July 5, 2017.

Photo 18: Prospect 13D. Bedrock ridge running roughly NW-SE between P13D-05 and P13D-02. Photo taken looking roughly southeast from P13D-02. Photo taken on July 3, 2017.

Photo 19: Prospect 13D. Drill set-up for rock coring at P13D-05. Photo taken on July 5, 2017.

Photo 20: Prospect 13D. Limestone bedrock outcrop at P13D-05. Photo taken on July 5, 2017.

Photo 21: Prospect 13D. Limestone bedrock outcrop at P13D-05. Photo taken on July 5, 2017.

Photo 22: Prospect 13D-01. Overburden was a mixed matrix of silt, sand, gravel and cobbles. Photo taken July 12, 2017

Photo 23: Prospect 13D. TASR alignment / old winter road at the site of Testpit 01. Photo taken July 11, 2017

Photo 24: Prospect 29. Looking east from the site of P29-05 towards P29-06 on the right side of the photo. Slightly undulating topography with limestone bedrock exposed throughout area. Access to P29-03 (left of photo area) along bedrock ridge in center of photo. Photo taken on June 27, 2017.

Photo 25: Prospect 29. Drill rig set-up at borehole P29-07. Limestone outcrop on surface. Photo looking to the east. Photo taken on June 26, 2017

Photo 26: Prospect 33A. Looking east along northern cutline at P33A prospect. Helicopter landing zone is behind photographer and site P33A-05 is to the right. Undulating topographic relief along northern cutline access. Photo taken on July 6, 2017.

Photo 27: Prospect 33A. Photo taken at P33A-07. Typical overburden cover encountered along northern cutline of P33A prospect area, at borehole locations P33A-06, 07, 08. Overburden consists of dominantly limestone material, a mix of gravels, cobbles and boulders. Photo taken on July 6, 2017.

Photo 28: Prospect 33A. Typical vegetation in the north end of the P33A prospect area. Looking south from site P33A-07. Photo taken on July 6, 2017

Photo 29: Prospect 33A. Looking west towards P33A-10. Low topographic relief at south end of P33A prospect area. Bedrock outcrops at or near surface along cutline. Photo taken on July 7, 2017

Photo 30: Prospect 69-03. Solid stem auger drilling revealed gravels and met refusal at 0.3 m upon probably cobbles.
Photo taken July 23, 2017

Photo 31: Prospect 69-07. Near surface cobbles exposed during hand excavating. Photo taken July 23, 2017

Photo 32: Prospect 69-05d. Diamond drill setup. Limestone bedrock observed at 7.2 m depth. Overburden considered to be GRAVEL, sandy, trace to some cobbles, trace silt. Photo taken July 23, 2017

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Photo 34: Prospect 69. Airborne looking east Prospect 69. View looking east over top of the landing zone.
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Photo 35: Prospect 69. Large boulder adjacent to the cutline.
Photo taken July 22, 2017

Photo 36: Prospect 69. Partially buried boulder adjacent to the cutline.
Photo taken July 22, 2017

Photo 37: Prospect 76-03. Solid stem auger drill setup. Drill met refusal at 0.3 m depth due to probably cobbles.
Photo taken July 22, 2017

Photo 38: Prospect 76. Typical cutline with small diameter trees, stumps and near surface boulders.
Photo taken July 22, 2017

Photo 39: Prospect 76-07. Looking west towards the landing zone (dust cloud).
Photo taken July 21, 2017

Photo 40: Prospect 76-07. Looking northwest over the landing zone site which consisted of sands and gravels.
Photo taken July 21, 2017

Photo 41: Prospect 76-03-03d. Looking north over a secondary landing zone.
Photo taken July 22, 2017

Photo 42: Prospect 76-07a. Hand excavated testpit revealing gravel and cobbles to a depth of 0.7 m.
Photo taken July 21, 2017

Photo 43: Prospect 76-07. Looking south over the TASR alignment / old winter road. Photo taken July 21, 2017

Photo 44: Prospect 86. Looking east from P86-04, typical hummocky limestone boulder outcrop. Weathered, vuggy calcitic dolomite boulders. Photo taken on July 13, 2017.

Photo 45: Prospect 86. Fine grained limestone/dolomite sands returned at drill collar annulus in water return. Sands were not recovered in drill core, but were observed in pitted vuggy dolomite core. Photo taken on July 13, 2017.

Photo 46: Prospect 86. Photo taken between P86-01 and helicopter landing zone. Weathered, vuggy calcitic dolomite boulders outcropping at surface. Photo taken on July 12, 2017.

Photo 47: Fine grained calcitic dolomite sands recovered from borehole annulus at P86-04. Fine grained sands are compositionally similar to weathered calcitic dolomite. Photo taken on July 12, 2017

Photo 48: Prospect 86. Recovered drill core from P86-01. Typical weathered, vuggy dolomite encountered in upper 4 to 5 m of all boreholes at Prospect 86. Fine grained calcitic dolomite sands observed in weathered core cavities. Photo taken on July 12, 2017

Photo 49: Prospect 86. Caclitic dolomite boulder fractured with rock hammer. Photo taken on July 15, 2017.

Photo 50: Prospect 86. Close up of calcitic dolomite boulder. Weathered outer surface with lichen growth. Weathered and vuggy material with frequent cavities of weathered sands. Photo taken on July 15, 2017.

Photo 51: Prospect 98-01. Solid stem auger setup; met refusal on probable cobbles at a depth of 0.4 m.
Photo taken July 20, 2017

Photo 52: Prospect 98. Surface boulders littered the prospect and made travel difficult for the tracked heli drill.
Photo taken July 20, 2017

Photo 53: Prospect 98. Surface boulders littered the prospect and made travel difficult for the tracked heli drill.
Photo taken July 20, 2017

Photo 54: Prospect 98. View looking east over the southeast end of the prospect. The esker continues past the end of the cutline towards the lake.
Photo taken July 20, 2017

Photo 55: Prospect 98. Surface boulders along cutline access trails within the prospect.
Photo taken July 20, 2017

Photo 56: Prospect 98. View looking northwest over the prospect.
Photo taken July 20, 2017

Photo 57: Prospect 98-13. Hand excavated testpit to a depth of 0.55 m. Gravel and cobbles recovered.
Photo taken July 21, 2017

Photo 58: Prospect 105. Iron alteration surface coating typically observed on joints. Photo taken on July 16, 2017.

Photo 59: Prospect 105. Bedrock exposure above P105-01.

Photo 60: Prospect 105. Looking towards the south from helicopter landing area. Drill set up for coring at P105-01. Photo taken on July 16, 2017.

Photo 61: Prospect 105. Fractured boulder from surface of rock outcrop. Photo taken on July 16, 2017

Photo 62: Prospect 105. Typical of recovered granite drill core. Photo taken on July 16, 2017.

Photo 63: Prospect 116. Existing gravel pit across the all season road from Testpit 14. Water was present at the bottom of the pit but was likely overland rainfall accumulation and not the water table. Photo taken July 17, 2017

Photo 64: Prospect 116-02. Overgrown existing gravel pit near Testpit 02. Photo taken July 17, 2017

Photo 65: Prospect 116-03. Existing gravel pit near Testpit 03. The upper soil is a sandy gravel while below the soil appears to be largely sandy.
Photo taken July 17, 2017

Photo 66: Prospect 116-01. Upper soils were SAND, gravelly and GRAVEL and SAND at depth.
Photo taken July 18, 2017

Photo 67: Prospect 116-05. Upper soils were SAND, gravelly and below were SAND and GRAVEL at depth. Permafrost was observed around 1.8 m deep.
Photo taken July 18, 2017

Photo 68: Prospect 116-05. Spoil pile for Testpit 05.
Photo taken July 18, 2017

Photo 69: Prospect 116-10. Upper and lower soils were primarily sand. A band of gravel was observed between 1.2 and 2.2 m deep. At 2.2 m, permafrost was observed.
Photo taken July 17, 2017

Photo 70: Prospect 116-10. Spoil pile for Testpit 10. Frozen pieces of sand are visible.
Photo taken July 17, 2017

Photo 71: Prospect 116-19. The soil was largely SAND with trace so some gravel noted near the surface. Water seepage observed below a band of permafrost soils at 3.3 m and standing water at 3.6 m upon testpit completion.
Photo taken July 18, 2017

Photo 72: Prospect 116-19. Spoil pile for Testpit 19.
Photo taken July 18, 2017

Photo 73: Prospect 116-02. Looking east along the Whati all season gravel Road.
Photo taken July 18, 2017

Photo 74: Prospect 116. Looking southeast along the Whati all season gravel Road; west of the prospect.
Photo taken July 18, 2017