Aquifer mapping report

Village of Teslin

August, 2025

Aquifer mapping
Teslin, Yukon

Government of Yukon
Water Resources Branch

Authors

WSP Canada Inc.

Background

The purpose of the project was to identify, delineate, and classify aquifers underlying the boundary of Teslin and build a foundation for future hydrogeological work in the area. This report presents the geological setting and relevant background information for the Study Area, methods used to process and interpret the subsurface hydrogeological data, and resultant aquifer delineations and classification according to the British Columbia aquifer classification system.

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- Department of Energy, Mines and Resources, Yukon Geological Survey
- Teslin Tlingit First Nation
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Citation:

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Disclaimer:

Study limitations

This document has been prepared for the purposes of identifying and mapping aquifers in the vicinity of Teslin and is provided for the exclusive use of the Government of Yukon Water Resource Branch (WRB).

The scope of work for this study was intended to provide a regional scale overview only and did not include such items as detailed subsurface investigations or site-specific hydrogeological assessments. In preparing this document, WSP has relied in good faith on information provided by sources noted in this document. We accept no responsibility for any deficiency, misstatements or inaccuracy contained in this document as a result of omissions, misstatements, or fraudulent acts of others.

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Executive summary

The purpose of the project was to identify, delineate, and classify aquifers within the boundary of Teslin and build a foundation for the development of a conceptual hydrogeological model for the area. This report presents the geological setting and relevant background information for the Study Area, methods used to process and interpret the subsurface hydrogeological data and resulting aquifer delineations and classification according to the BC aquifer classification system (Bernardinucci and Ronneseth, 2002).

Teslin is located in the Southern Yukon, approximately 130 km east of Whitehorse and approximately 20 km north of British Columbia border. Teslin is located at km 1244 (mile 804) of the Alaska Highway and is situated at the confluence of Teslin Lake and Nisutlin Bay Inlet. Teslin has a population of approximately 300 residents (Statistics Canada, 2021) and is in the traditional territory of the Teslin Tlingit Council.

Glacial deposits in the Teslin area are generally related to the McConnell glaciation, which covered the south and central Yukon between 26,500 and 10,000 years ago. During the McConnell glaciation, ice flowed towards the northwest from the Cassiar Mountains. There was a glacial lake in the area of Teslin during glacial retreat to the southeast. The glacial lake lowered slowly over time, leaving paleo-shoreline deposits along upland slopes such as near the sewage lagoons. Thick glacial lake sediments were deposited in the valley bottom and glaciolacustrine sediments are widespread at or near surface. Glaciofluvial sands and gravels were often deposited during stagnating and downwasting of the ice sheet. Moraine or till deposits occur on mid-elevation slopes and high elevation slopes and summits are covered with discontinuous colluvium or moraine veneer over bedrock. Alluvial fan deposits, frequently overlain by organic deposits, occur in the western part of Teslin near the Fox Point subdivision along with active fluvial deposits associated modern stream activity. Unmapped thin veneers of organics (10-30 cm) overlie much of Teslin. The surficial deposits in the Teslin area are described in detail by Palmer et al. (2020).

For the purposes of this report, an "aquifer" in unconsolidated materials (i.e., soil) is considered to be a geological deposit or formation that has high permeability relative to its surroundings and which readily transmits water to wells and springs. Bedrock aquifers have not been delineated in this report due to limited hydrogeological information and high variability in local permeability, though it is noted that in many cases wells drilled into the bedrock may yield a small groundwater supply suitable for domestic use.

Two proven aquifers and two potential aquifers were identified within the study area as part of project.

1. Nàghas'ê X'ayi tayî hîn (Water Under Fox Point): The Glaciofluvial Aquifer is a confined aquifer and is constrained to the glaciofluvial sand and gravel deposits in the valley.

2. Axh'áká tayî hîn (Water Under Teslin): The Deep Sand and Gravel Aquifer is a confined sand and gravel deposit in the vicinity of Village of Teslin.
3. The Potential Glaciofluvial Aquifer is a confined aquifer west of Fox Creek that has been truncated from the larger glaciofluvial deposits by fluvial processes and alluvial deposits associated with Fox Creek.
4. The Potential Fan Aquifer is an unconfined aquifer comprised of alluvial / fan deposits associated with Fox Creek northwest of the Fox Point subdivision

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Place names and acronyms

Tlingit Place Names

- Nàghas'ê X'ayi tayî hîn (Water Under Fox Point)
- Axh'áká tayî hîn (Water Under Teslin)

Acronyms

CDEM	Canadian Digital Elevation Model
GCDWQG	Government of Canada Drinking Water Guidelines
GW	Groundwater
ID	Identifier or Identification number
masl	Metres above sea level
mbgs	Metres below ground surface
WRB	Water Resources Branch
YOWN	Yukon Observation Well Network
YWWR	Yukon Water Well Registry

Study Area location

Teslin is located in the Southern Yukon, approximately 130 km east of Whitehorse and approximately 20 km north of British Columbia border. Teslin is located at km 1244 (mile 804) of the Alaska Highway and is situated at the confluence of Teslin Lake and Nisutlin Bay Inlet. Teslin has a population of approximately 300 residents (Statistics Canada, 2021) and is home to the Tlingit Community. For the purposes of aquifer mapping, the “Study Area” delimited on Figure 1 was constrained to the available data covering the Village of Teslin to Fox Point subdivisions.

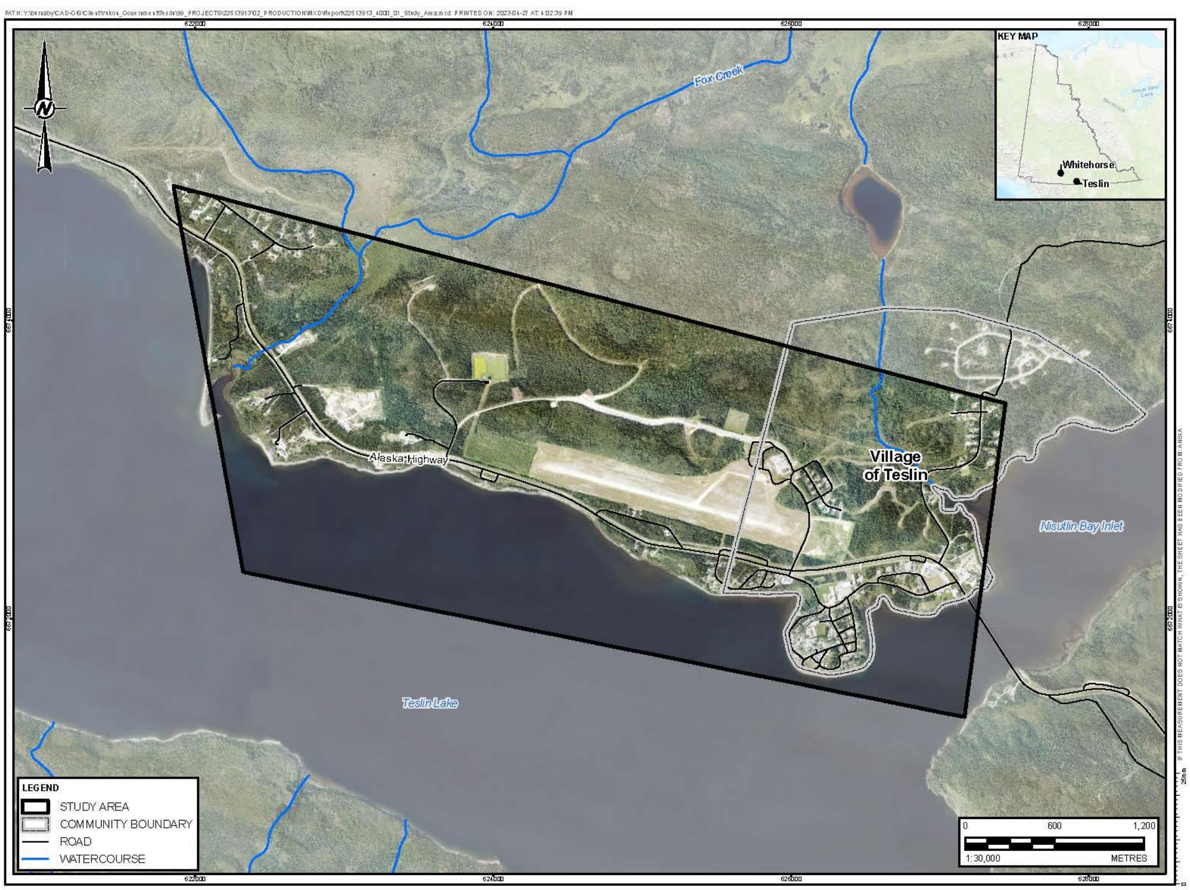


Figure 1. Study Area

Methods

Subsurface geological and hydrogeological data was compiled, preprocessed, standardized, and imported into Leapfrog Works (v 2022.1.0), a commercially available 3D subsurface modelling software package, for interpretation and aquifer delineation. The data sources and workflows for the preprocessing, lithological standardization, 3D visualization and interpretation are described in the subsections below.

Data Sources

WSP conducted a data gathering exercise to obtain Quaternary geologic and hydrogeologic information for the Study Area by means of correspondence with the Government of Yukon Department of Environment, Water Resources Branch (WRB) and on-line searches of publicly available information sources including the Yukon Water Well Registry (YWWR). The WRB coordinated the gathering of information from wells associated with Tlingit Community as well as available geological and subsurface data from other government agencies and consultants. Table 1 provides a summary of the data that was compiled.

Table 1: Summary of Data Sources

Source	Data Type	Data Coverage
Yukon Water Well Registry (YWWR)	Well locations and well logs for public and private water supply wells, environmental monitoring wells and industrial, commercial wells.	51 wells total, 40 wells with lithology available
1 m resolution bare earth LiDAR data from Geomatics Yukon (2015)	Digital elevation data to support accurate positioning of boreholes	Area of coverage of 24 km^2
Canadian Digital Elevation Model (CDEM)	Digital elevation data to support accurate positioning of boreholes	Data downloaded to cover Teslin and up to 18 km of the surrounding area
Surficial Geology Map (Palmer, 2020)	Finer scale mapped distribution of surficial geological units and descriptions	Regional coverage of Teslin
Yukon Observation Well Network (YOWN) Subsurface Investigation	Two stratigraphic boreholes installed, one monitoring well and one nested monitoring well	Two locations in Teslin (YOWN-2206 and YOWN-2207S/D)
Contaminated site investigation report (ERM Consultant Canada LTD, 2018)	Additional borehole logs	Five boreholes in the residential area in Village of Teslin (LM18-01 to LM18-06)

Source	Data Type	Data Coverage
Geotechnical Evaluation (Chilkoot Geological Engineer LTD, 2019)	Additional borehole logs	Five boreholes near the ice arena of Village of Teslin (BH1-19 to BH5-19)
Additional references such as the permafrost study (Kryotec Arctic Innovation Inc., 2021)	Geophysical surveys	Five Electrical Resistivity Tomography surveys conducted in Teslin

Data Standardization

Well information and lithological descriptors are variable in terms of documentation and overall data quality, with substantial variation depending on the age of the well record and drilling company. Common types of preprocessing that was conducted as part of this study include:

- Conversion from imperial units to metric
- Manual entry of lithological information from the YWWR and well records
- Standardization of lithological descriptors

Given the variability of the raw lithology descriptors, standardization of the lithological dataset was required for effective interpretation of subsurface stratigraphy and conditions. The method of standardization primarily consisted of keyword scripts to extract relevant data descriptors from the lithology field. Once the relevant lithological data were extracted, they were classified on the basis of sediment texture into groups that were expected to behave in a hydraulically similar manner. These sediment textural groupings were implemented in the 3D subsurface model and were used to facilitate the geological and hydrostatigraphic interpretations described in Sections 3.0 and 4.0, respectively. Table 2, below, presents the main lithological descriptors and their associated sediment textural grouping.

Table 2: Lithological Descriptor Standardization

Lithological Descriptor	Sediment Textural Grouping
Sand and Gravel	Sand and Gravel
Gravelly Sand/ Sandy Gravel	
Sand with some Gravel	
Sand (Fine / Medium / Coarse)	Sand
Silty Sand	Silt / Sand
Sand with Silt	
Sandy Silt	
Silt	Silt

Lithological Descriptor	Sediment Textural Grouping
Clay	Clay/Silt
Clay with some Silt	
Silty Clay	
Till	Till
Silt, Clay, Sand, Gravel	
Bedrock	Bedrock

It should be noted that these groupings and classifications are methods used only to facilitate visualization of the data in 3D for the interpreter; the full raw lithologies were still queried by the interpreter during the aquifer mapping and delineation process to ensure that professional judgement was applied throughout the process as opposed to being strictly an automated process.

Three-Dimensional Visualization and Hydrostratigraphic Interpretation

To conduct the 3D hydrostratigraphic visualization and interpretation, standardized datasets for lithology, degree of saturation, and groundwater levels / depths to water were imported into Leapfrog Works (v 2022.1.0) for 3D rendering. Well collar elevations were frequently unavailable or, where available, were typically low accuracy. In order to vertically reference well or borehole collars, collars were assigned elevations by projecting them onto the topographic surface in the 3D model, which was defined by the high-resolution LiDAR mapping. This allowed for vertical referencing of all associated wells and lithological data within the 3D space of the subsurface model; however, it also meant that vertical elevation errors could be introduced where the associated well record has low horizontal accuracy in an area of high topographic relief. Outside of the LiDAR coverage and at the edge of the low-resolution DEM vertical walls are sometimes present. These are an artifact of the difference between the LiDAR and low-resolution DEM and do not reflect actual near vertical changes in topography.

For the purposes of this report, an "aquifer" in unconsolidated materials (i.e. soil) is considered to be a geological deposit or formation that has high permeability relative to its surroundings and which readily transmits water to wells and springs. Bedrock aquifers have not been delineated in this report due to limited hydrogeological information and high variability in local permeability, though it is noted that in many cases wells drilled into the bedrock may yield a small groundwater supply suitable for domestic use. For the purposes of this report, an "aquitard" is a geological deposit or formation that has low permeability relative to its surroundings and which impedes or does not readily transmit groundwater to wells or springs.

Aquifers and hydrostratigraphy were interpreted by visualizing the associated datasets in 3D, cutting cross-sections, manipulating the model, and then by manually selecting and assigning various intervals to hydrostratigraphic units and aquifers. This method allowed the interpreter to assess and visualize the different types of hydrogeological data quickly and the ability to easily and continuously cut cross-sections to investigate areas of interest. Subsurface data, existing geological mapping, groundwater levels, and landform morphology were all considered when delineating the aquifer boundaries. Assumptions and notes regarding the delineation of the aquifers are documented in the associated aquifer description worksheets in Appendix 1.

Overview of Geology

The primary reference for bedrock geology for the Study Area is the Yukon Geological Survey bedrock compilation (Yukon Geological Survey, 2022) which has been developed from Gordey and Stevens (1994) in the Teslin map area (105C) (Figure 2). Three bedrock units underlie the Study Area and, from oldest to youngest, are:

- **Upper Devonian Snowcap Group Bedrock (PDS1)** – metamorphic bedrock unit underlying the northeast corner of the Study Area consisting of quartzite, psammite, pelite and marble with minor greenstone and amphibolite.
- **Upper Devonian Smart River Formation Bedrock (DMF1)** – metamorphic bedrock unit underlying part of the northeast portion of the Study Area and consisting of intermediate to mafic volcanic and volcaniclastic rocks.
- **Upper Triassic Shonektaw Formation Bedrock (uTrJS1)** – primary bedrock unit underlying the Study Area and consisting of sandstone and lesser siltstone and mudstone.

Two northwest/southeast to north-northwest/south-southeast trending faults, part of the Eastern Teslin fault system, traverse the northeastern portion of the Study Area, dividing the bedrock units.

Out of the 40 boreholes and wells with lithology descriptors present in the Study Area, only one well reached bedrock. Well VOT TW10-01 located in Village of Teslin reached bedrock at 129.8 mbgs and is described as chlorite schist which is associated with the Upper Devonian Smart River Formation.

The surficial geology in the Study Area is described in regional-scale mapping (Klassen, 1978; Morison et al. 1982; Morrison and Klassen, 1997) and more specifically for the Village of Teslin in Palmer (2020). Regional glacial history and stratigraphy that includes the Teslin area or adjacent areas is described in Jackson and Mackay, 1991, Jackson et al., 1991 and Jackson, 1994.

Glacial deposits in the Teslin area are generally related to the McConnell glaciation, which covered the south and central Yukon between 26,500 and 10,000 years ago. During the McConnell glaciation, ice flowed towards the northwest from the Cassiar Mountains (Jackson and Mackay, 1991; Jackson et al., 1991). There was a glacial lake in the area of Teslin during glacial retreat to the southeast. The glacial lake lowered slowly over time, leaving paleo-shoreline deposits along upland slopes such as near the sewage lagoons (Morison et al. 1982). Thick glacial lake sediments were deposited in the valley bottom. Glaciofluvial sands and gravels were often deposited during stagnating and downwasting of the ice sheet (Jackson, 1994). Moraine or till deposits occur on mid-elevation slopes and high elevation slopes and summits are covered with discontinuous colluvium or moraine veneer over bedrock.

On a regional scale in the Southern Lakes area, Jackson (1994) found that typical glacial tills had a wide range of sand content (20-70%) and silt content (20 to 80%) and generally lower clay content (5 to 30%). In the Teslin area, two common till textures were observed near surface: coarser-textured till within a weakly defined bench along the lower slopes above the highway and airstrip and finer textured till in veneers and blankets covering bedrock slopes as well as in undulating till (Palmer, 2020).

Glaciolacustrine sediments were deposited within a glacial lake and are widespread at or near surface throughout the study area (Palmer, 2020). Glaciolacustrine sediments in the valley bottom consists of fine-grained silt and clay deposited in paleo-lake bottoms. On hillsides, paleo-shoreline deposits are common with textures ranging from sand to pebble sized gravel. Undulating to hummocky glaciolacustrine deposits associated with deltaic environments occur in the west portion of the study area and have variable textures ranging from gravel to silt and clay (Palmer, 2020).

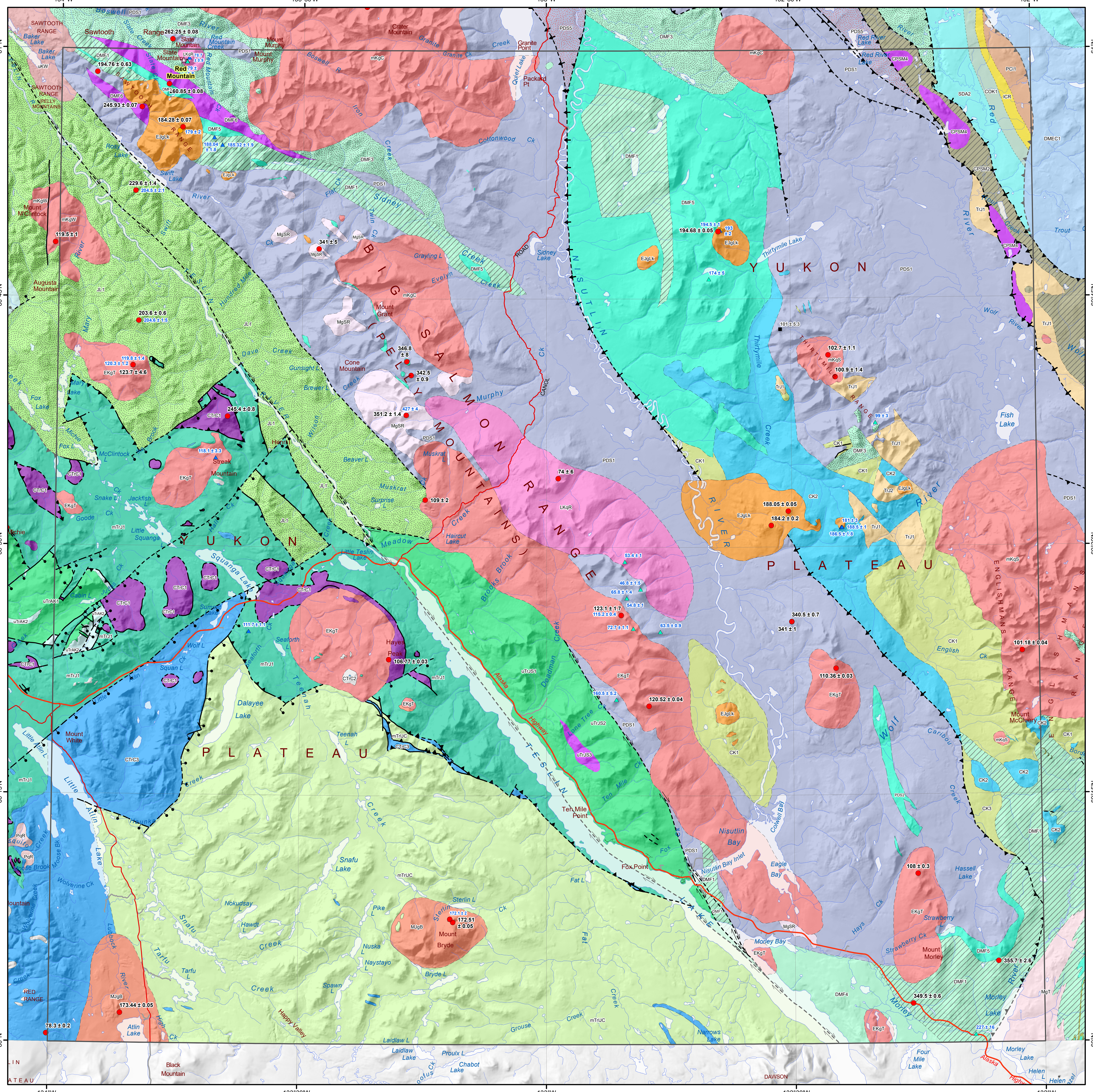
Glaciofluvial materials were not mapped at surface in the Teslin study area (Palmer, 2020) but glaciofluvial terrace deposits (generally silt, sand and gravel) were mapped nearby, flanking the valley walls near Johnsons Crossing to the west and extensive glaciofluvial outwash deposits (generally gravel, sand and silt) occur along the valley of the Teslin River (Morison et al. 1997).

Alluvial fan deposits occur in the western part of the study area near the Fox Point subdivision along with active fluvial deposits associated modern stream activity (Palmer, 2020). Alluvial fan deposits generally consist of gravel, sand and silt (Morison et al. 1997). Organic deposits overly much of the alluvial fan deposit and are also found in the eastern part of the study area to the northeast of the airport. Unmapped thin veneers of organics (10-30 cm) overlie much of the study area (Palmer, 2020).

Figure 2. Bedrock Geology - Teslin Area (YGS, 2022)

Yukon Geological Survey

Yukon



Note: legend contains geological information for the map extent and not the surrounding area.

MINERAL OCCURRENCE

- Deposit
- Historic Deposit
- Significant exploration project

GEOCHRONOLOGY METHOD

- U/Pb, Zircon
- U/Pb, Other
- Ar/Ar
- K/Ar

LATE CRETACEOUS

LKqR: RANCHERIA SUITE: Bt-Ms leucogranite and monzogranite

MID-CRETACEOUS

mKgC: CASSIAR SUITE: Bt ± Hbl ± titanite-bearing monzogranite to granodiorite

mKgW: WHITEHORSE SUITE: Bt-Hbl granodiorite, Hbl quartz diorite and Hbl diorite

mKqS: SEAGULL SUITE: Bt (± Ms) leucogranite to monzogranite

EARLY CRETACEOUS

EKgT: TESLIN SUITE: Hbl-Bt granite, granodiorite, quartz monzonite, quartz monzodiorite

UPPER CRETACEOUS

uKW: WINDY-TABLE: quartz-phyric dacite flows, ash and lapilli tuff

MID-JURASSIC

MJgB: BRYDE SUITE: Hbl monzodiorite, Hbl-Bt quartz monzodiorite, minor hornblendite

LOWER AND MIDDLE JURASSIC, HETTANGIAN TO BAJOCIAN

JL1: RICHTHOFEN: turbiditic sandstone-siltstone-mudstone, conglomerate

EARLY JURASSIC

EJgLk: LOKKEN SUITE: Hbl-Bt-Cpx monzodiorite to granodiorite, local monzonite

MIDDLE TRIASSIC TO LOWER JURASSIC

mTrJC: CACHE CREEK: ribbon chert interbedded with shale, siltstone and greywacke

UPPER TRIASSIC, CARNIAN TO RHAETIAN

uTrAK2: HANCOCK: massive to thick-bedded limestone

uTrAK1: CASCA: shale, siltstone, calcareous greywacke, argillaceous limestone

UPPER TRIASSIC TO LOWER JURASSIC?

uTrJS3: SHONEKTAW?: dunite, minor pyroxenite

uTrJS2: SHONEKTAW?: felsic volcanic/subvolcanic complex near Teslin

uTrJS1: SHONEKTAW: augite-bearing sandstone and lesser siltstone and mudstone

MIDDLE TRIASSIC

mTrJ1: JOE MOUNTAIN: massive basalt flows

MIDDLE TO UPPER TRIASSIC

TrJ2: JONES LAKE: bioclastic limestone and interbedded sandy or silty limestone

TrJ1: JONES LAKE: calcareous siltstone, shale, and fine sandstone

CARBONIFEROUS TO JURASSIC

CTrC4: KEDAHDA: thin-bedded, grey, black, red and brown chert

CTrC3: HORSEFEED: massive, finely crystalline, locally crinoidal and fusiline grey limestone

CTrC2: NAKINA: andesitic and basaltic spherulitic greenstone

CTrC1: NAHLIN: variably tectonized, serpentinized and chloritized ultramafic rocks

CARBONIFEROUS TO PERMIAN

CPSM5: SLIDE MOUNTAIN: medium to coarse-grained gabbro

CPSM4: SLIDE MOUNTAIN: brown weathering, variably serpentinized ultramafic rocks

CPSM2: CAMPBELL RANGE: dark green to black basalt, greenstone, locally pillowed

CARBONIFEROUS

CK3: KLINKIT: arkosic sandstone, basal polymictic metaconglomerate

CK2: KLINKIT: limestone, marble, locally fossiliferous

CK1: KLINKIT: mafic to intermediate metavolcaniclastic and metavolcanic rocks; minor felsite

MISSISSIPPIAN

MgT: TATLMAIN SUITE: Hbl quartz diorite, tonalite; Hbl-Bt granodiorite

MgSR: SIMPSON RANGE SUITE: Hbl-bearing metagranodiorite, metadiorite and metatonalite

DEVONIAN, MISSISSIPPIAN AND(?) OLDER

DMF6: FINLAYSON: ultramafic rocks, serpentinite; metagabbro

DMF5: FINLAYSON: light grey to white marble, locally crinoidal

DMF4: FINLAYSON: light green to grey, fine-grained siliciclastic and metavolcaniclastic rocks

DMF3: FINLAYSON: dark grey to black carbonaceous metasedimentary rocks, metachert

DMF1: FINLAYSON: intermediate to mafic volcanic and volcaniclastic rocks

UPPER DEVONIAN TO LOWER MISSISSIPPIAN

DMEC1: EARN - CASSIAR: black siliceous slate, quartz-chert greywacke, grit and conglomerate

MIDDLE SILURIAN TO MIDDLE DEVONIAN

SDA2: ASKIN: dolostone, silty and sandy dolostone, limestone

UPPER CAMBRIAN AND ORDOVICIAN

COK1: KECHIKA: thin-bedded, lustrous, calcareous, grey slate, phyllite, limestone

LOWER CAMBRIAN

ICR: ROSELLA: resistant, thick-bedded to massive, limestone and argillaceous limestone

NEOPROTEROZOIC AND PALEOZOIC

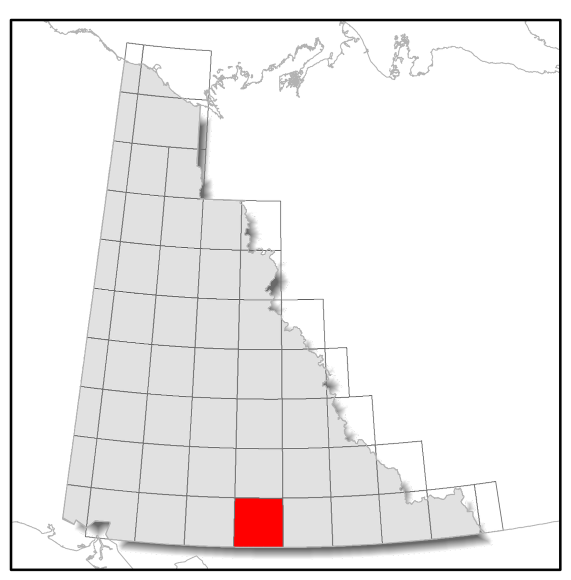
PDS5: SNOWCAP: psammite, quartzite and amphibolite metamorphosed to eclogite, blueschist

PDS2: SNOWCAP: light grey to buff weathering marble

PDS1: SNOWCAP: quartzite, psammite, pelite and marble; minor greenstone and amphibolite

NEOPROTEROZOIC TO LOWER CAMBRIAN

PCI1: SWANNELL/TSAYDIZ: calcareous sandstone, shale, quartz-eye grit, quartzite



1:250 000-scale base data produced by CENTRE FOR TOPOGRAPHIC INFORMATION, NATURAL RESOURCES CANADA

30 metre shaded relief from Geomatics Yukon www.geomaticsyukon.ca

BEDROCK GEOLOGY

TESLIN (105C)

YUKON

0 5 10 15 20 25

kilometres

These maps contain the most current bedrock geology information in Yukon. All geological data are from the Yukon Geological Survey and available free of charge. Data are from recent mapping, regional compilations and thesis work.

The geological data used to create these maps can be downloaded at https://data.geology.gov.yk.ca/Compilation/3.

These maps are subject to periodic updates. This map was last updated in February 2022.

The Yukon Geological Survey welcomes any revisions or new geological information. Any questions or comments can be directed to geology@gov.yk.ca.

YOWN Stratigraphic Boreholes

Following a review of the available data in the Study Area and a summary of the data gaps for aquifer mapping, the WRB advanced two stratigraphic boreholes (YOWN-2206 and YOWN-2207S/D) in May 2022 to provide additional data points, increase the confidence in the stratigraphic correlations, and to further the understanding of the depositional environment.

YOWN-2206

Borehole YOWN-2206 is located at a roadside pullout along the Alaska Highway, with Teslin Lake located immediately to the south. YOWN-2206 was subsequently completed as a monitoring well with a screened interval of 13.7 to 16.8 mbgs. The core from the stratigraphic borehole was logged by staff from the Yukon Geological Survey (YGS) and WSP. A simplified version of the borehole log, including the inferred depositional environment and hydraulic behavior is summarized in Table 3, below.

Table 3: Simplified YOWN-2206 Borehole Log

Start Depth (m)	End Depth (m)	Material	Texture / Structure	Depositional Setting	Inferred Hydraulic Behavior
0.0	0.9	Gravelly sand	Fine to coarse sand and fine to coarse, angular to sub-angular gravel; <10% fines (~4% each clay and silt); some iron oxide staining; poorly sorted diamict, cemented when dry	Ablation till	Low permeability
0.9	1.2	Silty gravelly sand with trace clay	Fine sand and fine to coarse, angular to rounded gravel; loose and powdery when dry	Ablation till	Low permeability
1.2	2.4	Gravelly sandy silt with trace clay	Fine to coarse, angular to sub-rounded gravel; diamict; cemented when dry	Basal till	Low permeability
2.4	4.2	Sand and gravel with trace silt	Fine to coarse sand and fine to coarse, angular to sub-rounded gravel; sand content increases (fine-medium) from 3.7 to 3.8 m; loose and crumbles when dry	Basal till	Low permeability
4.2	5.2	Sand	Fine to coarse (mostly fine) sand and trace fine gravel; loose when dry	Till	Low permeability
5.2	9.1	Silty sandy gravel with trace clay	Fine to coarse, subrounded to rounded gravel; moist and moderate hardness when extracted; crumbly when dry	Till	Low permeability

Start Depth (m)	End Depth (m)	Material	Texture / Structure	Depositional Setting	Inferred Hydraulic Behavior
9.1	11.2	Gravelly sand, trace silt	Mostly fine sand and fine to coarse, sub-angular to sub-rounded gravel	Glaciofluvial outwash	Permeable
11.2	14.8	Sand	Fine to coarse sand; fining upward; gravel content increases with depth below 11.9 m; no gravel from 11.3 to 11.9 m	Glaciofluvial outwash	Permeable
14.8	17.3	Gravelly sand, trace to some silt	Fine to coarse, sub-angular to rounded gravel; poorly sorted; loose; moist; coarser lens with more gravel from 14.9 to 15.2 m	Glaciofluvial outwash	Permeable
17.3	18.3	Sand with some gravel	Fine to coarse sand (mostly fine); loose; moist; well-sorted	Glaciofluvial outwash	Permeable
18.3	19.1	Sand and gravel	Fine to coarse, sub-angular to rounded gravel (mostly coarse); moist; loose	Glaciofluvial outwash	Permeable
19.1	33.3	Silty clay	Moist; dense	Proximal glacial lake bottom	Low permeability
33.3	59.4	Clay	Moist; dense	Distal glacial lake bottom	Low permeability

YOWN-2207 S/D

Borehole YOWN-2207 S/D is located to the north-northeast of YOWN-2206, near the Teslin sewage lagoons. YOWN-2207 S/D was subsequently completed as a monitoring well with a shallow (3.4 to 4.9 mbgs) and deep (39.6 to 42.7 mbgs) screened interval (YOWN-2207 S/D). The core from the stratigraphic borehole was logged by staff from the Yukon Geological Survey (YGS) and WSP. A simplified version of the borehole log, including the inferred depositional environment and hydraulic behavior is summarized in Table 4, below.

Table 4: Simplified YOWN-2207 S/D Borehole Log

Start Depth (m)	End Depth (m)	Material	Texture / Structure	Depositional Setting	Inferred Hydraulic Behavior
0.0	0.6	No core recovered		Fill	-
0.6	0.9	Clay with some sand and gravel	Coarse sand and fine gravel (grit + small pebbles)	Glaciolacustrine veneer	Low Permeability
0.9	4.8	Sand and clayey silt with some gravel	Fine to coarse sand and fine gravel; dense fine-grained diamict; cemented when dry; 0.6 to 3 m "loose" when extracted	Till	Low Permeability
4.8	7.6	Sandy silty clay with some gravel	Fine to coarse sub-angular to rounded gravel; dense sandy diamict with more gravel than unit above	Till	Low Permeability
7.6	20.0	Gravelly clay with trace sand and silt	Fine to coarse subangular to rounded gravel up to 10 cm; dense clayey diamict (till); cemented when dry	Till	Low Permeability
20.0	21.8	Silty sand with some gravel	Fine sand with <10% fine to coarse gravel; fine sandy diamict (till), dense and crumbly when dry	Till	Isolated Permeability
21.8	22.7	Silty sand	Fine sand, no gravel; dense/compact when dry; fine sand lens from 22.6 - 22.9 m	Till	Isolated Permeability
22.7	23.6	Silty clay with trace gravel	Fine gravel	Till	Low Permeability
23.6	31.2	Silty sand with trace gravel	Fine sand and <5% fine, angular to sub-angular gravel; fines upwards; dense diamict	Till	Permeable
31.2	40.9	Sand with some silt	Massive fine sand; well sorted; no gravel; moderately dense	Glaciofluvial/ deltaic	Permeable
40.9	43.9	Silty gravelly sand	Find sand and fine to coarse gravel (mostly fine); some clay from 42.1-42.4 m (dried hard); moderately dense	Glaciofluvial/ deltaic	Permeable
43.9	52.4	Sandy clayey silt with some gravel	Fine to coarse (mostly coarse), sub-angular to rounded gravel; dense diamict	Basal till	Low Permeability

The geological interpretation of the YOWN-2206 and YOWN-2207 S/D stratigraphic boreholes provide important insight into depositional processes and geological controls on groundwater movement in parts of the Study Area with otherwise limited stratigraphic information. To confirm the composition of the permeable units screened by YOWN-2206 and YOWN-2207 S/D, three soil samples were submitted to WSP's laboratory for grain size and hydrometer testing. A summary of the grain size analysis results is presented in Table 5 below. Full grain size analysis results are provided in Appendix 3.

Table 5: Summary of Grain Size Analysis

Grain Size	**Percentage Retained of Sample**		
	YOWN-2206	**YOWN-2207 S**	**YOWN-2207 D**
	Sample Depth 14.94 – 17.37 m	**Sample Depth 0.91 – 4.88 m**	**Sample Depth 41.15 – 44.20 m**
Gravel	29.1%	11.2%	22.5%
Sand	66.4%	46.1%	52.4%
Fines (Silt and Clay)	4.5%	42.7%	25.1%

Based on the stratigraphy encountered at YOWN-2206 (located towards the valley bottom, adjacent to Teslin Lake), and YOWN-2207 S/D (located further upslope), sand and gravel units, likely of glaciofluvial origin, exist at similar elevations to the shallow glaciofluvial outwash deposits used by many of the private domestic wells within the main village of Teslin. The stratigraphy of the YOWN wells supports extending the shallow sand and gravel deposits laterally across much of the Study Area (except towards the mountain north of Teslin). YOWN-2206 is screened within this glaciofluvial unit. Grain size analysis of the screened interval indicates good permeability with materials consisting of less than 5% fines (silt or clay) and predominantly fine to coarse sand (66%) and gravel (29%). YOWN-2207D is also interpreted to be screened in this glaciofluvial unit. Grain size analysis of the screened interval of YOWN-2207D indicates a higher proportion of fines (25%) than in YOWN-2206 (Appendix 3), noting that this sample was taken in a portion of the unit with higher fines content.

In YOWN-2206, a thick deposit of glaciolacustrine sediments extend from 33.3 mbgs to the maximum depth of the borehole (59.4 mbgs). The deeper sand and gravel unit observed in the village of Teslin community well was not encountered in YOWN-2206; however, the hole was terminated only slightly deeper than the upper elevation of the deep sand and gravel.

YOWN-2206 and YOWN-2207 S/D have an upper till unit above the glaciofluvial deposits. This till deposit may be associated with re-advancement of the glacier. The till is heterogeneous, from more permeable gravelly sand to a less permeable sandy, gravelly clay (Table 3 and Table 4). In YOWN-2207 S/D, the till unit is 30 m thick and overlain by a glaciolacustrine veneer. Similar till and glaciolacustrine deposits are observed across the study area. Borehole descriptions make it challenging to distinguish between the glaciolacustrine deposits (especially paleo-shoreline deposits) and the heterogenous till. YOWN-2207S is screened in the till unit. Grain size analysis of the screened interval indicates a high percentage of silt and clay fines (>40%) and fine sand (27%), indicating low permeability (Appendix 3).

YOWN-2206 and YOWN-2207 S/D did not extend to bedrock. Bedrock was expected to be shallow at YOWN-2207 S/D based on nearby bedrock outcrops, suggesting bedrock may be steeply sloped in a localized area around YOWN-2207 S/D.

Hydrogeology

The hydrostratigraphy of an area is a simplified representation of the geology where the various geological units are grouped and classified according to the hydraulic characteristics and expected hydrogeological behaviour (i.e., aquifer or aquitard). Classification of hydrostratigraphic units as aquifers or aquitards is completed on the basis of their relative hydraulic conductivity to other units and ability of the hydrostratigraphic unit to provide a useable source of groundwater. Table 6 presents a summary of the hydrostratigraphic units for the Study Area with detailed descriptions provided in the subheadings below.

Table 6: Inferred Hydrostratigraphic Units and Classifications

Hydrostratigraphic Unit	Thickness (m)	Elevation Range (masl)	Interpreted Depositional Environment	Hydrostratigraphic Classification
Fan Deposit	40	645 - 705	Alluvial Fan/Delta	Potential Localized Unconfined Aquifer
Till/Glaciolacustrine Deposit[(a)]	3 - 40	675 - 775	Glacial and Glaciolacustrine	Local Aquitard / Aquifer
Glaciofluvial Deposits (Sand and Gravel) [(a)]	5 - 30	640 - 710	Glaciofluvial	Proven Confined Aquifer and Local Potential Confined Aquifer (west of Fox Creek)
Deep Sand and Gravel[(a)]	10 - 17	585 - 605	Glacial Retreat Outwash	Potential Localized Confined Aquifer
Glaciolacustrine Deposit (Clay/Silt) [(a)]	15 -125	540 - 700	Glaciolacustrine (distal)	Aquitard
Till[(a)]	10 - 20	555 - 690	Glacial	Local Aquitard
Bedrock	-	< 740	N/A	Aquitard

Footnote
(a): Glacial Deposits (fluvial, lacustrine and till) units are assumed to be McConnell in age

Two confined aquifers were identified and delineated as part of the hydrostratigraphic interpretation. The aquifers mapped are associated with the Glaciofluvial Deposits (sand and gravel) and the Deep Sand and Gravel. Water well VOT TW10-02 is the well used to supply all drinking water of Village of Teslin (Village of Teslin Water Licence, 2020) and is screened in the Glaciofluvial Deposits. Deep Sand and Gravel was intersected only by two wells, the Community Well and well VOT TW10-01. Well WTH No. 1-87 may also potentially intersect the Deep Sand and Gravel, as the well is screened at the same elevation as the Community Well, but no lithology descriptors were available for confirmation. The Community Well screened in the Deep Sand and Gravel Deposit was the water supply well of Village of Teslin prior to 2010 and is no longer used as a drinking water source, but remains active for unanticipated circumstances (i.e., forest fires) (Village of Teslin Water Licence, 2020). The well did not produce enough water to meet the water demand of the Village of Teslin (Tetra Tech, 2017).

Two potential aquifers are identified in this report and are associated with the Fan Deposit and Glaciofluvial Deposit truncated by the Fan Deposit west of Fox Creek in the northwest of the Study Area. The two potential aquifers are described as follows:

- Fan Deposit – this likely permeable unit was delineated by Palmer (2020) but was not intersected by any well. At this time, there are no wells that are currently utilizing the Fan Deposit for water supply purposes and therefore insufficient evidence is present at this time to classify this permeable deposit as an aquifer (GeoYukon, 2023).
- Glaciofluvial Deposits truncated by fluvial processes associated with Fox Creek in the north-west of the Study Area – this deposit is of same origin as the Glaciofluvial Deposits near Village of Teslin but was truncated by the Fox Creek. Only one private domestic well is in this area (i.e., well name is Alaska Highway Mile 807, Fox Point Subdivision) and the Glaciofluvial Deposits are approximately 4.8 m thick. Insufficient boreholes/wells are available to definitively map this unit as an aquifer though these deposits are expected to behave hydraulically similarly to the Glaciofluvial Deposits near the Village of Teslin.

The proven aquifers, potential aquifers, and other hydrostratigraphic units are described in the subsections below with aquifer description sheets for the proven aquifers provided in Appendix 1. Hydrostratigraphic cross-sections showing the locations of the hydrostratigraphic units relative to one another are provided in Appendix 4, and an Aquifer Summary Table in the format of the BC Aquifer Mapping and Classification System (Bernardinucci and Ronneseth, 2002) is provided in Appendix 5. Aquifer shapefiles are provided in Appendix 6, aquifer-well correlations are provided in Appendix 7, and a table of the interpreted hydrostratigraphic picks by well record is provided in Appendix 8. The inferred extents of the two proven aquifers and the two potential aquifers are provided in Figures 2, 3 and 4.

Bedrock

The unconsolidated deposits in the Study Area are located within the bedrock valleys where the Cordilleran ice sheet was topographically controlled. Within the Study Area, the majority of the population resides in the valley bottom where bedrock is relatively deep and the unconsolidated deposits are thicker. A limited number of water wells have been drilled into bedrock and therefore the hydrogeological understanding of the bedrock is relatively low. As described in Section 3, there are three bedrock units as presented in the Yukon Geological Survey bedrock compilation (Yukon Geological Survey, 2022) that underlie the Study Area.

In general, the hydraulic conductivity of the bedrock is expected to be low in comparison to the unconsolidated sediments and is classified as an aquitard. Where appreciable groundwater flow within the bedrock occurs, it is expected to be controlled primarily by faults and fractures.

Despite the classification as an aquitard, low hydraulic conductivity shallow bedrock is often exploited for small-scale domestic water supply purposes. It is expected that the bedrock hydrostratigraphic unit would often be capable of providing a private domestic water supply, however the potential groundwater quality is unknown.

Till

The Till hydrostratigraphic unit is associated with the McConnell Glaciation and is generally observed as a thin deposit that directly overlies the bedrock. Three groundwater wells in the area intersected the till unit at valley bottom and information about the till deposits is limited. The Till unit is most likely dense at the bedrock contact and is inferred as an aquitard.

The Till unit was intersected by the stratigraphic borehole YOWN-2207 S/D at a depth of 43.9 m (~668 masl) in the base of the valley. At this location, the unit is described as a dense diamict consisting of sandy clayey silt with some gravel. The unit was not intersected by YOWN-2206. The unit was also intersected at two other wells in the Study Area – at the Community Well and well VOT TW10-01 at depths 99.1 m (~588 masl) and 120.4 m (~569 masl), respectively.

Glaciolacustrine Deposit (Clay/Silt) (Teslin Aquitard)

The Glaciolacustrine Deposit hydrostratigraphic unit directly overlies the Till unit and Bedrock. The deposit is interpreted to be comprised of clay and silt with some sand and is expected to have low hydraulic conductivity in relation to the overlying and underlying hydrostratigraphic units. The clay/silt aquitard is interpreted to be associated with a glacial lake that formed in the area and is assumed to be distributed relatively contiguously across the Study Area.

This hydrostratigraphic unit is considered to be an aquitard and is herein referred to as the Teslin Aquitard.

Nàghas'ê X'ayi tayî hîn (water under Fox Point): Deep Sand and Gravel Aquifer

The Deep Sand and Gravel hydrostratigraphic unit is confined by the Glaciolacustrine Deposit and generally overlies the Till unit. The Deep Sand and Gravel unit consists mainly of sand and gravel with trace of clay and silt. The Aquifer is located in Village of Teslin and was intersected at the Community Well and well VOT TW10-01. Well WTH No. 1-87 may also potentially intersect the Deep Sand and Gravel, as the well is screened at the same elevation as the Community Well, but no lithology descriptors were available for confirmation.

The depositional environment of the sand and gravel that comprise this aquifer are uncertain, but could be associated with the following:

a. Glaciofluvial retreat outwash from a local glacial retreat
b. Depositional processes from the nearby Nisutlin Bay Inlet discharging into Teslin Lake.
c. Subaqueous outwash / ice contact sediments

The Deep Sand and Gravel Aquifer unit is likely more extensive than mapped; however, limited information constrains the unit's mapped extent. One water supply well (Community Well located in Village of Teslin) is present in the unit. The well, VOT TW10-01 did not encounter enough water to meet water demand of Village of Teslin (Tetra Tech, 2017), but did intersect the Deep Sand and Gravel unit. Additional deep boreholes/wells at similar depths would be needed in the area to provide more information on the extents of the Deep Sand and Gravel. The inferred extent of the Deep Sand and Gravel hydrostratigraphic unit is presented in Figure 3.

This hydrostratigraphic unit is herein referred as the Deep Sand and Gravel Aquifer.

Axh'áká tayî hîn (water under Teslin): Glaciofluvial Aquifer and Potential Glaciofluvial Aquifer

The Glaciofluvial Deposits hydrostratigraphic unit overlies the Glaciolacustrine Deposits hydrostratigraphic unit and is overlain by the Till/Glaciolacustrine Deposits hydrostratigraphic unit. Lithological descriptors indicate that the deposits are predominantly sand and gravel with varying silt content. Most of the wells located in the Study Area intercept these Glaciofluvial Deposits and are screened in this unit. The Glaciofluvial Deposits extend throughout Teslin and is inferred to be a confined aquifer. This unit is the main water supply deposit of the Village of Teslin.

The Glaciofluvial Deposits were intersected by stratigraphic boreholes YOWN-2206 and YOWN-2207 S/D at a depth of 9.1 m (~677 masl) and 31.2 m (~682 masl), respectively. The hydrostratigraphic unit is described as a fine sand to gravelly sand.

This hydrostratigraphic unit is herein referred to as the Glaciofluvial Aquifer. Furthermore, Glaciofluvial Deposits truncated by alluvial processes associated with Fox Creek (the Fan Deposit) to the north-west of the Study Area is inferred to as a potential glaciofluvial aquifer. This deposit is of same origin as the Glaciofluvial Deposits near Village of Teslin but was truncated by fluvial processes and alluvial deposition associated with Fox Creek (the Fan Deposit). Only one private domestic well is in this area where the unit is approximately 4.8 m thick. Insufficient boreholes/wells are available to definitively map this unit as an aquifer.

The inferred extent of the Glaciofluvial Deposits hydrostratigraphic unit and the possible extent of the Glaciofluvial Deposit hydrostratigraphic unit west of Fox Creek is presented in Figure 4.

Till/Glaciolacustrine Deposit

The Till/Glaciolacustrine Deposit hydrostratigraphic unit is comprised of a mix of till and glaciolacustrine deposits described as silty clay to gravelly sandy silt and gravelly silty sand. The unit is overlying the Glaciofluvial Deposit and is extensive throughout the Study Area, except for the Fan Deposit identified near the Fox Point subdivision. The heterogeneity of this deposit may have localized areas of high permeability; however, it is anticipated that these portions would be of limited extent, and well yields would likely be limited. The depositional environment of the Till/Glaciolacustrine Deposit is inferred to be associated with a re-advance at the McConnell glaciation.

The Till/Glaciolacustrine Deposit was intersected by stratigraphic boreholes YOWN-2206 (at surface at ~688 masl with a thickness of 9.1 m) and YOWN-2207 S/D (at surface at ~715 masl with a thickness of 31.2 m). The Till/Glaciolacustrine Deposit at stratigraphic borehole YOWN-2206 and YOWN-2207 S/D is described at Section 3.

Fan Deposit (Potential Fan Aquifer)

The Fan Deposit hydrostratigraphic unit is comprised of an alluvial fan deposit located along the northwestern portion of the Study Area in the vicinity of Fox Point subdivision. The hydrostratigraphic unit was identified using the surficial mapping of Teslin delineated by Palmer (2020) and extends from surface to a depth of 40 mbgs. The unit is inferred to overlie bedrock and is constrained by Teslin Lake to the southwest. Alluvially deposited materials are assumed to be predominantly coarse and thus permeable. There are no water supply wells or wells/boreholes present in the unit, and no estimate of yield has been obtained at this time. Wells would need to be installed in the area to confirm the deposits are permeable as assumed and to provide more information on the Fan Deposit prior to it being classified as an aquifer. The possible extent of the Fan Deposit's hydrostratigraphic unit is presented in Figure 5.

The hydrostratigraphic unit is herein referred to as the Potential Fan aquifer. The potential fan aquifer is proposed based on the geomorphology and inferred depositional environment.

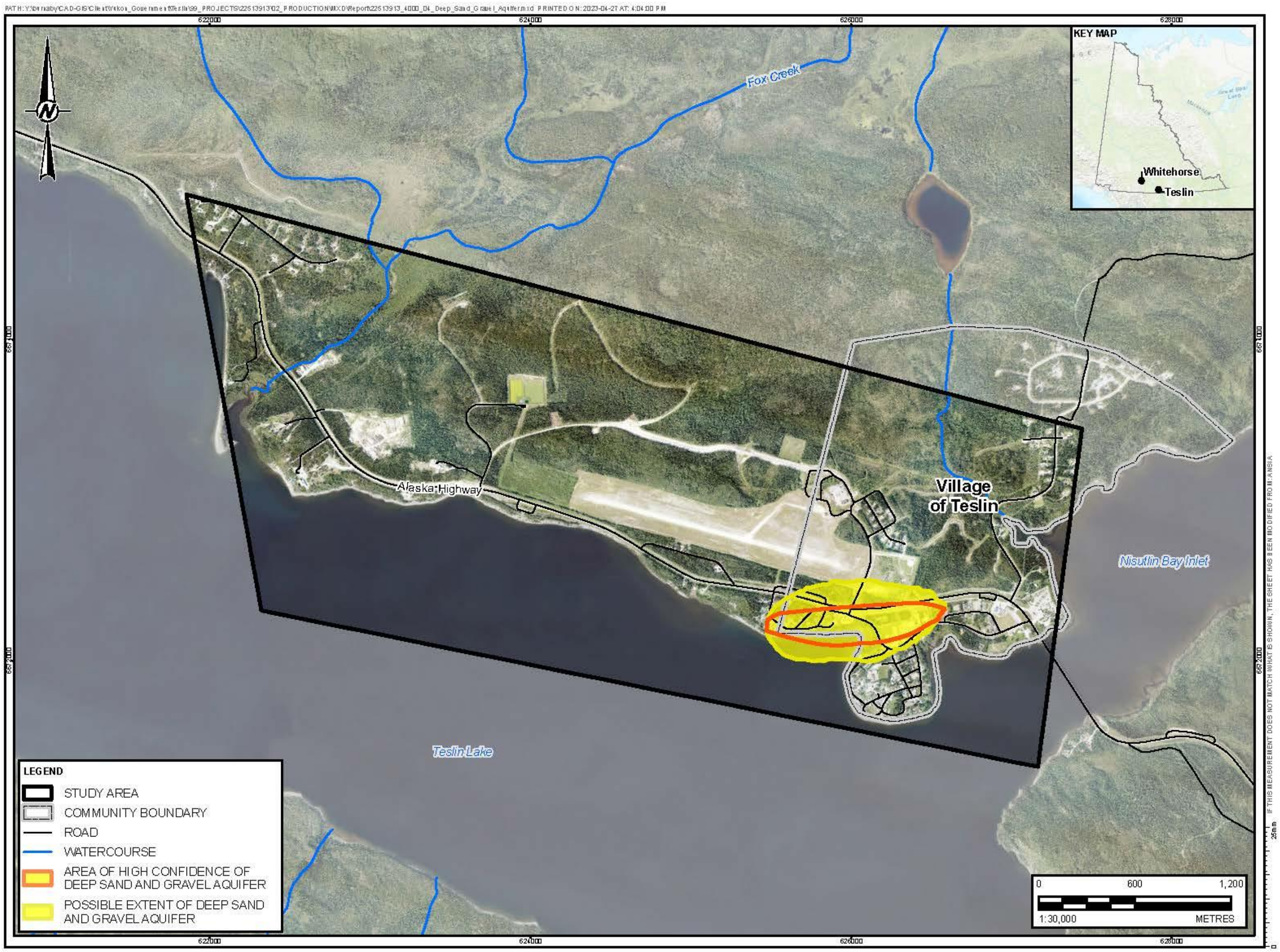


Figure 3. Inferred extent of the Deep Sand and Gravel hydrostratigraphic unit (Deep Sand and Gravel Aquifer)

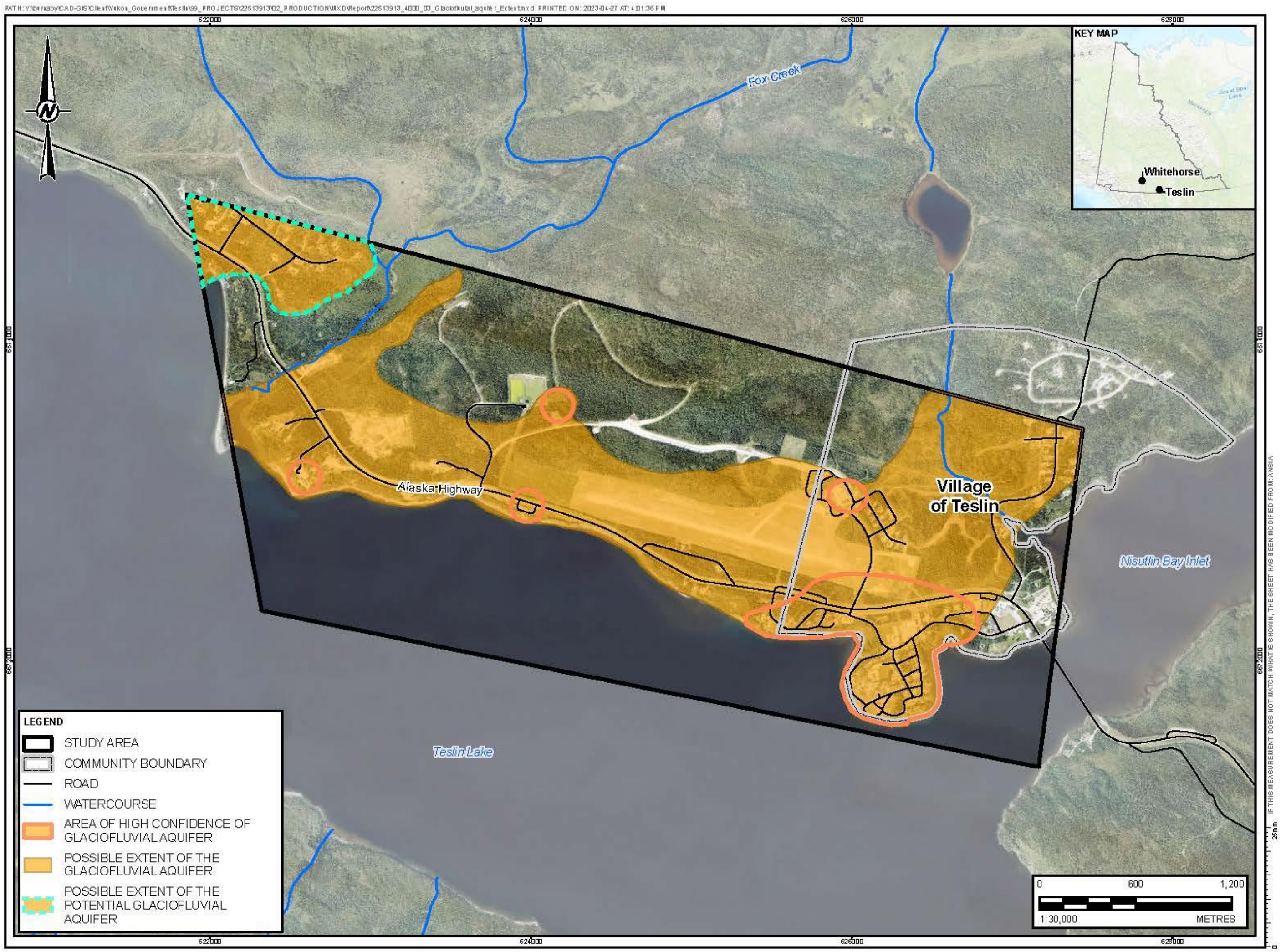


Figure 4. Inferred extent of the glaciofluvial deposit hydrostratigraphic unit (Glaciofluvial Aquifer) and possible extent of the glaciofluvial deposit hydrostratigraphic unit (Potential Glaciofluvial Aquifer) truncated by the alluvial

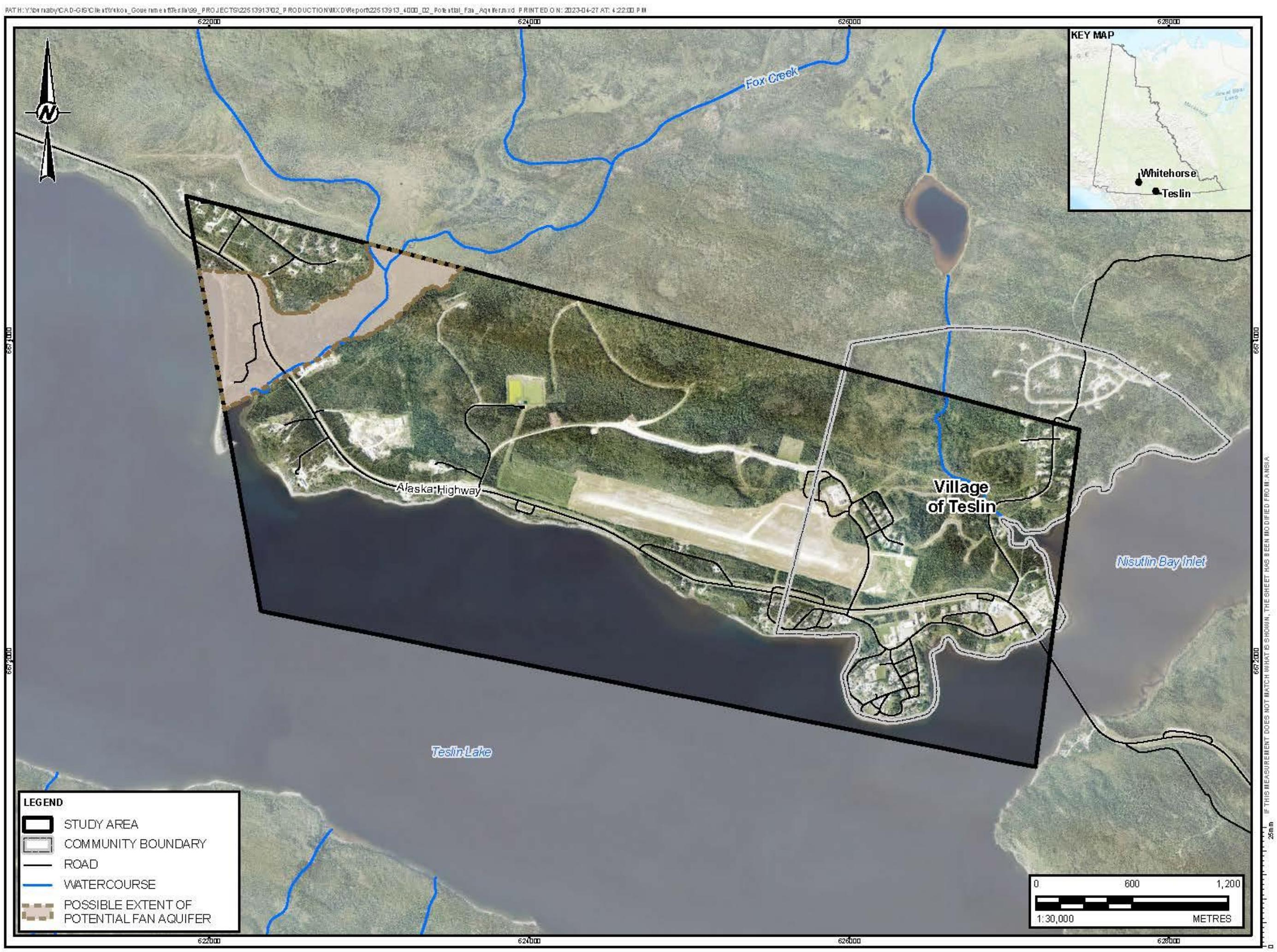


Figure 5. Possible extent of the Fan Deposit hydrostratigraphic unit (Potential Fan Aquifer)

Permafrost

Permafrost is defined as ground (soil or rock) that remains at or below 0 °C for two or more consecutive years. Active layer is defined as the top layer of ground subject to annual thawing and freezing in areas underlain by permafrost (Harris et al., 1988). Teslin lies within a sporadic to discontinuous permafrost zone (Bonnaventure et al., 2020; Brabets et al, 2000). To characterize permafrost in Teslin, Kryotec Arctic Innovation Inc (2021) conducted five electrical resistivity geophysical surveys in September 2021. The five 100-m surveys are located within the Study Area and are shown on Figure 5.

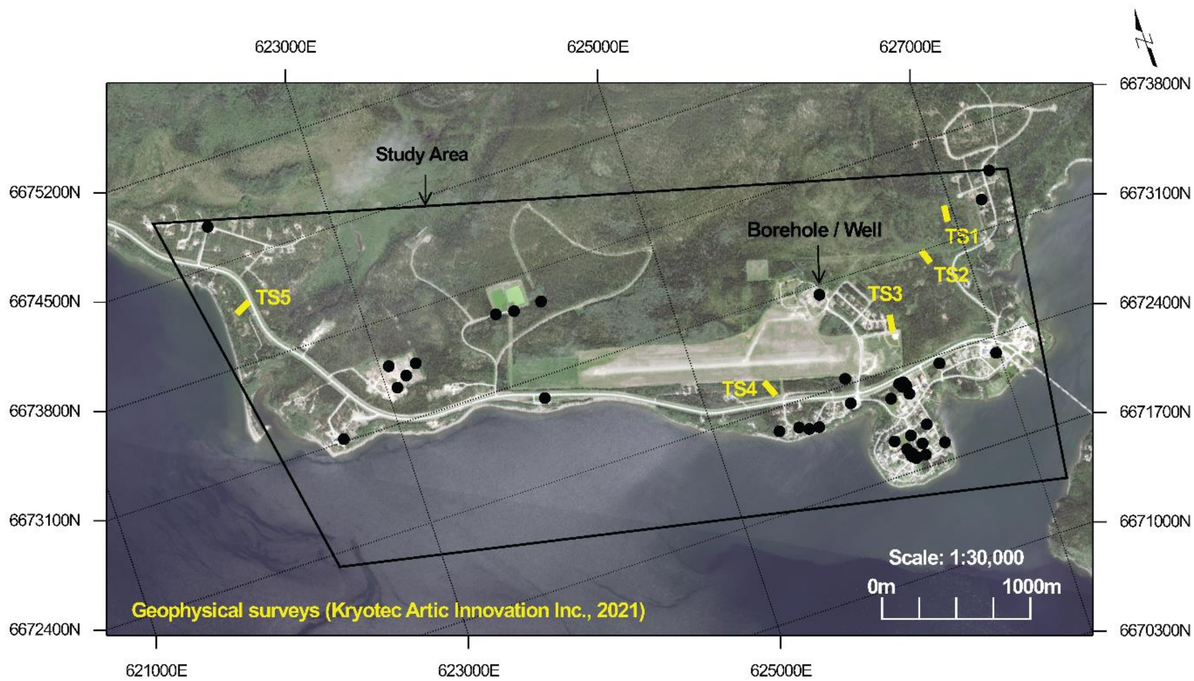


Figure 6. Approximate locations of the five geophysical surveys TS1, TS2, TS3, TS4 and TS5

Permafrost was identified at surveys TS1, TS2, TS3 and TS5. Landform evidence of degraded permafrost was observed on-site and agreed with the results of the electrical resistivity surveys for TS2, near the cleared powerline area, and TS5, near the Alaska Highway. Active layer thickness is generally greater than one meter in depth, except in degraded permafrost zones. It is inferred that the permafrost base can extend to approximately 18 m below ground surface. The coldest and most extensive permafrost zone was observed at survey TS5. Two inferred taliks were identified at surveys TS2 and TS5. A talik is defined as a layer or body of unfrozen ground in a permafrost area (Harris et al., 1988).

Permafrost was not incorporated into the model as limited information on permafrost conditions in Teslin are available. Although permafrost was not included in the model, the following should be considered:

- Permafrost has very low permeability and acts as a local confining layer in a context of discontinuous to sporadic permafrost distribution.
- Taliks are generally a preferential pathway for groundwater and tend to advect heat in aquifers.
- Climate change disrupts permafrost stability inducing its degradation. Permafrost thawing may increase an aquifers recharge, thus increasing base flow in streams.

Permafrost develops in frost-susceptible materials, predominantly in fine sediments such as silt and clays. Palmer et al. (2020) mapped surficial soils in Teslin and identified material where permafrost was most likely to be encountered. Permafrost would be encountered mainly in organic surficial material (13 % of the mapped area) and in colluvial surficial soils (3% of the mapped area). These materials are located to the north of the Study Area towards Fox Point subdivision and east of the airport. Permafrost could also be encountered in glaciolacustrine soil overlain by organics.

Data gaps and uncertainty

As part of a data gap assessment for the project, WSP reviewed available data for the Study Area and prepared a presentation on the Data Coverage and Gap Analysis for the Teslin area for YG WRB, Teslin Tlinglit Community, YGS, GSC and Yukon University. The primary data gaps identified during this assessment included:

- A limited number of deep boreholes (> 50 m)
- Uncertainty associated with the lithological descriptions included in the deeper boreholes from the Yukon Water Well Registry (descriptions are from well drillers and not geologists)
- Lack of spatial distribution of deep boreholes which would allow for stratigraphic correlation of potential deeper aquifers or confining units at depth (primarily below ~670 masl)
- Limited or inconsistent description/presence of possible confining units or aquitards (till, clay, silt) at depth
- Limited information outside of the populated area to delineate lateral extent of aquifers
- Limited information from borehole logs on the bedrock or depth of bedrock contacts in the valley
- Limited information on permafrost conditions and distribution in Teslin.

Based on the results of this data gap assessment, the YG WRB drilled the YOWN-2206 and YOWN-2207 S/D stratigraphic borehole to address some of the data gaps and uncertainties that were identified. The YOWN-2206 and YOWN-2207 S/D stratigraphic boreholes were extremely beneficial to the project as it provided the following:

- A deep borehole in a strategically important area that reached the top of bedrock
- High quality sediment descriptions, logged and reviewed with local experts at the YGS, that could be used to correlate lithology descriptions from other water well records and boreholes
- Information on the geological history and depositional environment, which allowed greater confidence in extrapolating aquifer boundaries in areas of uncertainty and limited information
- Monitoring wells that provide the opportunity for ongoing groundwater monitoring at these locations

Outstanding data gaps include the following:

- Other than the YOWN-2206 and YOWN-2007 S/D stratigraphic boreholes, limited information on the deeper hydrostratigraphic units (i.e. Deep Sand and Gravel Aquifer and Teslin Aquitard) exists to confirm lateral continuity of the units and the hydrostratigraphic interpretation
- Limited subsurface information outside of populated areas and areas of major projects (i.e. airport, highways).
- Limited information on permafrost conditions and distribution in Teslin (Section 4)

Conclusions and recommendations

Two proven aquifers and two potential aquifers have been delineated in the Teslin area. Nàghas'ê X'ayi tayî hîn, the Glaciofluvial Aquifer, is a confined sand and gravel aquifer constrained to the glaciofluvial deposit extending throughout Teslin Study Area and the majority of the wells are screened in this aquifer. Axh'áká tayî hîn, the Deep Sand and Gravel Aquifer is a confined sand and gravel aquifer located in the vicinity of Village of Teslin. The Potential Glaciofluvial Aquifer is a confined sand and gravel aquifer with the same depositional environment as the Glaciofluvial Aquifer but which has been isolated by fluvial processes associated with Fox Creek. The Potential Fan Aquifer is an unconfined aquifer located to the northwest of the Study Area near Fox Point subdivision. Additional wells and yields would be needed to confirm the viability of the Potential Glaciofluvial unit in the Fox Point subdivision and the Potential Fan unit as proven aquifers.

Recommendations for continuing study include:

- Digitization of YWWR well records into a database format to facilitate future mapping efforts or modifications as additional data become available.
- Surveying of newly installed YOWN-2206 and YOWN-2207 S/D monitoring wells to establish a groundwater elevation, and an on-going groundwater monitoring program at these wells.
- While high resolution LiDAR significantly reduces vertical uncertainty in comparison to the Canadian Digital Elevation Model (CDEM), further reduction in spatial uncertainty and errors associated with the well records could be accomplished with a well survey. Well survey data of important stratigraphic wells would increase the accuracy in the horizontal (XY) dimension as well as the vertical (Z) dimension, providing additional confidence and stratigraphic control on the interpretation.
- Areas with limited subsurface information are candidate locations where surficial geophysical methods (electric resistivity imaging, electromagnetic methods, or seismic surveys) could be employed to better understand stratigraphy. Ideally, to interpret the geophysical data, the data should be calibrated to the stratigraphy logged from a test borehole or at the very least a competent water well log.
- Uncertainties with respect to items such as lateral extents of aquifer borders, spatial uncertainty and interconnectivity of permeable units are highlighted both in this report and in the aquifer classification worksheets. Subsurface data continues to be generated that can address gaps in the current conceptual understanding. Consideration should be given to mechanisms where newly generated data that has the potential to improve the current interpretation of the subsurface is integrated and disseminated to the public in a timely manner.
- Assumptions concerning the extrapolation of aquifer boundaries using geological rationale to areas where there is limited to no subsurface lithological data are outlined

on the aquifer description sheets. The implications of these assumptions should be considered within the context of the Territorial aquifer mapping and water allocation strategies. For example, is it more desirable to have a situation where an aquifer is intersected where an aquifer has not been mapped as a result of conservative delineation or to have a situation where an aquifer is not intersected in an area where it is anticipated to be as a result of hydrostratigraphic extrapolation?

- Additional deep boreholes or wells located away from the YOWN-2206 and YOWN-2207 S/D stratigraphic borehole would be useful to confirm the bedrock topography and the presence and lateral continuity of the Potential Deep Sand and Gravel Aquifer.
- Additional deep boreholes or wells located to confirm the presence and lateral continuity of the Potential Glaciofluvial Aquifer as well as to reduce uncertainty in the hydrostratigraphic interpretation.

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Appendices

Appendix 1. Aquifer Description Sheets

Aquifer Description for Glaciofluvial Aquifer

1. Conceptual Understanding of Hydrostratigraphy

Aquifer Extents

The Glaciofluvial Aquifer is a confined sand and gravel aquifer located throughout Teslin.

Geologic Formation (Overlying Materials)

The aquifer is confined and overlain by till/glaciolacustrine deposits.

Geologic Formation (Aquifer)

The aquifer consists of sand and gravel with varying silt content. The aquifer is inferred to be associated with glacial outwash during the glacial retreat to the south of the Study Area. The YOWN-2206 stratigraphic borehole completed by the YG WRB suggests that the unit is up to 9 m thick and is described as a sand with some gravel to gravelly sand. The YOWN-2207 S/D stratigraphic borehole completed by the YG WRB suggests that the unit is up to 13 m thick in this area and is described as a fine sand with some silt to gravelly sand.

Vulnerability

Moderate – the aquifer is confined, and the water table is typically deep (> 10 m below surface). The aquifer is hydraulically connected to Teslin Lake along the southern edge of the aquifer. Some local areas of the overlying material may thin, coarse or discontinuous and not provide full confinement.

2. Conceptual Understanding of Flow Dynamics

Groundwater levels and flow direction

Groundwater levels for wells inferred to be screened in the aquifer unit are between 11 m and 40 m below ground with an average depth of 25.5 mbgs. Regional groundwater flow directions are expected to be towards Teslin Lake.

Recharge

Recharge occurs from infiltration from the overlying deposits, Teslin Lake and precipitation from the highlands.

Potential for hydraulic connection

The aquifer is assumed to be hydraulically connected to Teslin Lake.

3. Water Management

Additional information on water use and management

Wells screened in the Glaciofluvial Aquifer are used for public supply purposes, private domestic purposes, commercial/industrial purposes and environmental monitoring purposes. Well yield estimates for this aquifer obtained from airlifting or bailing range from 0.50 to 3.15 L/s (8 to 50 USGPM) with a geomean of 1.40 L/s (22.1 USGPM). Several small public supply wells are inferred to be screened in this aquifer based on wells depths, however detailed lithological well logs were not available for a number of these wells.

Additional Assessments or Management Actions

A water supply well (TTC-01-20) near the Teslin Tlingit Council was completed and tested in 2020 by Morrison Hershfield (Morrison Hershfield, 2021). Chloride concentrations in groundwater samples varied between 977 to 989 mg/L and exceeds the Guideline for Canadian Drinking Water Quality (GCDWQ) Aesthetic Objective (AO)of 250 mg/L. Correspondingly, total dissolved solids is high (2000 to 3000 mg/L) and exceeds the GCDWQ AO of 500 mg/L. Measured hardness values ranged between 1920 and 1980 mg/L, which classify the groundwater as “extremely hard”. Finally, groundwater samples from TTC-01-20 were found to significantly exceed both GCDWQ Maximum Allowable Concentration (MAC) (0.12 mg/L) and AO (0.02 mg/L) for total manganese (0.715 – 0.783 mg/L), while total iron concentrations (5.04 – 6.92 mg/L) were found to exceed GCDWQ AO (0.3 mg/L).

4. Aquifer references

Berardinucci, J. and Ronneseth, K., 2002. Guide to Using the BC Aquifer Classification Maps for the Protection and Management of Groundwater. BC Ministry of Water, Land and Air Protection, Water Air and Climate Change Branch, Water Protection Section.

Palmer. 2020. Teslin Terrain and Physical Development Constraints Mapping. Memorandum submitted June 20, 2022, p. 1-18.

Tetra Tech, 2017. Yukon Source Water Supply Protection Study – Village of Teslin Water Supply System. WTR.GWTR03022-04.

Wei, M., D. M. Allen, A. P. Kohut, S. Grasby, K. Ronneseth, and B. Turner. 2009. Understanding the Types of Aquifers in the Canadian Cordillera Hydrogeologic Region to Better Manage and Protect Groundwater. Streamline Watershed Management Bulletin, FORREX Forum for Research and Extension in Natural Resources.

5. Revision history

Date	Version	Revision Class	Comments	Author
20230410	001	Major	Initial mapping of aquifer	WSP

Aquifer Description for the Deep Sand and Gravel Aquifer

Aquifer Extents
The Deep Sand and Gravel is a confined sand and gravel aquifer. The aquifer is located in Village of Teslin. It is most likely the unit is more extensive than mapped, but limited information constrains the aquifer's extent.

Geologic Formation (Overlying Materials)
The aquifer is confined by the Glaciolacustrine Deposit and generally overlies glaciolacustrine materials or till.

Geologic Formation (Aquifer)
The aquifer consists mainly of sand and gravel with trace of clay and silt. The origin of the aquifer is uncertain by may be associated with glaciofluvial retreat outwash from a local glacial retreat, depositional processes from the nearby Nisutlin Bay Inlet discharging into Teslin Lake, or subaqueous outwash or ice contact deposits. The aquifer is likely more extensive than mapped; however limited information constrains the aquifer's extent.

Vulnerability
Low – the aquifer is confined, and the water table is typically deep (> 10 m below surface). The aquifer is indirectly hydraulically connected to Teslin Lake via the surrounding glaciolacustrine materials.

1. Conceptual Understanding of Flow Dynamics

Groundwater levels and flow direction
Lack of information on this unit does not allow to know groundwater levels for wells inferred to be screened in the aquifer unit. Regional groundwater flow directions are expected to be towards Teslin Lake.

Recharge
Recharge occurs from infiltration from the overlying Teslin Lake and regional groundwater movement from the highlands.

Potential for hydraulic connection
The aquifer is assumed to be indirectly hydraulically connected to Teslin Lake via the surrounding glaciolacustrine deposits.

2. Water Management

Additional information on water use and management
A limited number of wells (< 10 wells) in the Teslin area are inferred to be screened in the Deep Sand and Gravel aquifer and are used for public supply purposes only. Lack of well information does not allow an evaluation of the aquifer's yield.

Additional Assessments or Management Actions
Not available

3. Aquifer references

Berardinucci, J. and Ronneseth, K., 2002. Guide to Using the BC Aquifer Classification Maps for the Protection and Management of Groundwater. BC Ministry of Water, Land and Air Protection, Water Air and Climate Change Branch, Water Protection Section.

Palmer. 2020. Teslin Terrain and Physical Development Constraints Mapping. Memorandum submitted June 20, 2022, p. 1-18.

Village of Teslin Water Licence, 2020. Village of Teslin Water Licence MN99-025-1-1 Renewal Application.

Tetra Tech, 2017. Yukon Source Water Supply Protection Study – Village of Teslin Water Supply System. WTR.GWTR03022-04.

Wei, M., D. M. Allen, A. P. Kohut, S. Grasby, K. Ronneseth, and B. Turner. 2009. Understanding the Types of Aquifers in the Canadian Cordillera Hydrogeologic Region to Better Manage and Protect Groundwater. Streamline Watershed Management Bulletin, FORREX Forum for Research and Extension in Natural Resources.

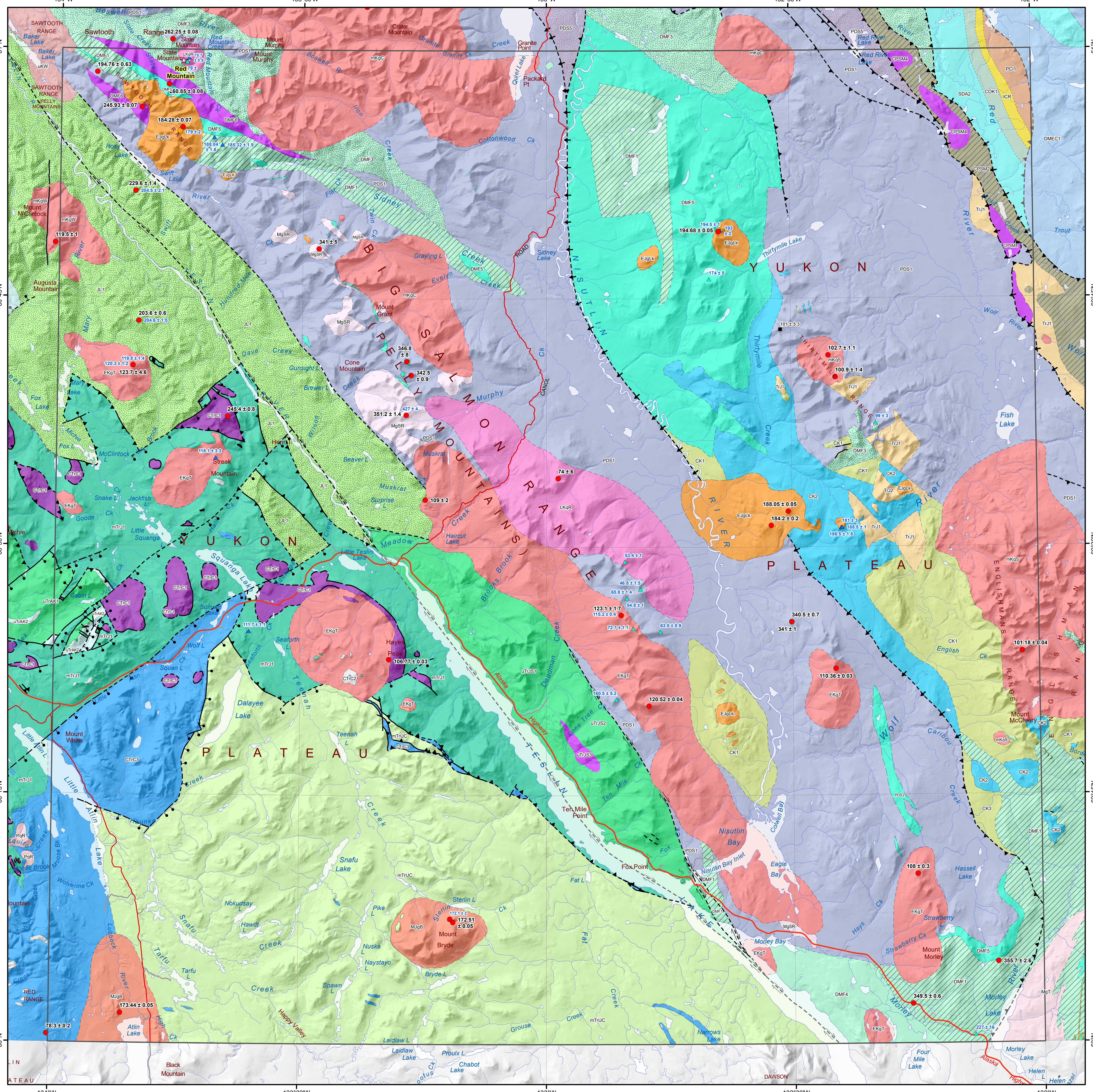
4. Revision history

Date	Version	Revision Class	Comments	Author
20230410	001	Major	Initial mapping of aquifer	WSP

Appendix 2. Geological Mapping

Yukon Geological Survey

Yukon



Note: legend contains geological information for the map extent and not the surrounding area.

MINERAL OCCURRENCE

- Deposit
- Historic Deposit
- Significant exploration project

GEOCHRONOLOGY METHOD

- U/Pb, Zircon
- U/Pb, Other
- Ar/Ar
- K/Ar

LATE CRETACEOUS

LKqR: RANCHERIA SUITE: Bt-Ms leucogranite and monzogranite

MID-CRETACEOUS

mKgC: CASSIAR SUITE: Bt ± Hbl ± titanite-bearing monzogranite to granodiorite

mKgW: WHITEHORSE SUITE: Bt-Hbl granodiorite, Hbl quartz diorite and Hbl diorite

mKqS: SEAGULL SUITE: Bt (± Ms) leucogranite to monzogranite

EARLY CRETACEOUS

EKgT: TESLIN SUITE: Hbl-Bt granite, granodiorite, quartz monzonite, quartz monzodiorite

UPPER CRETACEOUS

uKW: WINDY-TABLE: quartz-phyric dacite flows, ash and lapilli tuff

MID-JURASSIC

MJgB: BRYDE SUITE: Hbl monzodiorite, Hbl-Bt quartz monzodiorite, minor hornblendite

LOWER AND MIDDLE JURASSIC, HETTANGIAN TO BAJOCIAN

JL1: RICHTHOFEN: turbiditic sandstone-siltstone-mudstone, conglomerate

EARLY JURASSIC

EJgLk: LOKKEN SUITE: Hbl-Bt-Cpx monzodiorite to granodiorite, local monzonite

MIDDLE TRIASSIC TO LOWER JURASSIC

mTrJC: CACHE CREEK: ribbon chert interbedded with shale, siltstone and greywacke

UPPER TRIASSIC, CARNIAN TO RHAETIAN

uTrAK2: HANCOCK: massive to thick-bedded limestone

uTrAK1: CASCA: shale, siltstone, calcareous greywacke, argillaceous limestone

UPPER TRIASSIC TO LOWER JURASSIC?

uTrJS3: SHONEKTAW?: dunite, minor pyroxenite

uTrJS2: SHONEKTAW?: felsic volcanic/subvolcanic complex near Teslin

uTrJS1: SHONEKTAW: augite-bearing sandstone and lesser siltstone and mudstone

MIDDLE TRIASSIC

mTrJ1: JOE MOUNTAIN: massive basalt flows

MIDDLE TO UPPER TRIASSIC

TrJ2: JONES LAKE: bioclastic limestone and interbedded sandy or silty limestone

TrJ1: JONES LAKE: calcareous siltstone, shale, and fine sandstone

CARBONIFEROUS TO JURASSIC

CTrC4: KEDAHDA: thin-bedded, grey, black, red and brown chert

CTrC3: HORSEFEED: massive, finely crystalline, locally crinoidal and fusiline grey limestone

CTrC2: NAKINA: andesitic and basaltic spherulitic greenstone

CTrC1: NAHLIN: variably tectonized, serpentinized and chloritized ultramafic rocks

CARBONIFEROUS TO PERMIAN

CPSM5: SLIDE MOUNTAIN: medium to coarse-grained gabbro

CPSM4: SLIDE MOUNTAIN: brown weathering, variably serpentinized ultramafic rocks

CPSM2: CAMPBELL RANGE: dark green to black basalt, greenstone, locally pillowed

CARBONIFEROUS

CK3: KLINKIT: arkosic sandstone, basal polymictic metaconglomerate

CK2: KLINKIT: limestone, marble, locally fossiliferous

CK1: KLINKIT: mafic to intermediate metavolcaniclastic and metavolcanic rocks; minor felsite

MISSISSIPPIAN

MgT: TATLMAIN SUITE: Hbl quartz diorite, tonalite; Hbl-Bt granodiorite

MgSR: SIMPSON RANGE SUITE: Hbl-bearing metagranodiorite, metadiorite and metatonalite

DEVONIAN, MISSISSIPPIAN AND(?) OLDER

DMF6: FINLAYSON: ultramafic rocks, serpentinite; metagabbro

DMF5: FINLAYSON: light grey to white marble, locally crinoidal

DMF4: FINLAYSON: light green to grey, fine-grained siliciclastic and metavolcaniclastic rocks

DMF3: FINLAYSON: dark grey to black carbonaceous metasedimentary rocks, metachert

DMF1: FINLAYSON: intermediate to mafic volcanic and volcaniclastic rocks

UPPER DEVONIAN TO LOWER MISSISSIPPIAN

DMEC1: EARN - CASSIAR: black siliceous slate, quartz-chert greywacke, grit and conglomerate

MIDDLE SILURIAN TO MIDDLE DEVONIAN

SDA2: ASKIN: dolostone, silty and sandy dolostone, limestone

UPPER CAMBRIAN AND ORDOVICIAN

COK1: KECHIKA: thin-bedded, lustrous, calcareous, grey slate, phyllite, limestone

LOWER CAMBRIAN

ICR: ROSELLA: resistant, thick-bedded to massive, limestone and argillaceous limestone

NEOPROTEROZOIC AND PALEOZOIC

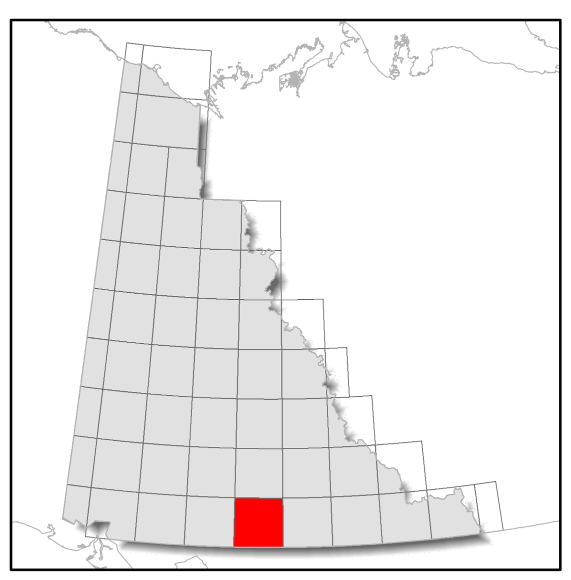
PDS5: SNOWCAP: psammite, quartzite and amphibolite metamorphosed to eclogite, blueschist

PDS2: SNOWCAP: light grey to buff weathering marble

PDS1: SNOWCAP: quartzite, psammite, pelite and marble; minor greenstone and amphibolite

NEOPROTEROZOIC TO LOWER CAMBRIAN

PCI1: SWANNELL/TSAYDIZ: calcareous sandstone, shale, quartz-eye grit, quartzite



1:250 000-scale base data produced by CENTRE FOR TOPOGRAPHIC INFORMATION, NATURAL RESOURCES CANADA

30 metre shaded relief from Geomatics Yukon www.geomaticsyukon.ca

BEDROCK GEOLOGY
TESLIN (105C)
YUKON

0 5 10 15 20 25
kilometres

These maps contain the most current bedrock geology information in Yukon. All geological data are from the Yukon Geological Survey and available free of charge. Data are from recent mapping, regional compilations and thesis work.

The geological data used to create these maps can be downloaded at https://data.geology.gov.yk.ca/Compilation/3.

These maps are subject to periodic updates. This map was last updated in February 2022.

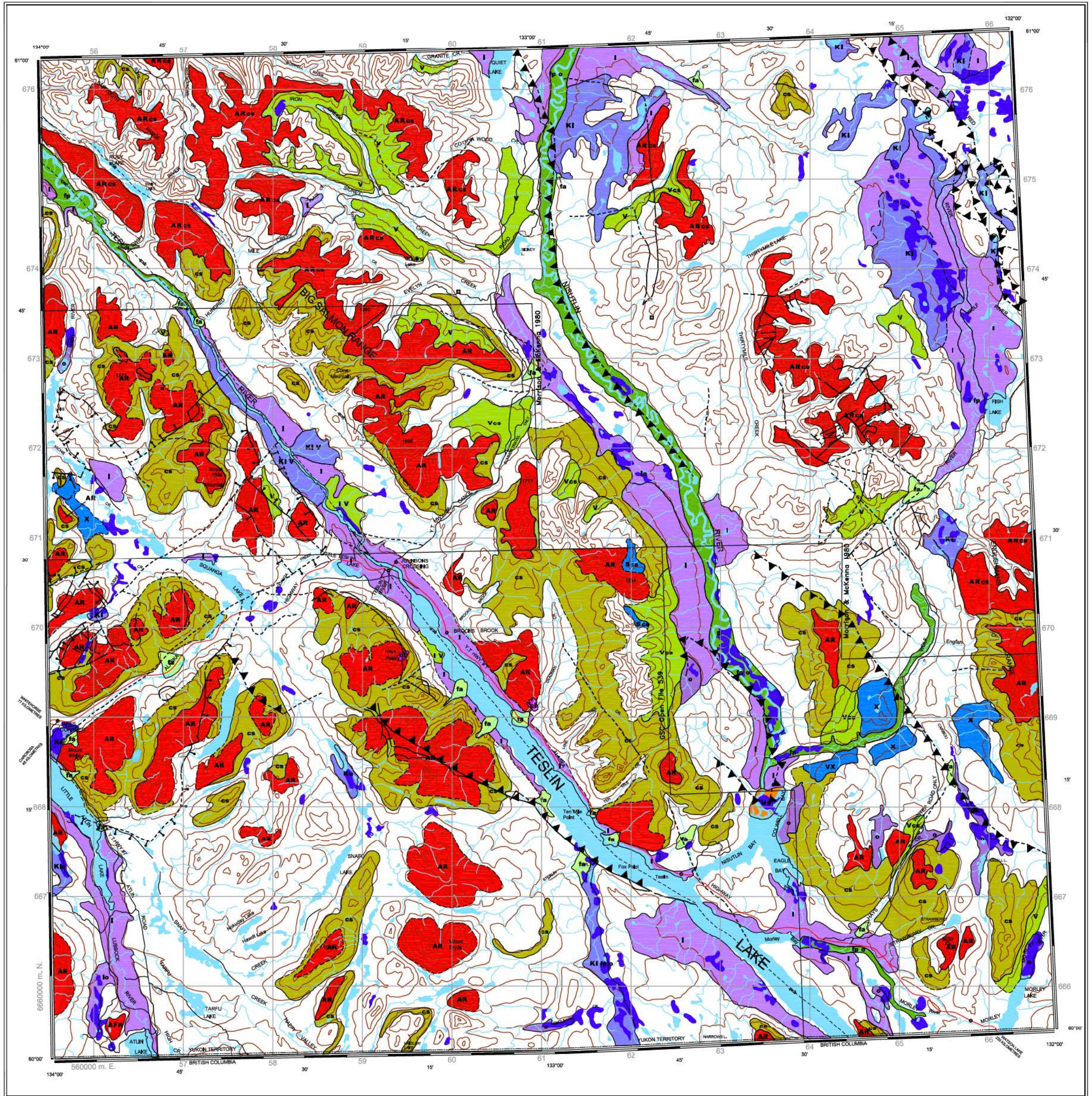
The Yukon Geological Survey welcomes any revisions or new geological information. Any questions or comments can be directed to geology@gov.yk.ca.

Yukon Government

YUKON GEOLOGY PROGRAM

Canada

NATIONAL TOPOGRAPHIC SERIES NTDB (1995) D.I.A.N.D. N.A.P. LAND RESOURCES CANADA SHEET 105C



TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID NAD 83 ZONE 8

NOTE: THIS MAP HAS BEEN PRODUCED BY THE COMPILATION OF DATA FROM VARIOUS SOURCES. IT IS NOT TO BE USED TO DEFINE LEGAL BOUNDARIES.

THIS MAP IS ISSUED AS A PRELIMINARY GUIDE FOR WHICH THE DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT WILL ACCEPT NO RESPONSIBILITY FOR ANY ERRORS, INACCURACIES OR OMISSIONS WHATSOEVER.

EDITION: 1 Print Date: 99/07/20

TESLIN
YUKON TERRITORY
105C

Scale

10 0 10 20 30 km

5 0 5 10 15 miles

CONTOUR INTERVAL 500 FEET Elevations in Feet above Mean Sea Level
North American Datum 1983 Transverse Mercator Projection
Universal Transvers Mercator Grid ZONE 8

Magnetic Declination 1989 varies from 29° 03' easterly at the centre of the west edge to 29° 01' easterly at the centre of the east edge. Mean annual change 12.3' westerly.

N

105E LABERGE	105F QUIET LAKE	105G FINLAYSON LAKE
105D WHITEHORSE	105C TESLIN	105B WOLF LAKE
104M B. C.	104N B. C.	104O B. C.

Index to Adjoining Sheets.

GEOPROCESS FILE - SUMMARY REPORT

TESLIN MAP AREA - NTS 105C

INTRODUCTION

The GEOPROCESS File is a compilation of information and knowledge on geological processes and terrain hazards, including mass movement processes, permafrost, flooding risks, faults, seismic activity and recent volcanism, etc. Please refer to the GEOPROCESS File User Guide for more in-depth information on how the maps were developed, which other GEOPROCESS File maps are available, how to utilize this inventory and how to interpret the legend. Special interest should be taken in the detailed description of the terrain hazard map units. Appendices in the User Guide include summary papers on the geological framework, permafrost distribution, and Quaternary geology in Yukon and a list of comprehensive GEOPROCESS File references.

This report includes a brief discussion of the scope and limitations of the GEOPROCESS File compilation maps followed by summaries of the bedrock geology, surficial geology and terrain hazards for this NTS map area, and a list of references.

Geological Processes and Terrain Hazard Compilation Maps

The GEOPROCESS File map units were drafted on the 1:250 000 topographic base maps through interpretation from bedrock geology maps, surficial geology maps and in some cases terrain hazard maps at various scales. The compilation maps have a confidence level reflecting the original source material. All materials used to produce the maps are listed in the references attached to each map. A file containing the documentation used to construct these maps is available at the Indian and Northern Affairs library in Whitehorse, Yukon. Areas for which no surficial geology or terrain hazard information is published were left blank. Summary reports on surficial geology and terrain hazards for these map sheets were written by extrapolating the data from adjacent map sheets or smaller scale maps. Information from small scale (e.g., 1:1 000 000) maps was used for the summary reports, but not redrafted onto the 1:250 000 GEOPROCESS File maps.

The GEOPROCESS File compilation maps are intended as a first cut planning tool; the legend on the maps describes the general aspects of terrain hazards (also see below) and associated geological processes. **These maps should never replace individual site investigations for planning of site specific features, such as buildings, roads, pits, etc.**

Bedrock Geology Summaries

Each 1:250 000 N.T.S. map area is described according to morphogeological belts and terranes defined by Gabrielse et al. (1991) and Wheeler et al. (1991). Bedrock geology (including structure) and mineral occurrences are briefly described and taken largely from the referenced, most recent 1:250 000 geological map with additional contributions from Wheeler and McFeely (1991), and Yukon MINFILE (1993). A summary paper ("A Geological Framework for Yukon") in Appendix A of the User Guide provides a framework and context for each of the bedrock summaries.

The level of knowledge and understanding of Yukon geology is constantly evolving with more detailed mapping and development of geological models. Names, ages and terrane affinities of rock units on the most recent 1:250 000 geological maps may, in some cases, now be considered incorrect. Thus information contained within some of the bedrock geology summaries may be out of date. Although much of the information reflects the knowledge at the time that the source map was published, additional information has been inserted whenever possible to assist the user in merging the information with current geological maps, concepts and understanding. The age ranges for similar packages of rocks may also vary between map areas since the actual rocks, or at least the constraints on their age, may vary between map areas.

BEDROCK GEOLOGY

The Teslin map area is in the Intermontane and Omineca Belts which occupy the southwestern and northeastern portions of the map area, respectively. The regions are separated by two large, through-going, northwest-trending, strike-slip faults that parallel the Teslin Lake and River valleys. The two faults are known as the "Teslin Suture Zone" or "Teslin Fault".

The southwestern part of the map area hosts a complex array of volcanic and sedimentary rocks of the Cache Creek Terrane that range from 350-250 million years in age. The volcanic rocks are composed of altered basalt and andesitic greenstone with associated peridotite, serpentinized peridotite, diorite and gabbro. Cache Creek Terrane sedimentary rocks are composed of well-bedded grey to green ribbon chert, shale, siltstone and greywacke. All Cache Creek Terrane rock successions are folded and complexly faulted.

The northwestern-most part of the map area, as well as the region immediately east of the Teslin Lake and River valley is underlain by the 220-160 million year old rocks of Stikine Terrane. Stikine Terrane is dominated by folded Laberge Group greywacke, shale and siltstone with minor conglomerate that overlie Lewes River Group limestone and greywacke. These two sedimentary packages collectively comprise the fill of the Whitehorse Trough. Quesnel Terrane occupies a narrow belt of rocks immediately east of Teslin Lake. They are similar to Stikine Terrane in that they are the same age and dominated by greywacke, siltstone and shale, but they also contain augite porphyry, augite tuff, diorite, gabbro, dunite and pyroxenite.

Northeast of Stikine and Quesnel Terrane are rocks of the Kootenay Terrane (Nisutlin subterrane) that are in thrust fault contact with Cassiar Terrane (North American margin) along the Nisutlin River valley. Kootenay Terrane is composed of very old (300 million years to greater than one billion years old) metamorphosed sedimentary and igneous rock packages that include schist, greenstone, marble, metagabbro, metadiorite, amphibolite, hornblendite, tonalite, graphitic phyllite and quartzite (in other areas of the Yukon these rocks are known as the Nasina and Nisling assemblages of the Yukon-Tanana Terrane). Cassiar Terrane is composed of variably metamorphosed, 345-325 million year old volcaniclastics and flows, limestone, phyllite, quartzite and siltstone that overlie a sedimentary package of shale, chert, sandstone, chert pebble conglomerate and siliceous argillite. The sedimentary package overlies the pre-650 million year old Ingenika Group sandstone, grit, siltstone, limestone, dolostone, schist, quartzite and gneiss. Cassiar Terrane rocks are structurally overlain by a northwest-trending strip of sedimentary and volcanic rocks of the Slide Mountain Terrane which includes peridotite, pyroxenite, serpentinite, conglomerate, greywacke, limestone and diorite.

Four felsic intrusive suites ranging in age from 188 to 80 million years form numerous plutons that cut the varied terranes. The most voluminous is the approximately 110 million year old suite of quartz monzonite, quartz monzodiorite and biotite granite plutons of the Cassiar Suite.

Mineral Occurrences and Deposits

There are 60 known mineral prospects listed in Yukon MINFILE for the Teslin map area, of which 22 host mineralization. Despite the small number of occurrences, there is a large diversity of types of mineralization. Most occurrences are vein-type, mainly lead-silver, copper plus or minus gold-silver, and gold silver. Tin and tungsten skarns are associated with the 110 million year old granitic plutons that intrude carbonates in the northeastern part of the map area. A few asbestos and chromium occurrences associated with ultramafic rocks of Cache Creek Terrane are documented. A single stratabound barite-lead-zinc-silver occurrence has been discovered in Cassiar Terrane rocks. The largest mineral deposit is the Red Mountain porphyry molybdenum deposit (187 million tonnes of 0.167% molybdenum) which is centred around a small, 100 million year old pluton that intrudes Kootenay Terrane metamorphic rocks. Production has been reported from only one property - a rhodonite occurrence in Kootenay Terrane. Placer gold has been reported from Iron, Sydney and Seaforth creeks.

SURFICIAL GEOLOGY

The main sources of information for the Teslin map sheet are a series of four surface geology and soil maps at the 1:100 000 scale (Morison and McKenna, 1990) and a surface geology map at the 1:250 000 scale (Morison and Klassen, in press).

The surface deposits of the Teslin map sheet are associated with the most recent Cordilleran ice sheet, the McConnell glaciers, believed to have covered south and central Yukon between 26,500 and 10,000 years ago. Most of the map sheet was covered by the Cassiar lobe which flowed westward and northwestward from the Cassiar Mountains (Jackson, 1994).

The distribution of Quaternary deposits in this area follows a general pattern. High elevation slopes are covered with colluvial or morainal veneer over bedrock. In most cases, at elevations of 1200 metres and above, the bedrock is weathered, frost shattered or covered by colluvium.

Moraine deposits cover most mid-elevation slopes, the base of which can consist of mixed moraine blankets and colluvial fans or aprons. Large portions of the map surface are covered by morainal deposits or till. Till, or more correctly diamicton of glacial origin, is an unsorted mixture of coarse material ranging in size from pebble to boulder, with a matrix of clay, silt and sand. The general composition of the till matrix in adjoining map sheets (Jackson, 1994) indicates a wide range of content: sand (20 to 70%), silt (20 to 80%) and commonly lower clay (5 to 30%). The low clay content is reflected by the low plasticity and high permeability of the matrix. Morainal deposits can provide a stable base, if there is no permafrost present. Isolated lenses of ice-rich permafrost may occur locally on north-facing slopes and at high elevations, where thick organic deposits are present over the Quaternary sediments. Many of the till covered slopes are channeled or gullied.

In some valleys, benches of glaciofluvial sand and gravel flank the low elevation slopes. Glaciofluvial sand and gravel of variable thickness and composition are found in Lubbock River and Michie Creek valleys, Teslin River and Squanga Creek valleys, and in the northeast corner of the map area in the Red River valley. These deposits are mostly free of permafrost, commonly have stable surfaces and may contain undesirable lithologies (weak) for their potential use as aggregate.

During deglaciation, large volumes of meltwater were dammed in some valleys and formed large glacial lakes. Beachlines, lake bottom sediments, and modern lakes are now found in many of these valleys. Teslin Lake, Little Atlin and Atlin Lakes, as well as the Nisutlin River valley and the Red River valley north of Fish Lake are bordered by glaciolacustrine silt and clay deposits which can be as thick as 15 m. They commonly contain massive ice bodies and are prone to retrogressive thaw slide and thermokarst degradation when disturbed either by river erosion, forest fires, or other changes in surface conditions.

The White River tephra, deposited approximately 1,200 years ago, is visible in the upper horizons of soil profiles on most surfaces, and can sometimes be used as an indicator of active mass movement or erosion.

TERRAIN HAZARDS

There are no terrain hazard maps available for this area. Information on terrain hazards is derived from surface geology and soil maps.

Slope failures in steep bedrock represent the highest risk hazard in the area. Although not documented in any of the publications available and not present on the terrain hazard map, the potential for rock slides and avalanches should be kept in mind when an area is investigated.

Seismicity

There are five recorded seismic events within the map area. All of the recorded events are 2.0 to 2.999 or less in magnitude.

Mass Movement Processes

Snow and rock avalanches involving potentially large volumes of boulders and debris could occur on steep bedrock slopes. Development close to steep escarpments, ridges, cirques and arrêtes prone to these hazards should be discouraged. Colluvium- covered slopes are usually unstable.

Permafrost

The Teslin map sheet lies within the Discontinuous Permafrost Zone (Brown, 1967). Ice content is expected to be nil to low in glaciofluvial and fluvial coarse-grained deposits in most landforms, such as terraces, fans, eskers, kames, as well as in recent slides. Ice content in morainal and colluvial deposits is expected to be low to moderate. Morainal and colluvial deposits located at high elevations covered by thick organic deposits are the most likely to contain significant ice content. Permafrost is often detected by the presence of thick organic mats in poorly drained sites, solifluction lobes and stripes and sorted stone polygons.

High ice content is possible in fine-grained fluvial terraces located above stream level, in silty to clayey glaciolacustrine sediments. Thermokarst collapse and thaw slides are possible hazards in fine-grained glaciolacustrine deposits around Atlin, Little Atlin, Teslin Lakes area, east of Quiet Lake and in the Red River valley north of Fish Lake.

Flooding and Other Risks

Floods related to ice-jams, snow melt and summer rainstorms are a possible hazard in the lower reaches of most streams in the area. The steep portions of alluvial fans are exposed to the flooding risk and to the additional risk of mud flows and debris flows associated with rapid discharge increase.

NOTE: A new digital compilation of Yukon Geology is now available by Steve Gordey and Andrew Makepeace (GSC Open File D3826 and/or DIAND Open File 1999-1(D)) , and more recent MINFILE updates should also be verified (Yukon MINFILE, 2001).

References

Teslin Map Area - NTS 105C

To be thorough, check the references for adjacent NTS map sheets and the General Reference List (See User Guide).

Most of the following references should be available for viewing in the DIAND library on the third floor of the Elijah Smith building in Whitehorse.

Bostock, H.S., 1936. Prospecting possibilities of Teslin-Quiet Lake - Big Salmon area, Yukon. Geological Survey of Canada, Paper 36-2, 6 p.

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Bustin, R.M. and McKenzie, K.J., 1989. Stratigraphy and depositional environments of the Sustut Group, southern Sustut Basin, north central British Columbia. Bulletin of Canadian Petroleum Geology, Vol. 37, No. 2, p. 210-223.

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Erdmer, P., 1981. Comparative studies of cataclastic allochthonous rocks in McQuesten, Laberge and Finlayson Lake map-areas. In: Yukon Geology and Exploration, 1979-1980, Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 60-64.

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LEGEND

LEGEND TERRAIN HAZARDS

MAP SYMBOL	TERRAIN HAZARDS	ASSOCIATED RISK LEVELS, COMMENTS
	Mass Movement Processes	
A	Snow Avalanched.	high
F	Extremely slow to moderate rates of failure in soil and bedrock, including soil creep, rock creep, earthflow, soil or rock slump, debris or rock slide.	low to intermediate
R	Moderate to extremely rapid rates of failure in soil and bedrock (1.5 m/d to >3 m/s), including rock slump, debris slide, rock slide, debris flow, debris torrent, debris avalanche, rockfall, rock avalanche.	high
	Arctic, Alpine and Periglacial Processes	
X	Permafrost present.	low
K	Thermokarst present.	low
S	Soliflucted.	low to intermediate
Z	Grouped, cryoturbated, soliflucted, nivated.	low to intermediate
	Fluvial Processes	
B	Braided, unstable channels, risk of flooding.	intermediate to high
E	Fluvial erosion, deposition and low risk of flooding.	low to intermediate
J	Anastomosing.	intermediate to high
U	Flooded regularly.	intermediate to high
	Miscellaneous Erosion Processes	
T	Karst.	intermediate
P	Piping.	intermediate to high
V	Gullied.	low to intermediate

	On Site Symbols	Risk Level
	Unit boundary (defined, approximate).	
	Erosional escarpment.	high
	Landslide escarpment.	high
	Landslide (includes source and runout areas).	high
	Pingo.	high
	Rock glacier.	high
*	Spring or saline seep.	low
	Observation of frozen soil or ground ice.	low
T	Rapid mass movements (debris torrent) with known point source. Limits of runout not implied by symbol.	high
E	Slow mass movement (earth flow) with landslide, escarpment source. Limits of landslide runout not implied by symbol.	intermediate to high

LEGEND SEISMIC EVENTS

SYMBOL	MAGNITUDE REPRESENTED	SYMBOL	MAGNITUDE REPRESENTED
	<2.0		4.0 to 4.999
	2.0 to 2.999		5.0 to 5.999
	3.0 to 3.999		>6.0

LEGEND GEOLOGICAL PROCESSES

MAP SYMBOL	DESCRIPTION	INFERRED HAZARDS
cf	Talus fan or apron, moderate to steep slope, coarse angular bedrock fragments, sources are often areas of rapidly disintegrating bedrock.	Rock fall and debris flows common on active fans, steep slopes generally unstable to traffic.
cl	Landslide, moderate slope, varies from large blocks of bedrock to finer material.	Landslides generally are recurrent in susceptible areas and may be become active if disturbed.
cs	Colluvium covered slope, gentle to moderate slope, underlain by unsorted rubble, solifluction and other periglacial features common.	Areas of fine textured materials and gentle slopes at high elevations, where there is ground ice will be susceptible to high solifluction rates and thermokarst if disturbed.
fa	Alluvial fan, active.	Subject to shifts in channel and bar positions, occasionally subject to flooding.
fp	Floodplain.	Subject to shift in channel and bar positions, occasionally subject to flooding.
ice	Glacier ice.	Crevasses.
im	Mountain ice caps.	Avalanches, ice and rock falls, and crevasses.
is	Cliff glacier.	Avalanches, ice and rock falls.
l	Lacustrine or glaciolacustrine sediments.	Silt and clay, usually susceptible to frost heaving and, if permafrost present, to thermokarsting when disturbed.
m/i	Rock glacier, debris covered glacier.	Ice at depth make surface susceptible to thermokarst, unstable slopes.
o	Organic.	Thick organic matter is often underlain by permafrost. Disturbance of permafrost may cause poor drainage and thermokarsting.

LEGEND FAULTS

Fault
defined, approximate, assumed, extrapolated beneath overburden

Fault
Solid circle indicates downthrown side
Arrows indicate relative movement

Thrust Fault (teeth indicate upthrust side)

Airphoto Lineament

LEGEND QUATERNARY VOLCANISM

No known recent volcanism in map area 105C

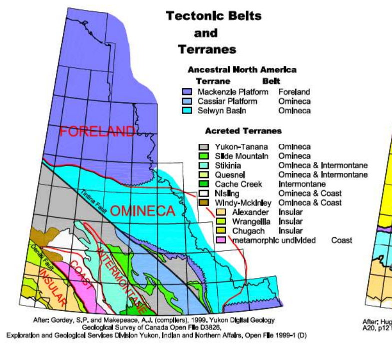
OTHER FEATURES

Roads | Lakes

Streams | Marsh

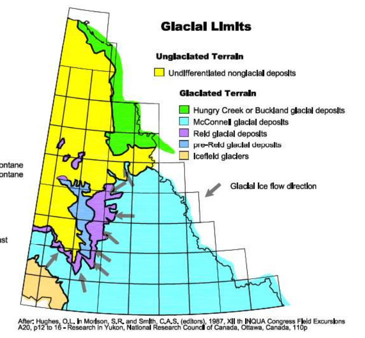
NOTE: Where areas have more than one identified process or hazard, the colour of the encompassing polygon is assigned based on a hierarchical scheme relating to the severity of the hazard. The relative order of severity is: Terrain Hazards (Mass Movement Processes then Fluvial Processes then Arctic, Alpine and Periglacial Processess) followed by Geological Processes.

Tectonic Belts and Terranes



After: Gordey, S.P. and Makepeace, A.J. (compilers), 1999, Yukon Digital Geology, Exploration and Geological Services Division Yukon Region, Indian and Northern Affairs, Open File 1999-1 (D)

Glacial Limits



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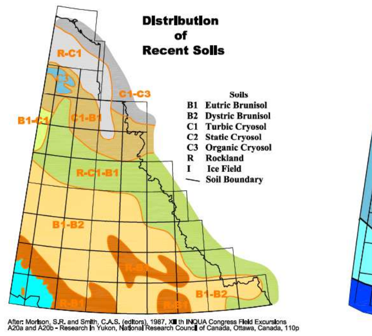
Distribution of Recent Soils



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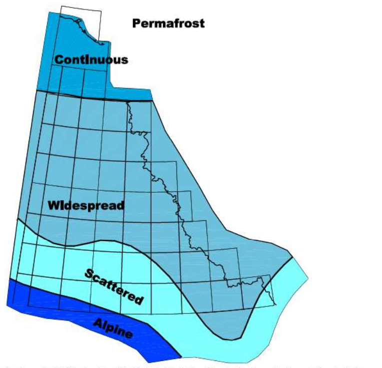
Permafrost



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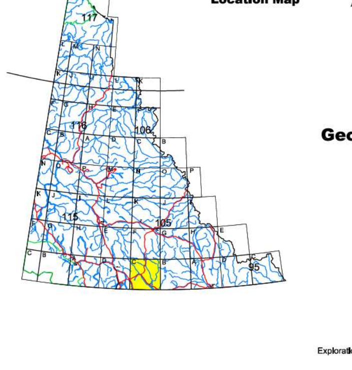
Location Map



Exploration and Geological Services Division
Yukon Region
Indian and Northern Affairs Canada

Yukon GEOPROCESS File

Geological Processes and Terrain Hazards of Teslin 105C

by

Mougeot, C.M. and Walton, L.A.

Copies of this map may be obtained from Geoscience and Information Sales c/o Whitehorse Mining Recorder, Indian and Northern Affairs Canada, Room 102, 300 Main Street, Whitehorse, Yukon Y1A 2B5 (867) 667-3266; FAX: (867) 667-3267

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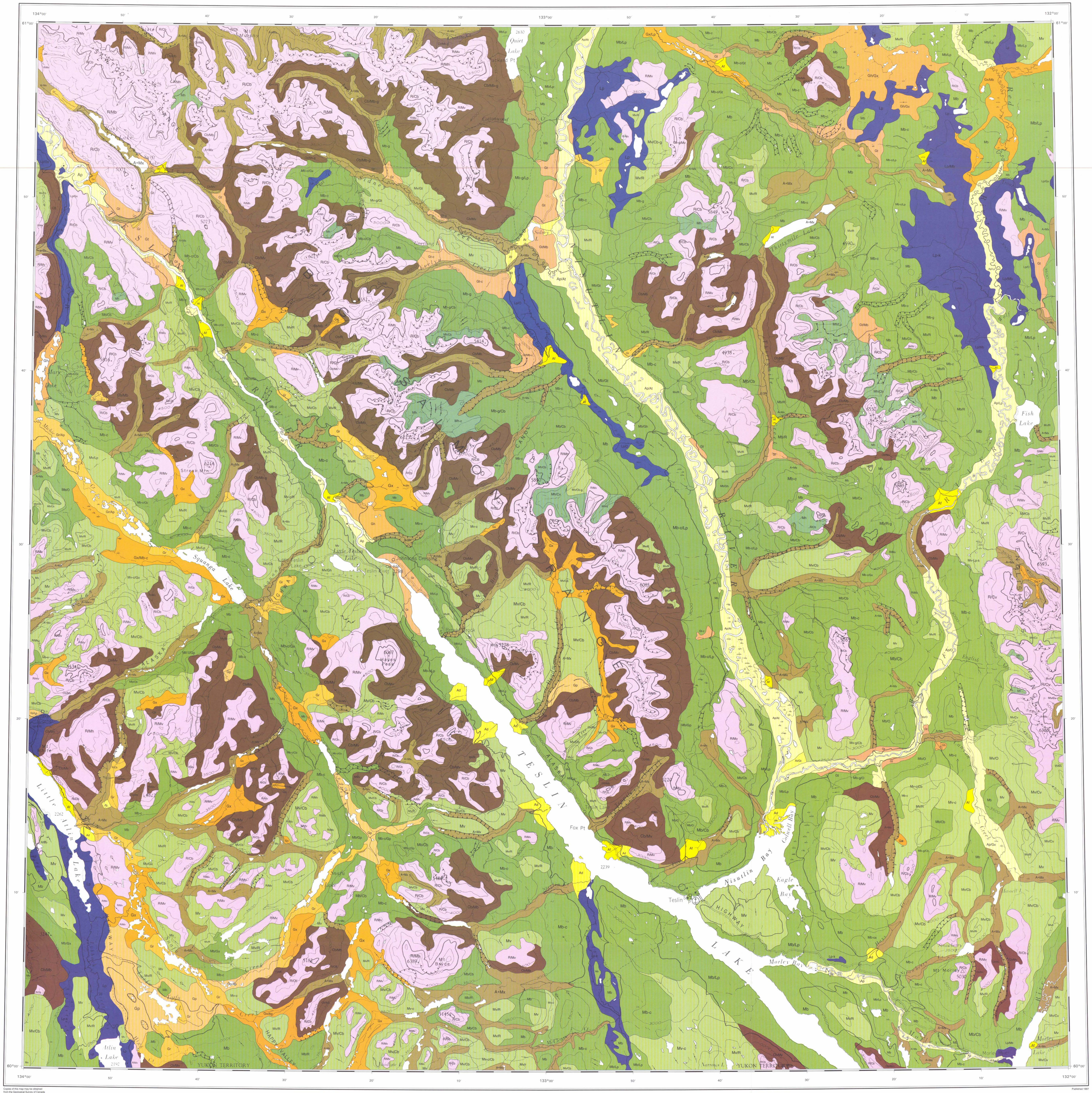
Natural Resources Canada Ressources naturelles Canada



LEGEND

	NATURE OF MATERIAL AND ESTIMATED THICKNESS	GENETIC DESCRIPTION	MORPHOLOGIC EXPRESSION	COMMENTS
O	*Peat and muck; 1 to 2 m thick*	*Organic deposits*	*Flat areas of bog and fen; distinctive features such as palsen and peat plateaus are rare*	*Bog and fen are of limited extent. Unmapped patches occur along the bottoms of some alpine valleys*
Cx	*Mixture of material derived from glacial deposits and bedrock; thickness is variable*	*Slope debris resulting from number of mass wasting processes; includes landslides, earth flows and solifluction*	*Irregular or hummocky surfaces*	*Mappable units are rare and restricted to the mountainous terrain between the Nisutlin River and Red River*
Cb	*Rock rubble and/or reworked glacial deposits*	*Colluvium consists mostly of weathered bedrock redeposited by downslope movement*	*Surface reflects morphology of underlying material; commonly occurs on bedrock slopes in mountainous terrain*	*Colluvium is widespread over mountain slopes, particularly in the zone between the lower parts of the slopes and the extensive bedrock exposures in the upper parts*
Ap	*Gravel, sand, and silt; 5 to 20 m thick*	*Alluvial valley bottom deposits*	*Gently irregular to nearly flat surfaces that include mostly floodplains of modern streams; small features such as stream terraces and alluvial fans may be present; abandoned channels and point bars are the most prominent features on these surfaces*	*Most of the deposits are mapped as compound units in valleys where modern streams are incised in older alluvium* **(At)** *or glaciofluvial deposits* **(Gt)***; aggregate source*
At	*Gravel, sand, and silt; 5 to 20 m thick*	*Alluvial terraces*	*Gently irregular or nearly flat, low level terraces bordering alluvial plains*	*Most terraces were formed by modern stream activity; they are separated from older terraces of glaciofluvial origin* **(Gt)** *on the basis of their close association with modern streams and by the absence of pitted ice-contact features; aggregate source*
Ad	*Gravel, sand, and silt; 5 to 20 m thick*	*Alluvial deltas*	*Gently irregular or nearly flat surfaces*	*Features mapped as deltas are not unlike alluvial fans, except for the relatively low gradients common to alluvial deltas; aggregate source*
Af	*Gravel, sand, and silt; 5 to 20 m thick*	*Alluvial fans*	*Gently irregular, channelled surfaces with marked slope towards valley bottom*	*Fans are common along the sides of steep-walled, glaciated valleys; most are small features and were not mapped; aggregate source*
Lp	*Clay, silt, and sand; 5 to 10 m thick*	*Glaciolacustrine deposits*	*Gently irregular or nearly flat surfaces along the bottoms and lower slopes of large valleys*	*Extensive glaciolacustrine deposits occur within Nisutlin River and Red River Valleys; thermokarst ponds are commonly developed in the silty sediments*
Gp	*Gravel, sand, and silt; 5 to 20 m thick*	*Outwash plains*	*Gently irregular or nearly flat terrain marked by shallow channel patterns or locally pitted surfaces*	*Extensive outwash occurs along the valley of Teslin River; glaciolacustrine deposits are included in places; aggregate source*
Gt	*Silt, sand, and gravel; 5 to 50 m thick*	*Terraces underlain by glaciofluvial and/or glaciolacustrine deposits*	*Nearly flat to irregular, pitted surfaces*	*Terraces occur within abandoned meltwater channels and meltwater channels occupied by modern streams; aggregate source*
Gr	*Sand and gravel; 5 to 30 m thick*	*Ice-contact glaciofluvial deposits*	*Strongly irregular, ridged, and kettled terrain with local relief to 30 m*	*Surfaces consist mainly of prominent esker-like, anastomosing ridges; aggregate source*
Gh	*Silt, sand, and gravel; 5 to 30 m thick*	*Ice-contact glaciofluvial deposits*	*Strongly irregular, pitted, or hummocky terrain with local relief to 30 m*	*Mainly knob-and-kettle to topography; aggregate source*
Gx	*Gravel, sand, silt and till; 1 to 20 m thick*	*Meltwater channel and glaciofluvial complexes*	*Gently irregular or hummocky glaciofluvial deposits along with minor patches of till and bedrock; surfaces are in part marked by braided channels*	*These complexes occur in broad valleys where meltwater activity resulted in closely spaced channels and depositional features too numerous and small to be mapped*
A + Mx	*Gravel, sand, silt, and till; thickness is variable*	*Valley bottom complex of alluvial, colluvial and glacial deposits*	*Nearly flat to strongly irregular terrain with relief to 30 m*	*These complexes are mapped within mountain valleys where different units are not separated because of mapping scale or because they cannot be recognized on airphotos*
Mh	*Till, boulders, gravel, sand, and silt; 5 to 30 m thick*	*Ablation till and ice-contact glaciofluvial deposit*	*Strongly irregular or hummocky terrain with local relief to 30 m*	*These features formed as end and lateral moraines of glacial and neoglacial alpine valley glaciers*
Mb	*Till; silty to sandy matrix; 1 to 30 m thick*	*Lodgment and ablation till*	*Gently irregular to strongly irregular bedrock controlled topography blanketed by till*	*Till forms a nearly continuous blanket over benches along the sides of large valleys and gentle mountain slopes*
Mv	*Till; silty to sandy matrix; bouldery; generally less than 1 m thick*	*Ablation and lodgment till*	*Gently irregular to strongly irregular bedrock terrain*	*Till and colluvium form a discontinuous veneer over bedrock*
R	*Bedrock and bedrock rubble*	*Bedrock outcrop and shattered bedrock*	*Mountainous terrain and low hills and ridges adjacent to mountain fronts or within broad mountain valleys*	*Rock rubble veneer is common on the slopes of the higher parts of mountainous terrain*

EXPLANATION OF LETTER NOTATION

A combination of letters is used to designate a map unit, e.g. Mv, or a component of a compound map unit, e.g. Mv/Cb. The upper case letter indictes the broad compositional-genetic class; the lower case letters indicate the morphology.

Occurrence of numerous erosional or other post-depositional features within a map unit is indicated by the addition of a dash and a lower case letter, to the first letter designation, e.g., Mv-c.

Compound map units are used for areas of more than one component that could be separated at the scale of mapping. The first component, which is the dominant one, is separated by a diagonal line from the second component, e.g. R/Mv.

COMPOSITIONAL - GENETIC CATEGORY

O - organic: peat and muck
C - colluvium: various materials
A - alluvial: gravel, sand, and silt
L - glaciolacustrine: clay, silt, and sand
G - glaciofluvial: silt, sand, and gravel
M - morainal: till

MORPHOLOGICAL CATEGORY

p - plain, floodplain
h - hummocky
t - terraced
f - fan
r - ridged
d - delta
b - blanket
v - veneer
x - complex

OTHER MODIFIERS

c - channelled
g - gullied
s - soliflucted
k - thermokarst

Geological boundary
Cirque
Drumlin, drumlinoid ridge, glacial fluting
Minor moraine, crevasse filling
Esker
Strandline
Meltwater channel (major, minor)

Geology by S.R. Morison and R.W. Klassen, 1978, 1980

Compiled by F. Anderson and T. Frazer, 1990

Digital cartography by Mario Hudon, Geoscience Information Division

Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

Base map at the scale of 1:250 000 published by the Department of National Defence, 1952

Copies of the topographical edition of this map may be obtained from the Canada Map Office, Natural Resources Canada, Ottawa, Ontario, K1A 0E9

Mean magnetic declination 1997, 27°32′ E, decreasing 11.7′ annually. Readings vary from 27°04′ in the SW corner to 28°00′ in the NE corner of the map

Elevations in feet above mean sea level

GEOLOGICAL SURVEY OF CANADA — COMMISSION GÉOLOGIQUE DU CANADA

MAP 1891A

SURFICIAL GEOLOGY

TESLIN

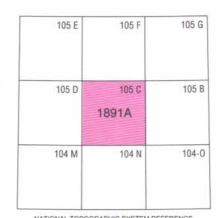
YUKON TERRITORY

Scale 1:125 000 - Échelle 1/125 000

Kilometres 2 0 2 4 6 8 10 Kilomètres

Universal Transverse Mercator Projection — Projection transverse universelle de Mercator

LOCATION MAP



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Canada

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1997: Surficial geology, Teslin, Yukon Territory, Geological Survey of Canada, Map 1891A, scale 1:125 000

LEGEND

	NATURE OF MATERIAL AND ESTIMATED THICKNESS	GENETIC DESCRIPTION	MORPHOLOGIC EXPRESSION	COMMENTS
O	*Peat and muck; 1 to 2 m thick*	*Organic deposits*	*Flat areas of bog and fen; distinctive features such as palsen and peat plateaus are rare*	*Bog and fen are of limited extent. Unmapped patches occur along the bottoms of some alpine valleys*
Cx	*Mixture of material derived from glacial deposits and bedrock; thickness is variable*	*Slope debris resulting from number of mass wasting processes; includes landslides, earth flows and solifluction*	*Irregular or hummocky surfaces*	*Mappable units are rare and restricted to the mountainous terrain between the Nisutlin River and Red River*
Cb	*Rock rubble and/or reworked glacial deposits*	*Colluvium consists mostly of weathered bedrock redeposited by downslope movement*	*Surface reflects morphology of underlying material; commonly occurs on bedrock slopes in mountainous terrain*	*Colluvium is widespread over mountain slopes, particularly in the zone between the lower parts of the slopes and the extensive bedrock exposures in the upper parts*
Ap	*Gravel, sand, and silt; 5 to 20 m thick*	*Alluvial valley bottom deposits*	*Gently irregular to nearly flat surfaces that include mostly floodplains of modern streams; small features such as stream terraces and alluvial fans may be present; abandoned channels and point bars are the most prominent features on these surfaces*	*Most of the deposits are mapped as compound units in valleys where modern streams are incised in older alluvium* **(At)** *or glaciofluvial deposits* **(Gt)**; *aggregate source*
At	*Gravel, sand, and silt; 5 to 20 m thick*	*Alluvial terraces*	*Gently irregular or nearly flat, low level terraces bordering alluvial plains*	*Most terraces were formed by modern stream activity; they are separated from older terraces of glaciofluvial origin* **(Gt)** *on the basis of their close association with modern streams and by the absence of pitted ice-contact features; aggregate source*
Ad	*Gravel, sand, and silt; 5 to 20 m thick*	*Alluvial deltas*	*Gently irregular or nearly flat surfaces*	*Features mapped as deltas are not unlike alluvial fans, except for the relatively low gradients common to alluvial deltas; aggregate source*
Af	*Gravel, sand, and silt; 5 to 20 m thick*	*Alluvial fans*	*Gently irregular, channelled surfaces with marked slope towards valley bottom*	*Fans are common along the sides of steep-walled, glaciated valleys; most are small features and were not mapped; aggregate source*
Lp	*Clay, silt, and sand; 5 to 10 m thick*	*Glaciolacustrine deposits*	*Gently irregular or nearly flat surfaces along the bottoms and lower slopes of large valleys*	*Extensive glaciolacustrine deposits occur within Nisutlin River and Red River Valleys; thermokarst ponds are commonly developed in the silty sediments*
Gp	*Gravel, sand, and silt; 5 to 20 m thick*	*Outwash plains*	*Gently irregular or nearly flat terrain marked by shallow channel patterns or locally pitted surfaces*	*Extensive outwash occurs along the valley of Teslin River; glaciolacustrine deposits are included in places; aggregate source*
Gt	*Silt, sand, and gravel; 5 to 50 m thick*	*Terraces underlain by glaciofluvial and/or glaciolacustrine deposits*	*Nearly flat to irregular, pitted surfaces*	*Terraces occur within abandoned meltwater channels and meltwater channels occupied by modern streams; aggregate source*
Gr	*Sand and gravel; 5 to 30 m thick*	*Ice-contact glaciofluvial deposits*	*Strongly irregular, ridged, and kettled terrain with local relief to 30 m*	*Surfaces consist mainly of prominent esker-like, anastomosing ridges; aggregate source*
Gh	*Silt, sand, and gravel; 5 to 30 m thick*	*Ice-contact glaciofluvial deposits*	*Strongly irregular, pitted, or hummocky terrain with local relief to 30 m*	*Mainly knob-and-kettle to topography; aggregate source*
Gx	*Gravel, sand, silt and till; 1 to 20 m thick*	*Meltwater channel and glaciofluvial complexes*	*Gently irregular or hummocky glaciofluvial deposits along with minor patches of till and bedrock; surfaces are in part marked by braided channels*	*These complexes occur in broad valleys where meltwater activity resulted in closely spaced channels and depositional features too numerous and small to be mapped*
A + Mx	*Gravel, sand, silt, and till; thickness is variable*	*Valley bottom complex of alluvial, colluvial and glacial deposits*	*Nearly flat to strongly irregular terrain with relief to 30 m*	*These complexes are mapped within mountain valleys where different units are not separated because of mapping scale or because they cannot be recognized on airphotos*
Mh	*Till, boulders, gravel, sand, and silt; 5 to 30 m thick*	*Ablation till and ice-contact glaciofluvial deposit*	*Strongly irregular or hummocky terrain with local relief to 30 m*	*These features formed as end and lateral moraines of glacial and neoglacial alpine valley glaciers*
Mb	*Till; silty to sandy matrix; 1 to 30 m thick*	*Lodgment and ablation till*	*Gently irregular to strongly irregular bedrock controlled topography blanketed by till*	*Till forms a nearly continuous blanket over benches along the sides of large valleys and gentle mountain slopes*
Mv	*Till; silty to sandy matrix; bouldery; generally less than 1 m thick*	*Ablation and lodgment till*	*Gently irregular to strongly irregular bedrock terrain*	*Till and colluvium form a discontinuous veneer over bedrock*
R	*Bedrock and bedrock rubble*	*Bedrock outcrop and shattered bedrock*	*Mountainous terrain and low hills and ridges adjacent to mountain fronts or within broad mountain valleys*	*Rock rubble veneer is common on the slopes of the higher parts of mountainous terrain*

EXPLANATION OF LETTER NOTATION

A combination of letters is used to designate a map unit, e.g. Mv, or a component of a compound map unit, e.g. Mv/Cb. The upper case letter indictes the broad compositional-genetic class; the lower case letters indicate the morphology.

Occurrence of numerous erosional or other post-depositional features within a map unit is indicated by the addition of a dash and a lower case letter, to the first letter designation, e.g., Mv-c.

Compound map units are used for areas of more than one component that could be separated at the scale of mapping. The first component, which is the dominant one, is separated by a diagonal line from the second component, e.g. R/Mv.

COMPOSITIONAL - GENETIC CATEGORY

- O - organic: peat and muck
- C - colluvium: various materials
- A - alluvial: gravel, sand, and silt
- L - glaciolacustrine: clay, silt, and sand
- G - glaciofluvial: silt, sand, and gravel
- M - morainal: till

MORPHOLOGICAL CATEGORY

- p - plain, floodplain
- h - hummocky
- t - terraced
- f - fan
- r - ridged
- d - delta
- b - blanket
- v - veneer
- x - complex

OTHER MODIFIERS

- c - channelled
- g - gullied
- s - soliflucted
- k - thermokarst

Geological boundary

Cirque

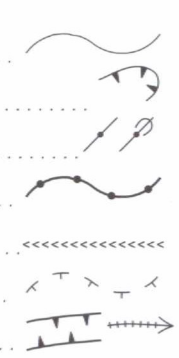
Drumlin, drumlinoid ridge, glacial fluting

Minor moraine, crevasse filling

Esker

Strandline

Meltwater channel (major, minor)



Appendix 3. Grainsize Analyses

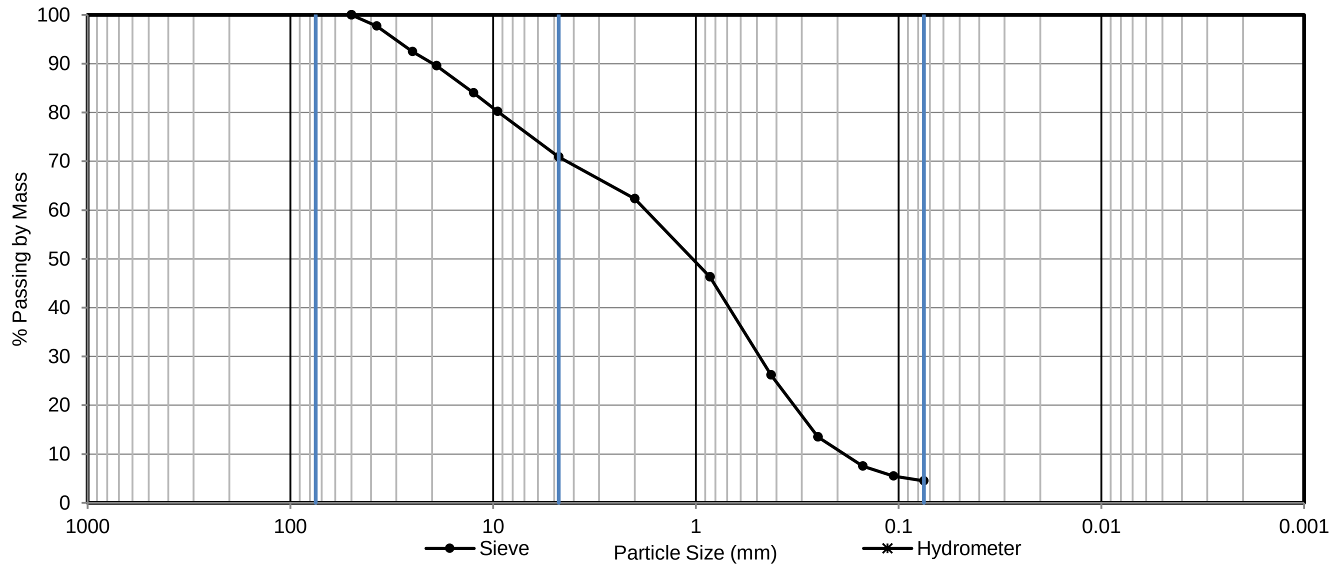
PARTICLE SIZE DISTRIBUTION

ASTM D6913
Method B

Test Request #	B23-062	Project Number:	22513913
Client:	Yukon Government Water Resources Branch	Project Location:	Teslin, Yukon
Project Name:	Teslin Aquifer Mapping	Sample Location:	YOWN 2206
Source:		Sample No.:	10272-1
Soil Description:		Type:	GS
		Depth (m):	14.94 - 17.37

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	2/28/2023
Specimen Description	NA				

Grain Size Distribution (%)			29.1		66.4			4.5
BOULDER	COBBLE	GRAVEL		SAND				FINES (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine		



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
2"	50	100.0		
1 1/2"	37.5	97.7		
1"	25	92.5		
3/4"	19	89.6		
1/2"	12.5	84.0		
3/8"	9.5	80.2		
#4	4.75	70.9		
#10	2	62.3		
#20	0.85	46.3		
#40	0.425	26.2		
#60	0.25	13.5		
#100	0.15	7.5		
#140	0.106	5.5		
#200	0.075	4.5		
			0.005 mm	
			0.002 mm	
			D60	1.77
			D30	0.49
			D10	0.19
			Cu	9.50
			Cc	0.72

Notes:

Disclaimer:

Tested by: KScribner **Date:** 28-Feb-23 **Checked by:** JPandez **Date:** 2-Mar-23 **Reviewed by:** SJohn **Date:** 8-Mar-23

WSP Canada Inc.
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada

[+1] 604 412 6899

PARTICLE SIZE DISTRIBUTION

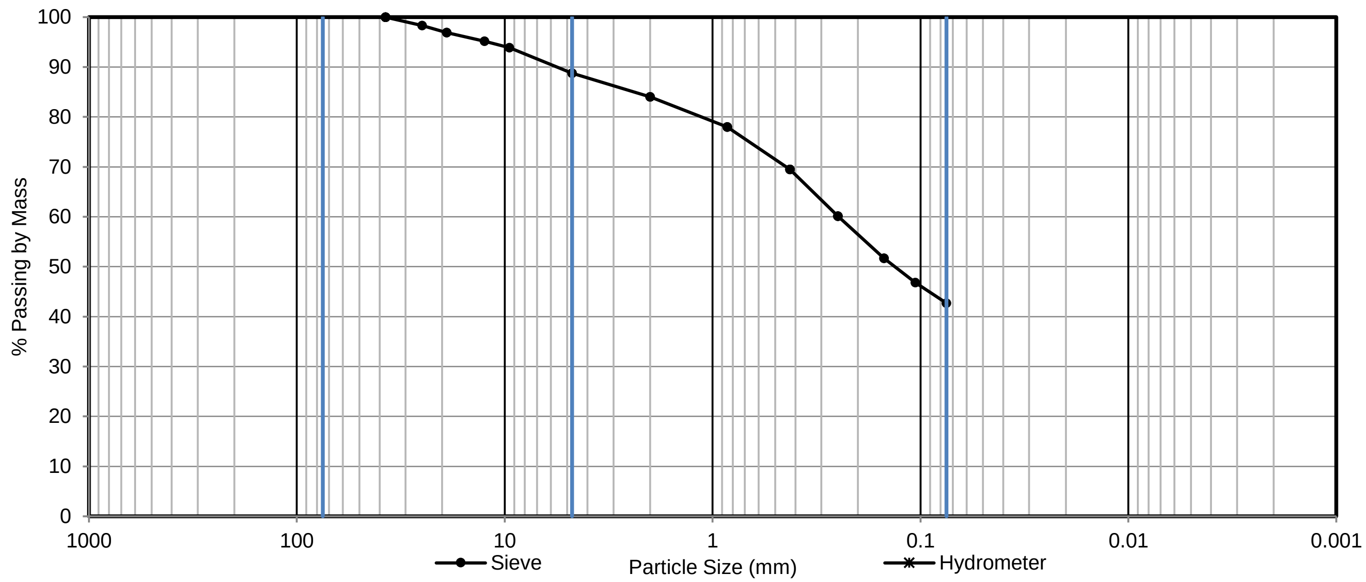
ASTM D6913
Method B

Test Request #	B23-062	Project Number:	22513913
Client:	Yukon Government Water Resources Branch	Project Location:	Teslin, Yukon
Project Name:	Teslin Aquifer Mapping	Sample Location:	YOWN 2207
Source:		Sample No.:	10272-2
Soil Description:		Type:	GS
		Depth (m):	0.91 - 4.88

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	3/2/2023
Specimen Description	NA				

Grain Size Distribution (%)

BOULDER	COBBLE	GRAVEL		SAND			FINES (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine	
		11.2		46.1			42.7



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
1 1/2"	37.5	100.0		
1"	25	98.3		
3/4"	19	96.9		
1/2"	12.5	95.2		
3/8"	9.5	93.9		
#4	4.75	88.8		
#10	2	84.0		
#20	0.85	78.0		
#40	0.425	69.5		
#60	0.25	60.1		
#100	0.15	51.7		
#140	0.106	46.8		
#200	0.075	42.7		
			0.005 mm	
			0.002 mm	
			D60	0.25
			D30	
			D10	
			Cu	
			Cc	

Notes:

Disclaimer:

The laboratory testing services reported herein have been performed in accordance with the terms of a contract with WSP's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of WSP's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: JPandez **Date:** 2-Mar-23 **Checked by:** JPandez **Date:** 6-Mar-23 **Reviewed by:** SJohn **Date:** 8-Mar-23

WSP Canada Inc.
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada

[+1] 604 412 6899

PARTICLE SIZE DISTRIBUTION

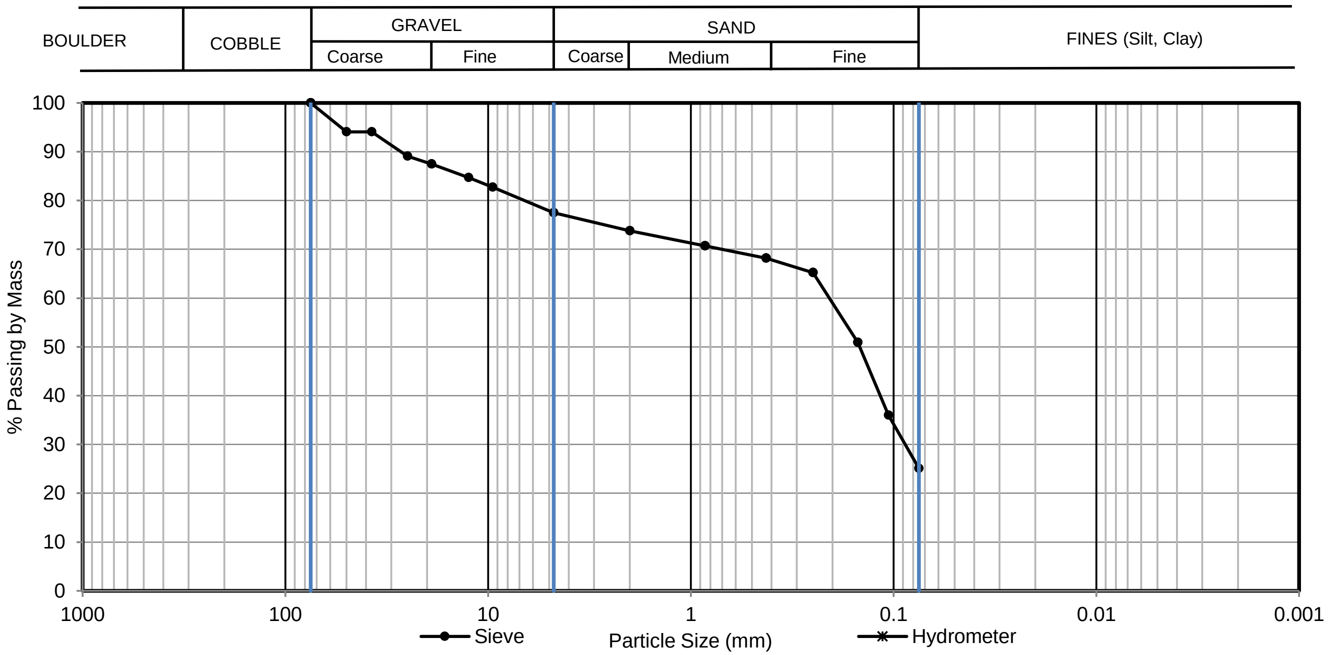
ASTM D6913
Method B

Test Request #	B23-062	Project Number:	22513913
Client:	Yukon Government Water Resources Branch	Project Location:	Teslin, Yukon
Project Name:	Teslin Aquifer Mapping	Sample Location:	YOWN 2207
Source:		Sample No.:	10272-3
Soil Description:		Type:	GS
		Depth (m):	41.15 - 44.20

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	3/2/2023
Specimen Description	NA				

Grain Size Distribution (%)

BOULDER	COBBLE	GRAVEL	SAND	FINES (Silt, Clay)
		22.5	52.4	25.1



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
3"	75	100.0		
2"	50	94.1		
1 1/2"	37.5	94.1		
1"	25	89.1		
3/4"	19	87.5		
1/2"	12.5	84.7		
3/8"	9.5	82.7		
#4	4.75	77.5		
#10	2	73.8		
#20	0.85	70.7		
#40	0.425	68.2		
#60	0.25	65.2		
#100	0.15	50.9		
#140	0.106	36.0		
#200	0.075	25.1	0.005 mm	
			0.002 mm	
			D60	0.21
			D30	0.09
			D10	
			Cu	
			Cc	

Notes:

Disclaimer:

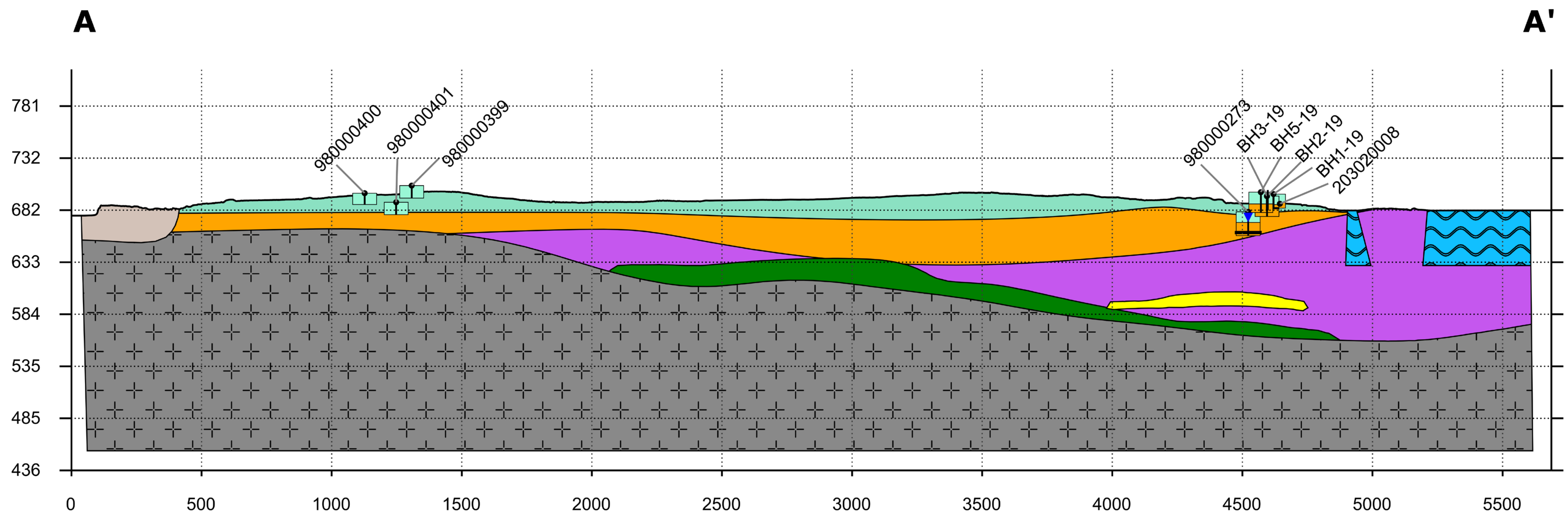
The laboratory testing services reported herein have been performed in accordance with the terms of a contract with WSP's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of WSP's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Tested by: JPandez **Date:** 2-Mar-23 **Checked by:** JPandez **Date:** 6-Mar-23 **Reviewed by:** SJohn **Date:** 8-Mar-23

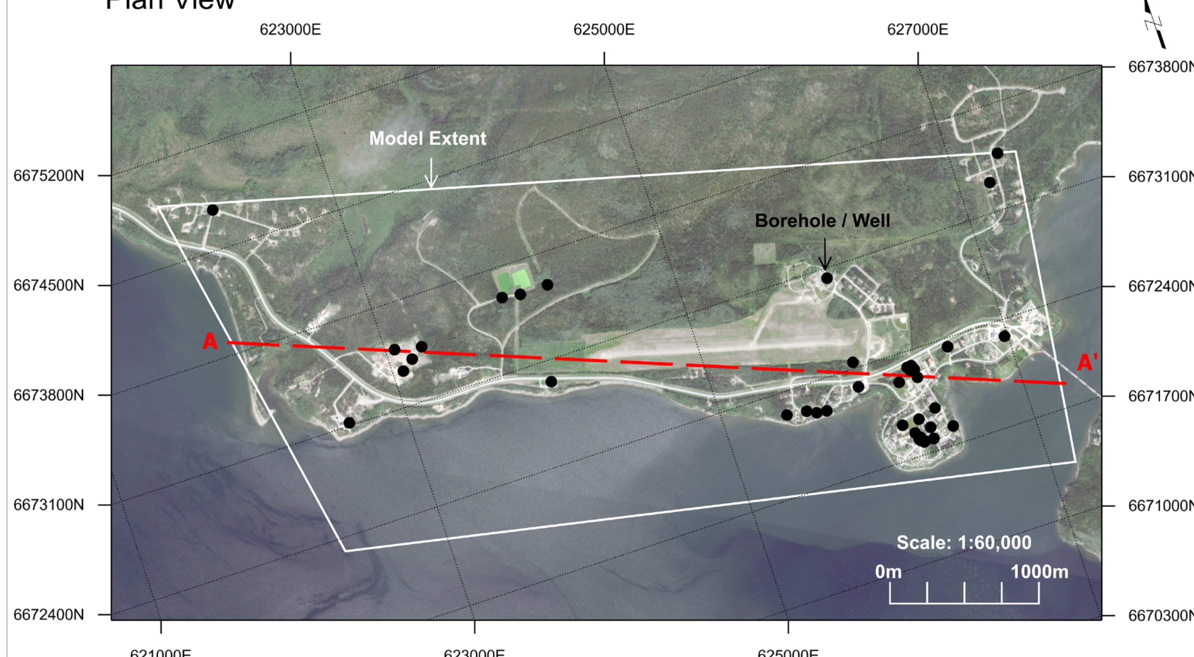
WSP Canada Inc.
Unit 300 - 3811 North Fraser Way, Burnaby, British Columbia, V5J 5J2, Canada

[+1] 604 412 6899

Appendix 4. Hydrostratigraphic Cross Sections



Plan View



Notes
Hydrostratigraphic contacts in cross-section are inferred.
Teslin lake bathymetry is conceptual. No accurate bathymetry data was available to better reproduce the lake bottom and shoreline.

Hydrostratigraphic units

- POTENTIAL FAN AQUIFER
- TESLIN LAKE
- BEDROCK
- DEEP SAND AND GRAVEL AQUIFER
- GLACIOFLUVIAL AQUIFER
- TESLIN AQUITARD
- TILL
- TILL/GLACIOLACUSTRINE DEPOSIT

Topography

Screened Interval

Groundwater Head (at time of drilling)

Cross-Section coordinates

A: 622013, 6673906

A': 627318, 6671855

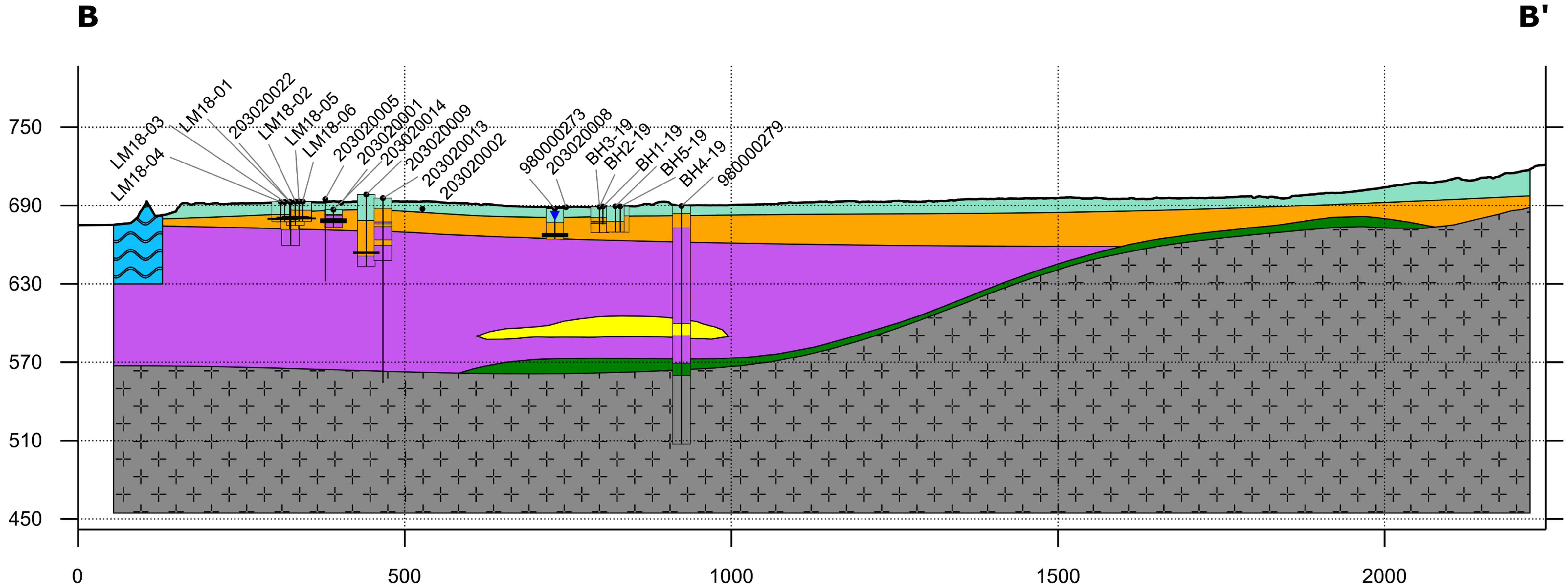
Scale

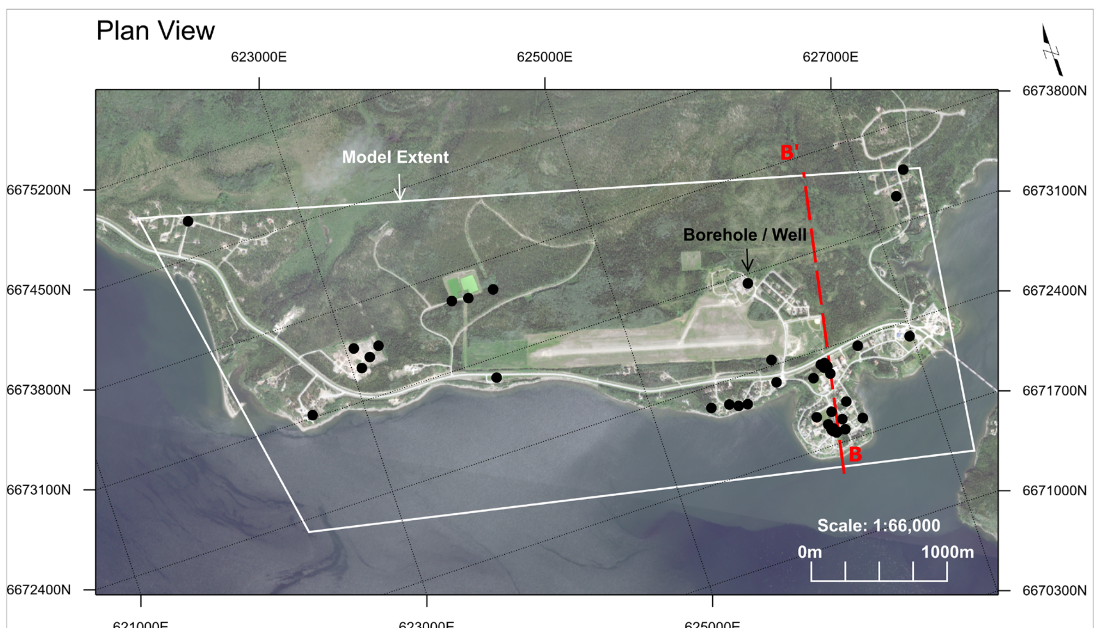
Scale: 1:23,000

Vertical exaggeration: 4x

0m 1000m

NOTE(S)	
REFERENCE	WELL COMPLETION DATA, AND WATER LEVELS OBTAINED FROM YUKON WELL REGISTRY
CLIENT	YUKON GOVERNMENT WATER RESOURCE BRANCH
CONSULTANT	
YYYY-MM-DD	2023-04-06
PREPARED	JP
DESIGN	JP
REVIEW	NG
APPROVED	
PROJECT	TESLIN AQUIFER MAPPING
TITLE	HYDROSTRATIGRAPHIC CROSS-SECTION A-A'
PROJECT No.	22513913
PHASE	4000
Rev.	A
FIGURE	App 4-2





Notes
Hydrostratigraphic contacts in cross-section are inferred.
Teslin lake bathymetry is conceptual. No accurate bathymetry data was available to better reproduce the lake bottom and shoreline.

Hydrostratigraphic units

- TESLIN LAKE
- BEDROCK
- DEEP SAND AND GRAVEL AQUIFER
- GLACIOFLUVIAL AQUIFER
- TESLIN AQUITARD
- TILL
- TILL/GLACIOLACUSTRINE DEPOSIT

Screened Interval

Topography

▼ Groundwater Head (at time of drilling)

Cross-Section coordinates

B: 626201, 6671476

B': 626617, 6673683

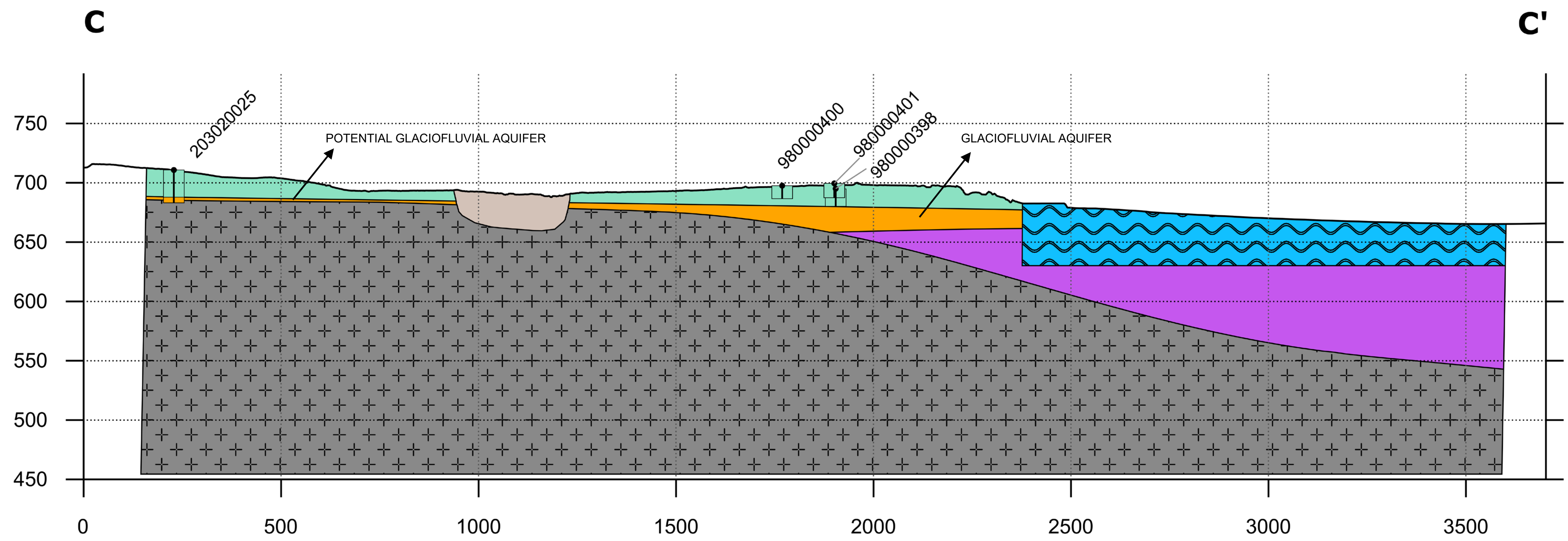
Scale

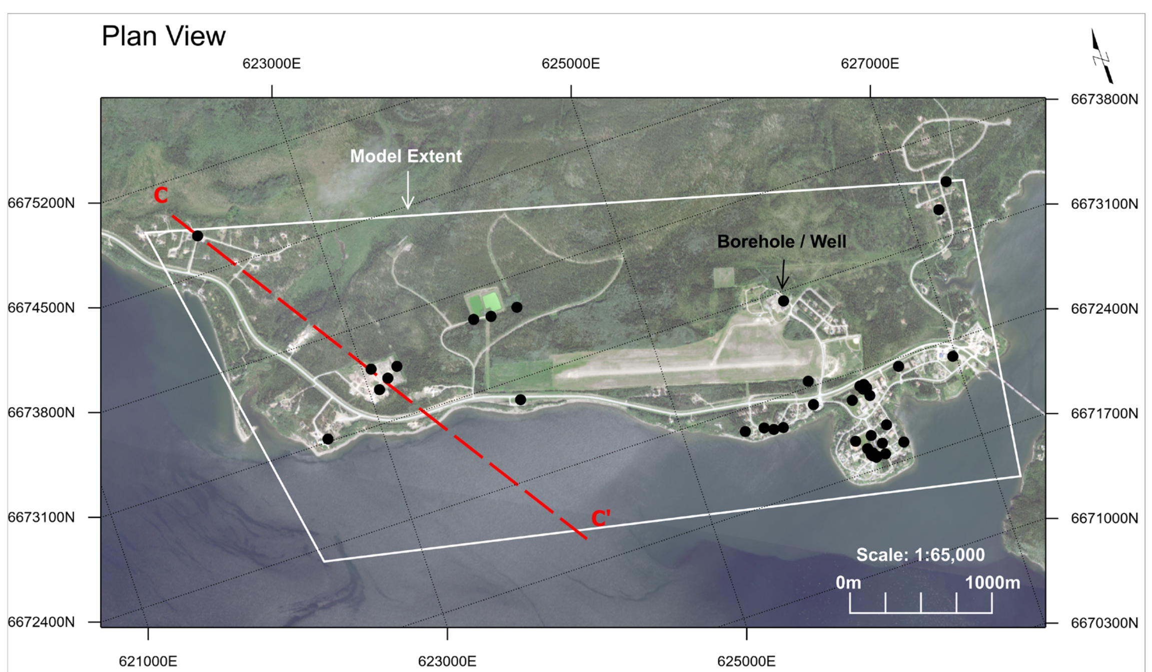
Scale: 1:9,000

Vertical exaggeration: 2x

0m 500m

NOTE(S)	
REFERENCE	WELL COMPLETION DATA, AND WATER LEVELS OBTAINED FROM YUKON WELL REGISTRY
CLIENT	YUKON GOVERNMENT WATER RESOURCE BRANCH
CONSULTANT	
YYYY-MM-DD	2023-04-06
PREPARED	JP
DESIGN	JP
REVIEW	NG
APPROVED	
PROJECT	TESLIN AQUIFER MAPPING
TITLE	HYDROSTRATIGRAPHIC CROSS-SECTION B-B'
PROJECT No.	22513913
PHASE	4000
Rev.	A
FIGURE	App 4-3





Notes

Hydrostratigraphic contacts in cross-section are inferred.

Teslin lake bathymetry is conceptual. No accurate bathymetry data was available to better reproduce the lake bottom and shoreline.

Hydrostratigraphic units

- POTENTIAL FAN AQUIFER
- GLACIOFLUVIAL AQUIFER AND POTENTIAL GLACIOFLUVIAL AQUIFER
- TESLIN LAKE
- TESLIN AQUITARD
- BEDROCK
- TILL/GLACIOLACUSTRINE DEPOSIT

Screened Interval

Topography

Cross-Section coordinates

C: 622073, 6674959

C': 624128, 6671879

Scale

Scale: 1:15,000

Vertical exaggeration: 3x

0m 1000m

NOTE(S)

REFERENCE

WELL COMPLETION DATA, AND WATER LEVELS OBTAINED FROM YUKON WELL REGISTRY

CLIENT

YUKON GOVERNMENT
WATER RESOURCE BRANCH

CONSULTANT

YYYY-MM-DD	2023-04-06
PREPARED	JP
DESIGN	JP
REVIEW	NG
APPROVED	

PROJECT

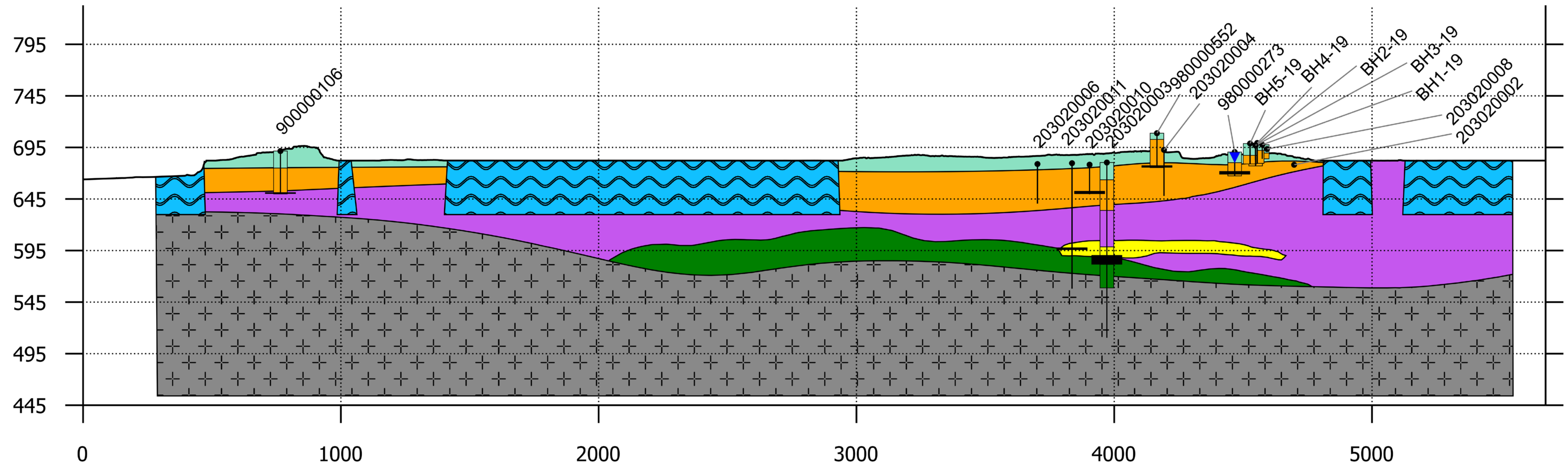
TESLIN AQUIFER MAPPING

TITLE

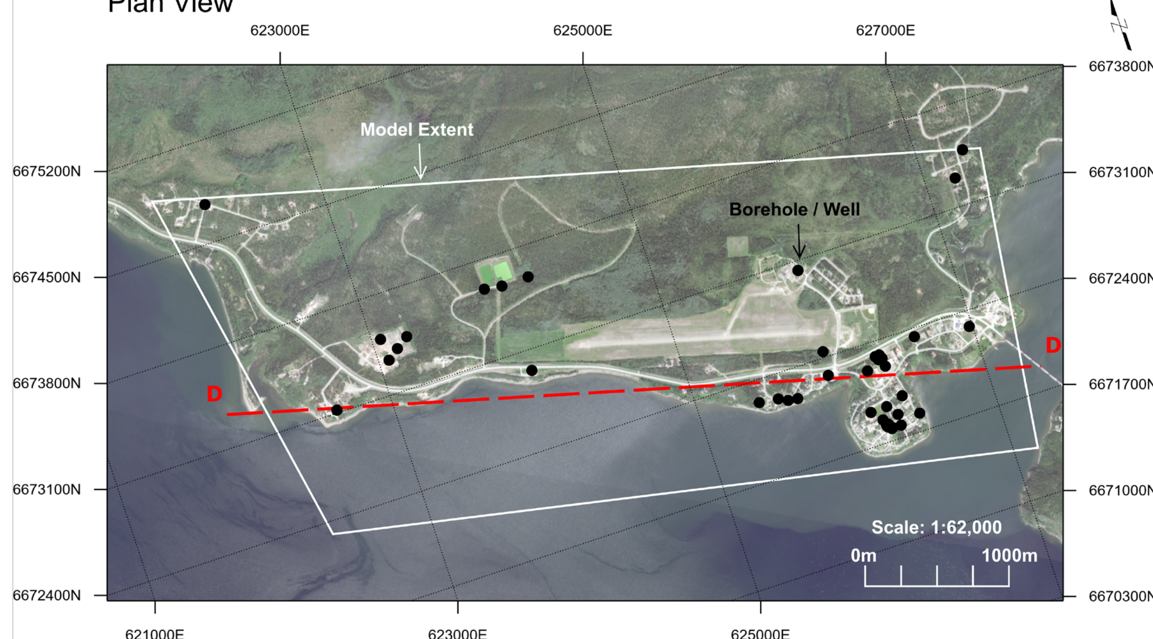
HYDROSTRATIGRAPHIC CROSS-SECTION C-C'

PROJECT No.	PHASE	Rev.	FIGURE
22513913	4000	A	App 4-4

D D'



Plan View



Hydrostratigraphic units

- TESLIN LAKE
- BEDROCK
- DEEP SAND AND GRAVEL AQUIFER
- GLACIOFLUVIAL AQUIFER
- TESLIN AQUITARD
- TILL
- TILL/GLACIOLACUSTRINE DEPOSIT

Screened Interval

Topography

Groundwater Head (at time of drilling)

Cross-Section coordinates

D: 621883, 6673333

D': 627365, 6671872

Scale

Scale: 1:23,000

Vertical exaggeration: 4x

0m 1000m

Notes

Hydrostratigraphic contacts in cross-section are inferred.

Teslin lake bathymetry is conceptual. No accurate bathymetry data was available to better reproduce the lake bottom and shoreline.

NOTE(S)

REFERENCE

WELL COMPLETION DATA, AND WATER LEVELS OBTAINED FROM YUKON WELL REGISTRY

CLIENT

YUKON GOVERNMENT
WATER RESOURCE BRANCH

CONSULTANT

YYYY-MM-DD	2023-04-06
PREPARED	JP
DESIGN	JP
REVIEW	NG
APPROVED	

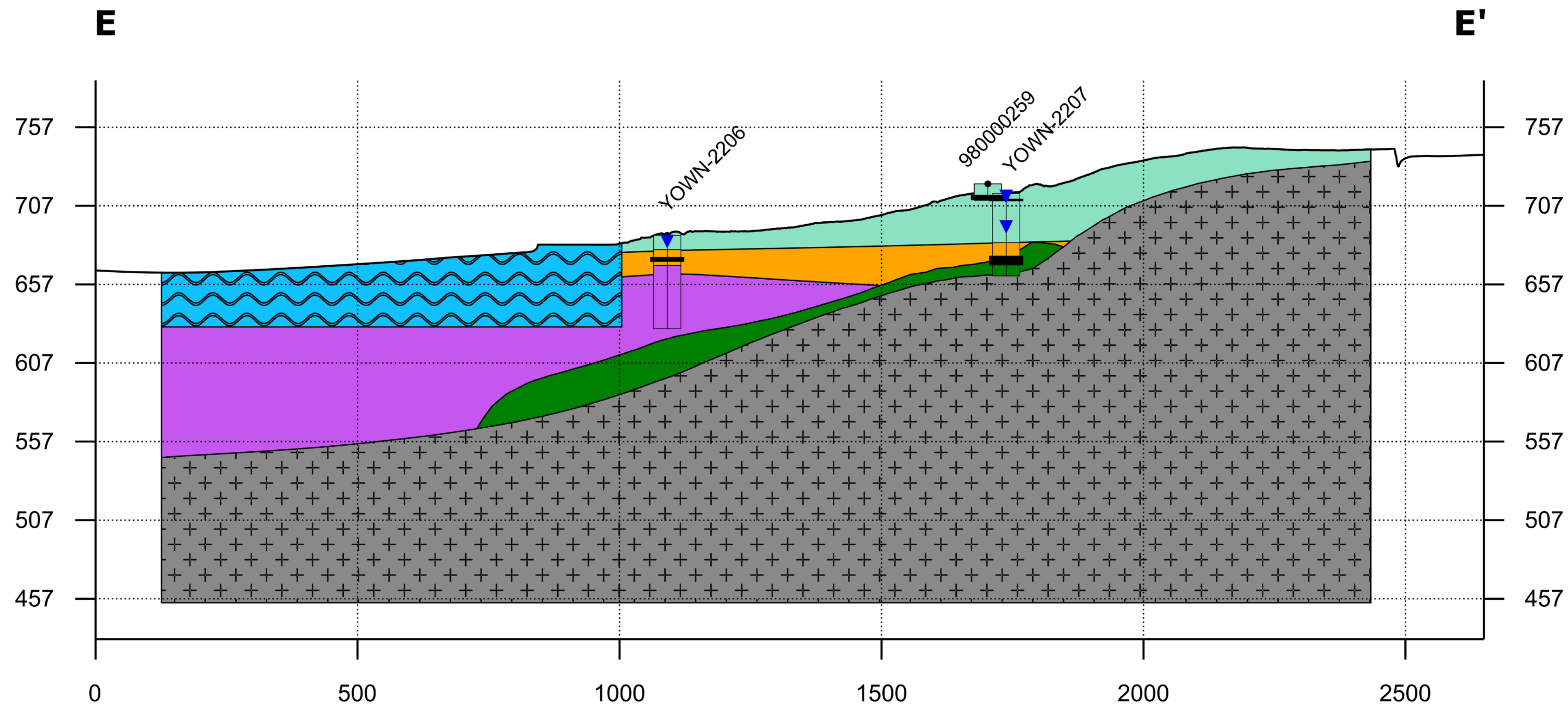
PROJECT

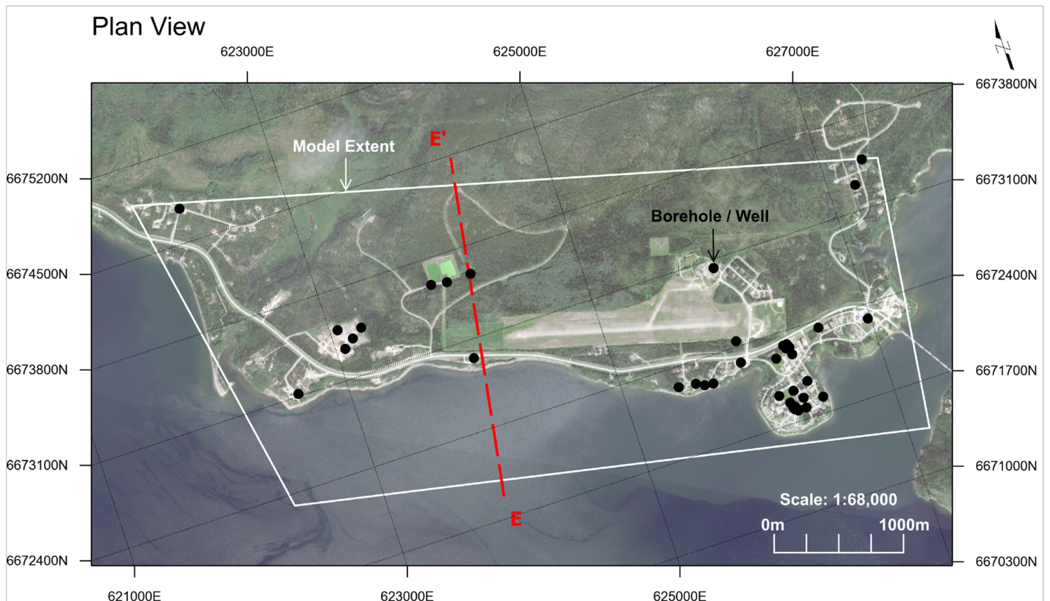
TESLIN AQUIFER MAPPING

TITLE

HYDROSTRATIGRAPHIC CROSS-SECTION D-D'

PROJECT No.	PHASE	Rev.	FIGURE
22513913	4000	A	App 4-5





Notes
Hydrostratigraphic contacts in cross-section are inferred.
Teslin lake bathymetry is conceptual. No accurate bathymetry data was available to better reproduce the lake bottom and shoreline.

Hydrostratigraphic units

- TESLIN LAKE
- BEDROCK
- GLACIOFLUVIAL AQUIFER
- TESLIN AQUITARD
- TILL
- TILL/GLACIOLACUSTRINE DEPOSIT

Screened Interval

Topography

▼ Groundwater Head (at time of drilling, except for YOWN wells - Measurements collected in June 2022)

Cross-Section coordinates

E: 623879, 6671869

E': 624310, 6674484

Scale

Scale: 1:13,000

Vertical exaggeration: 3x

0m — 1000m

NOTE(S)

REFERENCE
WELL COMPLETION DATA, AND WATER LEVELS OBTAINED FROM YUKON WELL REGISTRY

CLIENT
YUKON GOVERNMENT
WATER RESOURCE BRANCH

CONSULTANT

YYYY-MM-DD	2023-04-06
PREPARED	JP
DESIGN	JP
REVIEW	NG
APPROVED	

PROJECT
TESLIN AQUIFER MAPPING

TITLE
HYDROSTRATIGRAPHIC CROSS-SECTION E-E'

PROJECT No.	PHASE	Rev.	FIGURE
22513913	4000	A	App 4-6

Appendix 5. Aquifer Summary

Aquifer Summary Table

#	Name	Lithostratigraphic Unit	Descriptive Location	Vulnerability	Subtype	Material	Quality Concerns	Size (km^2)	Productivity	Demand	Artesian Conditions Noted	Observation Wells
1	Glaciofluvial Aquifer	Glaciofluvial	Within the valley	Moderate	4b	Sand and Gravel	Chloride	4.8	Moderate/ High	Low	None documented	YOWN-2206 and YOWN-2207 D
2	Deep Sand and Gravel Aquifer	Glaciofluvial	Vicinity of Village of Teslin	Low	4b	Sand and Gravel	None	0.45	Moderate / High	Low	None documented	None

The aquifer classifications in the above table are based on the BC aquifer classification system is outlined in the Guide to Using the BC Aquifer Classification Maps for the Protection and Management of Groundwater, issued by the BC Ministry of Water Land and Air Protection, June 2002 (Bernardinucci and Ronneseth, 2002).

Aquifer subtypes are described in Wei, M., D. Allen, A. Kohut, S. Grasby, K. Ronneseth and B. Turner, 2009. Understanding the Types of Aquifers in the Canadian Cordillera Hydrogeological Region to Better Manage and Protect Groundwater. Streamline Watershed Management Bulletin Vol. 13, No.1, Fall 2009.

- 4b: Confined glaciofluvial sand and gravel aquifers underneath till, in between till layers, or underlying glaciolacustrine deposits.

Appendix 6. Aquifer Shapefiles

Shapefiles for the Glaciofluvial Aquifer, Deep Sand and Gravel Aquifer, Potential Fan Aquifer, Potential Glaciofluvial Aquifer and Study Area are provided digitally in an attached folder entitled "Aquifer_Shapefiles_Teslin_May2023".

Appendix 7. Aquifer Well-Correlation

For Aquifer-Well correlation sheet of the Teslin area, reference the attached csv file entitled "Aquifer_Well_Correlation_Teslin_May2023.csv".

Appendix 8. Interpreted Hydrostratigraphy

For a summary of the hydrostratigraphic contacts for each well, reference the attached csv file entitled “Interpreted_Hydrostratigraphic_Units_Teslin_May2023.csv”.