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The conclusions and recommendations of this document are based upon applicable legislation and policy existing at the time the document was prepared. Changes to legislation and policy may alter conclusions and recommendations.

[1] https://csapsociety.bc.ca/wp-content/uploads/ATT-3_-CSAP-Professional-Judgement-May2nd.pdf

Background Groundwater Concentrations at Sites in British Columbia

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PGL ENVIRONMENTAL CONSULTANTS

solve and simplify

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List of Acronyms

AiP	-	Approval in Principle
AOI	-	area of interest
bgs	-	below ground surface
BCER	-	British Columbia Energy Regulator
COC	-	contaminant of concern
CofC	-	Certificate of Compliance
CSAP Society	-	Society of Contaminated Sites Approved Professionals of BC
ENV	-	BC Ministry of Environment and Parks
PGL	-	PGL Environmental Consultants
UST	-	underground fuel storage tank

I. AUTHORS AND ACKNOWLEDGEMENTS

The Society of Contaminated Sites Approved Professionals of BC (CSAP Society) retained PGL Environmental Consultants (PGL) to review background groundwater concentrations in BC as outlined in the "Background Groundwater Concentrations at Sites in British Columbia" RFP issued May 1, 2024. This document was prepared by Aio Haberli, Tom Berger, Melissa Pitz, Katie Scott, and Ingo Lambrecht of PGL.

The project was conducted under the direction of members of the CSAP Society Technical Review Committee led by Bob Symington (Gandalf Consulting Ltd.) and supported by Christine Thomas (WSP Canada Inc.) and Ian Hers (Hers Environmental Consulting Inc.).

The BC Ministry of Environment and Parks provided Site Registry database outputs, file retrieval support, guidance, and review comments. The support from Lavinia Zanini, Kerri Skelly, Patricia Fortin, and Roberto Prieto are gratefully acknowledged.

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II. DISCLAIMER

This document includes the authors' opinions and suggestions and does not necessarily reflect the opinions and recommendations of the CSAP Society or the BC Ministry of Environment and Parks.

PGL and the CSAP Society accept no responsibility for any damages that may be suffered by third parties because of decisions or actions based on this report. The findings and conclusions were developed in a manner consistent with the level of care and skill normally exercised by environmental professionals currently practicing under similar conditions in BC. Changing information, assessment techniques, and regulations mean that our conclusions can quickly become dated; our opinions and conclusions are subject to change as new information may be obtained.

III. REQUEST FOR COMMENTS

We welcome all comments and feedback. We are particularly interested in observations and experiences that practitioners have with background concentrations in groundwater in BC that could inform potential follow-up studies.

1.0 INTRODUCTION

The Society of Contaminated Sites Approved Professionals of British Columbia (CSAP Society) retained PGL Environmental Consultants (PGL) to research and propose, if possible, additional background groundwater concentrations for regions in BC. This document summarizes the project methodology, results, conclusions, and recommendations.

2.0 BACKGROUND

The release of the Stage 11 amendments to the BC Contaminated Sites Regulation in November 2017 resulted in lowered groundwater standards for several dissolved metals and metalloids and/or created standards that previously did not exist. The BC Ministry of Environment and Parks (ENV) recognized the challenge that this created within the industry and initiated a program of reviewing regional background groundwater quality conditions for metals/metalloids within five regions of the province.

In 2018 (revised in 2020), Core6 Environmental Ltd. (Core6) completed a study at the direction of the ENV (2018 Background Study) to review naturally occurring regional background groundwater quality within the following five regions of the province and establish regional backgrounds, if possible.

- Lower Mainland
- Thompson Okanagan
- Southern Vancouver Island
- Northeast BC
- Prince George

The 2018 Background Study supported the development of background groundwater concentrations for three out of five regions: Lower Mainland (including sub-regions 1 and 2), Thompson Okanagan, and Southern Vancouver Island. The local background concentrations for these three regions are available in Table 1 of Protocol 9 Establishing Local Background Concentrations in Groundwater,[1] and the underlying dataset used to develop the background levels (Background Concentrations in Groundwater Database) are published on the ENV website.[2] At the time of the 2018 Background Study, there was insufficient data to establish regional backgrounds in the Northeast BC and Prince George regions.

CSAP practitioners have identified that natural background levels of metals in groundwater can pose potential issues at sites in other parts of the province including the Northeast BC and Prince George regions. Elevated concentrations of metals unrelated to site activities may result in additional costs and potential delays of projects.

The CSAP Society commissioned this project to (1) assess whether it is now possible to establish regional background for the Northeast BC and Prince George regions using data that has become available since the 2018 Background Study, and (2) evaluate the feasibility of establishing background in new regions of the province that are outside the footprint of the 2018 Background Study areas. An overview of study areas is presented in Figures 0.1 through 0.4.

[1] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/protocols/protocol09.pdf
[2] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/contaminated-sites/groundwater_database_table.pdf

3.0 SCOPE OF WORK

The scope of work included the tasks listed below.

- Review and adopt the methodology from the 2018 Background Study for Site Registry database searches, identifying potential background sites, and assessing suitability of monitoring wells.
- For the Northeast BC and Prince George regions, identify new potential background sites, and obtain and review associated site investigation reports. Assess if sufficient suitable sites are available for follow-up studies.
- Identify new areas of interest (AOI) outside the footprint of the established three background regions and evaluate feasibility of establishing background in these AOIs.
- Connect with the British Columbia Energy Regulator (BCER) about available reports from potential background sites that are not available through the ENV's Site Registry.

Augmenting the dataset of the three existing regions established in the 2018 Background Study with data from regulatory applications between 2018 and 2024 was not within the scope of this project. PGL relied on the ENV to provide datasets with lists of potential background sites from the Site Registry.

4.0 METHODOLOGY

The following sections describe the methodology for the evaluation of background regions.

4.1 Identify Additional Potential Sites for Northeast BC and Prince George Regions

There were insufficient suitable background sites to establish regional backgrounds in the Northeast BC and Prince George regions (Figure 0.1) in the 2018 Background Study. The ENV provided PGL with a dataset from the Site Registry that contained regulatory applications organized by Site IDs from the years 2018 to 2024. The 2018–2024 dataset (Section 4.2.1) was used to identify new potential background sites to augment the suitable sites identified in the 2018 Background Study to reach a threshold of 10 background sites (Section 4.6) for establishing regional background for the two areas.

4.2 Identifying New Areas of Interest

The starting point to define new AOIs outside the footprint of the 2018 Background Study regions was to identify continuous regional surficial geologic units of the same or similar type in areas with an abundance of Site IDs, which could potentially yield sufficient suitable sites to conduct statistical analysis. The geologic units would define the spatial boundaries of potential background regions.

Surficial geology for each study region was assessed by reviewing surficial soil and geological data available from various sources (referenced in Appendix 1) and Geological Maps (Appendix 2), including:

- BC Soils Information Finder Tool for digital data including soil and quaternary geology
- Geological Survey of Canada published maps
- British Columbia Geological Survey and Geoscience BC published maps and digital data
- BC Water Resources Atlas for mapped aquifers

Where available, digital data or portions of published maps were compiled onto figures for each region. The maps were examined for information that could identify areas with surficial geology that are generally associated with fluvial and/or glacial units, since these were considered amenable to further assessment of background groundwater conditions as they are consistent with the types of material in the other established regions in BC.

PGL identified the Columbia, Skeena, and Bulkley Rivers catchments as areas that may comprise similar geology. The Penticton to Osoyoos area is within the Okanagan Basin, which is an extension of the established Thompson-Okanagan background area including Kelowna and Vernon. It was also expected that the geology on the eastern coast of Vancouver Island, north of the established South Vancouver Island background region, could be a similar type. These areas also contained larger municipalities and urban centres with many Site IDs.

Four regions were retained as AOIs (Figures 0.2 through 0.4) to evaluate the feasibility of potentially establishing groundwater background and were given the following designations:

- Mid-Island
- Skeena-Bulkley
- Columbia River
- Penticton

4.3 Site Registry Datasets

The ENV provided datasets from the Site Registry database to facilitate site identification. Analogous to the 2018 Background Study, the ENV applied a ‘filter’ to the database queries, which limited the output of Site IDs to sites that contained any of the following investigation, application, determination, and/or certification categories:

- Protocol 9 Determinations
- Determinations (site not contaminated)
- Approval in Principle (AiP)
- Certificates of Compliance (CofC)
- Investigation reports (Stage 2 Preliminary Site Investigation, Detailed Site Investigation, etc.)

The ENV conducted queries from two separate databases, which covered two separate time spans (i.e., pre-2018 and 2018 to 2024) and produced datasets with different formats and information. The following two sections summarize the attributes of the two datasets.

4.3.1 2018–2024 Dataset

The ENV provided the data from this database as a single spreadsheet that contained a *province-wide* list of 872 Site Registry entries of unique Site IDs for which regulatory applications were received between the years 2018 and 2024 (i.e., in the time since the 2018 Background Study was conducted). For each Site ID, the spreadsheet contained information for the following attributes:

- City
- Common name (e.g., “Langara Autobody”)
- Review Process (CSAP or ENV)
- Risk Designation (Non-High Risk or High Risk)
- Service Family (Instrument Applications, Decisions)
- Service Type (e.g., AiP, CofC numeric, CofC DRA, CofC SLRA, Preliminary Determination, Final Determination, Protocol 9 Background)

The attribute 'Service Type' was coded for a single 'highest tier' application or submission in the dataset received from the ENV. Data scrubbing tasks to allow for summary statistics and site identification included the following:

- Missing municipality names were added, and locations of Site IDs verified using iMapBC.
- City names were spell checked and corrected.
- Each Site ID, based on its spatial location, was assigned to an established background region, background region under re-evaluation (i.e., Prince George and Northeast BC), a new AOI (i.e., Mid-Island, Skeena-Bulkley, Columbia River, Penticton), or aggregated into a category outside footprint of any preceding areas/regions (i.e., 'Rest of BC').
- Site IDs that were already used in the 2018 Background Study were flagged and not used in the evaluation.
- Affiliated Site IDs (e.g., affected parcels, subdivision daughter parcels, environmental management areas, etc.) were identified, and a single 'parent' Site ID was designated to avoid duplication by establishing a single site.

Summary statistics conducted on the 2018–2024 dataset was used to identify areas of the province that had high activities for Site Registry entries, particularly for Protocol 9 determinations.

4.3.2 Pre-2018 Dataset

There was no *province-wide* dataset available for Site Registry entries with applications or regulatory submissions dated prior to 2018. PGL provided the ENV with AOIs and received individual spreadsheets for the four new areas under evaluation. In contrast to the 2018–2024 spreadsheet, the pre-2018 spreadsheets contained multiple entries per Site IDs (i.e., Site IDs were not coded for the 'highest tier' application or submission for the 'Service Type' attribute).

Data scrubbing tasks to allow for summary statistics and site identification included the following:

- Application and/or certification notation categories were coded for the 'highest tier' 'Service Type' to derive unique Site ID entries. The most relevant 'Service Type' attribute was used to derive a single 'Service Type' in the following order of priority: Protocol 9, Determination, CofC, AiP, investigation reports.
- Each unique Site ID was assigned to an AOI and/or background region under re-evaluation.
- Affiliated Site IDs (e.g., affected parcels, subdivision daughter parcels, environmental management areas, etc.) were identified, and a single 'parent' Site ID was designated to avoid duplication by establishing a single site.

4.4 Site Identification

For the Northeast BC and Prince George regions, the 2018 Background Study already completed a review of sites that were in the Site Registry before 2018. Therefore, the identification of Site IDs for these two regions was limited to the 2018–2024 Dataset. Suitable background sites identified in the 2018 Background Study are shown as green squares on the Figures for Northeast BC and Prince George. Potential background sites identified by PGL in the 2018–2024 Dataset are shown as red dots with associated Site IDs in the Figures.

For new AOIs that were not previously reviewed in the 2018 Background study (i.e., Mid-Island, Skeena-Bulkley, Columbia, Penticton), a search for Site IDs was completed for both the pre-2018 and 2018–2024 datasets. The two datasets were merged, and Site IDs that were listed in both the pre-2018 and the 2018–2024 datasets were flagged as duplicate entries. Sites listed in the 2018–2024 dataset were carried forward as single Site ID entry since they would have contained more recent information about a site.

In a first iteration, Site ID locations for the above regions were plotted onto figures with surficial geology maps to evaluate their locations with respect to the underlying geological units. If plotted Site ID locations were in proximity of each other and/or had consecutive Site ID numbers, the locations were further reviewed to identify potential duplications. If duplication was identified, multiple Site IDs were amalgamated to derive a single 'parent' potential background site, which was represented by the Site ID with the most recent Site Registry notation.

Examples of duplicates that were combined into singe background sites include offsite migration with a source parcel spawning multiple affected parcels, or Site IDs that were discontinued in favour of another Site ID, or multiple Site IDs that were associated with a parent Site ID due to subdivision.

In a final iteration, following amalgamation and removal of duplicate entries, potential background sites identified by PGL in the pre-2018 and/or the 2018–2024 datasets and suitable background sites identified in the 2018 Background Study were included in Figures 1.1 through 6.4.

4.5 Report Review and Well Selection Criteria

Pertinent Site Details Reports, investigation reports, determinations, and/or certification documents were requested from the ENV and/or CSAP Society for a review of sites identified in the 2018–2024 dataset for Northeast BC and Prince George.

To ensure analytical data was representative of naturally occurring background conditions and not influenced by anthropogenic sources or secondary impacts, each selected report and the data within it was reviewed and evaluated based on a well selection criteria established in the 2018 Background Study.

Below is a summary of prerequisites and precluding conditions for report review and well selection to identify suitable background sites, adopted from the 2018 Background Study. Precluding conditions were only assessed if prerequisites were met.

Prerequisites

- Reports contain metals and metalloid data.
- Geographical location of the site must be known.
- Borehole logs were present with stratigraphic information.

Precluding Conditions

- Monitoring well must not be screened within fill or backfill.
- Monitoring well must not be influenced by secondary contaminant release processes.
- Monitoring well must not be screened in deep aquifers or bedrock.
- Monitoring well must not be situated in close proximity down- or cross-gradient from the contaminant source.
- There must not be detectable concentrations of contaminants of concern (COCs) in soil in the screened interval of monitoring well, or directly above the screen, with the potential to affect metal concentration in well screen due to secondary release processes.
- Exclude analytical data if concentrations are less than the laboratory detection limit and the standards are lower than the detection limit.

Application of Screening Criteria

Some precluding conditions such as exclusions of monitoring wells screened in fill or backfill are clear cutoff criteria. Other conditions such as location and distance of monitoring wells relative to the contaminant source are of qualitative nature and require evaluation on a case-by-case basis based on site conditions.

4.6 Statistical Analysis

The 2018 Background Study generally followed Protocol 9 procedures for statistical analysis to establish groundwater background. Below is a high-level summary of the procedure.

- Establish background for sites
  - 95th percentile of multiple sampling events per monitoring well
  - 95th percentile of multiple monitoring wells per site
- Establish background for regions
  - Required minimum 10 sites for evaluation
  - Outlier tests and data distribution analysis (e.g., QQ plot, etc.)
  - 95th percentile of all sites

Statistical analysis was not conducted for this project because additional review of hydrogeological and geochemical data is needed to determine whether sites in Northeast BC and Prince George regions can be used to achieve the threshold of 10 sites per region.

5.0 RESULTS

5.1 Summary Statistics

Table A presents the summary statistics of the 2018–2024 dataset for the five 2018 Background Study regions and for all the other areas of BC outside the footprint of these regions, designated 'Rest of BC' in the table as point of reference for how many Site IDs are available in the various regions. It is evident that the bulk of new Site Registry entries since 2018 were in the largest urban centres where the 2018 Background Study was able to establish background areas. Fewer potential background sites are available in less populous areas of BC.

Table A: Number of Site IDs by Province-wide Regions and Service Type

	Notations					
Regions	**AiP**	**CofC**	**Determination (Final)**	**Determination (Preliminary)**	**P9**	**Total**
Lower Mainland	129	340	78	8	10	565
South Vancouver Island	22	56	9		2	89
Thompson-Okanagan	4	40	3		4	51
Northeast BC		5			4	9
Prince George	1	9	2		2	14
Rest of BC	13	100	17	3	10	143
Total	**169**	**550**	**109**	**11**	**32**	**871**

Table B shows that the four new regions selected for evaluation account for 88 out of 143 (~60%) Site IDs from the areas outside the footprint of the 2018 Background Study regions (aka 'Rest of BC') and 8 out of 10 for Protocol 9 determinations (80%) based on the 2018–2024 dataset.

Table B: Number of Site IDs by New Regions and Service Type

	Notations					
Potential Regions	**AiP**	**CofC**	**Determination (Final)**	**Determination (Preliminary)**	**P9**	**Total**
Penticton	1	4	1	1	1	8
Mid-Island	1	14	3	1	2	21
Skeena-Bulkley	3	23	2		1	29
Columbia River		25	1		4	30
Total	**5**	**66**	**7**	**2**	**8**	**88**

Based on the above Site Registry activity since the 2018 Background Study, it appeared that the four new regions could potentially yield sufficient data for evaluating background if sites from the pre-2018 dataset were also included.

5.2 Prince George

5.2.1 Geology

Prince George had previously been identified as a potential background region in the 2018 Background Study. Due to insufficient background sites available at the time, no regional background values could be determined. The 2018 Background Study identified four suitable sites with Site IDs 2151, 3217, 8397, and 11952 (Figure 1.1).

We reviewed available geological information for Williams Lake, Vanderhoof, Quesnel, and 150 Mile House to potentially increase the spatial extent and thus the number of potentially suitable background sites for considerations in this area. The published resources available to assess surficial geology and soils in the Prince George region included:

- British Columbia Geological Survey Open File 2017-8, 9p. Data version 2019-12-19 via BC Data Catalogue
- BC Soils Information Finder Tool, 2018 via BC Data Catalogue
- Geological Survey of Canada, Map 1288A Surficial geology, Prince George
- Geological Survey of Canada, Map 3-1969 Surficial geology, Prince George, BC

The surficial geology of the Prince George region generally consists of glacial sediments and can generally be described as till, eskers, drumlins, glaciolacustrine, and glaciofluvial deposits that overly bedrock. The City of Prince George is within the glaciolacustrine deposits of a former glacial lake and glaciofluvial deposits from a former outwash plain. Review of mapped aquifers through the BC Water Resources Atlas identified that the same area is underlain by an unconfined sand and gravel aquifer described as alluvial sands and gravels (Lower Nechako River Aquifer #92).

The surficial geology of Williams Lake, Vanderhoof, and Quesnel can generally be described as fluvial, glacial lacustrine, and glacial till. These areas of fluvial, glaciolacustrine, and till are amenable to further assessment of background groundwater conditions as they are consistent with the types of material in the Prince George area to the north. Mapped aquifers in these areas within surficial deposits are sand and gravel aquifers hosted in glacial, fluvial, and alluvial units. Areas with surficial deposits of these types have potential for similar hydrogeological and geochemical characteristics as the Prince George region to the north.

5.2.2 Site Identification and Report Review

PGL identified 14 sites for review in the 2018–2024 dataset. Of those sites, 3 were affected parcels, which reduced the number of potential background sites to 11. Reports from 11 sites were obtained from the CSAP Society/ENV for review. The locations of these Site IDs and of suitable sites previously identified in the 2018 Background Study are shown on Figure 1.1.

Reports received from the ENV and/or CSAP were screened for prerequisites and precluding conditions to assess whether sites could be suitable background sites. Table C indicates the potential suitability of sites identified in the 2018–2024 dataset for further review and potential future data extraction.

Table C*:* Prince George Region – Screening Results

	Prerequisites			Precluding Conditions			Comments	Potential Suitable Site?
Site ID	**Location Known**	**Borehole Logs Available**	**Metals Data in GW**	**MWs Screened in Fill / Backfill**	**MW Screened in Deep Aquifer or Bedrock[+]**	**Potential secondary release processes influence**		
48	✓	✓	✓			✓	CofC; gas station; MWs with metal data within footprint of detectable soil and/or groundwater hydrocarbon concentrations, and/or LNAPL	No
584	✓	✓	✓	some		✓	CofC; rail yard; MWs with metal data within footprint of detectable soil and/or groundwater hydrocarbon concentrations, and/or LNAPL, and/or railway	No
1858*	✓		✓			✓	Protocol 6; bulk fuel plant and railway; MWs with metal data within footprint of detectable soil and/or groundwater hydrocarbon concentrations, and/or LNAPL, and/or railway	No
2021	✓	✓				✓	AiP; laydown area; neighbouring refinery with limited metals data in groundwater within footprint of former hazardous waste land farm	No
2097	✓	✓	✓	some	✓		Determination; service station; groundwater table >30m bgs	likely[+]
9980	✓	✓	✓				Protocol 9; plywood plant	Yes
10453	✓	✓	✓				CofC; sawmill	Yes
11098	✓	✓	✓		✓		CofC; Protocol 9; service station; groundwater table ~20m bgs	likely[+]
21231	✓	✓	✓		✓		Determination, gas station; groundwater table >20m bgs; site is ~5km north of Prince George with different mapped geology compared to other sites and outside the mapped footprint of the Dawson Creek Overburden Aquifer	likely[+]
22338	✓	✓	Limited				CofC; shooting range; site is ~10km east of Prince George, likely within different mapped geology compared to other sites and outside the mapped footprint of the Dawson Creek Overburden Aquifer	No
22930	✓	✓	✓				CofC; repair shops	Yes

Notes: * Some reports or backup information unavailable at the time of reporting

[+] Refer to discussion below for variability of depth to groundwater in Prince George

bgs = below ground surface

A review of available reports indicated that the location of sites, lack of metal data, potential secondary release processes, and/or deep groundwater (>20m) would preclude some sites for consideration as background sites based on screening criteria.

The 2018 Background Study had previously identified four sites, two of which had shallow screened monitoring wells (~5m bgs) and two had deep screened monitoring wells (~30m bgs). A similar pattern was noted for reviewed sites listed in Table C, whereas the depth to groundwater within the municipal boundaries of Prince George ranged from ~2m bgs to >30m bgs, which may be attributable to the slope of the land. If it can be shown that groundwater in shallow and deep zones is part of the same unconfined aquifer with similar hydrogeological and geochemical attributes, then a threshold of 10 sites for statistical analysis would be within reach.

Based on the current prerequisites and precluding conditions (Section 4.5), and assuming that the shallow and deep monitoring wells are screened within the same unconfined aquifer, the combined number of suitable sites established in the 2018 Background Study (n=4) and potential sites identified in the current study (n=6) would reach the threshold of 10 sites to evaluate background concentrations.

Refer to Section 6.0 for additional discussion.

5.3 Northeast BC

5.3.1 Geology

Fort St. John and Dawson Creek had previously been identified as a potential background region in 2018 Background Study, jointly referred to as Northeast BC. Due to insufficient background sites available at the time, no regional background values could be determined. The 2018 Background Study identified three sites in Dawson Creek with Site IDs 1962 (two sets of wells) and 14277 (Figure 2.1) and five suitable sites in Fort St. John with Site IDs 1975, 2024, 2064, 1956, and 20960 (Figure 2.2).

We reviewed the available geological information for Chetwynd and Tumbler Ridge to potentially increase the spatial extent and thus the number of potentially suitable background sites for considerations in this area. The published resources available to assess surficial geology and soils in the Northeast BC region included:

- British Columbia Geological Survey Open File 2017-8, 9p. Data version 2019-12-19 via BC Data Catalogue
- BC Soils Information Finder Tool, 2018 via BC Data Catalogue
- Geoscience BC Map 2011-08-1, Compilation of Geological Survey of Canada surficial geology maps for NTS 94A and 93P

The surficial geology of Fort St. John can generally be described as till veer and glacial fluvial hummocky, while Dawson Creek can generally be described glaciolacustrine deposits. Chetwynd and Tumbler Ridge are described as having streamlined till ridges. Within the Tumbler Ridge area, alluvial fan and alluvial plains are also mapped. Mapped aquifers in these areas within surficial deposits are sand and gravel aquifers hosted in glacial, fluvial, and alluvial/colluvial units.

The Fort St. John Overburden Aquifer System Aquifer #444 is mapped underneath Fort St. John as an unconfined sand and gravel unit within Mid-Wisconsinan fluvial gravel and Late-Wisconsinan

outwash. The Dawson Creek Overburden Aquifer #851 is mapped underneath Dawson Creek as a confined sand and gravel unit underlying glaciolacustrine deposits or in between till layers.

These four areas where alluvial, glaciofluvial, glaciolacustrine, and till are present at surface are amenable to further assessment of background groundwater conditions. Areas with surficial deposits of these types have potential for similar hydrogeological and geochemical characteristics; however, statistical analysis would have to be conducted to assess whether groundwater concentrations in these areas with distinct geology constitute the same population.

5.3.2 Site Identification and Report Review

PGL identified nine sites for review in the 2018–2024 dataset, two in Dawson Creek and seven in Fort St. John. Of the seven sites in Fort St. John, three were determined to be related parcels, leaving a total of seven sites for review. Of those, six reports could be obtained from the ENV/CSAP Society for review. Table D indicates the potential suitability of sites identified in the 2018–2024 dataset for further review and potential future data extraction.

Table D: Northeast BC Region – Site Screening Results

	Prerequisites			Precluding Conditions				
Site ID	**Location Known**	**Borehole Logs Available**	**Metals Data in GW**	**MWs Screened in Fill / Backfill**	**MW Screened in Deep Aquifer or Bedrock**	**Potential secondary release processes influence**	**Comments**	**Potential Suitable Site?**
Fort St. John								
2078	✓	✓					CofC; gas station	No
11676	✓	✓	✓				CofC; Protocol 9; fuel bulk plant and fertilizer facility	Yes
17688	✓	✓	✓				CofC; hospital	Yes
22345	✓	✓	✓		some		CofC; Protocol 9; bulk fuel plant; some of the groundwater background for MWs screened in bedrock	Yes
23550	✓	✓	✓			✓	CofC; Works yard with fueling infrastructure	No
Dawson Creek								
1994*	✓						Protocol 9; service station	potentially
28504	✓	✓	✓				Protocol 9; tank farm	Yes

Notes: * some reports or backup information unavailable at the time of reporting

A review of available reports indicated that lack of metal data or potential influence of secondary release processes would preclude some sites for consideration as potential background sites.

The 2018 Background Study had previously identified five sites for Fort St. John and three sites for Dawson Creek. Based on the current prerequisites and precluding conditions (Section 4.5), the combined number of suitable sites established in the 2018 Background Study (n=8) and potential sites identified in the current study (n=4) for both municipalities would reach the threshold of 10 sites to evaluate background concentrations for the Northeast BC region.

However, the surficial geology in Fort St. John is mapped as till deposits, while Dawson Creek is underlain by glaciolacustrine deposits. The two municipalities are >60km apart and additional evaluation of hydrogeological and geochemical attributes is needed to determine if the two areas can be combined into one region, or if they are distinct subregions.

Refer to Section 6.0 for further discussion.

5.4 Mid-Island Region

We reviewed available information in the Mid-Island region from Nanoose Bay to Campbell River, BC. Currently, there is no background region established for this area as the Southern Vancouver Island Background Region extends to Nanaimo as its northernmost.

5.4.1 Geology

The area north of Nanaimo may be amenable to extending the Southern Vancouver Island regions farther northward or establishing a Mid-Island background region depending on the continuity of surficial geology conditions to the north. The published resources available to assess surficial geology and soils in the Mid-Island region included:

- British Columbia Geological Survey Open File 2017-8, 9p. Data version 2019-12-19 via BC Data Catalogue
- BC Soils Information Finder Tool, 2018 via BC Data Catalogue
- Geological Survey of Canada, Open File 837 Map, Surficial geology, Vancouver Island and adjacent mainland, BC
- Geological Survey of Canada, Open File 7681 Surficial geology and Pleistocene stratigraphy from Deep Bay to Nanoose Harbour, Vancouver Island, BC
- Geological Survey of Canada Map 49-1959 Surficial geology, Oyster River, Comox, Nanaimo and Sayward districts, BC
- Geological Survey of Canada Map 32-1960 Surficial geology, Courtenay, Comox, Nelson, Nanaimo and Newcastle districts, Vancouver Island, BC
- Geological Survey of Canada Map 1111A Surficial geology Horne Lake, Vancouver Island, BC
- Geological Survey of Canada Map 1112A Surficial geology, Parksville, Vancouver Island, BC
- Geological Survey of Canada Map 27-1963 Surficial geology, Nanaimo, BC
- British Columbia Soil Survey Report No. 44 Soils of Southern Vancouver Island

Based on the information reviewed, it appears that the surficial geology observed in the Mid-Island region is of similar character to that observed in the region to the south. The area appears to be generally blanketed by quaternary alluvium and cover materials that are of fluvial, glaciofluvial, glaciolacustrine, marine, and colluvial depositional origins. Areas where fluvial, glaciofluvial, glaciolacustrine, and marine deposits are dominant are amenable to further assessment of

background groundwater conditions as they are consistent with the types of material in the established region to the south.

Review of mapped aquifers through the BC Water Resources Atlas identified several mapped aquifers within the quaternary deposits that blanket the area. They are generally described as sand and gravel aquifers hosted in fluvial, lacustrine, and glaciofluvial units, which is consistent with the mapped surficial geology.

Areas with surficial deposits of these types have potential for similar hydrogeological and geochemical characteristics as the region to the south. Available hydrogeological and geochemical data for this area could be further assessed to determine whether the established background region could be extended, or a new region established.

5.4.2 Site Identification

Table E summarizes the number of Site IDs that were identified in the pre-2018 and 2018–2024 datasets within the Penticton area for further evaluation for well criteria. The locations of these Site IDs are shown in Figures 3.1 through 3.4, and a list of the Site IDs is included in the attached Table 1.

Table E: Mid-Island Region – Count of Service Type by Location

Municipality	P9	Determination	CofC	AiP	Investigation Report	Total
2018-2024 Dataset	**1**	**4**	**10**	**1**		**16**
Campbell River	1	2	6			9
Comox		1	2			3
Errington			1			1
Parksville		1				1
Qualicum Beach			1			1
Union Bay				1		1
Pre-2018 Dataset		**5**	**29**	**3**	**51**	**88**
Bowser					1	1
Campbell River		2	13	1	16	32
Comox			1		2	3
Courtenay		1	12	2	15	30
Cumberland					3	3
Errington		1			1	2
Fanny Bay					1	1
Nanoose Bay			1		1	2
Parksville		1	1		7	9
Qualicum Beach			1		4	5
Total	**1**	**9**	**39**	**4**	**51**	**104**

5.5 Skeena-Bulkley

We reviewed available information for the Skeena-Bulkley region including Prince Rupert, Terrace, Kitimat, the Hazeltons, Smithers, and areas between the major centres. Currently, there is no background region established for this area.

5.5.1 Geology

The published resources available to assess surficial geology and soils of the Skeena-Bulkley region included:

- British Columbia Geological Survey Open File 2017-8, 9p. Data version 2019-12-19 via BC Data Catalogue
- BC Soils Information Finder Tool, 2018 via BC Data Catalogue
- Geological Survey of Canada, Map 1557A Surficial geology, Skeena River-Bulkley River area, BC (5 Map Sheets)

The surficial geology in the Prince Rupert area is predominantly bedrock and soil of organic origin (i.e., peat, muck). Bedrock and colluvial deposits are predominant along the Skeena River valley to the east of Prince Rupert, except the valley bottom where alluvial deposits occur. Approaching Terrace, the surficial bedrock gradually gives way to surficial deposits of glacial origin including glaciofluvial gravels and sands, glacial till, and glaciomarine silt, clay. The glacial materials extend south toward Kitimat, with a band of alluvial deposits occurring along the Kitimat River. Glacial till and bedrock are predominant along the Skeena River valley north of Terrace toward the Hazeltons. The area of the Hazeltons is predominantly glacial till with glaciofluvial and alluvial deposits in the lower lying areas and valley bottom. The Bulkley River area from the Hazeltons to Smithers is predominantly glacial till.

Review of mapped aquifers through the BC Water Resources Atlas identified several mapped aquifers within the study area at the urban nodes of Kitimat, Terrace, the Hazeltons, Smithers, and Telkwa. The mapped aquifers are generally described as sand and gravel aquifers hosted in glacial and fluvial units, which is consistent with the mapped surficial geology in those locations.

It is unlikely that a continuous background region could be established along the Skeena-Bulkley corridor. The region would likely have to be divided into separate areas based on the predominant surficial geology:

- Prince Rupert to Terrace – Bedrock
- Terrace to Kitimat – Glaciofluvial/Alluvial
- Terrace to the Hazeltons – Bedrock/Glacial Till
- Hazeltons to Smithers – Glacial Till

Available hydrogeological and geochemical data for these areas could be further assessed to determine whether background regions could be established.

5.5.2 Site Identification

Table F summarizes the number of Site IDs that were identified in the pre-2018 and 2018–2024 datasets within the Penticton area for further evaluation for well criteria. The locations of these Site IDs are shown in Figures 4.1 through 4.3, and a list of the Site IDs is included in the attached Table 2.

Table F: Skeena-Bulkley Count of Service Type by Location

Municipality	P9	Determination	CofC	AiP	Investigation Report	Total
2018-2024 Dataset	**1**	**2**	**10**	**3**		**16**
Burns Lake			2	1		3
Kitimat			3	1		4
Smithers	1		1			2
Terrace		2	4	1		7
Pre-2018 Dataset		**5**	**21**	**6**	**25**	**57**
Burns Lake			1		1	2
Cedarvale					1	1
Decker Lake				1	1	2
Houston			5	1	2	8
Kitimat		1	1	1		3
Smithers		1	4	1	9	15
Telkwa					1	1
Terrace		3	8	2	10	23
Topley			2			2
Total	**1**	**7**	**31**	**9**	**25**	**73**

5.6 Columbia River

We reviewed available information for the Columbia River Valley region including Revelstoke, Invermere, Canal Flats, and Radium Hot Springs. Currently, there is no background region established for this area.

5.6.1 Geology

The published resources available to assess surficial geology and soils of the Columbia River region included:

- British Columbia Geological Survey Open File 2017-8, 9p. Data version 2019-12-19 via BC Data Catalogue
- BC Soils Information Finder Tool, 2018 via BC Data Catalogue
- Geological Survey of Canada, Open File 156, Sixteen surficial geology maps of parts of the Columbia River valley from Donald to Revelstoke, BC

The surficial geology along the valley region can generally be described as fluvial and glaciofluvial in origin along the low-lying areas of the valley, giving way to glacial till and colluvium. The continuity of fluvial and glaciofluvial is interrupted in some areas (i.e., Canal Flats) by colluvium. Areas where fluvial, glaciofluvial, and glaciolacustrine deposits are dominant are amenable to further assessment of background groundwater conditions as they are relatively continuous through the valley.

Review of mapped aquifers through the BC Water Resources Atlas identified several mapped aquifers within the study area at the urban nodes of Revelstoke, Radium Hot Springs, Invermere, Canal Flats, and Golden. The mapped aquifers are generally described as sand and gravel aquifers hosted in glacial, fluvial, and alluvial/colluvial fan units, which is consistent with the mapped surficial geology in those locations.

Areas with surficial deposits of these types have potential for similar hydrogeological and geochemical characteristics. Available hydrogeological and geochemical data for this area could be further assessed to determine whether a background region could be established.

5.6.2 Site Identification

Table G summarizes the number of Site IDs that were identified in the pre-2018 and 2018–2024 datasets within the Columbia River area for further evaluation for well criteria. The locations of these Site IDs are shown in Figures 5.1 through 5.5, and a list of the Site IDs is included in the attached Table 3.

Table G: Columbia River Region – Count of Service Type by Location

Municipality	P9	Determination	CofC	AiP	Investigation Report	Total
2018-2024 Dataset	**4**	**1**	**17**			**22**
Canal Flats	1	1				2
Golden			1			1
Invermere	1					1
Jaffray			4			4
Nakusp			6			6
Radium Hot Springs			1			1
Revelstoke			2			2
Windermere	2		3			5
Pre-2018 Dataset		**3**	**21**	**3**	**14**	**41**
Canal Flats			1			1
Golden			9		6	15
Invermere			3		2	5
Nakusp					2	2
Radium Hot Springs					2	2
Revelstoke		3	8	3	2	16
Total	**4**	**4**	**38**	**3**	**14**	**63**

5.7 Penticton

We reviewed available information for Penticton, Keremos, Naramata, Okanagan Falls, Oliver, Osoyoos, and Summerland. Currently, there is no background region established for this area. The Thompson - Okanagan Background Region extends to Kelowna but does not continue farther south.

5.7.1 Geology

The published resources available to assess surficial geology and soils of the Penticton region included:

- British Columbia Geological Survey Open File 2017-8, 9p. Data version 2019-12-19 via BC Data Catalogue
- BC Soils Information Finder Tool, 2018 via BC Data Catalogue
- British Columbia Geological Survey Bulletin 46, Late glacial history and surficial deposits of the Okanagan Valley, BC
- British Columbia Soil Survey Report No. 52, Soils of the Okanagan and Similkameen Valleys.

The surficial geology within the Okanagan Valley south of Kelowna down to Osoyoos Lake can generally be described as fluvial, glaciofluvial, and glaciolacustrine with areas of glacial till and colluvium. Areas where fluvial, glaciofluvial, glaciolacustrine, and colluvium deposits are dominant are amenable to further assessment of background groundwater conditions as they are consistent with the types of material in the established region to the north.

Review of mapped aquifers through the BC Water Resources Atlas identified several mapped aquifers within the surficial deposits in the study area. The mapped aquifers are generally described as sand and gravel aquifers hosted in glacial, fluvial, and alluvial/colluvial fan units, which is consistent with the mapped surficial geology in those locations.

Areas with surficial deposits of these types have potential for similar hydrogeological and geochemical characteristics as the region to the north. Available hydrogeological and geochemical data for this area could be further assessed to determine whether the established background region could be extended, or a new region established.

5.7.2 Site Identification

Table H summarizes the number of Site IDs that were identified in the pre-2018 and 2018–2024 datasets within the Penticton area for further evaluation for well criteria. The locations of these Site IDs are shown in Figures 6.1 through 6.4, and a list of the Site IDs is included in the attached Table 4.

Table H: Penticton Region - Count of Service Type by Location

Municipality	P9	Determination	CofC	AiP	Investigation Report	Total
2018-2024 Dataset	**2**	**2**	**4**			**8**
Oliver		1				1
Penticton	2	1	4			7
Pre-2018 Dataset	**2**	**6**	**30**	**4**	**38**	**80**
Keremeos			2		3	5
Naramata					1	1
Okanagan Falls			1		2	3
Oliver		1	1	1	2	5
Osoyoos	1		3		5	9
Penticton	1	5	22	4	20	51
Summerland			1		5	6
Total	**4**	**8**	**34**	**5**	**38**	**89**

5.8 British Columbia Energy Regulator Communication

PGL approached the BCER for reports with shallow groundwater information, specifically in Northeast BC. The BCER indicated that groundwater data is collected as part of site assessments and remediation activities, but, currently, they were not able to share any information. However, re-engagement with the BCER could potentially yield additional groundwater data for evaluation.

6.0 CONCLUSIONS AND DISCUSSION

PGL set out to (1) assess whether the threshold of 10 potential background sites in the Northeast BC and Prince George regions has been reached using sites that have become available since the 2018 Background Study, and (2) to evaluate the feasibility of potentially establishing background in new regions of the province that are outside the footprint of the 2018 Background Study areas.

Based on our analysis, described in this report, we conclude the following:

- **Northeast BC**: Reached 10 potential background sites. Fort St. John and Dawson Creek are >60km apart and the surficial geology is till and glaciolacustrine deposits, respectively. Additional evaluation of hydrogeological and geochemical attributes is needed to determine if the two areas have similar hydrogeological and geochemical attributes to combine the potential background sites into one region, or if subregions are required.
- **Prince George**: Reached 10 potential background sites if sites with shallow and deep groundwater tables are considered. The depth of the groundwater table within the municipal boundaries varied greatly between sites and was as shallow as ~5m bgs and as deep as >20m bgs. If the monitoring wells screened in the deep water table are excluded from consideration as potentially suitable background sites, then the threshold of 10 sites to conduct statistical analysis is not reached. Additional review of hydrogeological and geochemical data is needed to evaluate whether the groundwater data from shallow and deep groundwater are of the same population.
- **Four new areas of interest (Mid-Island, Skeena-Bulkley, Columbia River, and Penticton)**: Based on a review of the geological setting and number of sites, the Mid-Island, Columbia River, and Penticton regions are underlain by similar contiguous geological units and may potentially be amenable to establishing groundwater background. Many sites in these areas are former gas/service stations or related to automotive repair activities, which will require careful review of data to rule out secondary release processes. A portion of the Skeena-Bulkley region may be underlain by shallow bedrock, which may diminish the number of sites that may be suitable for establishing background groundwater.

The methodology to establish regional background uses a threshold of 10 individual, suitable sites to conduct statistical analysis to establish background. Achieving this threshold may not be feasible in areas with a low density of urban clusters. Increasing the footprint of regions may be feasible in some cases but can be limited by geological heterogeneity. An alternate approach to establishing background in regions with limited numbers of sites could be to combine suitable monitoring wells from less than 10 sites into one dataset for statistical analysis if there is reasonable spatial coverage. This approach may be amenable for Prince George and the Northeast BC regions where multiple Protocol 9 decisions have already established lithium, strontium, uranium, and/or sulphate concentrations routinely exceeding applicable Contaminated Sites Regulation standards. Metrics and criteria could be established to ensure establishment of background is based on a robust dataset even when the number of sites are limited.

Most sites in the four new potential regions for further evaluation were identified in the pre-2018 dataset. Reports from these sites are expected to be largely stored in paper format in ENV's storage, which would currently require significant resources for file retrieval. The ENV is reportedly in the process of digitizing paper-based documents in their repository. It is therefore anticipated that file retrieval will become much more expedient in the foreseeable future and will benefit additional work to establish background in new regions.

7.0 RECOMMENDATIONS

This study laid the groundwork to further evaluate and potentially establish groundwater background concentrations in new regions in BC. Our recommendations for follow-up studies include the following considerations:

- Obtain reports, conduct well criteria screening, extract data, and conduct statistical analysis (if feasible) for the four newly identified AOIs:
  - Penticton
  - Mid-Island
  - Columbia River
  - Skeena-Bulkley
- Extract data, conduct statistical analysis, and review hydrogeological and geochemical data to evaluate whether the groundwater data from shallow and deep groundwater in Prince George is within the same unconfined aquifer and of the same population to establish background.
- Extract data, conduct statistical analysis, and review hydrogeological and geochemical data to evaluate whether the groundwater data from Fort St. John and Dawson Creek can be correlated and combined to reach a threshold of 10 sites to establish background, or if subregions for the two municipalities are required.
- Review whether alternative statistical methods could be utilized in regions where less than 10 suitable background sites are available but local Protocol 9 Determinations were granted. This may support establishment of background with a limited spatial footprint such as the Prince George and/or Northeast BC regions.
- Evaluate expansion of the search radius for sites around the Prince George and Northeast BC regions to increase the number of suitable sites for statistical analysis:
  - Prince George: Review geology, mapped aquifers, and Site IDs for Williams Lake, Vanderhoof, Quesnel, and 150 Mile House to determine whether the spatial footprint of the Prince George region could be extended.
  - Northeast BC: Review geology, mapped aquifers, and Site IDs for Chetwynd and Tumbler Ridge to determine whether the spatial footprint of the Northeast BC region could be extended.
- Identify and exclude sites within Environmental Management Areas (formerly wide area sites) from consideration, or sites close to marine environments potentially impacted by saltwater intrusion.
- Engage with the BCER to potentially obtain groundwater analytical data for Northern BC. Obtain, if available, reports listed in the Federal Contaminated Sites Inventory.
- Refine some of the boundaries of the three established background regions.

Figures

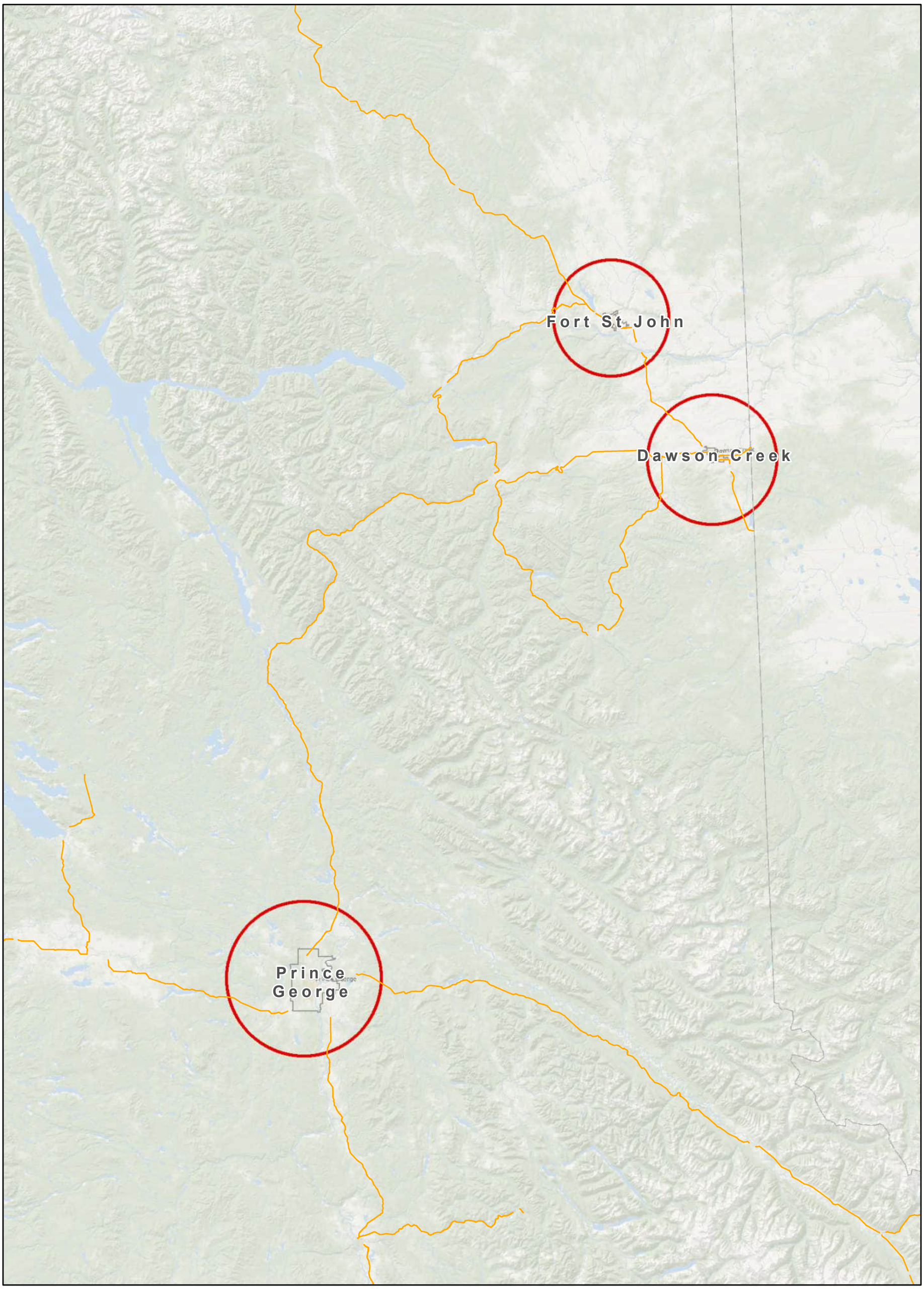


FIGURE 0.1

OVERVIEW OF STUDY AREAS – PRINCE GEORGE AND NORTHEAST BC

N

1:1,500,000

0 100,000 m

PGL
ENVIRONMENTAL CONSULTANTS

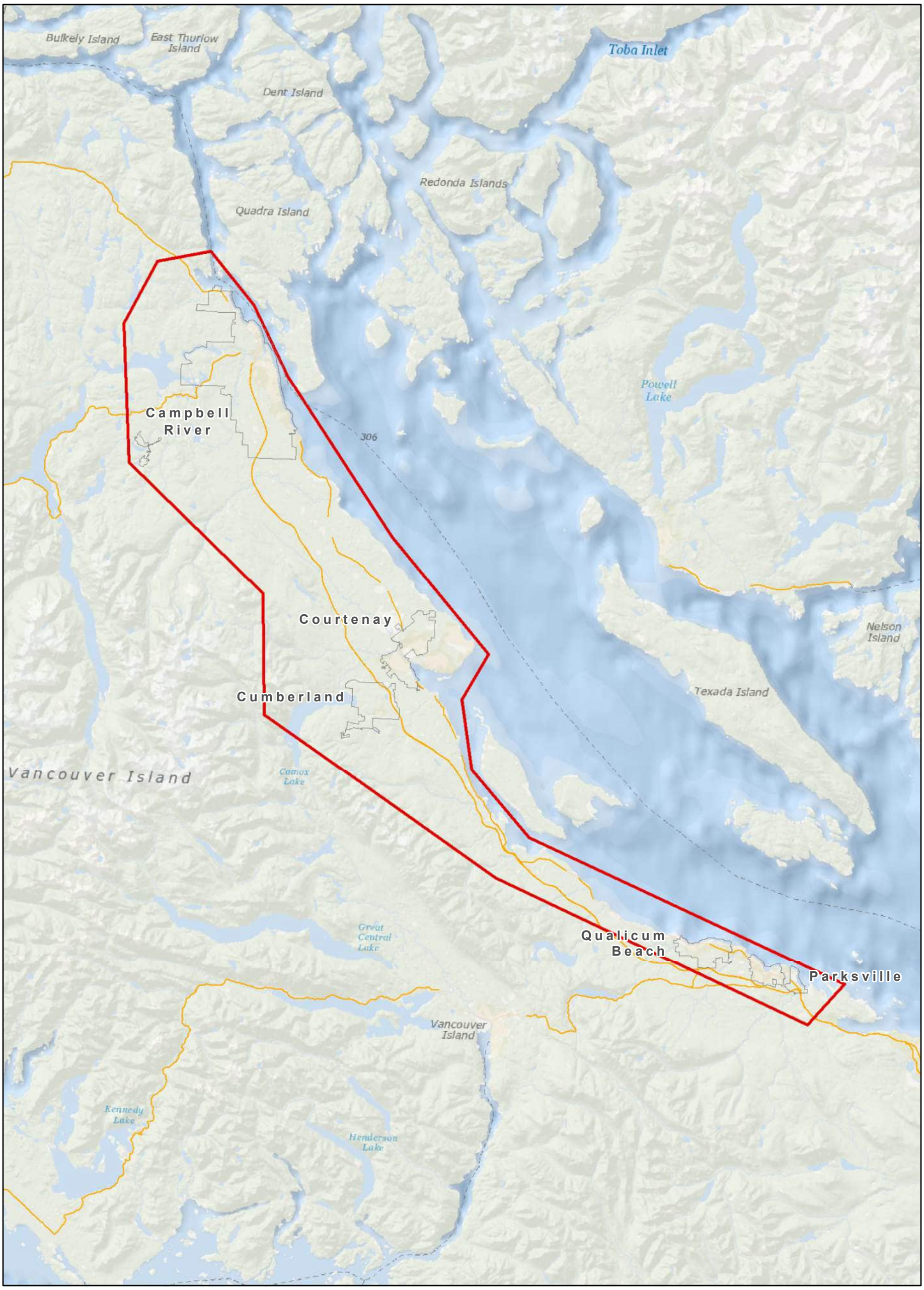


FIGURE 0.2

OVERVIEW OF STUDY AREAS – MID-VANCOUVER ISLAND

N

1:500,000

0 25,000 m

PGL ENVIRONMENTAL CONSULTANTS

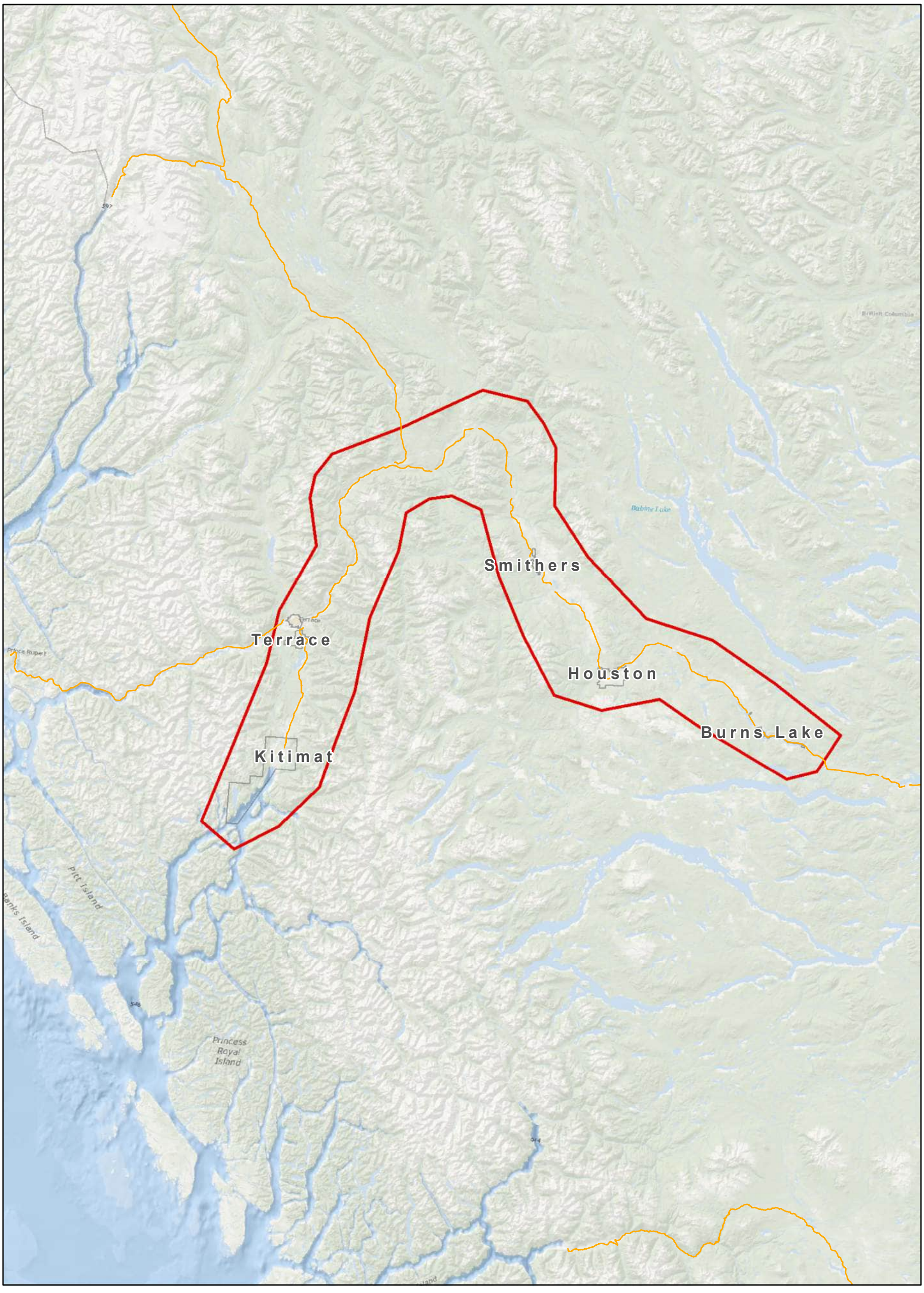


FIGURE 0.3

OVERVIEW OF STUDY AREAS – SKEENA-BULKLEY

N

1:1,500,000

0 100,000 m

PGL
ENVIRONMENTAL CONSULTANTS

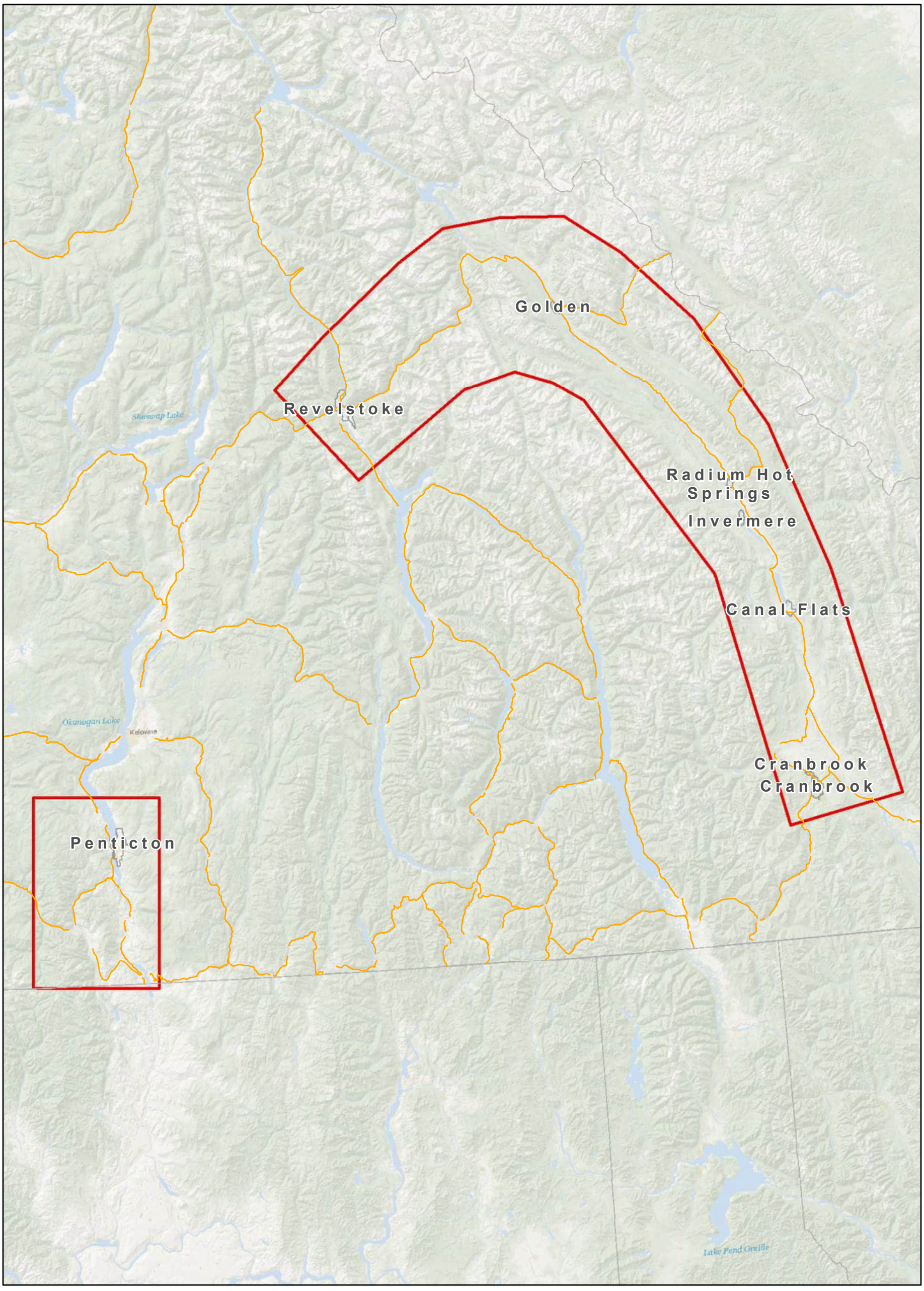


FIGURE 0.4

OVERVIEW OF STUDY AREAS – COLUMBIA RIVER AND PENTICTON

N

1:1,500,000

0 100,000 m

PGL
ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024
Data obtained from Open Data BC, 2024
NAD 1983 UTM Zone 10N

FIGURE 1.1

POTENTIAL BACKGROUND SITE LOCATIONS - PRINCE GEORGE

Potential Background Sites (PGL)

Suitable Background Sites (Core6)

Municipal Boundary

Quaternary Geology

N

1:100,000

0 5,000 m

PGL ENVIRONMENTAL CONSULTANTS

Geological Description

A — **Alluvial Deposits:** General term for material deposited from flowing water; consist of silt, sand, and gravel, at or near stream level. **Ap** alluvial plain; **Af** alluvial fan; **At** Alluvial terrace.

C — **Colluvial Deposits:** Rock or sediment transported mainly by gravity; consists of silt, sand, gravel, rubble, and rock debris; also implies steep slopes and eroded bluffs and exposed bedrock in the Peace River Valley. **Cv** colluvial veneer (thin, less than 2 m).

E — **Aeolian Deposits:** Sediment deposited by wind; consists of silt and sand. Ev aeolian veneer (thin, less than 2 m); $\frac{Er}{T}$ aeolian ridges (dunes) over till.

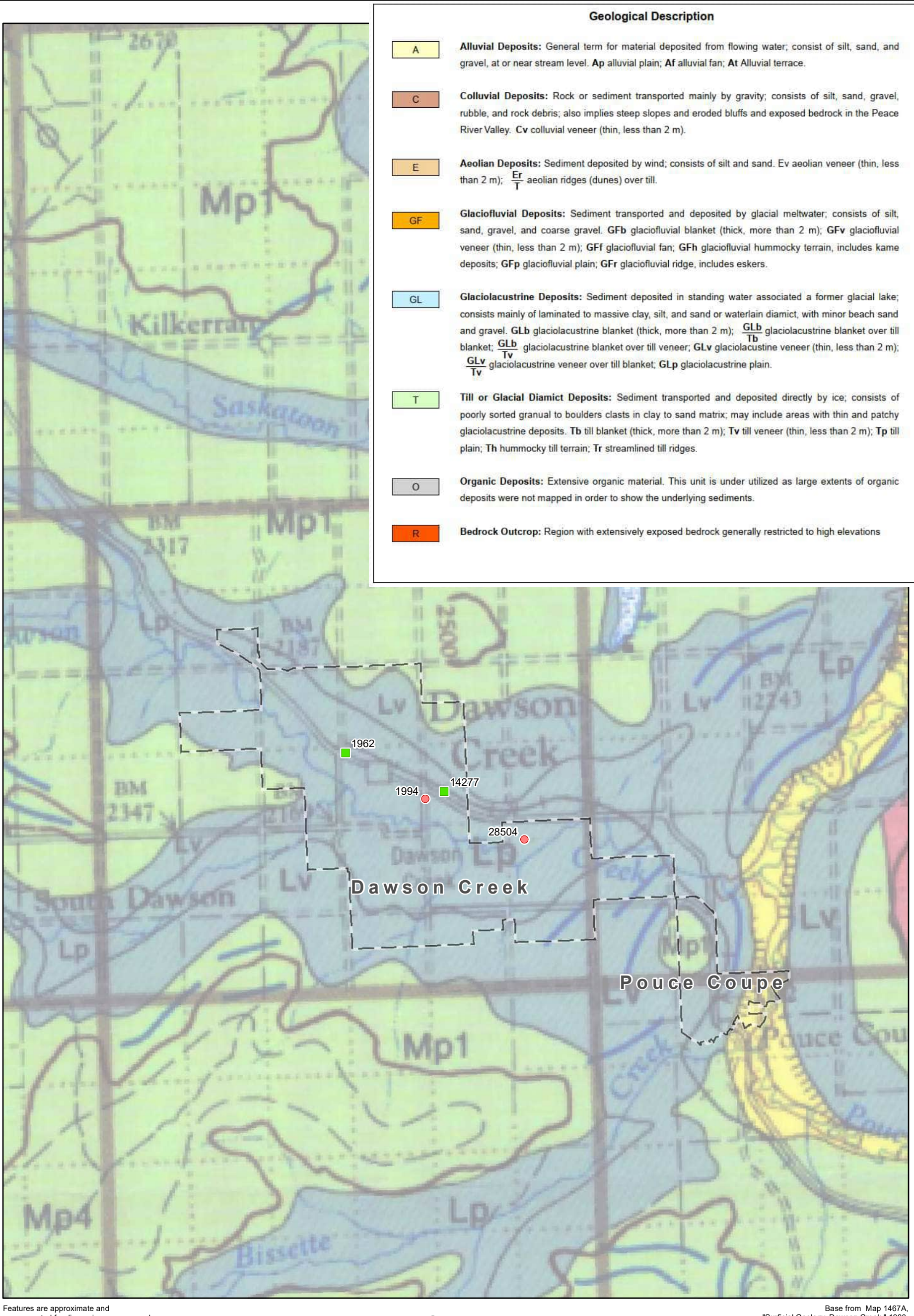
GF — **Glaciofluvial Deposits:** Sediment transported and deposited by glacial meltwater; consists of silt, sand, gravel, and coarse gravel. **GFb** glaciofluvial blanket (thick, more than 2 m); **GFv** glaciofluvial veneer (thin, less than 2 m); **GFf** glaciofluvial fan; **GFh** glaciofluvial hummocky terrain, includes kame deposits; **GFp** glaciofluvial plain; **GFr** glaciofluvial ridge, includes eskers.

GL — **Glaciolacustrine Deposits:** Sediment deposited in standing water associated a former glacial lake; consists mainly of laminated to massive clay, silt, and sand or waterlain diamict, with minor beach sand and gravel. **GLb** glaciolacustrine blanket (thick, more than 2 m); $\frac{GLb}{Tb}$ glaciolacustrine blanket over till blanket; $\frac{GLb}{Tv}$ glaciolacustrine blanket over till veneer; **GLv** glaciolacustine veneer (thin, less than 2 m); $\frac{GLv}{Tv}$ glaciolacustrine veneer over till blanket; **GLp** glaciolacustrine plain.

T — **Till or Glacial Diamict Deposits:** Sediment transported and deposited directly by ice; consists of poorly sorted granual to boulders clasts in clay to sand matrix; may include areas with thin and patchy glaciolacustrine deposits. **Tb** till blanket (thick, more than 2 m); **Tv** till veneer (thin, less than 2 m); **Tp** till plain; **Th** hummocky till terrain; **Tr** streamlined till ridges.

O — **Organic Deposits:** Extensive organic material. This unit is under utilized as large extents of organic deposits were not mapped in order to show the underlying sediments.

R — **Bedrock Outcrop:** Region with extensively exposed bedrock generally restricted to high elevations



Features are approximate and
are presented for discussion purposes only.

Base from Map 1467A,
"Surficial Geology, Dawson Creek," 1980.
Data obtained from Open Data BC, 2024
NAD 1983 UTM Zone 10N

FIGURE 2.1

POTENTIAL BACKGROUND SITE LOCATIONS - NORTHEAST BC REGION - DAWSON CREEK

Potential Background Sites (PGL)

Suitable Background Sites (Core6)

Municipal Boundary

N

1:75,000

0 5,000 m

PGL
ENVIRONMENTAL CONSULTANTS

Geological Description

A — **Alluvial Deposits:** General term for material deposited from flowing water; consist of silt, sand, and gravel, at or near stream level. **Ap** alluvial plain; **Af** alluvial fan; **At** Alluvial terrace.

C — **Colluvial Deposits:** Rock or sediment transported mainly by gravity; consists of silt, sand, gravel, rubble, and rock debris; also implies steep slopes and eroded bluffs and exposed bedrock in the Peace River Valley. **Cv** colluvial veneer (thin, less than 2 m).

E — **Aeolian Deposits:** Sediment deposited by wind; consists of silt and sand. Ev aeolian veneer (thin, less than 2 m); $\frac{Er}{T}$ aeolian ridges (dunes) over till.

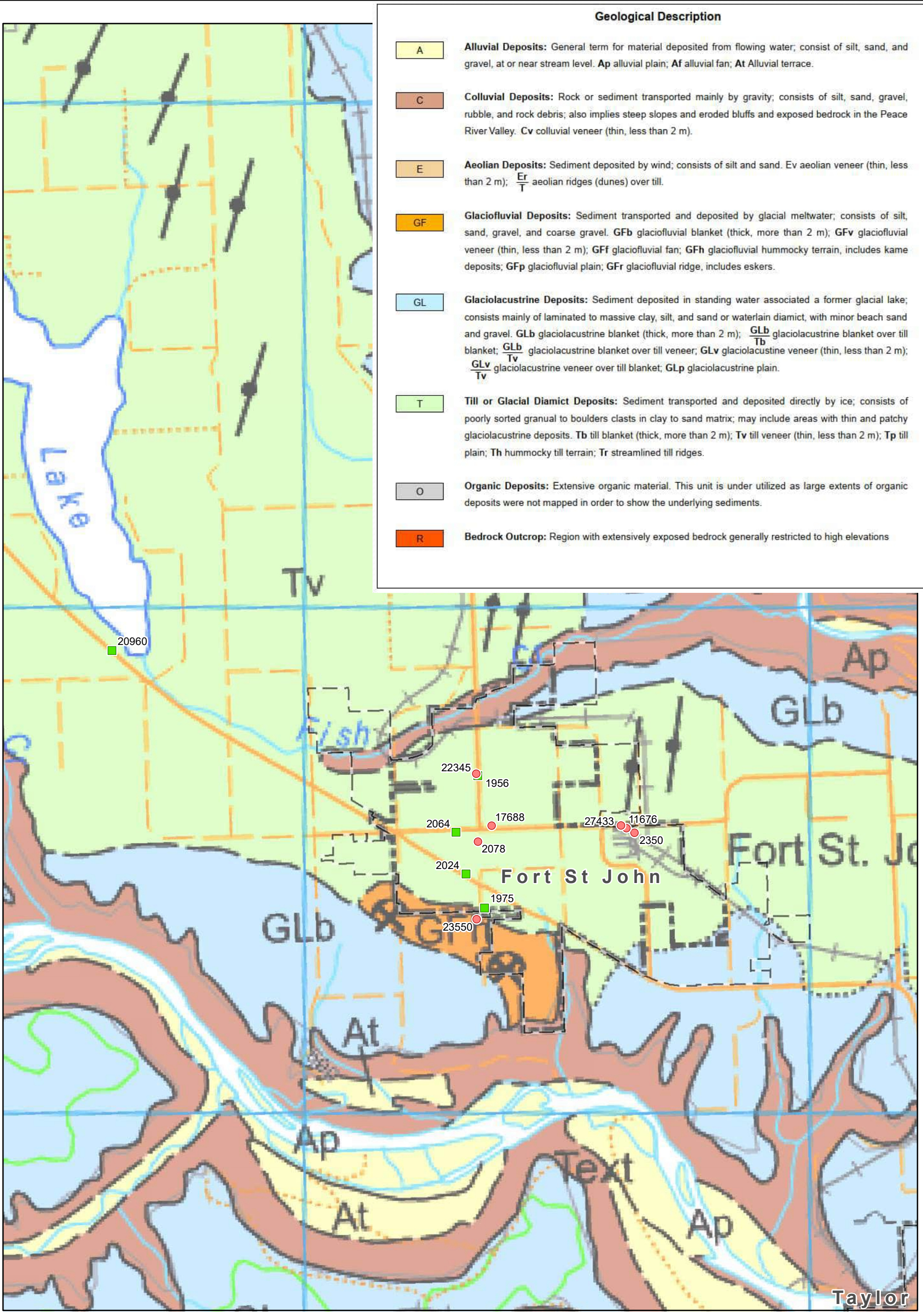
GF — **Glaciofluvial Deposits:** Sediment transported and deposited by glacial meltwater; consists of silt, sand, gravel, and coarse gravel. **GFb** glaciofluvial blanket (thick, more than 2 m); **GFv** glaciofluvial veneer (thin, less than 2 m); **GFf** glaciofluvial fan; **GFh** glaciofluvial hummocky terrain, includes kame deposits; **GFp** glaciofluvial plain; **GFr** glaciofluvial ridge, includes eskers.

GL — **Glaciolacustrine Deposits:** Sediment deposited in standing water associated a former glacial lake; consists mainly of laminated to massive clay, silt, and sand or waterlain diamict, with minor beach sand and gravel. **GLb** glaciolacustrine blanket (thick, more than 2 m); $\frac{GLb}{Tb}$ glaciolacustrine blanket over till blanket; $\frac{GLb}{Tv}$ glaciolacustrine blanket over till veneer; **GLv** glaciolacustine veneer (thin, less than 2 m); $\frac{GLv}{Tv}$ glaciolacustrine veneer over till blanket; **GLp** glaciolacustrine plain.

T — **Till or Glacial Diamict Deposits:** Sediment transported and deposited directly by ice; consists of poorly sorted granual to boulders clasts in clay to sand matrix; may include areas with thin and patchy glaciolacustrine deposits. **Tb** till blanket (thick, more than 2 m); **Tv** till veneer (thin, less than 2 m); **Tp** till plain; **Th** hummocky till terrain; **Tr** streamlined till ridges.

O — **Organic Deposits:** Extensive organic material. This unit is under utilized as large extents of organic deposits were not mapped in order to show the underlying sediments.

R — **Bedrock Outcrop:** Region with extensively exposed bedrock generally restricted to high elevations



Features are approximate and
are presented for discussion purposes only.

FIGURE 2.2

Base from Geological Survey of Canada
and BC Ministry of Energy and Mines
Surficial Geology Maps 94A and 93P.
Data obtained from Open Data BC, 2024
NAD 1983 UTM Zone 10N

POTENTIAL BACKGROUND SITE LOCATIONS - NORTHEAST BC REGION - FORT ST. JOHN

- Potential Background Sites (PGL)
- Suitable Background Sites (Core6)
- Municipal Boundary

N

1:75,000

0 — 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

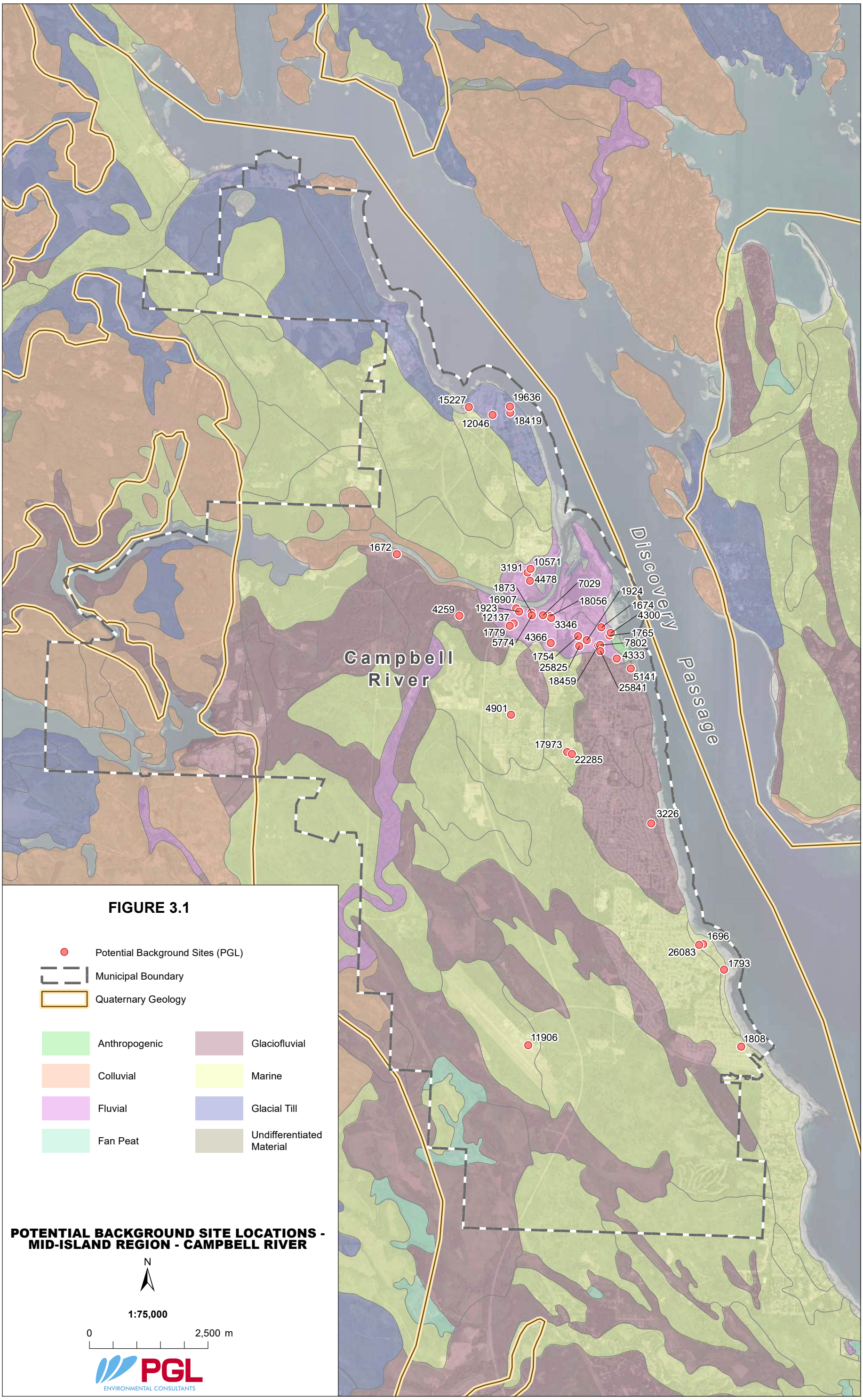


FIGURE 3.1

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Geology

Anthropogenic

Colluvial

Fluvial

Fan Peat

Glaciofluvial

Marine

Glacial Till

Undifferentiated Material

POTENTIAL BACKGROUND SITE LOCATIONS - MID-ISLAND REGION - CAMPBELL RIVER

N

1:75,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 10N

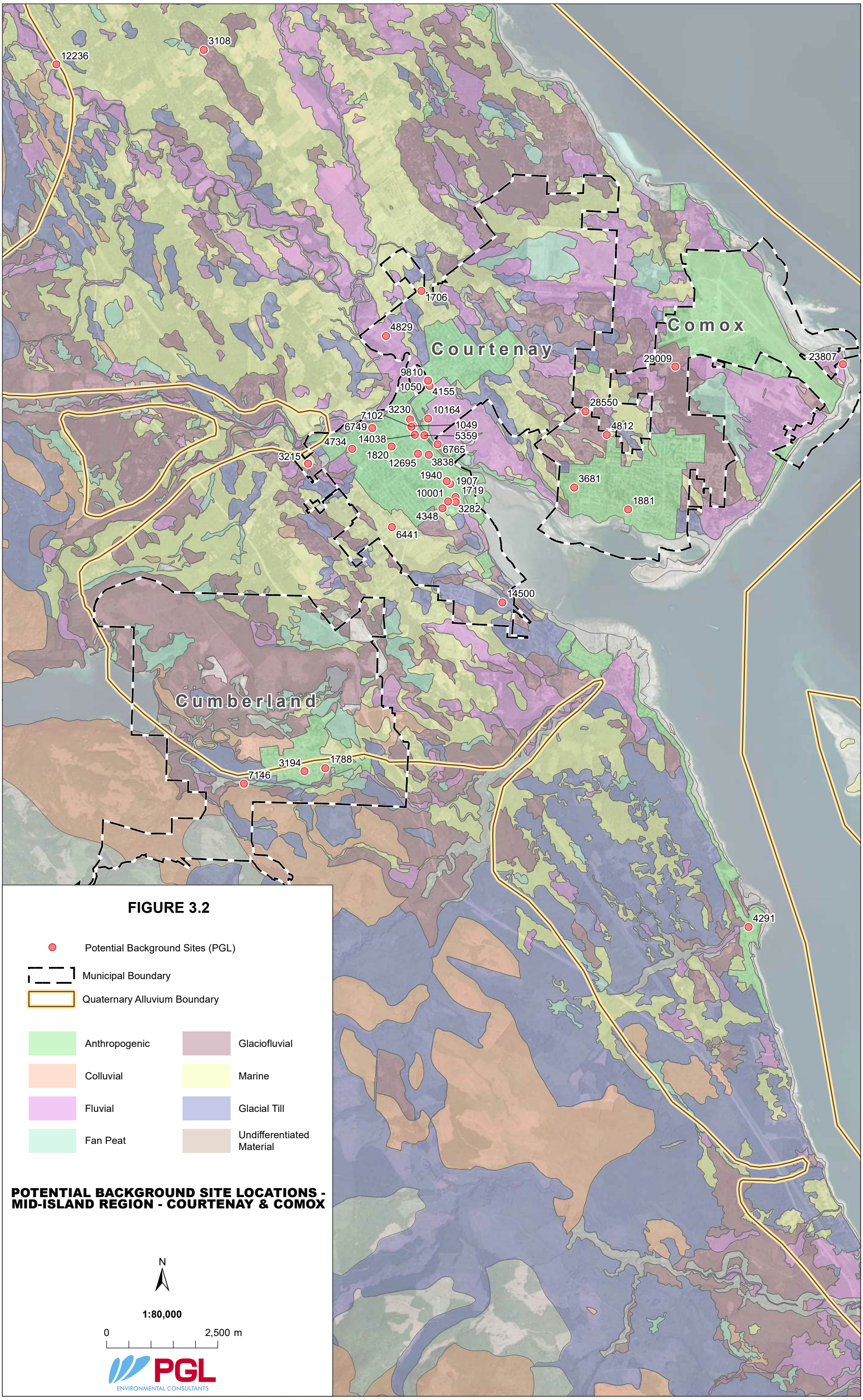


FIGURE 3.2

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Alluvium Boundary

Anthropogenic

Colluvial

Fluvial

Fan Peat

Glaciofluvial

Marine

Glacial Till

Undifferentiated Material

POTENTIAL BACKGROUND SITE LOCATIONS - MID-ISLAND REGION - COURTENAY & COMOX

N

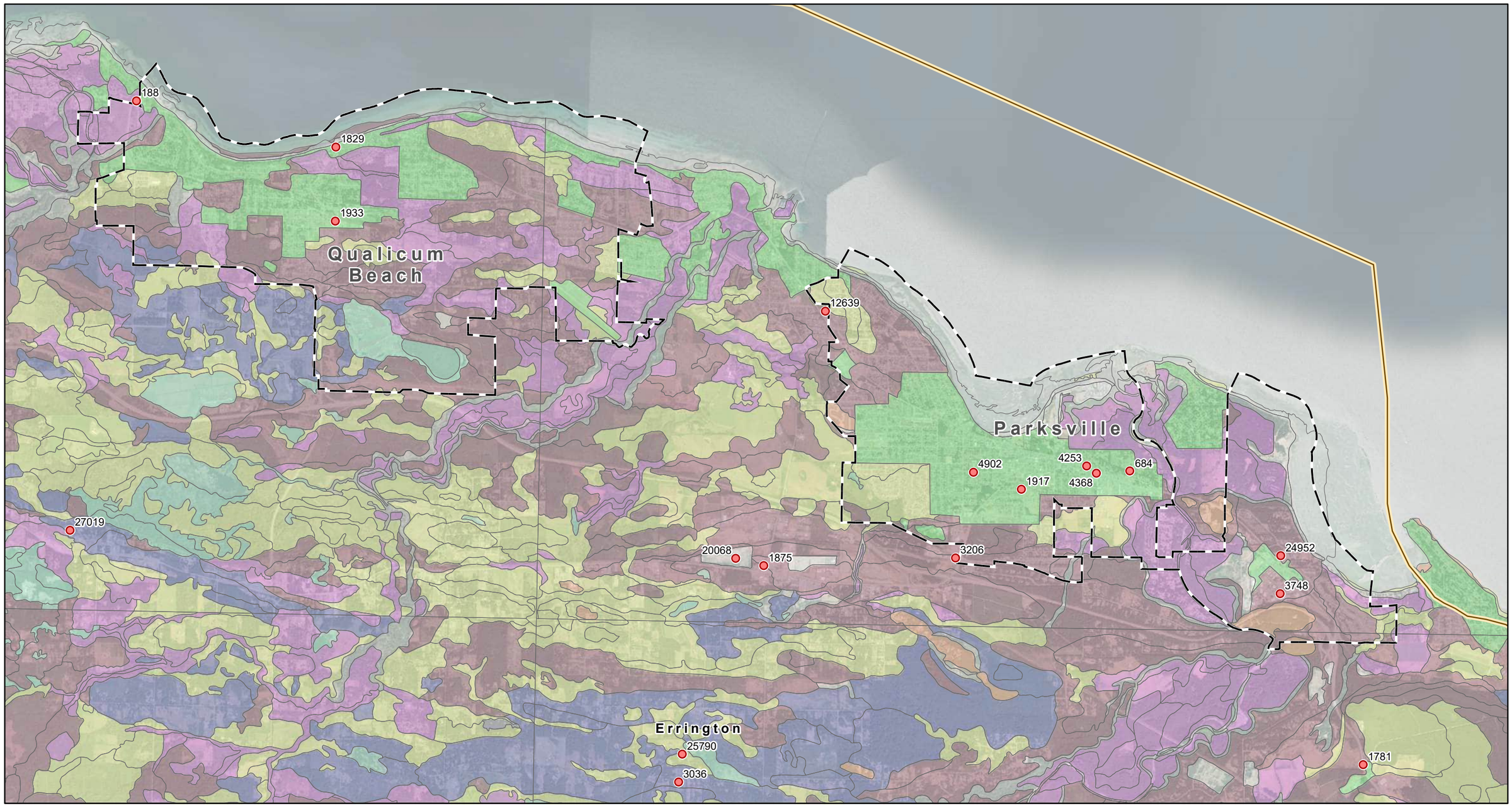
1:80,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024
Data obtained from Open Data BC, 2024
NAD 1983 UTM Zone 10N



Features are approximate and
are presented for discussion purposes only.

FIGURE 3.3

POTENTIAL BACKGROUND SITE LOCATIONS - MID-ISLAND REGION - PARKSVILLE & QUALICUM

Base image fronm ESRI, 2024
Data obtained from Open Data BC, 2024
NAD 1983 UTM Zone 10N

Municipal Boundary
Quaternary Alluvium Boundary
Anthropogenic
Colluvial
Fluvial
Fan Peat
Glaciofluvial
Marine
Glacial Till

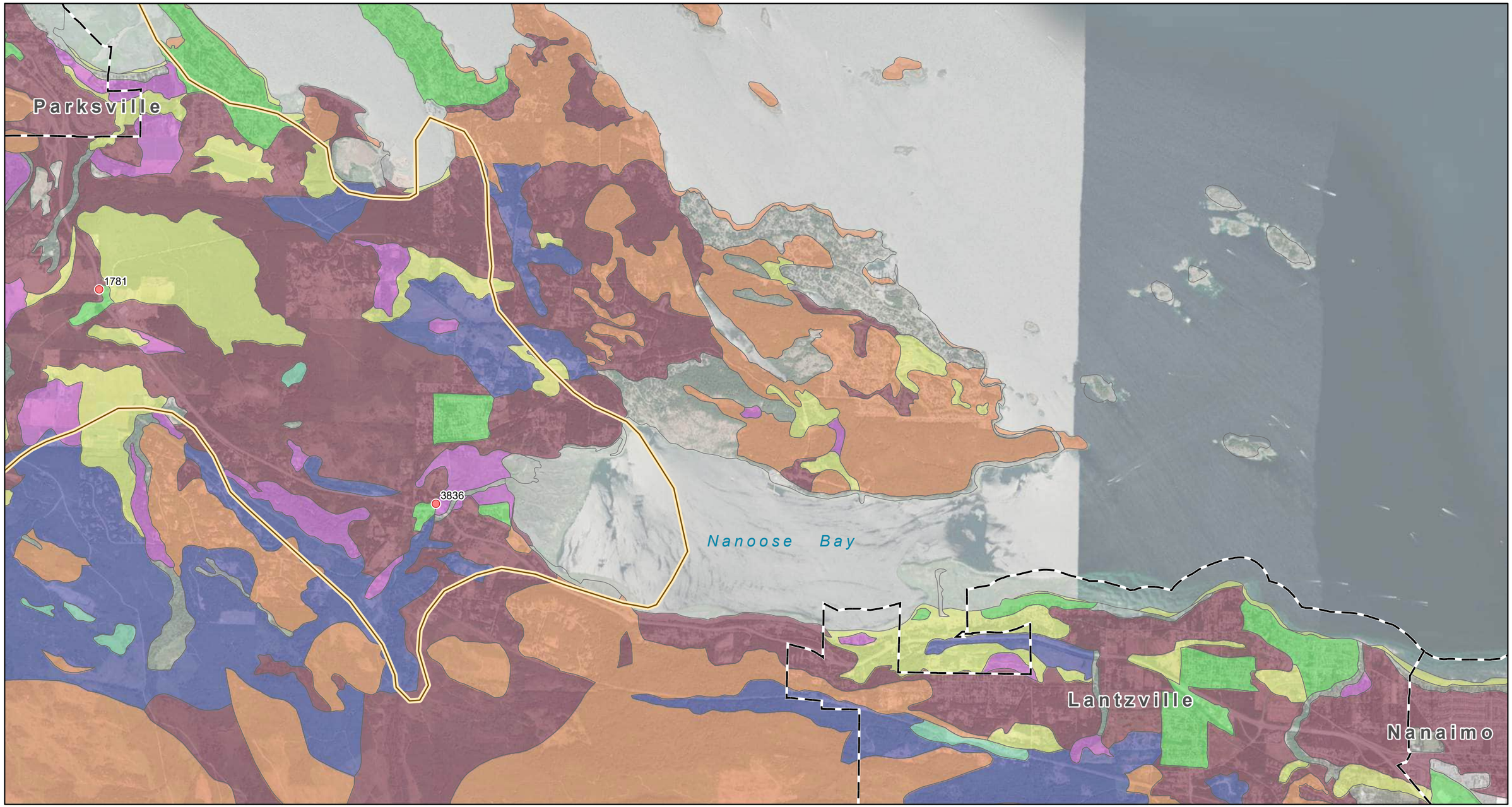
N

1:50,000

0 2,500 m

Potential Background Sites (PGL)

PGL ENVIRONMENTAL CONSULTANTS



Features are approximate and
are presented for discussion purposes only.

FIGURE 3.4
POTENTIAL BACKGROUND SITE LOCATIONS - MID-ISLAND REGION - NANOOSE BAY

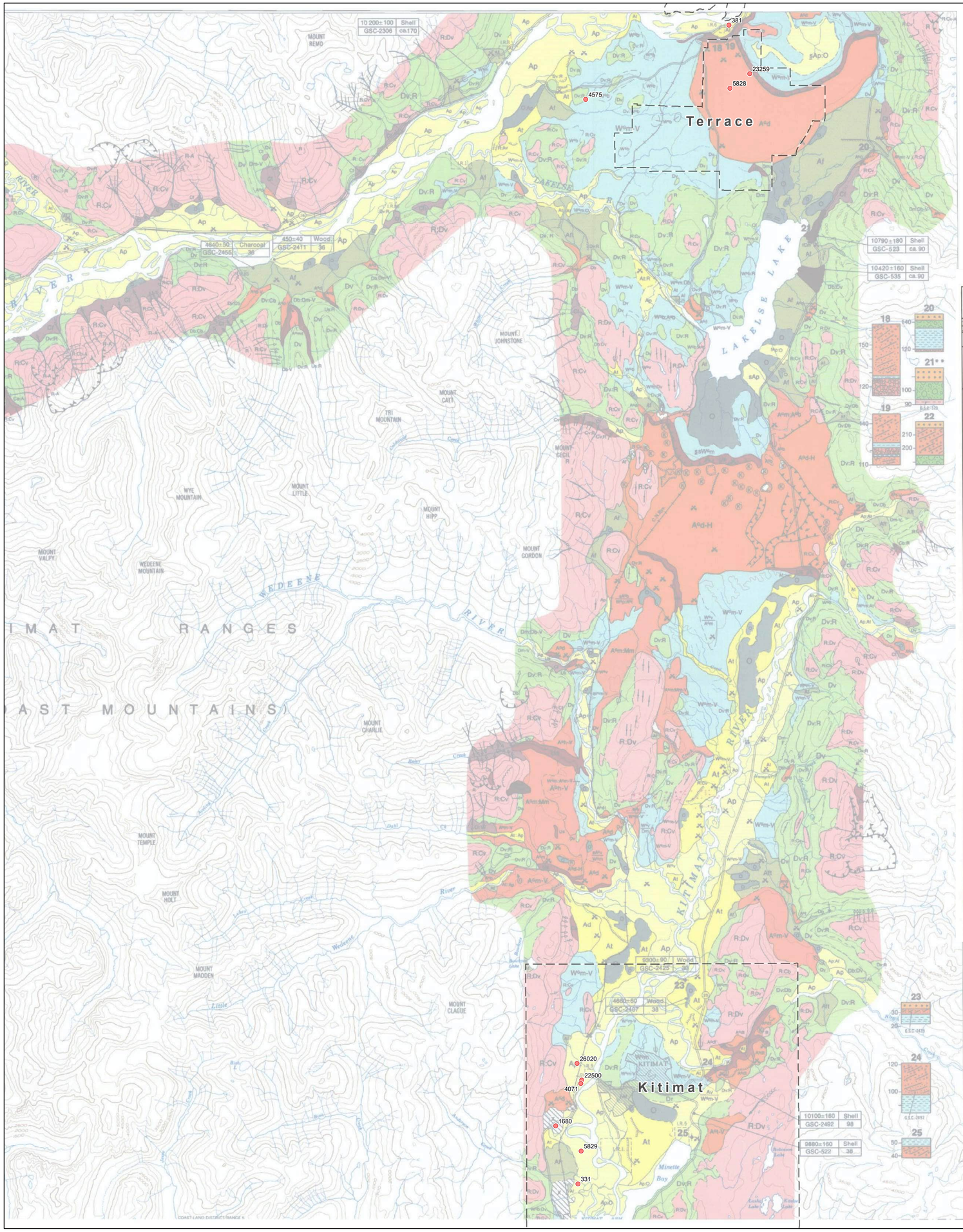
Base image fronm ESRI, 2024
Data obtained from Open Data BC, 2024
NAD 1983 UTM Zone 10N

Municipal Boundary
Quaternary Geology
Anthropogenic
Colluvial
Fluvial
Fen Peat
Glaciofluvial
Marine
Glacial Till
Undifferentiated Material

N
1:40,000
0
2,500 m

Potential Background Sites (PGL)

PGL ENVIRONMENTAL CONSULTANTS



LEGEND AND DESCRIPTION OF TERRAIN UNITS

SYMBOL		NAME	SURFICIAL DEPOSITS		LANDFORM		COMMENTS
			MATERIAL	THICKNESS (metres)	TOPOGRAPHY	SLOPES (degrees)	
		man-made terrain	diamicton, rubble, gravel, sand	>2	plain	0-3	landfill
I		glacier ice	ice and snow	>20	rolling, sloping, crevassed	1-30	steep slopes occur in areas of ice falls
O	O	organic terrain	peat, muck	<15	plain	0-3	bogs, fens, swamps
	* Ob	organic blanket	peat, muck	>1	takes form of underlying surface	0-10	
	* Ov	organic veneer	peat, muck	0.5-1	takes form of underlying surface	0-15	
C	Cl Cm	landslide	diamicton; blocks and rubble of local bedrock	>3	hummocky, rolling	0-35 0-15	includes landslides involving bedrock and landslides involving unconsolidated Quaternary sediments
	* Cf	avalanche fan, debris-flow fan	gravel, diamicton	>5	fan	5-30	includes fans with entrenched channels and fans close to local base level
	* Ca	talus	blocks and rubble of local bedrock	>2	apron, sheet	25-35	little or no vegetation on presently active slopes
	* Cb	colluvial blanket	colluvium	>1	takes form of underlying surface	1-35	includes slopewash, minor talus, talus stabilized by vegetation
	* Cv	colluvial veneer	colluvium	0.5-1	takes form of underlying surface	1-40	includes slopewash, minor talus, talus stabilized by vegetation
A	Af	alluvial fan	gravel and sand	>5	fan	1-20	includes terraced fan remnants (Aft), fans with entrenched channels, and fans close to local base level
	Ap	floodplain	gravel and sand	>2	plain with shallow channels	0-3	includes low benches subject to occasional flooding
	* Ax	valley floor complex	alluvium and colluvium	>2	plain, fan, terraces, lower valley walls	0-35	includes Ap, At, Af, and Cf; differentiation of these units is not possible at scale of map
	* Av	alluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	At	river terrace	gravel and sand	>2	terrace and scarp	0-3	generally one to several metres of sand overlying gravel
	* Ad	delta	gravel and sand	>5	terrace	0-5	marine delta
A^G	A^{Pm} A^{Ph}	kames, ice stagnation terrain	gravel and sand	>10	rolling, hummocky	0-15 0-30	unit deposited in contact with stagnant glacier ice; interbeds of diamicton commonly present in unit
	A^{Pr}	esker	gravel and sand	>10	ridge	0-30	unit deposited beneath and within stagnant glacier ice
	* A^{Pb}	glaciofluvial blanket	gravel and sand	>1	takes form of underlying surface	0-20	
	* A^{Pv}	glaciofluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	* A^{Pf}	glaciofluvial fan	gravel and sand	>10	fan	1-20	ice-contact feature, commonly with kettles
	A^{Pt}	kame terrace	gravel and sand	>10	terrace and scarp	0-3	ice-contact feature, commonly with kettles
	A^{Pd}	delta	gravel and sand	>10	terrace, fan	0-20	proglacial and ice-contact lacustrine and marine deltas
L^G	* L^{Lm}	rolling glaciolacustrine terrain	silt, clay, minor sand (locally with dropstones)	>2	rolling	0-10	ice-marginal depositional environment; relict lake floor
	L^{Lt}	glaciolacustrine terrace	silt, clay, minor sand (locally with dropstones)	>2	terrace	0-3	
	L^{Lb}	glaciolacustrine blanket	silt, clay, minor sand (locally with dropstones)	>1	takes form of underlying surface	0-10	
	L^{Lv}	glaciolacustrine veneer	silt, clay, minor sand (locally with dropstones)	0.5-1	takes form of underlying surface	0-15	
W^G	* W^{Fm}	rolling glaciomarine terrain	silt, clay (locally with dropstones)	>2	rolling	0-10	proglacial depositional environment; relict seafloor
	* W^{Fp}	glaciomarine plain	silt, clay (locally with dropstones)	>2	plain	0-2	proglacial depositional environment
	* W^{Fb}	glaciomarine blanket	silt, clay (locally with dropstones)	>1	takes form of underlying surface	0-15	
	* W^{Fv}	glaciomarine veneer	silt, clay (locally with dropstones)	0.5-1	takes form of underlying surface	0-20	
M	Mm	ground moraine	till	>2	rolling	0-15	constructional morainic topography (not controlled by form of underlying unit)
	Mb	till blanket	till	>1	takes form of underlying surface	0-20	
	Mv	till veneer	till	0.5-1	takes form of underlying surface	0-25	
D	Dr Dm	drift	till, gravel, and colluvium	>2	ridged, rolling	0-15	constructional drift topography (not controlled by form of underlying unit)
	Db	drift blanket	till, gravel, and colluvium	>1	takes form of underlying surface	0-25	
	Dv	drift veneer	till, gravel, and colluvium	0.5-1	takes form of underlying surface	0-30	
Us		terrace scarps, river banks	all types of unconsolidated Quaternary sediments	>20 (scarp height)	steep erosional slopes	>30	unit consists of several stratigraphic units of contrasting lithologies, in places with a blanket or veneer of colluvium
R	R	bedrock			rolling, sloping, hummocky, ridged	0-60	thin (<0.5 m) or no cover of unconsolidated Quaternary sediments
	Rs	canyon walls, river banks			steep slopes	>45	Rs used mainly in conjunction with Us for canyon walls

* Does not occur as a dominant unit on this sheet

FIGURE 4.1

Potential Background Sites (PGL)

Municipal Boundary

POTENTIAL BACKGROUND SITE LOCATIONS - SKEENA-BULKLEY REGION - TERRACE & KITIMAT

N

1:100,000

0 10,000 m

PGL ENVIRONMENTAL CONSULTANTS

FIGURE 4.2

Potential Background Sites (PGL)

Municipal Boundary

POTENTIAL BACKGROUND SITE LOCATIONS - SKEENA-BULKLEY REGION - TERRACE

N

1:100,000

0 10,000 m

PGL ENVIRONMENTAL CONSULTANTS

6879

7361

24165 24184

8280 6035 5136 3851 6701 19813 11688 9165 7326 3917 7688 7874 67 5806 4230 4126 15766 8234 4661 5776 19781 9241

Terrace

37200±1060 | Wood | GSC-2528 | 214

10900±110 | Shell | GSC-2276 | cn. 85

10700±160 | Shell | GSC-2408 | 64

3280±50 | Wood | GSC-2546 | 107

LEGEND AND DESCRIPTION OF TERRAIN UNITS

SYMBOL	NAME	SURFICIAL DEPOSITS: MATERIAL	SURFICIAL DEPOSITS: THICKNESS (metres)	LANDFORM: TOPOGRAPHY	LANDFORM: SLOPES (degrees)	COMMENTS
X	man-made terrain	diamicton, rubble, gravel, sand	>2	plain	0-3	landfill
I	glacier ice	ice and snow	>20	rolling, sloping, crevassed	1-30	steep slopes occur in areas of ice falls
O / O	organic terrain	peat, muck	<15	plain	0-3	bogs, fens, swamps
O / *Ob	organic blanket	peat, muck	>1	takes form of underlying surface	0-10	
O / *Ov	organic veneer	peat, muck	0.5-1	takes form of underlying surface	0-15	
C / Ch Cm	landslide	diamicton; blocks and rubble of local bedrock	>3	hummocky, rolling	0-35 0-15	includes landslides involving bedrock and landslides involving unconsolidated Quaternary sediments
C / *Cr	avalanche fan, debris-flow fan	gravel, diamicton	>5	fan	5-30	includes fans with entrenched channels and fans close to local base level
C / *Ca	talus	blocks and rubble of local bedrock	>2	apron, sheet	25-35	little or no vegetation on presently active slopes
C / *Cb	colluvial blanket	colluvium	>1	takes form of underlying surface	1-35	includes slopewash, minor talus, talus stabilized by vegetation
C / *Cv	colluvial veneer	colluvium	0.5-1	takes form of underlying surface	1-40	includes slopewash, minor talus, talus stabilized by vegetation
A / Af	alluvial fan	gravel and sand	>5	fan	1-20	includes terraced fan remnants (Aft), fans with entrenched channels, and fans close to local base level
A / Ap	floodplain	gravel and sand	>2	plain with shallow channels	0-3	includes low benches subject to occasional flooding
A / *Ax	valley floor complex	alluvium and colluvium	>2	plain, fan, terraces, lower valley walls	0-35	includes Ap, At, Af, and Cf_l differentiation of these units is not possible at scale of map
A / *Av	alluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
A / At	river terrace	gravel and sand	>2	terrace and scarp	0-3	generally one to several metres of sand overlying gravel
A / *Ad	delta	gravel and sand	>5	terrace	0-5	marine delta
A^G / A^{Fm} A^{Fh}	kames, ice stagnation terrain	gravel and sand	>10	rolling, hummocky	0-15 0-30	unit deposited in contact with stagnant glacier ice; interbeds of diamicton commonly present in unit
A^G / A^{Fr}	esker	gravel and sand	>10	ridge	0-30	unit deposited beneath and within stagnant glacier ice
A^G / *A^{Fb}	glaciofluvial blanket	gravel and sand	>1	takes form of underlying surface	0-20	
A^G / *A^{Fv}	glaciofluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
A^G / *A^{Ff}	glaciofluvial fan	gravel and sand	>10	fan	1-20	ice-contact feature, commonly with kettles
A^G / A^{Ft}	kame terrace	gravel and sand	>10	terrace and scarp	0-3	ice-contact feature, commonly with kettles
A^G / A^{Fd}	delta	gravel and sand	>10	terrace, fan	0-20	proglacial and ice-contact lacustrine and marine deltas
L^G / *L^{Fm}	rolling glaciolacustrine terrain	silt, clay, minor sand (locally with dropstones)	>2	rolling	0-10	ice-marginal depositional environment; relict lake floor
L^G / L^{Ft}	glaciolacustrine terrace	silt, clay, minor sand (locally with dropstones)	>2	terrace	0-3	
L^G / L^{Fb}	glaciolacustrine blanket	silt, clay, minor sand (locally with dropstones)	>1	takes form of underlying surface	0-10	
L^G / L^{Fv}	glaciolacustrine veneer	silt, clay, minor sand (locally with dropstones)	0.5-1	takes form of underlying surface	0-15	
W^G / *W^{Fm}	rolling glaciomarine terrain	silt, clay (locally with dropstones)	>2	rolling	0-10	proglacial depositional environment; relict seafloor
W^G / *W^{Fp}	glaciomarine plain	silt, clay (locally with dropstones)	>2	plain	0-2	proglacial depositional environment
W^G / *W^{Fb}	glaciomarine blanket	silt, clay (locally with dropstones)	>1	takes form of underlying surface	0-15	
W^G / *W^{Fv}	glaciomarine veneer	silt, clay (locally with dropstones)	0.5-1	takes form of underlying surface	0-20	
M / Mm	ground moraine	till	>2	rolling	0-15	constructional morainic topography (not controlled by form of underlying unit)
M / Mb	till blanket	till	>1	takes form of underlying surface	0-20	
M / Mv	till veneer	till	0.5-1	takes form of underlying surface	0-25	
D / Dr Dm	drift	till, gravel, and colluvium	>2	ridged, rolling	0-15	constructional drift topography (not controlled by form of underlying unit)
D / Db	drift blanket	till, gravel, and colluvium	>1	takes form of underlying surface	0-25	
D / Dv	drift veneer	till, gravel, and colluvium	0.5-1	takes form of underlying surface	0-30	
Us	terrace scarps, river banks	all types of unconsolidated Quaternary sediments	>20 (scarp height)	steep erosional slopes	>30	unit consists of several stratigraphic units of contrasting lithologies, in places with a blanket or veneer of colluvium
R / R	bedrock			rolling, sloping, hummocky, ridged	0-60	thin (<0.5 m) or no cover of unconsolidated Quaternary sediments
R / Rs	canyon walls, river banks			steep slopes	>45	Rs used mainly in conjunction with Us for canyon walls

*Does not occur as a dominant unit on this sheet

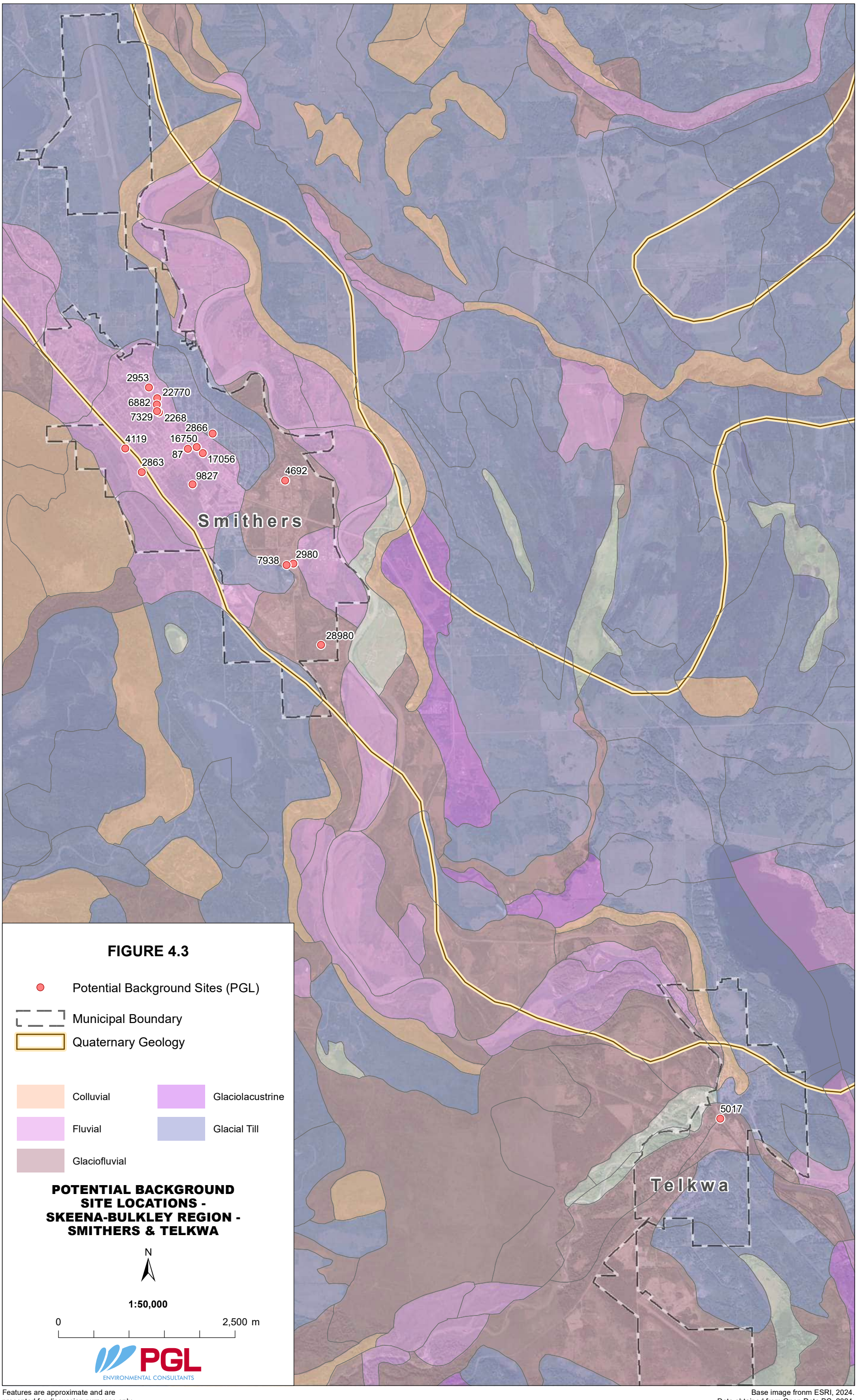


FIGURE 4.3

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Geology

Colluvial

Glaciolacustrine

Fluvial

Glacial Till

Glaciofluvial

POTENTIAL BACKGROUND SITE LOCATIONS - SKEENA-BULKLEY REGION - SMITHERS & TELKWA

N

1:50,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 9N

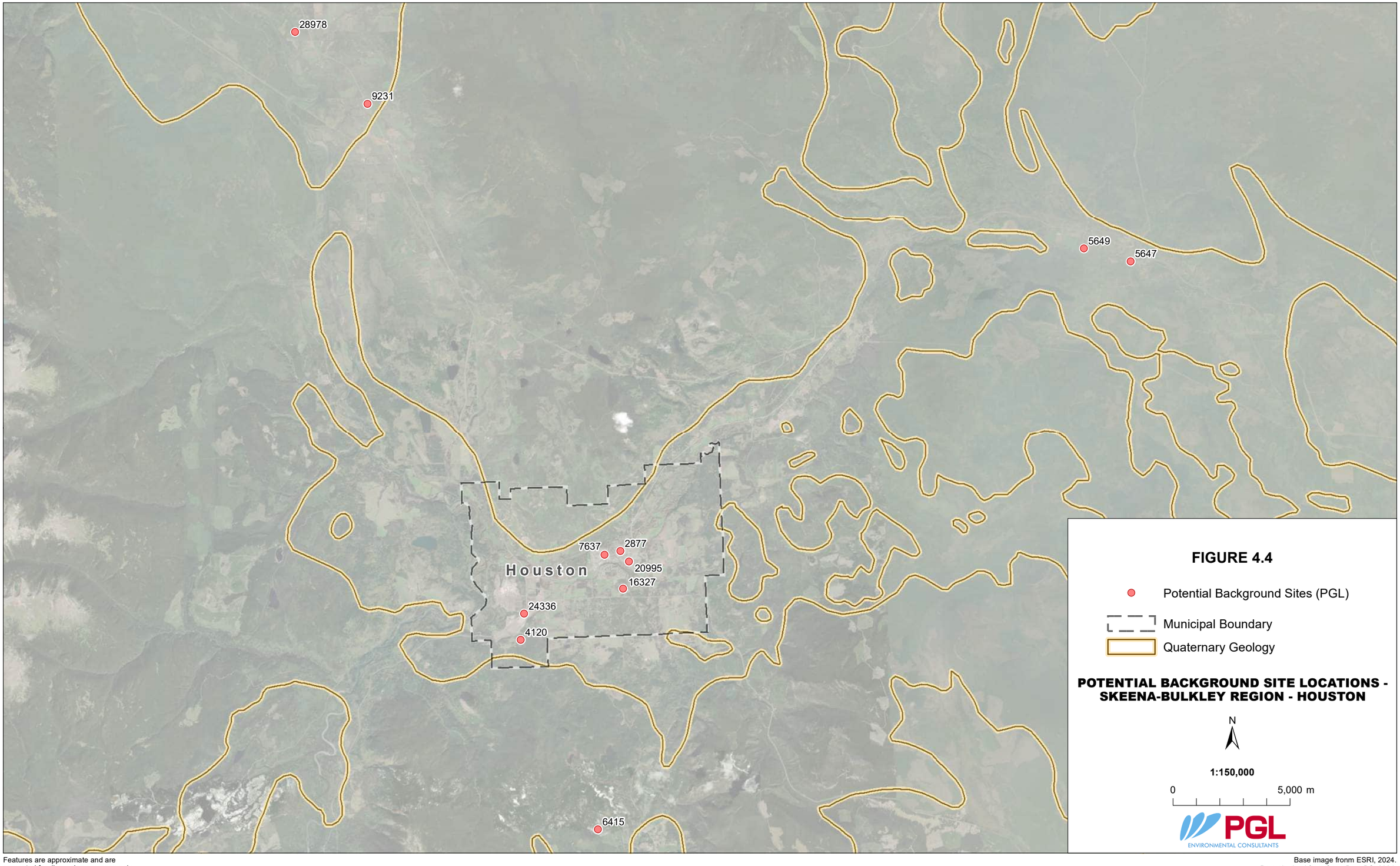


FIGURE 4.4

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Geology

POTENTIAL BACKGROUND SITE LOCATIONS - SKEENA-BULKLEY REGION - HOUSTON

N

1:150,000

0 5,000 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 9N

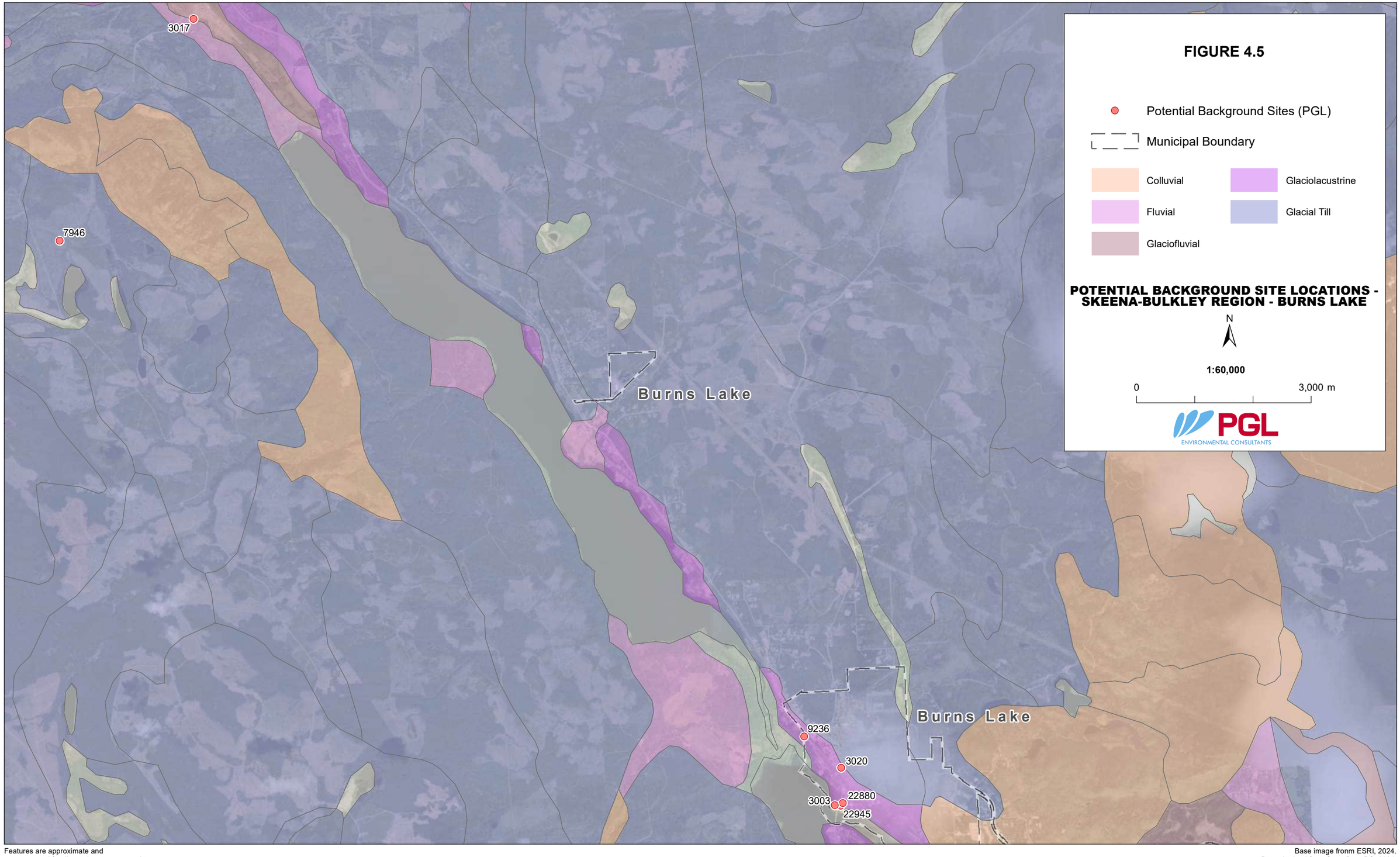


FIGURE 4.5

Potential Background Sites (PGL)

Municipal Boundary

Colluvial

Glaciolacustrine

Fluvial

Glacial Till

Glaciofluvial

POTENTIAL BACKGROUND SITE LOCATIONS - SKEENA-BULKLEY REGION - BURNS LAKE

N

1:60,000

0 3,000 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and
are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 9N

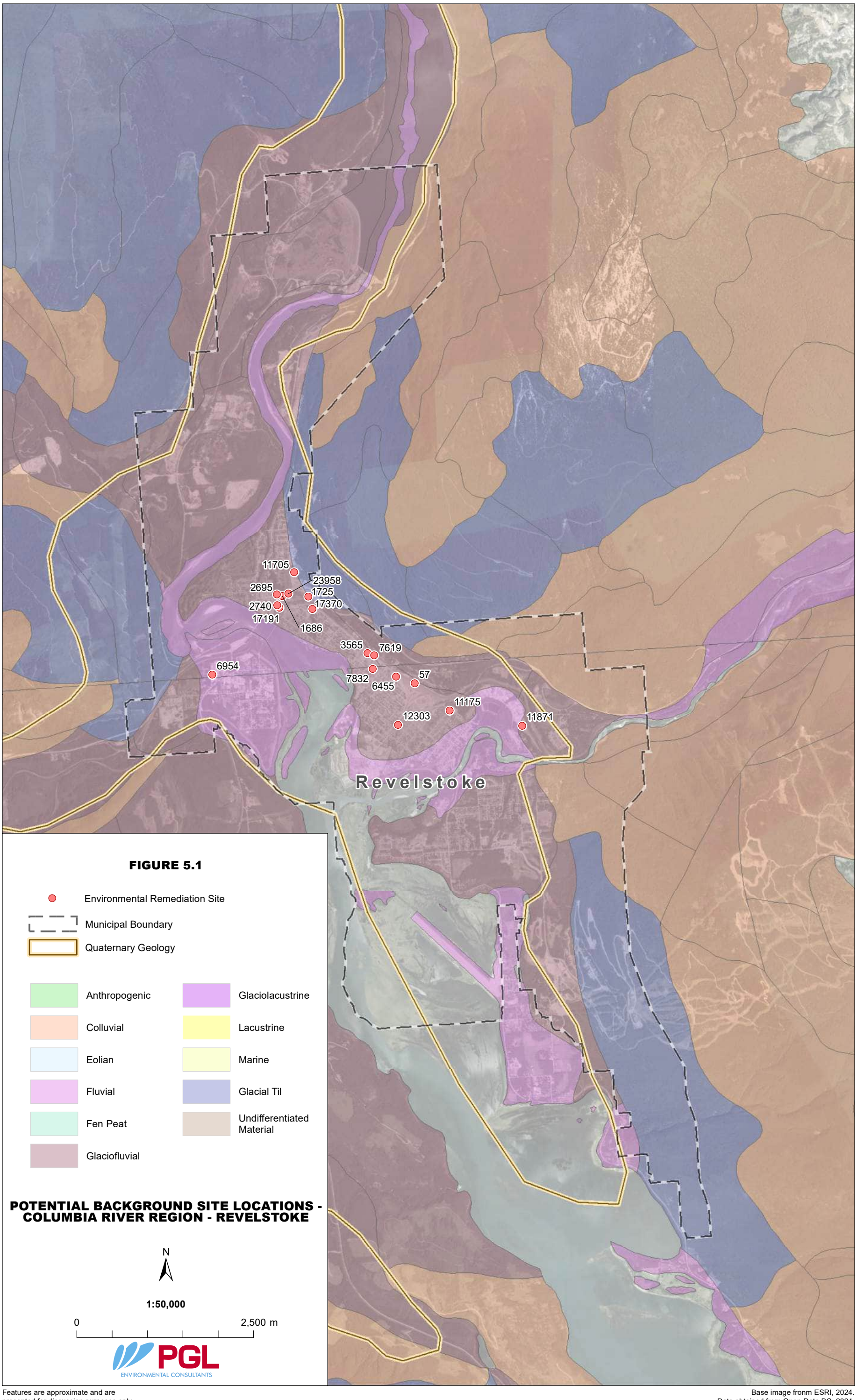


FIGURE 5.1

- Environmental Remediation Site
- Municipal Boundary
- Quaternary Geology

- Anthropogenic
- Colluvial
- Eolian
- Fluvial
- Fen Peat
- Glaciofluvial
- Glaciolacustrine
- Lacustrine
- Marine
- Glacial Til
- Undifferentiated Material

POTENTIAL BACKGROUND SITE LOCATIONS - COLUMBIA RIVER REGION - REVELSTOKE

N

1:50,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 10N

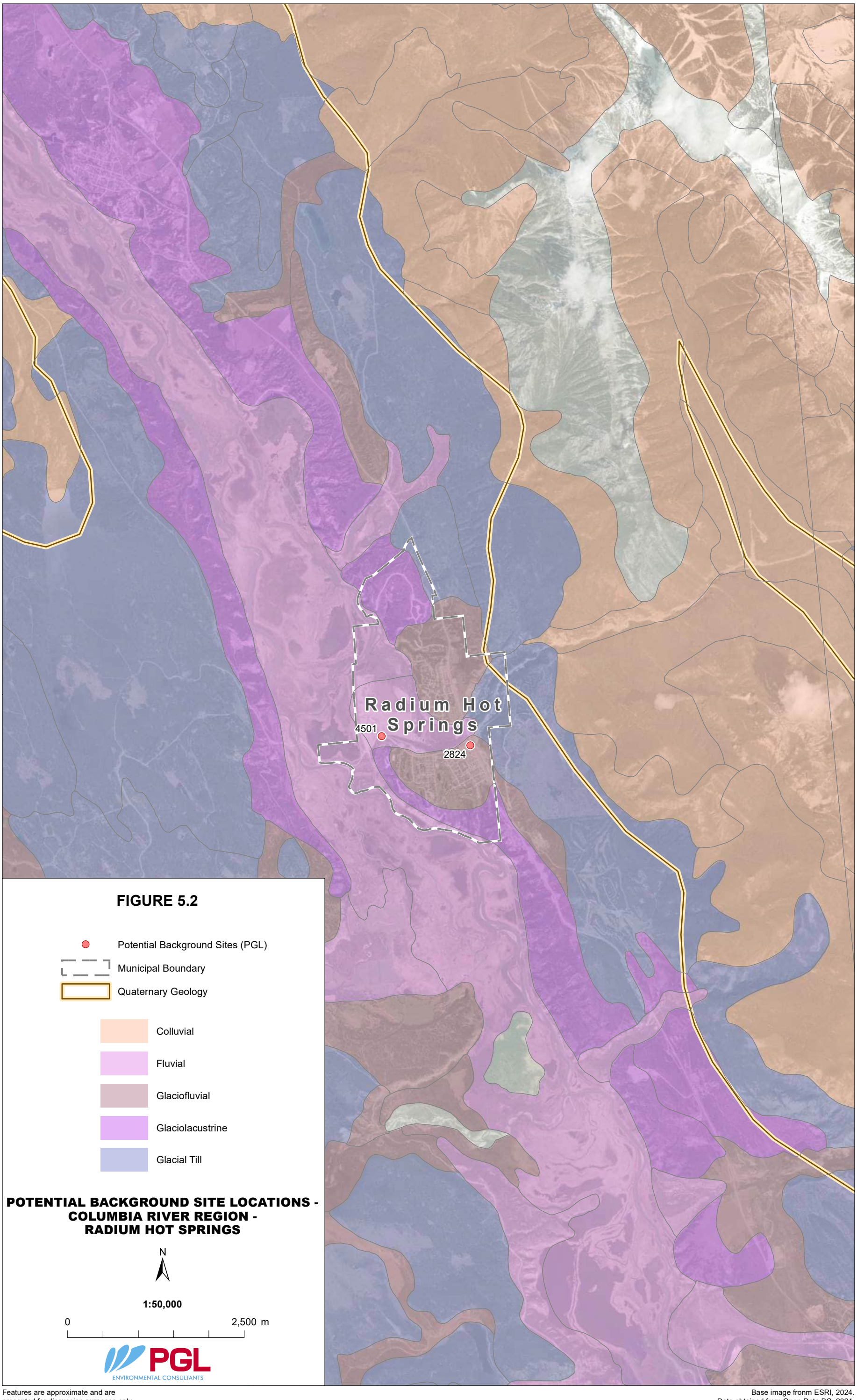


FIGURE 5.2

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Geology

Colluvial

Fluvial

Glaciofluvial

Glaciolacustrine

Glacial Till

POTENTIAL BACKGROUND SITE LOCATIONS - COLUMBIA RIVER REGION - RADIUM HOT SPRINGS

N

1:50,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 10N

16648
9010
8323
5992
9441
Invermere
13352
11059
18014
15136
2835
22358

FIGURE 5.3

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Geology

Colluvial

Fluvial

Fen Peat

Glaciofluvial

Glaciolacustrine

Glacial Till

POTENTIAL BACKGROUND SITE LOCATIONS - COLUMBIA RIVER REGION - INVERMERE

N

1:50,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 10N

Canal Flats

21873
2833
11543

FIGURE 5.4

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Geology

- Anthropogenic
- Colluvial
- Eolian
- Fluvial
- Fen Peat
- Glaciofluvial
- Glaciolacustrine
- Lacustrine
- Marine
- Glacial Till
- Undifferentiated Material

POTENTIAL BACKGROUND SITE LOCATIONS - COLUMBIA RIVER REGION - CANAL FLATS

N

1:50,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 10N

5618

24180

6993

8028

10745

6143

5343

12187

1220

7608

9365

2830

7170

Golden

1731

6130

FIGURE 5.5

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Geology

POTENTIAL BACKGROUND SITE LOCATIONS - COLUMBIA RIVER REGION - GOLDEN

N

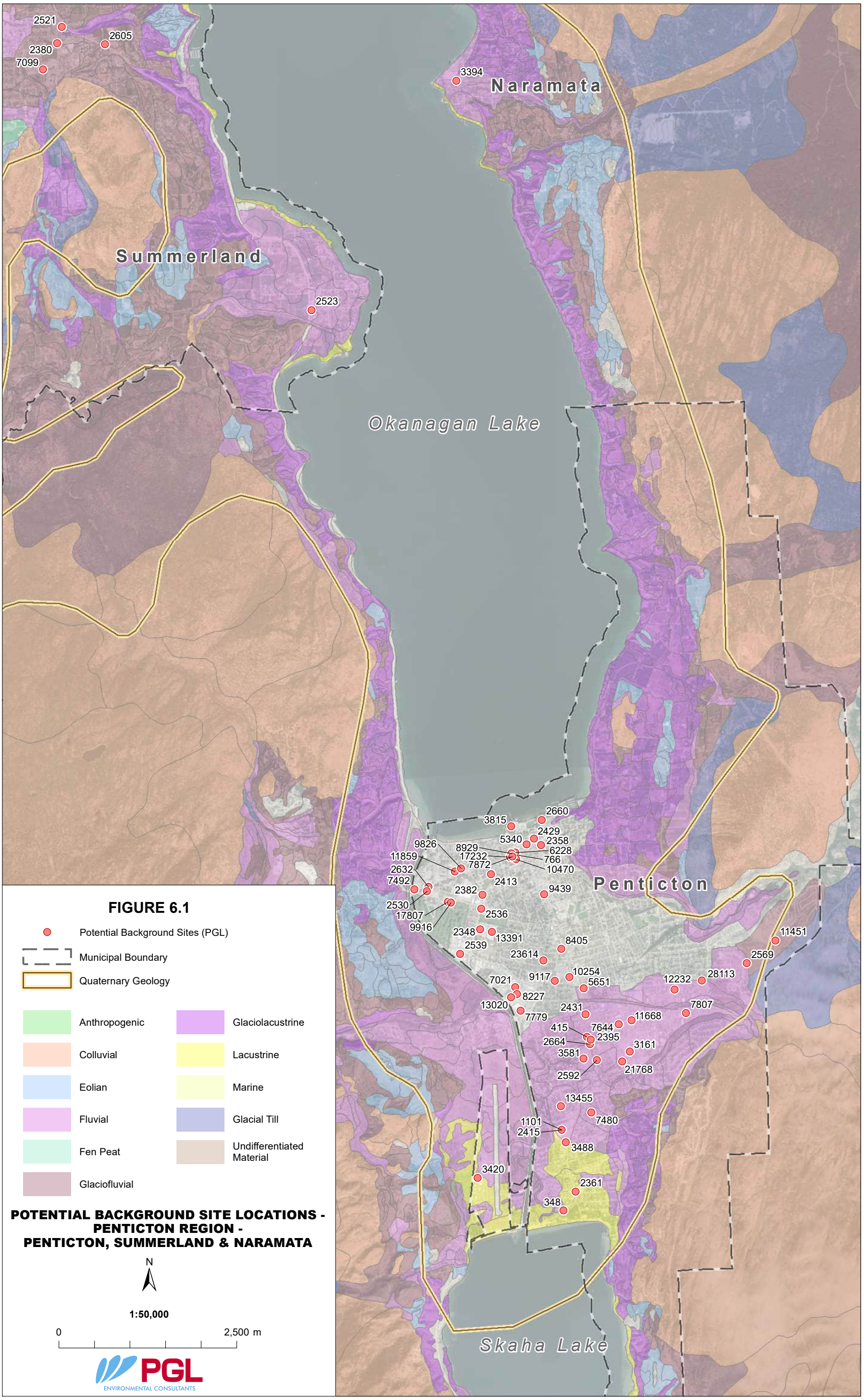
1:50,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 10N



Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 10N

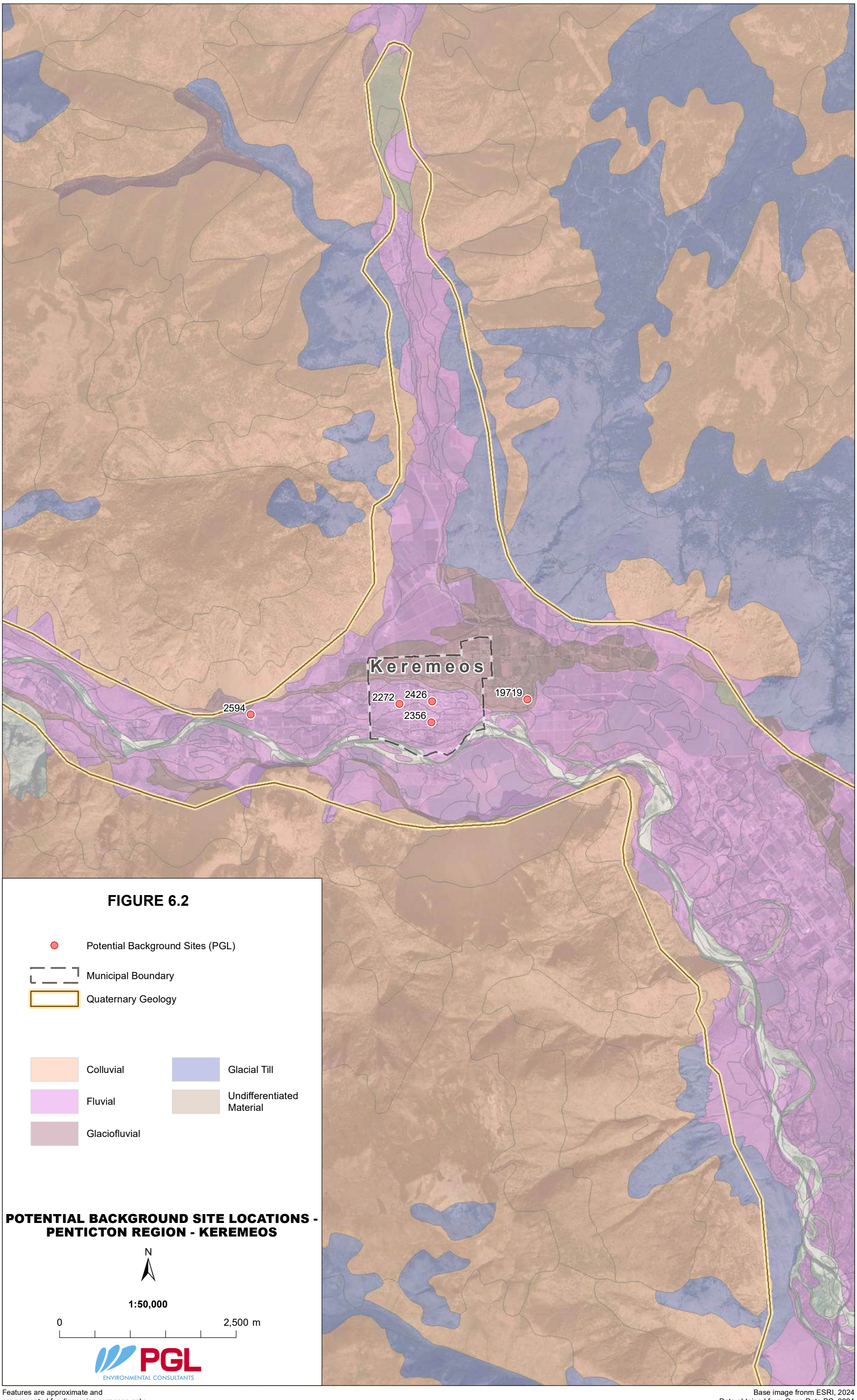


FIGURE 6.2

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Geology

Colluvial

Glacial Till

Fluvial

Undifferentiated Material

Glaciofluvial

POTENTIAL BACKGROUND SITE LOCATIONS - PENTICTON REGION - KEREMEOS

N

1:50,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024
Data obtained from Open Data BC, 2024
NAD 1983 UTM Zone 10N

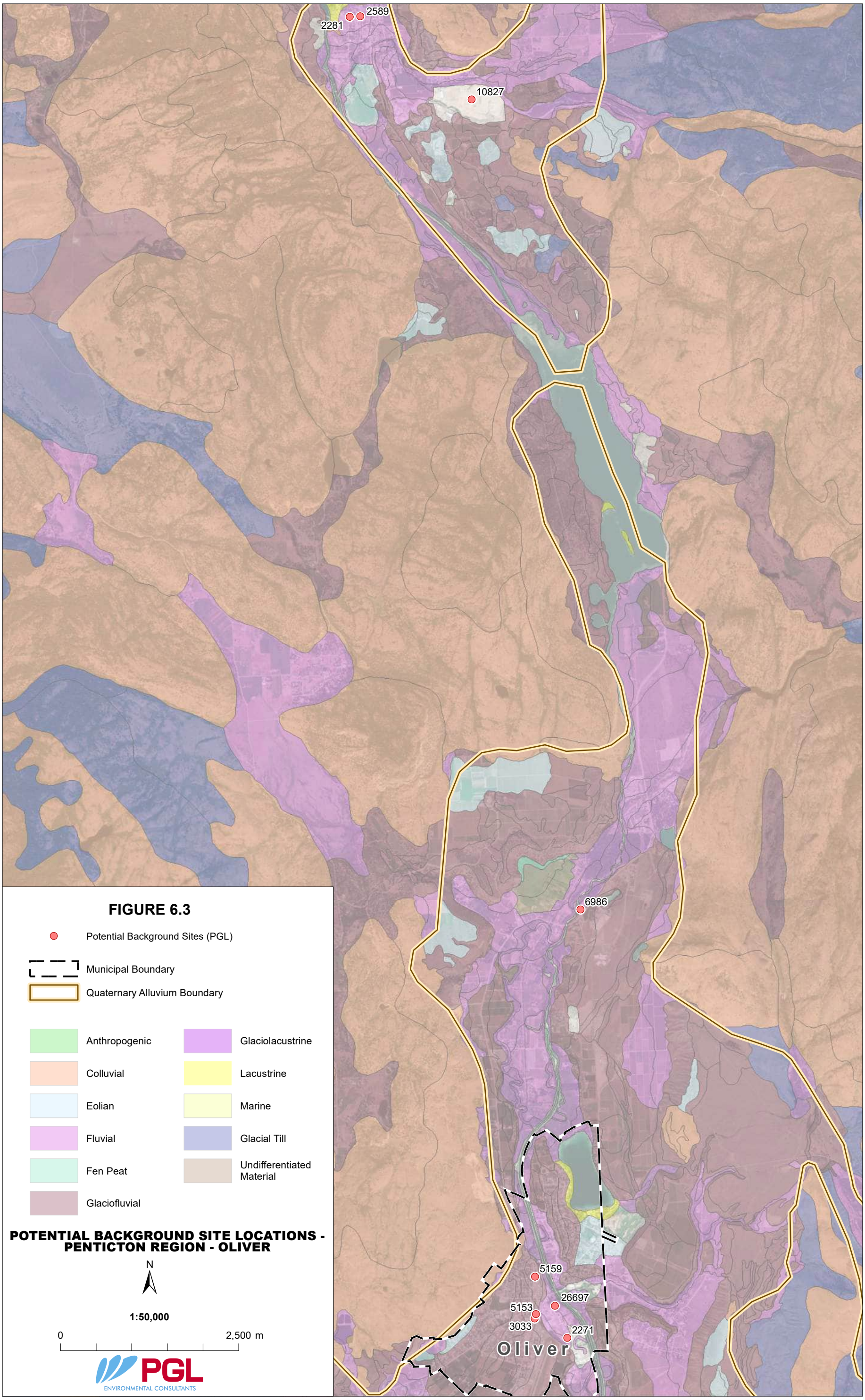


FIGURE 6.3

Potential Background Sites (PGL)

Municipal Boundary

Quaternary Alluvium Boundary

Anthropogenic

Colluvial

Eolian

Fluvial

Fen Peat

Glaciofluvial

Glaciolacustrine

Lacustrine

Marine

Glacial Till

Undifferentiated Material

POTENTIAL BACKGROUND SITE LOCATIONS - PENTICTON REGION - OLIVER

N

1:50,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024
Data obtained from Open Data BC, 2024
NAD 1983 UTM Zone 10N

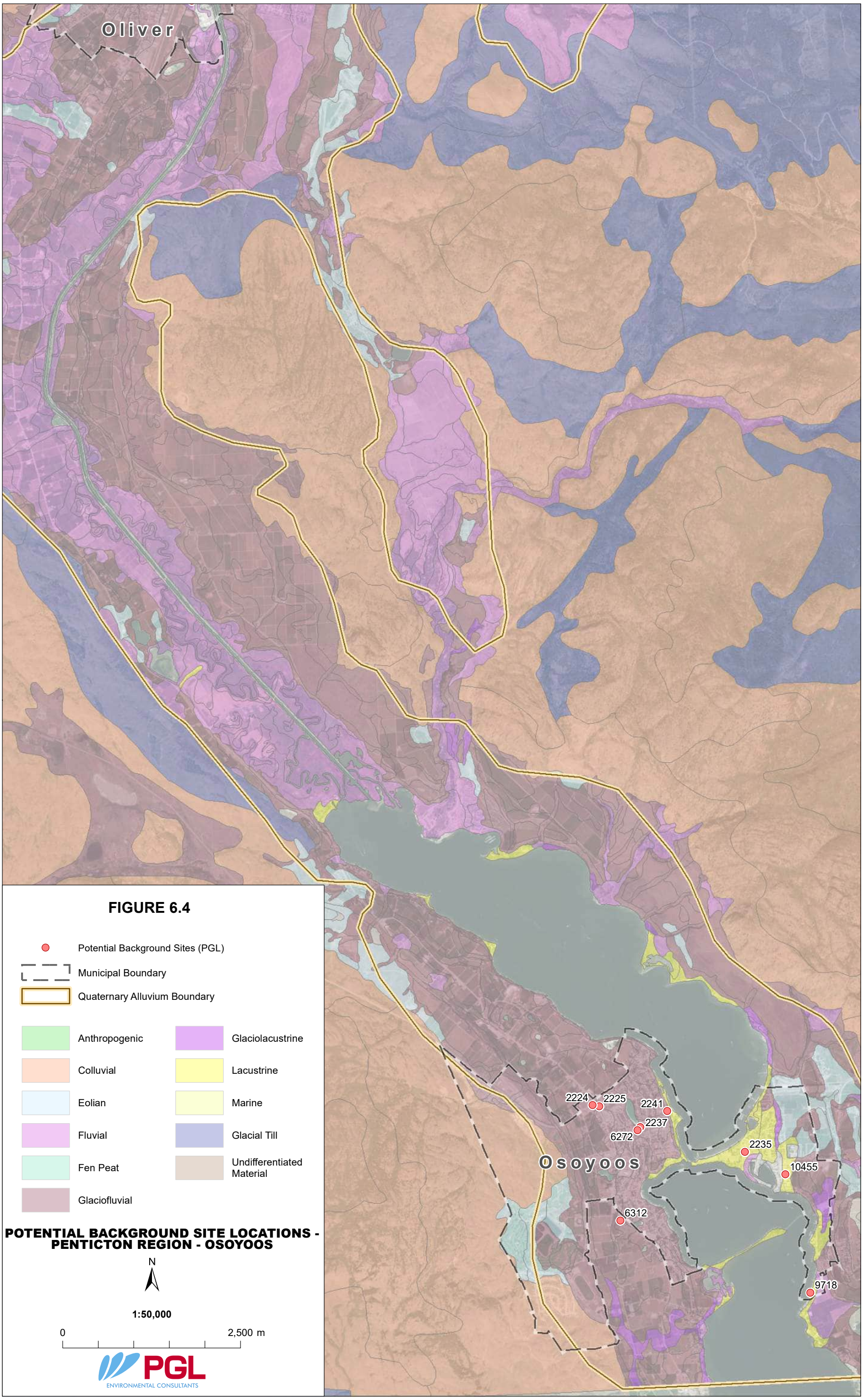


FIGURE 6.4

- Potential Background Sites (PGL)
- Municipal Boundary
- Quaternary Alluvium Boundary

- Anthropogenic
- Colluvial
- Eolian
- Fluvial
- Fen Peat
- Glaciofluvial
- Glaciolacustrine
- Lacustrine
- Marine
- Glacial Till
- Undifferentiated Material

POTENTIAL BACKGROUND SITE LOCATIONS - PENTICTON REGION - OSOYOOS

N

1:50,000

0 2,500 m

PGL ENVIRONMENTAL CONSULTANTS

Features are approximate and are presented for discussion purposes only.

Base image fronm ESRI, 2024.
Data obtained from Open Data BC, 2024.
NAD 1983 UTM Zone 10N

Tables

Table 1
List of Site IDs for Mid-Island
Background Groundwater Concentrations at Sites in British Columbia
CSAP Society, PGL File 4136-230.01

Site ID	City/Town/Hamlet	Service	Received Date	Completed Date	Database
188	Qualicum Beach	Investigation Report	.	12-Jun-1989	pre-2018
684	Parksville	Investigation Report	.	No Entry	pre-2018
1049	Courtenay	CofC	.	19-Jan-1999	pre-2018
1050	Courtenay	Investigation Report	.	18-Aug-1995	pre-2018
1672	Campbell River	Investigation Report	.	27-Jun-1994	pre-2018
1674	Campbell River	Investigation Report	.	27-May-1991	pre-2018
1696	Campbell River	AiP	.	17-May-2001	pre-2018
1706	Courtenay	Investigation Report	.	24-Jul-1995	pre-2018
1718	Bowser	Investigation Report	.	27-Sep-1994	pre-2018
1719	Courtenay	Investigation Report	.	02-May-1994	pre-2018
1754	Campbell River	Investigation Report	.	01-May-1996	pre-2018
1765	Campbell River	CofC	.	30-May-2018	pre-2018
1771	Campbell River	Investigation Report	.	07-Sep-1995	pre-2018
1779	Campbell River	Investigation Report	.	12-Mar-1996	pre-2018
1781	Nanoose Bay	Investigation Report	.	26-Jul-1993	pre-2018
1788	Cumberland	Investigation Report	.	25-Mar-1994	pre-2018
1793	Campbell River	Investigation Report	.	17-Nov-1993	pre-2018
1808	Campbell River	CofC	2020-02-21	.	2018-2024
1820	Courtenay	CofC	.	12-Nov-2002	pre-2018
1829	Qualicum Beach	Investigation Report	.	22-Jun-1994	pre-2018
1873	Campbell River	Investigation Report	.	08-Mar-1994	pre-2018
1875	Parksville	Investigation Report	.	No Entry	pre-2018
1881	Comox	Investigation Report	.	04-Apr-1995	pre-2018
1907	Courtenay	Investigation Report	.	16-May-1994	pre-2018
1917	Parksville	Investigation Report	.	19-Feb-1994	pre-2018
1923	Campbell River	CofC	.	31-May-2004	pre-2018
1924	Campbell River	Investigation Report	.	11-Jun-1990	pre-2018
1933	Qualicum Beach	CofC	.	11-Apr-2000	pre-2018
1940	Courtenay	Investigation Report	.	21-Dec-1988	pre-2018
3036	Errington	Investigation Report	.	15-Jun-1995	pre-2018
3108	Courtenay	CofC	.	24-Mar-2010	pre-2018
3191	Campbell River	Investigation Report	.	15-May-1995	pre-2018
3194	Cumberland	Investigation Report	.	29-Aug-1994	pre-2018
3206	Parksville	Investigation Report	.	15-Sep-1995	pre-2018
3212	Qualicum Beach	Investigation Report	.	23-Feb-1996	pre-2018
3215	Courtenay	Investigation Report	.	13-Nov-1995	pre-2018
3226	Campbell River	Investigation Report	.	07-Nov-1995	pre-2018
3230	Courtenay	Investigation Report	.	19-May-1995	pre-2018
3282	Courtenay	Investigation Report	.	16-Nov-1994	pre-2018
3346	Campbell River	CofC	2021-04-15	.	2018-2024
3681	Comox	Investigation Report	.	17-Sep-1996	pre-2018
3748	Parksville	Investigation Report	.	28-Feb-1997	pre-2018
3836	Nanoose Bay	CofC	.	29-Apr-1999	pre-2018

Table 2
List of Site IDs for Skeena-Bulkley
Background Groundwater Concentrations at Sites in British Columbia
CSAP Society, PGL File 4136-230.01

Site ID	City/Town/Hamlet	Service	Received Date	Completed Date	Database
67	Terrace	CofC	.	31-Aug-2000	pre-2018
87	Smithers	CofC	.	14-Aug-2014	pre-2018
331	Kitimat	AiP	.	16-Sep-1999	pre-2018
381	Terrace	Investigation Report	.	30-Mar-1995	pre-2018
1680	Kitimat	CofC	.	05-Jun-2014	pre-2018
2268	Smithers	AiP	.	26-Sep-1997	pre-2018
2863	Smithers	Investigation Report	.	26-Jan-1998	pre-2018
2866	Smithers	P9	2023-09-13	.	2018-2024
2877	Houston	CofC	.	07-Nov-2011	pre-2018
2953	Smithers	CofC	.	18-Mar-2004	pre-2018
2980	Smithers	Investigation Report	.	29-Oct-2001	pre-2018
3003	Burns Lake	AiP	2020-11-26	.	2018-2024
3017	Decker Lake	Investigation Report	.	16-Jun-2000	pre-2018
3020	Burns Lake	CofC	.	30-Oct-2014	pre-2018
3851	Terrace	AiP	.	28-Apr-1997	pre-2018
3917	Terrace	CofC	.	01-Apr-2014	pre-2018
4071	Kitimat	CofC	2022-08-17	.	2018-2024
4119	Smithers	Investigation Report	.	15-Jul-1997	pre-2018
4120	Houston	Investigation Report	.	09-Sep-1997	pre-2018
4126	Terrace	Investigation Report	.	12-Sep-1997	pre-2018
4230	Terrace	Investigation Report	.	12-Aug-1997	pre-2018
4575	Terrace	CofC	.	05-Jul-1999	pre-2018
4661	Terrace	CofC	.	06-Dec-2001	pre-2018
4692	Smithers	Investigation Report	.	16-Nov-1999	pre-2018
5017	Telkwa	Investigation Report	.	15-Sep-1998	pre-2018
5136	Terrace	CofC	.	.	2018-2024
5647	Topley	CofC	.	14-Jun-2018	pre-2018
5649	Topley	CofC	.	14-Jun-2018	pre-2018
5776	Terrace	AiP	.	15-Jan-2003	pre-2018
5806	Terrace	CofC	2023-12-22	.	2018-2024
5828	Terrace	Investigation Report	.	29-Feb-2000	pre-2018
5829	Kitimat	CofC	2019-10-03	.	2018-2024
6035	Terrace	Investigation Report	.	27-Jan-2000	pre-2018
6415	Houston	CofC	.	28-Apr-2000	pre-2018
6503	Cedarvale	Investigation Report	.	20-Jun-2001	pre-2018
6701	Terrace	Investigation Report	.	11-Jul-2000	pre-2018
6879	Terrace	Investigation Report	.	28-Jul-1999	pre-2018
6882	Smithers	Investigation Report	.	03-Nov-2000	pre-2018
7326	Terrace	CofC	.	09-Jun-2016	pre-2018
7329	Smithers	Investigation Report	.	20-Aug-2001	pre-2018
7361	Terrace	Investigation Report	.	16-Jul-2001	pre-2018
7637	Houston	CofC	.	07-Apr-2015	pre-2018
7688	Terrace	CofC	.	16-Feb-2009	pre-2018
7874	Terrace	Investigation Report	.	16-Jul-2002	pre-2018
7938	Smithers	CofC	.	06-Dec-2002	pre-2018
7946	Decker Lake	AiP	.	10-Sep-2002	pre-2018
8234	Terrace	Investigation Report	.	08-May-2003	pre-2018
8280	Terrace	Determination	.	24-Feb-2004	pre-2018
9165	Terrace	AiP	2022-02-18	.	2018-2024
9231	Houston	Investigation Report	.	30-Nov-2004	pre-2018
9236	Burns Lake	Investigation Report	.	20-Jun-2022	pre-2018
9241	Terrace	CofC	2021-01-21	.	2018-2024
9827	Smithers	Determination	.	20-Jun-2006	pre-2018
11688	Terrace	CofC	.	05-Feb-2014	pre-2018
15766	Terrace	Determination	.	17-Dec-2013	pre-2018
16327	Houston	CofC	.	25-Aug-2014	pre-2018
16750	Smithers	Investigation Report	.	15-Nov-2016	pre-2018
17056	Smithers	CofC	.	14-Jul-2015	pre-2018
17465	Kitimat	Determination	.	03-Mar-2015	pre-2018
19781	Terrace	CofC	.	30-Nov-2017	pre-2018
19813	Terrace	Determination	.	15-Mar-2017	pre-2018
20995	Houston	CofC	.	30-Jan-2018	pre-2018
22500	Kitimat	AiP	2023-12-11	.	2018-2024
22770	Smithers	CofC	2023-09-15	.	2018-2024
22880	Burns Lake	CofC	2020-11-26	.	2018-2024
22945	Burns Lake	CofC	2020-11-26	.	2018-2024
23259	Terrace	CofC	2022-04-11	.	2018-2024
24165	Terrace	Determination	2021-03-11	.	2018-2024
24184	Terrace	Determination	2021-04-27	.	2018-2024
24336	Houston	AiP	.	29-Jun-2022	pre-2018
26020	Kitimat	CofC	2023-07-21	.	2018-2024
28978	Smithers	Investigation Report	.	30-May-2024	pre-2018
28980	Smithers	Investigation Report	.	30-May-2024	pre-2018

Table 3
List of Site IDs for Columbia River
Background Groundwater Concentrations at Sites in British Columbia
CSAP Society, PGL File 4136-230.01

Site ID	City/Town/Hamlet	Service	Received Date	Completed Date	Database
57	Revelstoke	AiP	.	29-Aug-2002	pre-2018
1220	Golden	CofC	.	27-Aug-1997	pre-2018
1686	Revelstoke	AiP	.	15-Jun-2006	pre-2018
1725	Revelstoke	CofC	.	03-May-2010	pre-2018
1731	Golden	CofC	2021-10-20	.	2018-2024
2695	Revelstoke	CofC	.	22-Aug-2014	pre-2018
2740	Revelstoke	CofC	.	09-Dec-2014	pre-2018
2824	Radium Hot Springs	CofC	2022-11-07	.	2018-2024
2830	Golden	Investigation Report	.	01-Apr-1999	pre-2018
2833	Canal Flats	CofC	.	26-Jun-1998	pre-2018
2835	Windermere	CofC	2020-01-30	.	2018-2024
3496	Golden	Investigation Report	.	12-Feb-1999	pre-2018
3565	Revelstoke	CofC	.	08-Oct-1998	pre-2018
4501	Radium Hot Springs	Investigation Report	.	23-Aug-2000	pre-2018
5343	Golden	Investigation Report	.	07-Dec-1998	pre-2018
5618	Golden	Investigation Report	.	16-Sep-1999	pre-2018
5650	Revelstoke	Investigation Report	.	03-May-1999	pre-2018
5718	Nakusp	Investigation Report	.	23-Apr-1999	pre-2018
5992	Invermere	Investigation Report	.	13-Sep-1999	pre-2018
6130	Golden	Investigation Report	.	18-Dec-1998	pre-2018
6143	Golden	CofC	.	20-Sep-2000	pre-2018
6455	Revelstoke	AiP	.	29-Aug-2002	pre-2018
6954	Revelstoke	CofC	.	17-Mar-2011	pre-2018
6993	Golden	CofC	.	28-Jun-2005	pre-2018
7170	Golden	CofC	.	13-Feb-2006	pre-2018
7514	Radium Hot Springs	Investigation Report	.	01-Sep-2001	pre-2018
7544	Jaffray	CofC	2020-05-14	.	2018-2024
7608	Golden	CofC	.	17-May-2017	pre-2018
7619	Revelstoke	Investigation Report	.	07-Jun-2002	pre-2018
7832	Revelstoke	CofC	.	28-Oct-2013	pre-2018
7865	Nakusp	Investigation Report	.	01-Aug-1991	pre-2018
8028	Golden	CofC	.	16-Dec-2003	pre-2018
8323	Invermere	P9	2019-11-01	.	2018-2024
9010	Invermere	CofC	.	26-Jun-2014	pre-2018
9365	Golden	CofC	.	12-Jan-2011	pre-2018
9441	Invermere	CofC	.	26-Jun-2014	pre-2018
10745	Golden	CofC	.	20-Jun-2012	pre-2018
11059	Windermere	P9	2022-05-10	.	2018-2024
11175	Revelstoke	Determination	.	16-Jul-2009	pre-2018
11543	Canal Flats	Determination	2022-05-26	.	2018-2024
11705	Revelstoke	CofC	.	20-Dec-2012	pre-2018
11871	Revelstoke	Determination	.	14-Jun-2010	pre-2018
12187	Golden	CofC	.	29-Apr-2014	pre-2018
12301	Nakusp	CofC	2020-12-29	.	2018-2024
12303	Revelstoke	CofC	2020-03-16	.	2018-2024
13352	Invermere	Investigation Report	.	31-Aug-2011	pre-2018
15056	Jaffray	CofC	2020-05-14	.	2018-2024
15136	Windermere	CofC	2024-03-04	.	2018-2024
15261	Jaffray	CofC	2020-05-14	.	2018-2024
16648	Invermere	CofC	.	26-Jun-2014	pre-2018
17191	Revelstoke	CofC	.	09-Dec-2014	pre-2018
17370	Revelstoke	Determination	.	23-Nov-2016	pre-2018
18014	Windermere	CofC	2024-03-04	.	2018-2024
21873	Canal Flats	P9	2023-10-24	.	2018-2024
22358	Windermere	P9	2019-10-01	.	2018-2024
23319	Nakusp	CofC	2021-01-29	.	2018-2024
23479	Jaffray	CofC	2020-05-14	.	2018-2024
23958	Revelstoke	CofC	2020-10-15	.	2018-2024
24171	Nakusp	CofC	2020-12-29	.	2018-2024
24172	Nakusp	CofC	2020-12-29	.	2018-2024
24173	Nakusp	CofC	2020-01-29	.	2018-2024
24174	Nakusp	CofC	2020-01-29	.	2018-2024
24180	Golden	Investigation Report	.	29-Jan-2021	pre-2018

Table 4
List of Site IDs for Penticton
Background Groundwater Concentrations at Sites in British Columbia
CSAP Society, PGL File 4136-230.01

Site ID	City/Town/Hamlet	Service	Received Date	Completed Date	Database
348	Penticton	Investigation Report	.	09-Jul-1990	pre-2018
415	Penticton	Investigation Report	.	15-Jul-1992	pre-2018
766	Penticton	CofC	.	14-Jan-2009	pre-2018
1101	Penticton	CofC	.	12-Aug-2004	pre-2018
2224	Osoyoos	Investigation Report	.	05-Oct-1993	pre-2018
2225	Osoyoos	Investigation Report	.	05-Oct-1993	pre-2018
2235	Osoyoos	Investigation Report	.	30-Aug-1993	pre-2018
2237	Osoyoos	P9	.	16-May-2014	pre-2018
2241	Osoyoos	Investigation Report	.	08-Jul-1993	pre-2018
2271	Oliver	AiP	.	06-Dec-1996	pre-2018
2272	Keremeos	Investigation Report	.	29-Jul-1992	pre-2018
2281	Okanagan Falls	Investigation Report	.	24-Mar-1994	pre-2018
2348	Penticton	Investigation Report	.	07-Mar-1996	pre-2018
2356	Keremeos	CofC	.	25-Jul-1996	pre-2018
2358	Penticton	Investigation Report	.	16-Dec-1993	pre-2018
2361	Penticton	CofC	.	29-Apr-2013	pre-2018
2380	Summerland	Investigation Report	.	03-Nov-1994	pre-2018
2382	Penticton	CofC	.	12-Feb-2009	pre-2018
2395	Penticton	CofC	2021-11-24	.	2018-2024
2413	Penticton	CofC	.	21-Jul-2003	pre-2018
2415	Penticton	CofC	.	12-Aug-2004	pre-2018
2426	Keremeos	Investigation Report	.	13-Oct-1994	pre-2018
2429	Penticton	Investigation Report	.	01-Mar-1994	pre-2018
2431	Penticton	Investigation Report	.	07-Mar-1994	pre-2018
2521	Summerland	Investigation Report	.	17-Feb-1992	pre-2018
2523	Summerland	Investigation Report	.	23-Aug-1993	pre-2018
2530	Penticton	CofC	.	16-Jun-2010	pre-2018
2536	Penticton	Investigation Report	.	24-May-1995	pre-2018
2539	Penticton	Investigation Report	.	14-Jul-1993	pre-2018
2569	Penticton	Investigation Report	.	23-Feb-2004	pre-2018
2589	Okanagan Falls	Investigation Report	.	22-Aug-1994	pre-2018
2592	Penticton	Investigation Report	.	13-Sep-1994	pre-2018
2594	Keremeos	Investigation Report	.	17-Jul-1995	pre-2018
2605	Summerland	Investigation Report	.	29-Nov-1994	pre-2018
2628	Penticton	AiP	.	22-May-1996	pre-2018
2632	Penticton	Investigation Report	.	23-Mar-1992	pre-2018
2634	Penticton	Investigation Report	.	19-Dec-1994	pre-2018
2660	Penticton	CofC	.	21-May-1998	pre-2018
2664	Penticton	Determination	.	01-Oct-2001	pre-2018
3033	Oliver	Investigation Report	.	19-Aug-1996	pre-2018
3161	Penticton	AiP	.	02-May-1996	pre-2018
3394	Naramata	Investigation Report	.	21-Apr-1998	pre-2018
3420	Penticton	AiP	.	23-Oct-1996	pre-2018
3488	Penticton	AiP	.	26-Nov-1996	pre-2018
3581	Penticton	CofC	.	11-Jan-1999	pre-2018
3669	Summerland	Investigation Report	.	17-Jan-1997	pre-2018
3815	Penticton	Investigation Report	.	26-Nov-1996	pre-2018
5153	Oliver	CofC	.	25-Feb-2003	pre-2018
5159	Oliver	Determination	.	23-May-2002	pre-2018
5340	Penticton	Investigation Report	.	21-Aug-1998	pre-2018
5651	Penticton	Determination	.	12-May-1999	pre-2018
6228	Penticton	Determination	.	17-Nov-1999	pre-2018
6272	Osoyoos	CofC	.	12-Sep-2001	pre-2018
6312	Osoyoos	Investigation Report	.	30-Mar-2001	pre-2018
6986	Oliver	Investigation Report	.	29-Sep-2000	pre-2018
7021	Penticton	Investigation Report	.	01-Nov-2000	pre-2018
7099	Summerland	CofC	.	20-Sep-2005	pre-2018
7480	Penticton	Determination	.	06-Jan-2003	pre-2018
7492	Penticton	Investigation Report	.	24-Sep-2001	pre-2018
7644	Penticton	CofC	.	30-Aug-2005	pre-2018
7779	Penticton	Investigation Report	.	05-Nov-2002	pre-2018
7807	Penticton	CofC	.	No Entry	pre-2018
7872	Penticton	CofC	.	16-May-2016	pre-2018
8227	Penticton	CofC	2024-06-06	.	2018-2024
8405	Penticton	Investigation Report	.	18-Mar-2004	pre-2018
8929	Penticton	CofC	.	03-Apr-2007	pre-2018
9117	Penticton	CofC	.	14-Feb-2006	pre-2018
9439	Penticton	Determination	.	23-Mar-2010	pre-2018
9718	Osoyoos	CofC	.	18-Aug-2006	pre-2018
9826	Penticton	CofC	2022-12-23	.	2018-2024
9916	Penticton	CofC	.	24-Jun-2015	pre-2018
10254	Penticton	CofC	.	01-Mar-2016	pre-2018
10455	Osoyoos	CofC	.	03-Jan-2008	pre-2018
10470	Penticton	CofC	.	17-Feb-2011	pre-2018
10827	Okanagan Falls	CofC	.	25-Sep-2012	pre-2018
11451	Penticton	P9	.	23-Oct-2018	pre-2018
11668	Penticton	CofC	.	24-Jan-2013	pre-2018
11859	Penticton	CofC	.	16-Oct-2017	pre-2018
12232	Penticton	CofC	.	01-Oct-2010	pre-2018
13020	Penticton	Investigation Report	.	29-Jul-2011	pre-2018
13391	Penticton	P9	2020-07-27	.	2018-2024
13455	Penticton	Investigation Report	.	02-Dec-2011	pre-2018
17232	Penticton	CofC	.	16-May-2016	pre-2018
17807	Penticton	CofC	.	24-Jun-2015	pre-2018
19719	Keremeos	CofC	.	15-Feb-2017	pre-2018
21768	Penticton	CofC	2023-08-15	.	2018-2024
23614	Penticton	Determination	2021-11-24	.	2018-2024
26697	Oliver	Determination	2024-02-09	.	2018-2024
28113	Penticton	P9	2024-03-26	.	2018-2024

Appendix 1

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Appendix 2

Surficial Geology Maps

PGL
ENVIRONMENTAL CONSULTANTS

Prince George

PGL
ENVIRONMENTAL CONSULTANTS

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES

PRELIMINARY SERIES

LEGEND

CENOZOIC

QUATERNARY

POST-GLACIAL (7-9)

9 BOG DEPOSITS: muck and peat

8 FAN DEPOSITS: poorly sorted mixtures of gravel, sand, and silt

7 ALLUVIAL DEPOSITS: sand, gravel, silt, minor muck and peat; 7a, mainly sand and gravel; 7b, mainly silt; 7c, mainly sand and gravel forming terraces along major rivers

FRASER GLACIATION (2-6)

5 6 GLACIOLACUSTRINE DEPOSITS:
5. Beach deposits: poorly sorted gravel and sand generally less than 10 feet thick
6. Lake bottom deposits: silt, clay, and fine to medium sand; 6a, mainly silt; 6b, mainly clay; 6c, mainly sand

3 4 GLACIOFLUVIAL DEPOSITS:
3. Ice-contact stratified drift: poorly sorted sand and gravel characterized by hummocky and kettled topography; 3a, kame gravel and sand; 3b, esker gravel and sand; 3c, mainly sand, largely of lacustrine origin but deposited against and on ice
4. Proglacial stratified drift: sand, gravel, and minor silt characterized by flat topography broken in places by kettle holes and terrace slopes; 4a, outwash plain, sand and gravel; 4b, outwash plain, sand; 4c, outwash delta, sand and gravel; 4d, kettled outwash plain, sand and gravel

2 GROUND MORAINE DEPOSITS: till; includes minor sand, gravel, and silt within and on top of till; 2a, compact unoxidized till characterized by drumlinoid ridges, overlain in many places by rill deposits; 2b, ablation till; 2c, thin mantle (generally less than 5 feet) of compact till and associated glaciofluvial deposits (including rill deposits) on bedrock; 2d, poorly consolidated till-like mixtures overlying Plateau basalt

PRE-FRASER GLACIATION (1)

1 GLACIAL AND NON-GLACIAL DEPOSITS: gravel, sand, silt, clay, and till deposited during two pre-Fraser glaciations; gravel, sand, silt, and clay deposited during interglacial and interstadial intervals; 1a, localities where at least two tills separated by non-glacial deposits have been observed, mostly in near-vertical cliffs

TERTIARY

MIOCENE AND EARLY PLIOCENE

T Poorly consolidated to unconsolidated conglomerate (gravel) sandstone, and mudstone (clay to silt); minor diatomite, lignite (brown peaty coal), and basalt

Areas of rock outcrop and of rock with thin discontinuous mantle of drift and colluvium . . . . R

Geological boundary, approximate . . . .

Drumlinoid ridge, crag-and-tail hill (direction of ice movement known, unknown) . . . .

Esker (direction of stream flow known) . . . . >>>>>>>>>>>>>>>

Meltwater channel (small, large). . . . .

Landslide scar . . . .

Locality where age has been determined in millions of years . . . . . . .6640Ⓐ

Gravel pit. . . . . ×

Colluvium (see Explanatory notes). . . . . Qc

Geology by S. P. Leaming and J. E. Armstrong, 1966-67

This preliminary edition was prepared without final drafting and may be subject to revision and correction
Geological cartography by the Geological Survey of Canada, 1969

Topographic base-map at the same scale published by the Surveys and Mapping Branch, 1967

Magnetic declination 1969 varies from 24° 31' easterly at centre of east edge to 25° 13' easterly at centre of west edge. Mean annual change decreasing 3.7'

All elevations in feet above mean sea-level

EXPLANATORY NOTES

SAND AND/OR GRAVEL: in many places in the map-area evidence of the origin of these deposits is lacking and they have been included arbitrarily in the map-units shown in the legend; for example, 7c mapped as alluvial deposits may be partly or wholly glaciofluvial deposits; 6a mapped as glaciolacustrine deposits and 2b mapped as ablation till may be partly glaciofluvial deposits

ABLATION TILL: unsorted mixture of sand and gravel, 5 feet or more thick, believed to have been deposited from a superglacial position through the melting of underlying stagnant ice

COLLUVIUM: deposits of mass-wasting processes and consisting of an unsorted mixture of angular to rounded gravel and rubble, sand, and silt found on most slopes. In most places too thin (less than 3 feet) to differentiate as a map-unit. Where thicker deposits (more than 3 feet) have been observed the symbol Qc has been put on the map

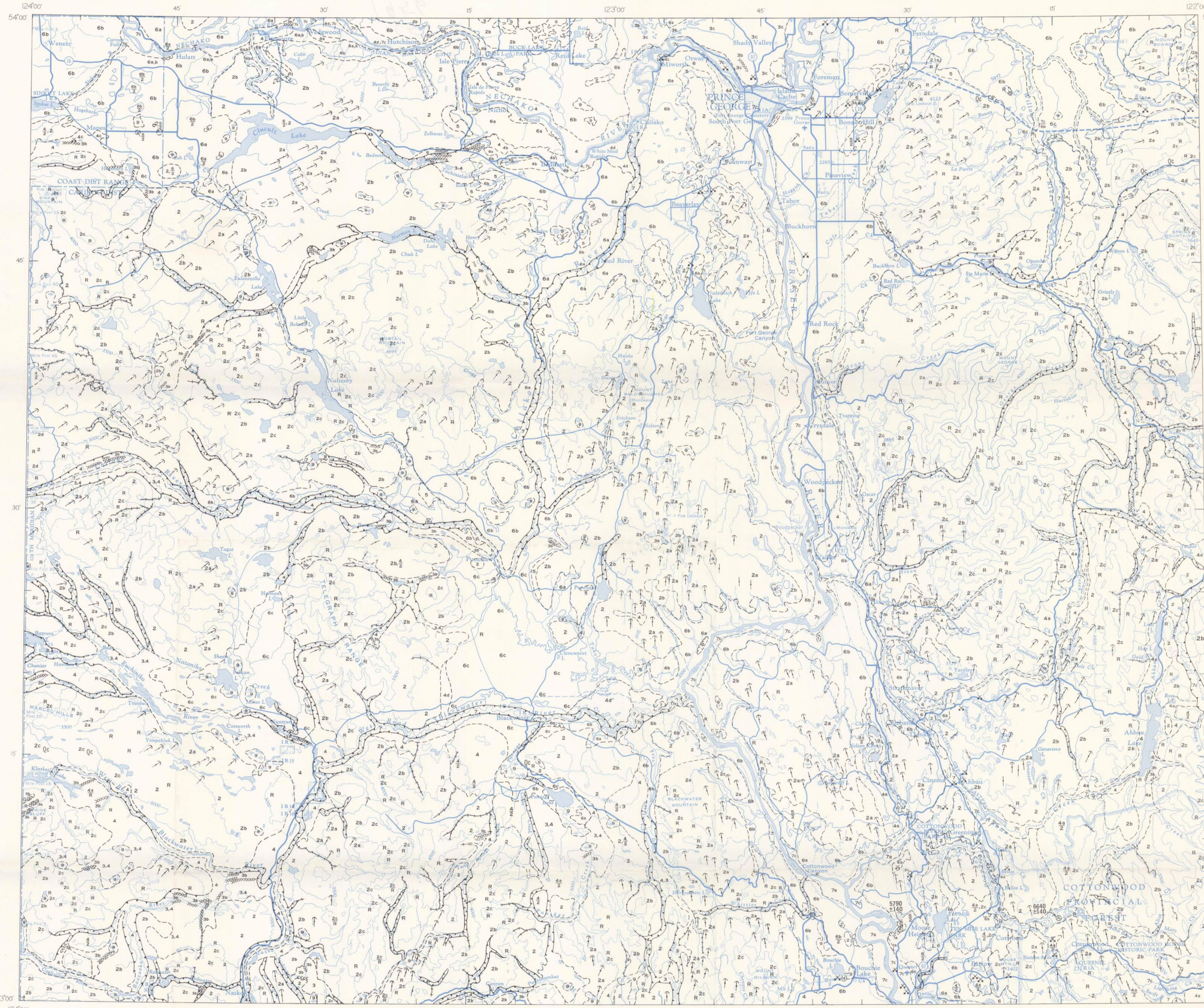
TERRACES: in many areas mapped as alluvial deposits (7) and glaciofluvial deposits (4)

RILL DEPOSITS: lag gravel, channel-bottom gravel, hummocky gravel, and pockets of blackwater silt closely associated with till (2a, 2c); in general these are morainal deposits washed and channelled by meltwater. Because these deposits are so widespread no attempt was made to differentiate them as a map-unit. They are most abundant in areas exhibiting small meltwater channels

TILL (2a and 2c lodgement): mechanical analyses on more than 60 samples of lodgement till indicate a stone content, which varies from 5 to 50 per cent of the volume in a matrix that is predominantly clay loam or loam, although in about 20 per cent of the samples the matrix is sandy loam or silty loam. In many places the composition of the till reflects the underlying materials or nearby bedrock but exceptions are common. Where sections of till were sampled from the base to the top, the material at the base normally contains a higher percentage of the clay and silt than the material at the top, but in some places the composition is uniform throughout. The older tills (1) vary as much in composition as the youngest till (2a, 2c) and textural variations cannot be used to distinguish the various tills from one another

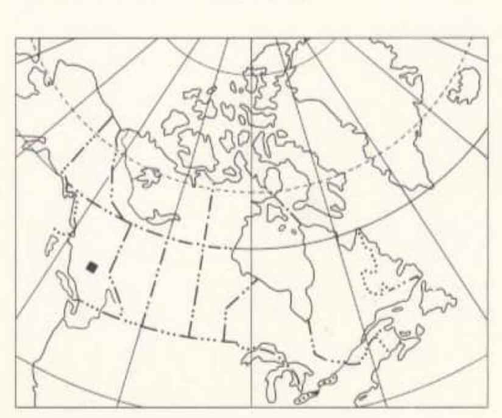
FRACTIONAL UNITS (e.g. $\frac{6a}{2a}$): are used where the surface map-unit averages less than 5 feet in thickness. The upper number applies to the surface unit and the lower number to the principal underlying unit. Thus $\frac{6a}{2a}$ means that glaciolacustrine clay (unit 6a) extends a few feet below the surface and rests upon ground moraine (unit 2a)

B.C. Prince George
1:250,000
Prelim. Map Series. 3-1969
C.2



Published, 1969
Copies of this map may be obtained from the Geological Survey of Canada, Ottawa

Printed by the Surveys and Mapping Branch



INDEX MAP

MAP 3-1969

SURFICIAL GEOLOGY

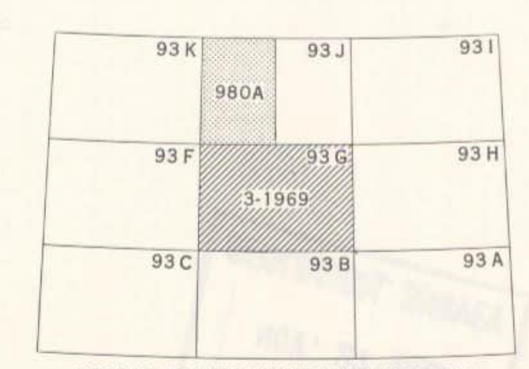
PRINCE GEORGE

BRITISH COLUMBIA

Scale 1:250,000

Miles 4 0 4 8 12 Miles

Kilometres 6 0 6 12 18 Kilometres



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

PRINCE GEORGE
BRITISH COLUMBIA

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES

LEGEND

- Drumlin (direction of flow known, unknown)
- Rock drumlin (direction known from crag and tail)
- Glacial grooves
- Glacial striae on bedrock
- Large meltwater or outwash channels and river channels bounded by cutbanks and terraces (arrows indicate direction of flow)
- Small meltwater or abandoned stream channels (direction of flow known, unknown)
- Lake deposits (shorelines indicated in places by beaches)
- Pitted terrane
- Eskers and esker complexes

Geology by H.W. Tipper, 1954-1969

To accompany GSC Bulletin 196 by H.W. Tipper

Geological cartography by the Geological Survey of Canada

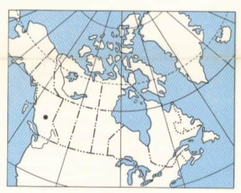
Topographic base-map at the same scale, compiled by the Department of Lands and Forest and Water Resources, British Columbia. Published by the Surveys and Mapping Branch, 1966

Magnetic declination 1970, varies from 25°08' easterly at centre of west edge to 24°46' easterly at centre of east edge. Mean annual change decreasing 3·7'

Copies of the topographical edition of this map may be obtained from the map distribution office, Department of Energy, Mines and Resources, Ottawa

93L	93K	93J 1287A	93I
93E	93F	93G 1288A	93H
93D	93C 1289A	93B 1290A	93A
92M	92N 1291A	92O 1292A	92P 1293A

NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO GEOLOGICAL SURVEY OF CANADA MAPS



INDEX MAP

Published, 1971
Copies of this map may be obtained from the Geological Survey of Canada, Ottawa

Printed by the Surveys and Mapping Branch

MAP 1288A

SURFICIAL GEOLOGY

PRINCE GEORGE

BRITISH COLUMBIA

Scale 1:250,000

Miles 4 0 4 8 12 Miles

Kilometres 6 0 6 12 18 Kilometres

MAP 1288A
PRINCE GEORGE
BRITISH COLUMBIA

1288A

Northeast BC

PGL
ENVIRONMENTAL CONSULTANTS

Compilation of Geological Survey of Canada surficial geology maps for NTS 94A and 93P

ENERGY OPEN FILE NUMBER 2011-2
GEOSCIENCE BC MAP 2011-08-1

Scale 1:250,000

10 5 0 10 20

Kilometres

North American Datum 1983
Universal Transverse Mercator Projection, Zone 10 North
Contour interval 200 metres

It is recommended that the original Geological Survey of Canada maps be cited when referring to the geology of the map area. The recommended citation for this compilation map is:

Hickin, A.S. and Fournier, M.A. (2011): Compilation of Geological Survey of Canada surficial geology maps for NTS 94A and 93P; BC Ministry of Energy and Mines, Energy Open File 2011-2, Geoscience BC Map 2011-08-1, 1:250 000 scale map.

Cartography provided by M.A. Fournier, MAF Geographix

Geological Description

A — **Alluvial Deposits:** General term for material deposited from flowing water; consist of silt, sand, and gravel, at or near stream level. **Ap** alluvial plain; **Af** alluvial fan; **At** Alluvial terrace.

C — **Colluvial Deposits:** Rock or sediment transported mainly by gravity; consists of silt, sand, gravel, rubble, and rock debris; also implies steep slopes and eroded bluffs and exposed bedrock in the Peace River Valley. **Cv** colluvial veneer (thin, less than 2 m).

E — **Aeolian Deposits:** Sediment deposited by wind; consists of silt and sand. Ev aeolian veneer (thin, less than 2 m); Er/T aeolian ridges (dunes) over till.

GF — **Glaciofluvial Deposits:** Sediment transported and deposited by glacial meltwater; consists of silt, sand, gravel, and coarse gravel. **GFb** glaciofluvial blanket (thick, more than 2 m); **GFv** glaciofluvial veneer (thin, less than 2 m); **GFf** glaciofluvial fan; **GFh** glaciofluvial hummocky terrain, includes kame deposits; **GFp** glaciofluvial plain; **GFr** glaciofluvial ridge, includes eskers.

GL — **Glaciolacustrine Deposits:** Sediment deposited in standing water associated a former glacial lake; consists mainly of laminated to massive clay, silt, and sand or waterlain diamict, with minor beach sand and gravel. **GLb** glaciolacustrine blanket (thick, more than 2 m); GLb/Tb glaciolacustrine blanket over till blanket; GLb/Tv glaciolacustrine blanket over till veneer; **GLv** glaciolacustine veneer (thin, less than 2 m); GLv/Tv glaciolacustrine veneer over till blanket; **GLp** glaciolacustrine plain.

T — **Till or Glacial Diamict Deposits:** Sediment transported and deposited directly by ice; consists of poorly sorted granual to boulders clasts in clay to sand matrix; may include areas with thin and patchy glaciolacustrine deposits. **Tb** till blanket (thick, more than 2 m); **Tv** till veneer (thin, less than 2 m); **Tp** till plain; **Th** hummocky till terrain; **Tr** streamlined till ridges.

O — **Organic Deposits:** Extensive organic material. This unit is under utilized as large extents of organic deposits were not mapped in order to show the underlying sediments.

R — **Bedrock Outcrop:** Region with extensively exposed bedrock generally restricted to high elevations

Geological Contact

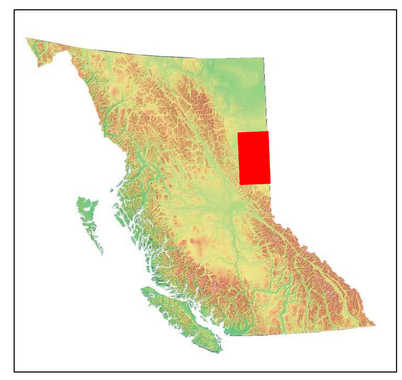
- Approximate
- Assumed
- Defined

Surficial Geology Symbols

- Aeolian dune
- Hummocky terrain
- Gravel pit
- Cirque
- Streamlined landform
- Shoreline
- Meltwater channel major
- Meltwater channel minor

Base map symbols

- Municipality
- Contour - Index
- Contour - Intermediate
- Contour interval 200 metres
- Cart track, overgrown road
- Road: Gravel, dry weather
- Road: Paved
- Rail
- River, island, sand bas
- Lake - definite
- Lake - definite
- Swamp, marsh, marshy lake



094F	094G	094H
094C	094B	*This Map* **094A**
093N	093O	**093P** *This Map*
093K	093J	093I

NATIONAL TOPOGRAPHIC SYSTEM REFERNCE AND INDEX
COLOURED MAP SHEETS APPLY TO THIS SURFICIAL MAP

The map presented is a compilation of two previously published 1:250 000 surficial geology maps completed by the Geolgical Survey of Canada. Original references are provided below and should be cited when referring to the geological interpretation. The extent, geometry, and interpretation of surface material polygons has not been changed with the exception of those along the map boundary. Polygon labels have been modified and summarized to conform to the Geological Survey of Canada's preliminary national surficial geology legend. The compiled map is not an update of the previous work, but is only an amalgamation of the two existing maps.

Mathews, W.H., 1978. Quaternary stratigraphy and geomorphology of Charlie Lake (94A) map-area, British Columbia; Geological Survey of Canada, Paper 76-20, 25 pages, Map 1460A, 1:250 000 scale map.

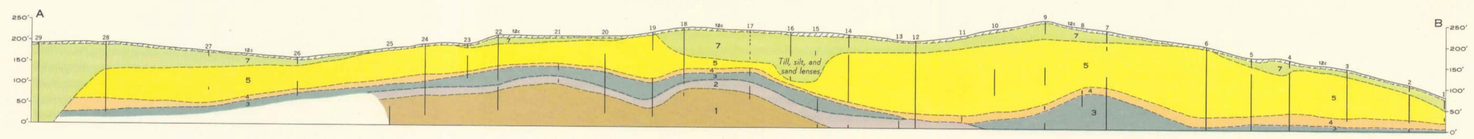
Reimchen, T.H.F, 1980. Surficial Geology Dawson Creek; Geological Survey of Canada, Map 1467A, 1:250 000 scale map

Funding for the digitization and compilation of this map was provided by the Montney Water Project, a collaborative effort between BC Ministry of Energy and Mines, Geoscience BC and industry partners, with support from the BC Oil & Gas Commission's SCEK Fund. The Montney Water Project is designed to provide a comprehensive inventory of water resource related data in the Montney Gas Play area.

Mid-Island

PGL
ENVIRONMENTAL CONSULTANTS

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS



Projected view of Dashwood Sea Cliff along line A-B

Measured exposures shown by heavy vertical lines and numbered serially from West (B) to East (A).

Horizontal Scale of Feet
500 0 500 1000

SHEET 92 F/7

LEGEND

PLEISTOCENE AND RECENT

SALISH SEDIMENTS

16 — *SHORE, DELTAIC AND FLUVIAL DEPOSITS:* gravel, sand, silt, clay, peat; **16a**, alluvial fan deposits

CAPILANO SEDIMENTS (12, 13)

13 — *TERRACED FLUVIAL DEPOSITS:*
13a, Deltaic deposits: gravel and sand commonly underlain by silt and clay
13b, Channel and floodplain deposits: gravel, sand, minor silt; in Alberni Valley includes estuarine deposits with lenses of clay (shown only where more that 5 feet thick)
13c, Alluvial fan deposits: poorly sorted gravel and silt

12a,b | 12c — *MARINE DEPOSITS (INCLUDING GLACIO-MARINE):*
12a, silt, clay, stony clay
12b, sand, sandy gravel, generally underlain by clay — *Thickness few inches to 30 feet*
12c, Marine veneer complex: varied stony gravel, gravel, sand, silt, clay, stony loam; discontinuous in bedrock areas — *Thickness generally less than 5 feet*

VASHON DRIFT (7-11)

11 — *GLACIAL LANDSLIDE DEPOSITS:* blocks and rubble

10 — *GLACIAL LAKE DEPOSITS:* sand and silt

8 | 9 — *GLACIO-FLUVIAL DEPOSITS:* gravel, sand, lenses of till
8, Hummocky (kame), knob-and-kettle, and ridged deposits; **8a**, esker deposits; **9**, Terrace and pitted-terrace deposits: **9a**, kame terrace and kame delta deposits; **9b**, ice-contact alluvial fan deposits

7 — *GROUND MORAINE DEPOSITS:* till, lenses of gravel, sand, and silt; **7a**, sandy till west side of Alberni Valley; **7b**, slope complex of till, alluvium, and colluvium

QUADRA SEDIMENTS (3-5)

5 — Sand, minor gravel; in part covered by remnants of till

6 — Gravel, sand, silt, clay, peat, till; beneath Vashon ground moraine, relation to Quadra not known

14 | 15 — **14**, *LANDSLIDE AND TALUS DEPOSITS:* blocks and rubble
15, *UPLAND SWAMP DEPOSITS:* peat and muck

4 — Silt, gravel, sand, peat, peaty soil, driftwood

3 — Clay and stony clay with marine shells; basal lenses laminated clay and silt

DASHWOOD DRIFT

2 — Till, lenses of gravel and silt

MAPLEGUARD SEDIMENTS

1 — Sand, silt; minor clay and gravel

Distinguished on sections only; included with unit 5 on map

CENOZOIC

R — Areas of bedrock outcrop and of outcrop interspersed with patches of thin overburden

Bedrock outcrop in area of overburden
Scarp bordering delta or other terrace (symbol at top of scarp)
Abandoned channel
Limit of marine overlap (not shown on deltas)
Gravel pit

Note: Fractional units (e.g. 12c/7) are used where the surface map-unit averages less than 5 feet in thickness. The upper number applies to the surface unit and the lower number to the principal underlying unit. Thus 12c/7 means that marine veneer (unit 12c) extends a few feet below the surface and rests upon ground moraine (unit 7)

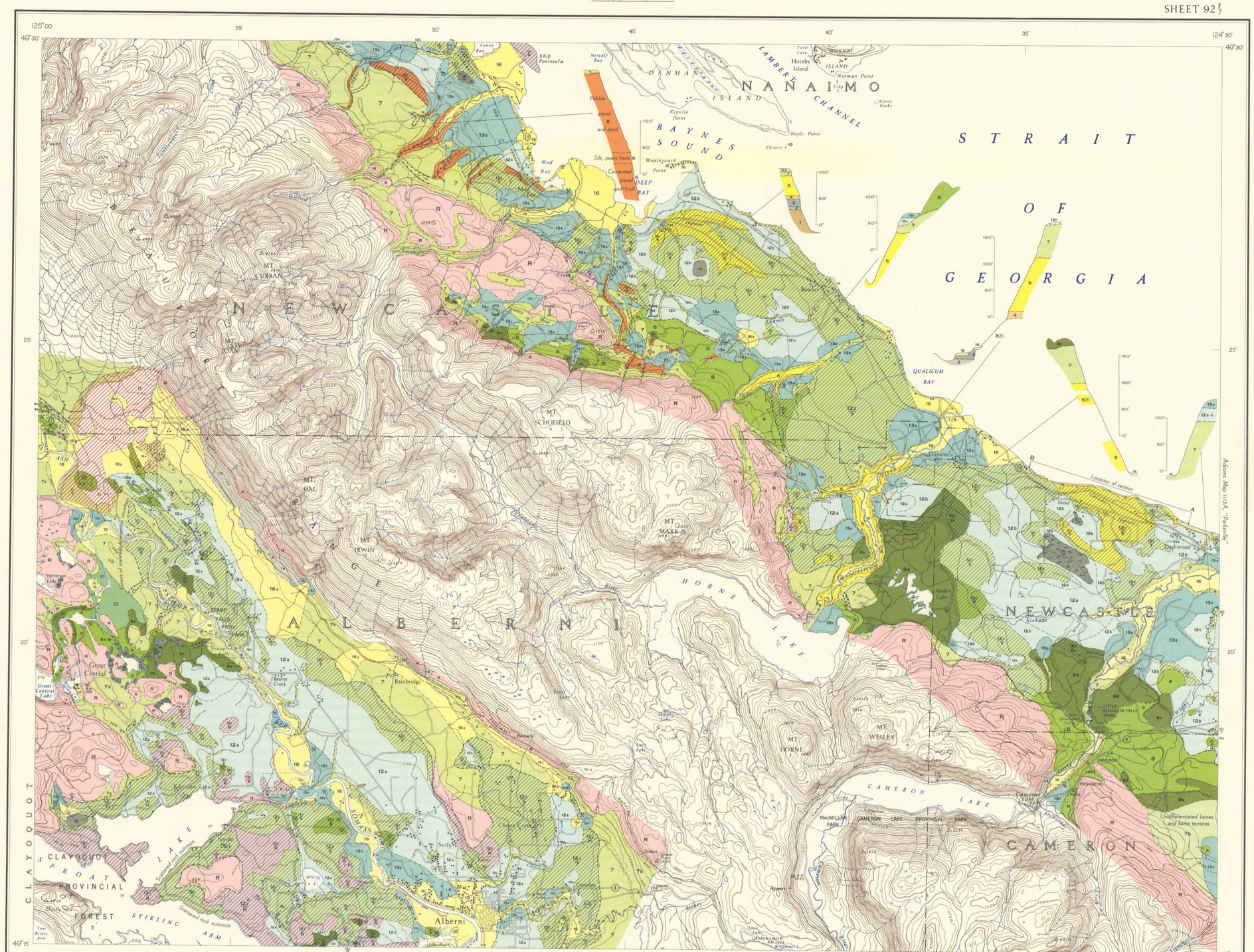
Geology by J. G. Fyles, 1950-1953

To accompany G. S. C. Memoir 318 by J. G. Fyles

Cartography by the Geological Survey of Canada, 1962

Base-map prepared by the Army Survey Establishment, R. C. E., Department of National Defence. Revisions to roads by the Geological Survey of Canada from maps of the Department of Lands and Forests, British Columbia

Approximate magnetic declination, 24°00' East, decreasing 3.0' annually



PUBLISHED, 1963

INDEX MAP

MAP 1111A

SURFICIAL GEOLOGY

HORNE LAKE

VANCOUVER ISLAND
BRITISH COLUMBIA

Scale: One Inch to One Mile = 1/63,360
Miles
1 ½ 0 1 2 3

COPIES OF THIS MAP MAY BE OBTAINED FROM THE DIRECTOR, GEOLOGICAL SURVEY OF CANADA, OTTAWA

PRINTED BY THE SURVEYS AND MAPPING BRANCH

LEGEND

Road, hard surface, all weather	Lighthouse
Road, loose surface, all weather	Wharf
Road, loose surface, dry weather	Horizontal control point
Private road (logging)	District boundary
Road, four-wheel drive	Park boundary
Trail	Indian Reserve boundary
Power transmission line	Stream (intermittent)
Building or cabin	Marsh
Church	Sand or gravel
School	Contours (interval 100 feet)
Post Office	Height in feet above mean sea-level

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

SHEET 92 F/8

LEGEND

PLEISTOCENE AND RECENT

SALISH SEDIMENTS

16 — *SHORE, DELTAIC AND FLUVIAL DEPOSITS:* gravel, sand, silt, clay, peat; **16a**, alluvial fan deposits

CAPILANO SEDIMENTS (12,13)

13 — *TERRACED FLUVIAL DEPOSITS:* **13a**, Deltaic deposits: gravel and sand commonly underlain by silt and clay; **13b**, Channel and floodplain deposits: gravel, sand, minor silt; in Alberni Valley includes estuarine deposits with lenses of clay (shown only where more that 5 feet thick); **13c**, Alluvial fan deposits: poorly sorted gravel and silt

12 / 12c — *MARINE DEPOSITS (INCLUDING GLACIO-MARINE):* **12a**, silt, clay, stony clay; **12b**, sand, sandy gravel, generally underlain by clay — *Thickness few inches to 30 feet*; **12c**, Marine veneer complex: varied stony gravel, gravel, sand, silt, clay, stony loam; discontinuous in bedrock areas — *Thickness generally less than 5 feet*

VASHON DRIFT (7-11)

11 — *GLACIAL LANDSLIDE DEPOSITS:* blocks and rubble (appears on Map 1111A, "Horne Lake" only)

10 — *GLACIAL LAKE DEPOSITS:* sand and silt (appears on Map 1111A, "Horne Lake" only)

8 / 9 — *GLACIO-FLUVIAL DEPOSITS:* gravel, sand, lenses of till **8**, Hummocky (kame), knob-and-kettle, and ridged deposits; **8a**, esker deposits; **9**, Terrace and pitted-terrace deposits; **9a**, kame terrace and kame delta deposits; **9b**, ice-contact alluvial fan deposits; (9b appears on Map 1111A, "Horne Lake" only)

7 — *GROUND MORAINE DEPOSITS:* till, lenses of gravel, sand, and silt; **7a**, sandy till west side of Alberni Valley; **7b**, slope complex of till, alluvium, and colluvium; (7a appears on Map 1111A, "Horne Lake" only)

QUADRA SEDIMENTS (3-5)

5 — *Sand, minor gravel; in part covered by remnants of till*

6 — *Gravel, sand, silt, clay, peat, till; beneath Vashon ground moraine, relation to Quadra not known (appears on Map 1111A, "Horne Lake" only)*

14 / 15 — **14**, *LANDSLIDE AND TALUS DEPOSITS:* blocks and rubble (appears on Map 1111A, "Horne Lake" only); **15**, *UPLAND SWAMP DEPOSITS:* peat and muck

4 — *Silt, gravel, sand, peat, peaty soil, driftwood*

3 — *Clay and stony clay with marine shells; basal lenses laminated clay and silt*

DASHWOOD DRIFT

2 — *Till, lenses of gravel and silt*

MAPLEGUARD SEDIMENTS

1 — *Sand, silt; minor clay and gravel (appears on Map 1111A, "Horne Lake" only)*

Distinguished on cross-sections only; included with unit 5 on map

R — *Areas of bedrock outcrop and of outcrop interspersed with patches of thin overburden*

Bedrock outcrop in area of overburden
Scarp bordering delta or other terrace (symbol at top of scarp)
Abandoned channel
Limit of marine overlap (not shown on deltas)
Gravel pit

Note: Fractional units (e.g. 12c/5) are used where the surface map-unit averages less than 5 feet in thickness. The upper number applies to the surface unit and the lower number to the principal underlying unit. Thus 12c/5 means that marine veneer (unit 12c) extends a few feet below the surface and rests upon ground moraine (unit 7)

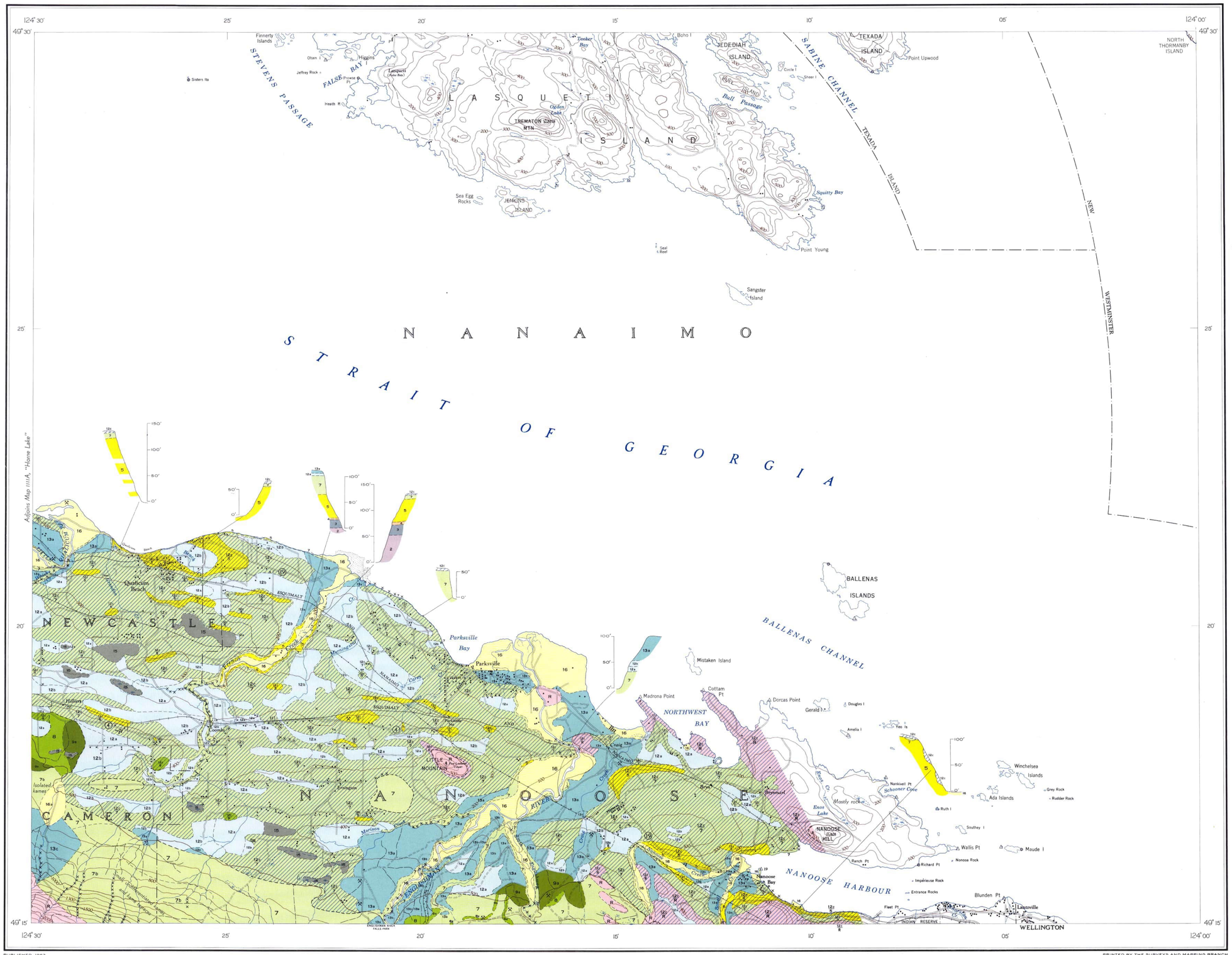
Geology by J. G. Fyles, 1950-1953

To accompany G. S. C. Memoir 318 by J. G. Fyles

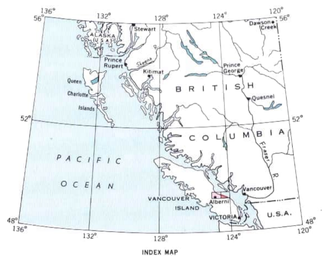
Cartography by the Geological Survey of Canada, 1962

Base-map prepared by the Army Survey Establishment, R. C. E., Department of National Defence. Revisions to roads by the Geological Survey of Canada from maps of the Department of Lands and Forests, British Columbia

Approximate magnetic declination, 23°45′ East, decreasing 3.0′ annually



PUBLISHED, 1963



MAP 1112A

SURFICIAL GEOLOGY

PARKSVILLE

VANCOUVER ISLAND
BRITISH COLUMBIA

Scale: One Inch to One Mile = 1/63,360

Miles 1 ½ 0 1 2 3

COPIES OF THIS MAP MAY BE OBTAINED FROM THE DIRECTOR, GEOLOGICAL SURVEY OF CANADA, OTTAWA

LEGEND

Road, hard surface, all weather (19)	Lighthouse
Road, loose surface, all weather	Wharf
Road, loose surface, dry weather	Horizontal control point
Private road (logging)	District boundary
Road, four-wheel drive	Park boundary
Trail	Indian Reserve boundary
Power transmission line	Stream, (intermittent)
Building or cabin	Marsh
Church	Sand or gravel
School	Contours (interval 100 feet) 500
Post Office	Height in feet above mean sea-level 1078

PRINTED BY THE SURVEYS AND MAPPING BRANCH

Vancouver (NM 9/10)

LEGEND FOR QUATERNARY OF CANADIAN CORDILLERA

R.J. Fulton

HOLOCENE

m — Made-land: mixed texture materials dumped to provide additional unusable land or built during disposal of waste materials; includes mill tailings dumps and spoil ground.

I — Alpine glaciers and ice caps: ice and debris covered ice; includes minor associated glacial deposits and small areas of rock (mainly nunataks).

O — Organic deposits: peat, mucky peat and muck; brown to black in color; in many places underlain by grey to light brown muck consisting largely of fine grained carbonate mud and mollusc fragments. Occurs in shallow depressions and poorly drained areas. Thickness generally 1-4 m but rarely to 15 m.

S — Landslide: rubble and diamicton with texture dependant on the composition of the material in which the slope failure occurred. In mountainous terrain, slides generally are small rockfalls and result in small piles of rubble; locally large landslides have occurred resulting in hummocky valley fills and large fans of rubble. Slope failures in Quaternary sediments and poorly consolidated or highly altered older rocks result in earthflows with a diamicton texture. Thicknesses are variable and may be up to 80 m.

Fc Fo Fx Ff — Fluvial sand, silt, and gravel: medium grained sand and gravel and fine grained sand and silt occurring as modern and Holocene floodplain, terrace and fan deposits. Thickness 2 to 10 m but where streams enter lakes fluvial sediments overlie with gradational contact, deltaic fill sequences as thick as 200 m.

Fc — Fc, dominantly channel sands and gravels and associated sand and gravel terraces. Clasts commonly rounded and lithologies mixed and variable, reflecting the composition of local bedrock and glacial deposits. Sediments generall well stratified with cut-and-fill structures and cross bedding. Texture varies vertically and laterally but individual beds are generally well sorted. A capping of silt to medium grained sand <1 m thick is common.

Fo — Fo, dominantly fine grained sand and silt overbank deposits including associated organic materials and channel deposits. Characterized by horizontal and ripple laminations which in many places may have been destroyed by plant rooting activities. Sediments generally occur in upward fining units. May enclose sinuous bodies of channel sands and gravels but these are a minor part of the map unit.

Ff — Ff, diamicton and gravel occurring as alluvial fan deposits. Consist of thickly bedded, internally massive units and cross bedded units characterized by cut-and-fill structures. Texture varies vertically and laterally with a general decrease in grain size from fan head to fan toe. Sorting is generally poor but locally may be good. Lithologies reflect local bedrock or glacial deposits. Clasts are generally subangular to subrounded but may be well rounded where they are derived from pre-existing fluvial gravels.

Fx — Fx, a complex of channel and overbank deposits, and intertonguing colluvial and alluvial fans (this unit is commonly used in mountain valleys). Consists of units Fc, Fo and Ff in addition to rubble in the form of colluvial fans and cones. The typical map unit occupies the floor of a mountain valley in which the stream is overwhelmed by a large supply of fluvial and colluvial materials. Deposits on the valley floor include colluvial and alluvial fan materials from tributary valleys and gullies, channel gravels and sands where the stream flows over fan deposits, sand and silt overbank deposits and peats in reaches partly dammed by the infringing fans and rubble at the toes of the impinging colluvial aprons and cones. This is also used in parts of the Fraser, Thomson and Nicola valleys which are occupied by a complex of alluvial fans, terraces, floodplain deposits and remnants of thick valley fill.

Lt Lx — Lacustrine silt, clay and sand: commonly light grey in color; dominantly rhythmites consisting of thick silt (<1 m) and thin (<1 cm) clay couplets. Gradational increase in grain size in most thick sequences.

Lt — Lt, thick lacustrine deposits generally seen as a terrace or partly dissected valley fill but also often underlies Holocene fluvial deposits. Thickness <100 m.

Lx — Lx, lacustrine silt, sand and clay and minor ice contact sand and gravel: Stratification generally parallel but contorted and faulted due to melting of buried ice. Thickness <10 m. Locally includes lenses of gravel and sand. Generally occurs as low relief hummocky landform.

HOLOCENE AND FRASER

Wt Wb Wv — Marine and glaciomarine deposits: clay, silt, sand, gravel, and diamicton deposited in lowland areas transgressed by the sea during latest Pleistocene and Holocene time. Coarse littoral sediments commonly veneer glaciomarine and glacial sediments.

Wt — Thick marine and glaciomarine deposits masking details of relief of underlying units, and with surface expression reflecting genesis of deposit. Dominantly silt, clay and stony silt and clay. Thicknesses locally as great as 200 m.

Wb — Marine and glaciomarine deposits thick enough to mask minor irregularities in the underlying units, but which still conform to the general underlying topography (1-3 m).

Wv — Discontinuous, thin marine and glaciomarine deposits; relief details of underlying units generally visible; outcrops of underlying units may be common. Dominantly sand and gravel occurring as a lag on glacial or glaciomarine sediments and glaciomarine stony silt and clay. Thickness generally <2 m.

Gt Gx — Glaciofluvial sand and gravel: dominantly coarse grained sand, pebbly sand and fine gravel but locally poorly sorted and bouldery. Texture varies laterally and vertically. Clasts generally subrounded to well-rounded and lithologies reflect local bedrock and till.

Gt — Gt, sand and gravel in the form of terraces and deltas associated with the ice retreat drainage regime. Generally well stratified with cross bedding and cut-and-fill structures common. Sorting within individual sediment units generally good. Thickness <10 m.

Gx — Gx, sand and gravel in the form of ridges and hummocks (kames, kame complexes and eskers) and other features associated with deposition of sand and gravel in contact with ice. Generally well stratified but stratification in many places contorted and faulted by the melting of buried ice. Sorting variable. May include lenses of diamicton. Thickness <50 m.

1M — Loamy till: Olive-brown, brown, grey-brown or reddish brown till. Slightly to moderately calcareous. Texture generally loam, sandy loam to silty clay loam; locally stony to bouldery. Generally compact. Clast lithologies variable and chiefly argillite, greenstone, granitics and crystalline metamorphics in areas underlain by sandstones and shales; dominantly basalt and dacite in areas underlain by volcanic rocks. Areas mapped as this unit are largely underlain by weakly consolidated sandstones and shales and unmetamorphosed basalts and dacites.

1Mt 1Mb — 1Mt 1Mb: continuous till cover with thickness >10 m on valley floors and lower slopes, 1-3 m in most other areas (1Mb).

1Mv — 1Mv: thin to discontinuous till with scattered outcrops; thickness generally >2 m.

dM — Sandy loamy till: olive-grey, olive, olive-brown, grey-brown, grey and pale olive till. Generally moderately calcareous but strongly calcareous in areas of limestone and slightly calcareous in areas where till overlies or was derived from ice advance sediments. Textures generally sandy loam, loam, sandy clay loam, loam, loamy sand and locally sand or silt loam were derived from unconsolidated sediments. Generally compact and commonly stony. Clast lithologies variable reflecting diverse bedrock lithologies from which till was derived and diverse clast composition of overridden outwash. Areas mapped as this unit are largely underlain by argillite, greywacke, limestone, quartzite, arkase, agglomerate, greenstone, andisite and other medium grade metamorphic sediments and by pre-last ice advance sands, gravels and silts.

dMt dMb — dMt dMb: continuous till cover with thicknesses >10 m on valley walls and lower slopes, 1-3 m in most other areas (dMb).

dMv — dMv: thin to discontinuous till was scattered outcrops; thickness generally <2 m.

sM — Sandy till: olive grey, grey and pale olive till. Weakly to noncalcareous. Textures generally loamy sand, sandy loam and sand. Generally gravelly, cobbley or bouldery. Clast lithologies variable reflecting local bedrock which is chiefly grandorite, dorite, quartzdorite, quartzmonzonite and a variety of crystalline metamorphic lithologies. Areas mapped as this unit are largely underlain by acid igneous intrusives and associated igneous rocks.

sMt sMb — sMt sMb: continuous till cover with thicknesses up to 10 m on valley floors and lower slopes, 1-3 m in most other areas (sMb).

sMv — sMv: thin to discontinuous till with scattered outcrops; thickness generally <2 m.

Ra — Rock with discontinuous colluvium and till — alpine mountains: major rock landforms consist of arêtes, cirques, glaciated valleys and various other alpine glacial forms. A discontinuous mantle of colluvial rubble is present on most slopes and aprons and cones of colluvial debris occur at the toes of many slopes. A till veneer (dMv sMv) is present on lower parts of valley walls with thicker till occurring locally in valley bottoms and thin discontinuous till present at higher elevations. Colluvium and till are generally <2 m thick. Valleys are generally occupied by complexes of colluvial debris, channel sediments, overbank deposits and low gravel terraces (Fx) which locally may be as much as 10 m thick but are too small to map at this scale.

Rs — Rock with discontinuous colluvium and till — steep slopes: rock landforms consist dominantly of steep slopes. Discontinuous colluvial rubble is present on most slopes with thicker accumulations near slope toes. Thin patches of till are locally present. Unconsolidated sediments are generally <2 m thick.

Rm — Rock with minor colluvium and till — low relief: flat to gently rolling areas of rock. Bare rock locally covered by patches of peat, colluvium and till.

Qv — Quaternary volcanics: lava flows, breccia and ash; dominantly basaltic and andesitic composition but locally includes more acidic material; consists of flows and cinder cones.

Geology compiled by R.J. Fulton and J.J. Clague, Geological Survey of Canada and J.M. Ryder, British Columbia Department of the Environment. Compilation co-ordination by R.J. Fulton.

SYMBOLS

- Cirque or group of cirques (not shown in areas of Ra).
- Direction of ice movement: erosional features (grooves, striae, chattermarks etc).
- Drumlin or group of drumlins.
- Senses of ice movement; depositional feature other then drumlins.
- Streamlined topography indicating direction of ice movement (includes grooves in drift, drumlinoid ridges etc.).
- Crest of transverse till ridges.
- Esker or ice fracture filling.
- Abandoned channel; includes meltwater channels and underfit streams.
- Spillway threshold of glacial lake.
- Deltas too small to appear as a map unit.
- Surface unit overlies a thick (<600 m) of Quaternary sediments.
- Volcanic ash locality (Bridge River, St. Helen's Y, Mazama, Olympia "Intergacial").
- A — Important stratigraphic section (brief description given in Table II).
- 1 — Important radiometric date locality (date and brief explanation given in Table I).

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Table I

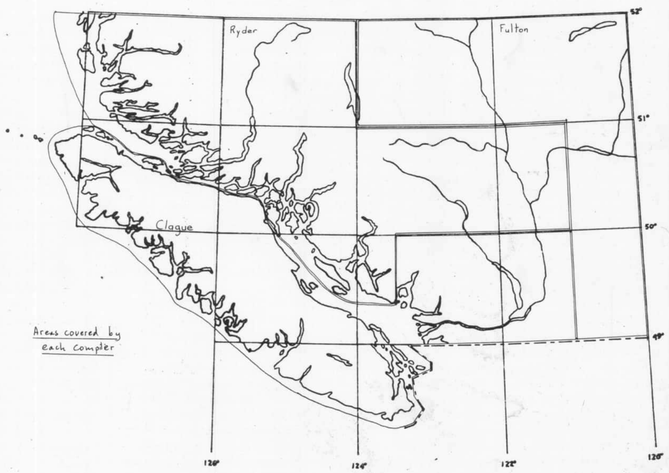
RADIOMETRIC DATES

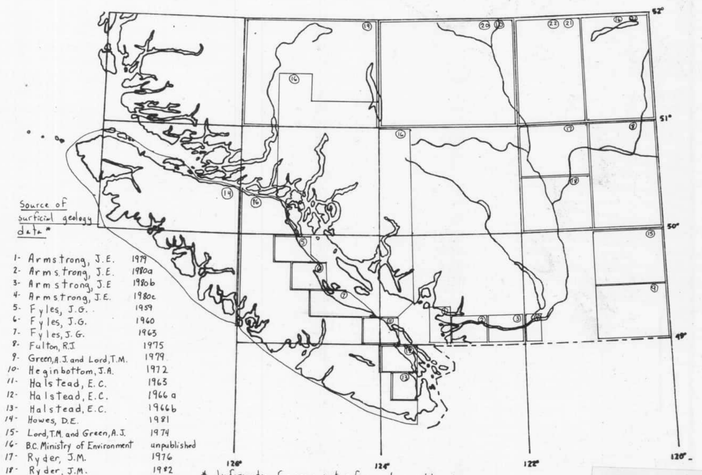
Locality		Date	Material	Significance	Reference
1	GSC-948	2225 ± 130	peat	Neoglacial advance	Fulton, 1971
	GSC-938	2940 130	peat	Neoglacial advance	Fulton, 1971
2	I-6057	11 430 ± 150	gyttja	Fraser retreat	Mathewes et al., 1972
3	GSC-38	12 360 140	shells	Fraser retreat	Dyck & Fyles, 1962
4	GSC-389	12 740 170	worm tubes	Fraser retreat	Dyck et al., 1966
5	GSC-2193	12 900 170	shells	Fraser retreat	Lowdon et al., 1977
6	GSC-2768	16 700 500	wood	Fraser advance	Clague et al., 1980
7	GSC-2297	17 800 150	wood	Fraser advance	Clague et al., 1980
	GSC-2416	21 700 130	wood	Coquitlam ice advance	Hicock & Armstrong, 1981
8	GSC-2344	18 700 170	wood	Youngest Quadra Sand	Armstrong & Clague, 1977
	GSC-2273	25 800 310	wood	Youngest Cowichan Head Formation	Armstrong & Clague, 1977
	GSC-2167	40 500 1700	wood	Oldest Cowichan Head Formation	Armstrong & Clague, 1977
9	GSC-95	28 800 740	wood	Oldest Quadra Sand	Armstrong & Clague, 1977

Table II

IMPORTANT STRATIGRAPHIC SECTIONS

Locality	Significance	Reference
A	Type section: Quadra Sand	Armstrong & Clague, 1977
B	Type section: Mapleguard Sediments and Dashwood Drift	Fyles, 1963
C	Type section: Cowichan Head Formation	Armstrong & Clague, 1977
D	Type section: Capilano Sediments	Armstrong, 1981
E	Type section: Coquitlam Dirft	Hicock & Armstrong, 1981
F	Type section: Fort Longley Formation	Armstrong, 1981
G	Type section: Sumas Drift	Armstrong, 1981
H	Type section: Semiahmoo Drift	Armstrong, 1975
I	Type section: Muir Point Formation	Hicock, 1980





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Sheet 2 of 2

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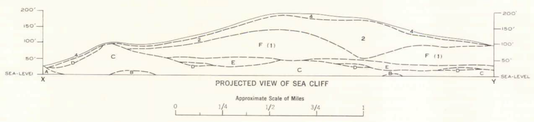
GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRELIMINARY SERIES

SHEET 92 G/4 and 92 F/1 (East)



Road, all weather . . . . . Route No.
Other roads . . . . .
Trail . . . . .
Railway . . . . .
Abandoned railway . . . . .
Power transmission line . . . . .
Post Office . . . . . P
Indian Reserve boundary . . . . .
Marsh . . . . .
Cliff . . . . .
Sand or gravel . . . . .
Contours (interval 100 feet) 200
Height in feet above mean sea-level . . . . . +162

Base-map by the Army Survey Establishment, R. C. E. Dept. of National Defence

Mean magnetic declination 23° 04' East decreasing 3.0° annually

LEGEND

CENOZOIC

PLEISTOCENE AND RECENT

SALISH SEDIMENTS (7):

7 SHORE, DELTAIC, FLUVIAL, AND UPLAND SWAMP DEPOSITS: gravel, sand, silt, clay, peat

CAPILANO SEDIMENTS (4,5)

5 TERRACED FLUVIAL DEPOSITS: deltaic, floodplain and channel deposits, gravel, sand, lag gravel, and cobbles

4 MARINE DEPOSITS (INCLUDING GLACIO-MARINE)
- 4a, silt, clay and stony clay } thickness up to 50 feet
- 4b, gravel, sand, silt in spits and bars
- 4c, gravel, sand mainly marine veneer } commonly less than 5 feet thick
- 4d, varied stony, loamy and clayey marine veneer

VASHON DRIFT (2,3)

3 GLACIO-FLUVIAL DEPOSITS: gravel, sand, lenses of till
- 3a, hummocky knob and kettle deposits
- 3b, terrace and pitted terrace deposits

2 GROUND MORAINE DEPOSITS: till, lenses of gravel, sand and silt

QUADRA SEDIMENTS (1)

1 Sand, minor gravel

6 VALLEY ALLUVIUM AND COLLUVIUM: (6) boulders, gravel, sand, silt, clay on terraces and as channel deposits; includes patches of 5 and 7

Older deposits, units B,C,D and E are exposed on cliff faces and described in the marginal notes

Note: fractional units (i. e. 4c/2) are used where the surface map unit averages less than 5 feet in thickness. The upper number applies to the surface unit and the lower number to the principal underlying unit. Thus 4c/2 means that gravel and sand marine veneer extends a few feet below the surface and rests upon ground moraine.

Areas of bedrock outcrop and outcrop with thin patches of overburden . . . . . R
Bedrock outcrop in area of overburden . . . . . ×
Geological boundary (approximate) . . . . .
Limit of geological mapping . . . . .
Glacial striae (S), stoss-and-lee surfaces (SL) direction of ice movement indicated . . . . .
Drumlinoid ridges, direction of ice indicated . . . . .
Scarp between deltas or river terraces . . . . .
Gravel pit . . . . .
Fossil locality . . . . . F

Geology by E. C. Halstead, 1961

Cartography by the Geological Survey of Canada, 1963

INDEX MAP

DESCRIPTIVE NOTES

The west half of the map-area is mountainous, with elevations rising to more than 4,400 feet above sea-level. The east half is part of the east coast lowland of Vancouver Island, which extends diagonally across the map-area with a maximum width of about 8 miles. Except for volcanic rocks exposed at Cottle Hill and Woodley Range, bedrock that underlies the lowland consists of shale, sandstone, and conglomerate, whose weaker units have been eroded to form longitudinal valleys; the more resistant units provide cuesta-like ridges. Quennel, Holden, Beck, and Long Lakes, and other smaller lakes, occupy the deepened parts of these longitudinal valleys. The largest of these valleys is drowned at its northern and southern ends to form Nanaimo and Ladysmith Harbours, respectively. Midway in its course, it is entered from the west by the largest of the transverse valleys; through the latter, Nanaimo River flows eastward from the upland. Upon entering the longitudinal valley it flows north to Nanaimo Harbour, in which it is building a large delta.

In most places the glaciers that overrode the area contributed little more than a rounding and polishing of the rock surfaces and deepening of the longitudinal valleys. However, much of the lowland north of Nanaimo is mantled with drift, which in places is more than 250 feet thick. South of Nanaimo, and on the islands adjacent to the lowland, bedrock lies at the surface or is covered by a few feet of marine veneer, chiefly clay.

The unconsolidated deposits throughout much of the area are related to the regimen and wasting of the last major ice-sheet that occupied Vancouver Island, the British Columbia mainland, and the Strait of Georgia. The drift left from this glaciation is recognized in the area as the classical Wisconsin.

Older glacial deposits identified in the sea cliffs at Icarus Point indicate at least two earlier periods of ice accumulation and wasting. At this locality the oldest glacial deposits (unit B on section X–Y) are believed to rest on bedrock (unit A) and consist of grey stony clayey till. The oldest till (unit B, on section X–Y) is exposed at two places. It extends beneath the rubble and boulders of the present beach deposits and is assumed to continue beneath present sea-level. Laminated silts and clays with minor sand (unit C) overlie the oldest till and are exposed continuously along the base of the cliff. The maximum exposed thickness of these clays is about 120 feet, and they continue beneath recent beach deposits and extend beneath present sea-level. Unit C has also been identified in logs of the deeper drilled wells and has been exposed in an excavation at Nanaimo. The uneven, dissected surface of this unit represents an erosion surface upon which a second ice-sheet advanced and deposited a grey stony clay (unit D), much of which has been removed by subsequent erosion leaving remnants as shown. Resting on the second till (unit D), or on unit C where the till has been removed, is unit E, consisting of oxidized sand, silt, and clay, with peat layers. The peat is continuous throughout the cliff face. Its thickness is commonly less than 1 inch, but in places is as much as 10 inches. Crossbedded buff sands (unit F on section X–Y and unit 1 on map), in places as much as 90 feet thick, overlie unit E and are correlated with Quadra sediments mapped in Courtenay and Oyster River map-areas, north of Nanaimo[1].

The last major ice-sheet, which attained a thickness of more than 7,000 feet, overrode the Quadra sediments and upon retreat left a blanket of till (unit 2). During retreat and wastage of this ice, sea-level was considerably higher than present. Heavily loaded streams issuing from valley glaciers in Nanaimo River and Haslam Creek valleys, deposited sand and gravel as deltas (3b) into a sea that was about 500 feet higher than present sea-level. That sea-level reached these higher elevations is evidenced not only by the elevation of the top beds of the deltas but by erosion features such as wave-eroded caves on sandstone and conglomerate cliffs at elevations 380 to 420 feet near Extension, and also by gravel deposits that occur at a common elevation of about 500 feet along the west side of the lowland. Marine and glacio-marine deposits (4) were laid down in the seas that overlapped the lowland and left a marine veneer of gravel, sand, or silty clay with fossils. The age of shells collected from silty sand overlying the top till was determined by radiocarbon methods as 12,420 150 years BP (GSC-80)[2]. During the period of lowering of sea-level to the present, streams deposited gravel and sand and cut terraces in older deposits (5), and clays and silts were continually being deposited in the deeper waters.

Present sea-level has been maintained for a considerable time, during which Nanaimo River has built a sizeable delta in Nanaimo Harbour, and silt and clays have accumulated in Ladysmith Harbour. In the upland areas, swamp deposits are filling the depressions.

The deltaic deposits in the Nanaimo River valley are the source of aggregate material for the sand and gravel industry. During 1961, production from pits in this area was valued at more than $197,000[3]. The sand and gravel over much of this same area provide an extensive aquifer, which is recharged partly by rainfall and partly by the Nanaimo River. It supplies about 23 million gallons daily to meet the requirements for process and service water at the bleached sulphate pulp mill, Harmac, near Nanaimo.

[1] Fyles, J. G.: Surficial Geology, Oyster River, British Columbia; Geol. Surv., Canada, Map 40-1959; Surficial Geology, Courtenay, British Columbia; Geol. Surv., Canada, Map 32-1960

[2] Dyck, W., and Fyles, J. G.: Geological Survey of Canada, Radiocarbon Dates II; Radiocarbon, Vol. 5, 1963

[3] Annual Report, British Columbia Minister of Mines and Petroleum Resources, 1961

PUBLISHED, 1963
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PRINTED BY THE SURVEYS AND MAPPING BRANCH

MAP 27-1963
SURFICIAL GEOLOGY
NANAIMO
BRITISH COLUMBIA

Scale: One Inch to One Mile = 1/63,360
Miles
1 ½ 0 1 2 3

MAP 27-1963
NANAIMO
BRITISH COLUMBIA
SHEET 92 G/4 and 92 F/1 East

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRELIMINARY SERIES

SHEETS 92 F/11 (East Half) AND 92 F/10 (West Half)

LEGEND

CENOZOIC

PLEISTOCENE AND RECENT

SALISH SEDIMENTS (8)

8 — SHORE, DELTAIC, AND FLUVIAL DEPOSITS: gravel, sand, silt, clay, peat; 8a, alluvial-fan deposits; 8b, dune sand

CAPILANO SEDIMENTS (5, 6)

6 — TERRACED FLUVIAL DEPOSITS:
6a, Deltaic deposits: gravel and sand commonly underlain by silt and clay
6b, Floodplain and channel deposits: gravel, sand, minor silt (shown only where averaging 5 feet or more in thickness; thinner deposits included in unit 7)
6c, Alluvial-fan deposits; poorly sorted gravel

7 — VALLEY ALLUVIUM AND COLLUVIUM: boulders, gravel, stony loam, sand, silt, clay (thickness generally less than 5 feet). Includes patches of 6 and 8

5 — MARINE DEPOSITS (INCLUDING GLACIO-MARINE):
5a, silt, clay, stony clay
5b, sand, pebbly sand, sandy gravel; generally underlain by clay } thickness few inches to 30 feet
5c, gravel, sand; in spits, bars, etc.
5d, varied stony, gravelly, and sandy marine-veneer deposits } thickness generally less than 5 feet
5e, varied stony, sandy, loamy, and clayey marine-veneer deposits

VASHON DRIFT (3, 4)

4 — GLACIO-FLUVIAL DEPOSITS: gravel, sand; lenses of till; 4a, hummocky, knob-and-kettle, and ridged deposits (eskers shown by symbol); 4b, terrace and pitted terrace deposits

3 — GROUND MORAINE DEPOSITS: till; lenses of gravel, sand, and silt; 3a, till, alluvium, and colluvium

1 — QUADRA SEDIMENTS (1)
Sand; minor gravel, silt, peat, peaty soil, driftwood

2 — Gravel, sand, silt, clay, till; beneath Vashon ground moraine, relation to Quadra not known

Areas of bedrock outcrop and of outcrop interspersed with patches of thin overburden ..... R
Bedrock outcrop in area of overburden ..... ×
Geological boundary (approximate) .....
Limit of geological mapping .....
Glacial striae (S), grooves (G), stoss-and-lee surfaces (SL), miniature crag-and-tail forms (CT) (direction of ice movement indicated, not indicated) .....
Crag-and-tail hills .....
Landslide scar .....
Scarp between deltas or river terraces .....
Abandoned channel .....
Limit of marine overlap (not shown on deltas) .....
Gravel pit .....

Note: Fractional units (e.g. 5d/3) are used where the surface map unit averages less than 5 feet in thickness. The upper number applies to the surface unit and the lower number to the principal underlying unit. Thus, 5d/3 means that stony, gravelly marine-veneer (unit 5d) extends a few feet below the surface and rests upon ground moraine (unit 3).

Geology by J.G. Fyles, 1956-1957

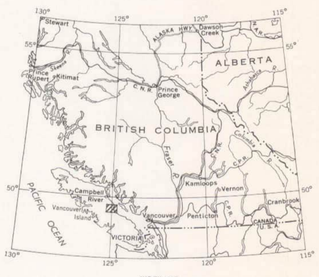
Main highway ..... (19)
Other roads .....
Trail .....
Railway .....
Power transmission line .....
Post Office ..... P
District boundary .....
Intermittent stream .....
Falls .....
Marsh .....
Sand .....
Contours (interval 500') 2500
Quarry or cliff .....
Height in feet above mean sea-level 440

Cartography by the Geological Survey of Canada, 1960

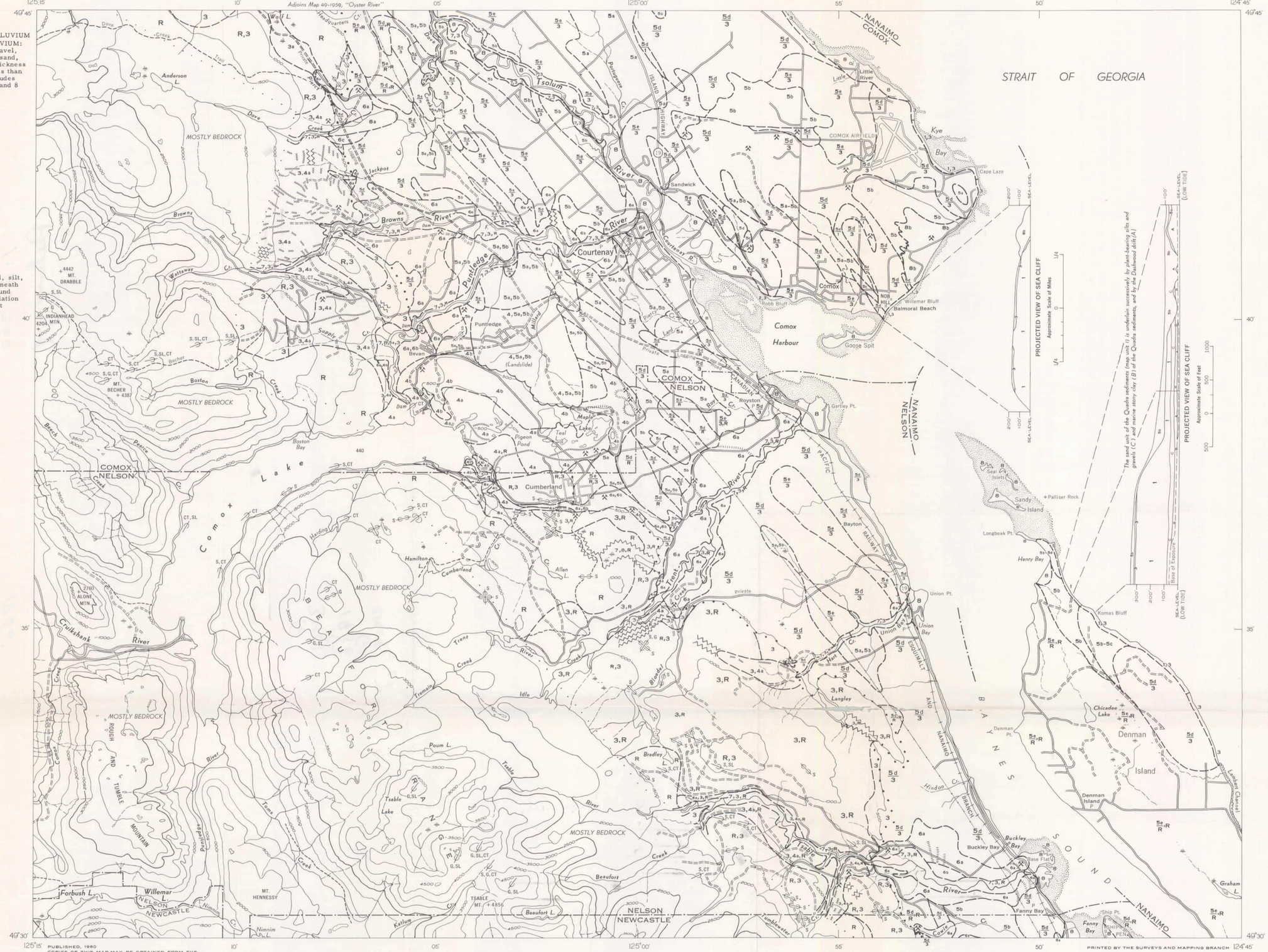
Approximate magnetic declination, 24° 12' East

In response to public demand for earlier publication, Preliminary Series maps are issued in this simplified form and will be clearer to read if all or some of the map-units are hand-coloured

Air photographs covering this area may be obtained through the National Air Photographic Library, Topographical Survey, Ottawa



INDEX MAP



PUBLISHED, 1960
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PRINTED BY THE SURVEYS AND MAPPING BRANCH

MAP 32-1960
SURFICIAL GEOLOGY
COURTENAY
COMOX, NELSON, NANAIMO AND NEWCASTLE DISTRICTS
VANCOUVER ISLAND
BRITISH COLUMBIA

Scale: One Inch to One Mile = 1/63,360
Miles
1 1/2 0 1 2 3

MAP 32-1960
COURTENAY
BRITISH COLUMBIA

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRELIMINARY SERIES

SHEET 92 F/14

LEGEND

CENOZOIC

PLEISTOCENE AND RECENT

SALISH SEDIMENTS (8)

8 — SHORE, DELTAIC, AND FLUVIAL DEPOSITS: gravel, sand, silt, clay, peat; 8a, alluvial-fan deposits

CAPILANO SEDIMENTS (5, 6)

6 — TERRACED FLUVIAL DEPOSITS: 6a, Deltaic deposits: gravel and sand commonly underlain by silt and clay; 6b, Floodplain and channel deposits: gravel, sand, minor silt (shown only where averaging 5 feet or more in thickness; thinner deposits included in unit 7)

5 — MARINE DEPOSITS (INCLUDING GLACIO-MARINE):
5a, silt, clay, stony clay
5b, sand, pebbly sand; generally underlain by clay — thickness few inches to 30 feet
5c, gravel, sandy gravel; in spits, bars, etc.
5d, varied stony, gravelly, and sandy marine-veneer deposits
5e, varied stony, loamy, and clayey marine-veneer deposits — thickness generally less than 5 feet

VASHON DRIFT (3, 4)

4 (Vashon) — GLACIO-FLUVIAL DEPOSITS: gravel, sand; lenses of till; 4a, hummocky, knob-and-kettle, and ridged deposits (eskers shown by symbol); 4b, terrace and pitted terrace deposits

3 — GROUND MORAINE DEPOSITS: till; lenses of gravel, sand, and silt

QUADRA SEDIMENTS (2)

1 — Sand; minor gravel, silt, peat, peaty soil, driftwood

2 — Gravel, sand, silt, clay, peat, driftwood, till; beneath Vashon ground moraine, relation to Quadra not known

7 — VALLEY ALLUVIUM AND COLLUVIUM: boulders, gravel, stony loam, sand, silt, clay (thickness generally less than 5 feet)

Areas of bedrock outcrop and of outcrop interspersed with patches of thin overburden . . . R
Bedrock outcrop in area of overburden . . . ×
Geological boundary (approximate)
Limit of geological mapping
Glacial striae (S), grooves (G), stoss-and-lee surfaces (SL), miniature crag-and-tail forms (CT) (direction of ice movement indicated, not indicated)
Drumlinoid ridges, crag-and-tail hills (direction of ice movement indicated, not indicated)
Landslide scar
Scarp between deltas or river terraces
Abandoned channel
Limit of marine overlap (not shown on deltas)
Gravel pit

Note: Fractional units (e.g. $\frac{5e}{5}$, $\frac{7}{2}$ etc.) are used where the surface map unit averages less than 5 feet in thickness. The upper number applies to the surface unit and the lower number to the principal underlying unit. Thus, $\frac{5e}{5}$ means that stony, gravelly marine veneer (unit 5d) extends a few feet below the surface and rests upon ground moraine (unit 3).

Geology by J.G. Fyles, 1956-1957

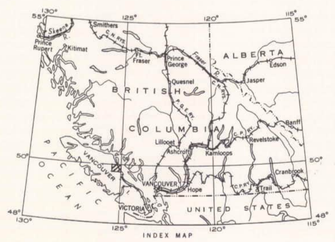
Main highway
Other roads
Power transmission line
Post Office — P
District boundary
Intermittent stream
Marsh
Sand
Contours (interval 500')
Height in feet above mean sea-level — 5700

Cartography by the Geological Survey of Canada, 1959

Approximate magnetic declination, 24° 00' East

In response to public demand for earlier publication, Preliminary Series maps are now being issued in this simplified form, thereby effecting a substantial saving in time. There is no loss of information, but the maps will be clearer to read if all or some of the map-units are hand-coloured.

Air photographs covering this area may be obtained through the National Air Photographic Library, Topographical Survey, Ottawa, Ontario



125°30' 25' 20' 15' 10' 05' 125°00'
50°00' 55' 50' 49°45'

PUBLISHED, 1960
COPIES OF THIS MAP MAY BE OBTAINED FROM THE DIRECTOR, GEOLOGICAL SURVEY OF CANADA, OTTAWA

PRINTED BY THE SURVEYS AND MAPPING BRANCH

MAP 49-1959
SURFICIAL GEOLOGY
OYSTER RIVER
COMOX, NANAIMO and SAYWARD DISTRICTS
BRITISH COLUMBIA

Scale: One Inch to One Mile = $\frac{1}{63,360}$
Miles
1 ½ 0 1 2 3

49-1959

MAP 49-1959
OYSTER RIVER
BRITISH COLUMBIA
SHEET 92 F/14

Skeena-Bulkley

PGL
ENVIRONMENTAL CONSULTANTS

GEOLOGICAL SURVEY OF CANADA COMMISSION GÉOLOGIQUE DU CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES
MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES

LEGEND AND DESCRIPTION OF TERRAIN UNITS

SYMBOL		NAME	SURFICIAL DEPOSITS: MATERIAL	SURFICIAL DEPOSITS: THICKNESS (metres)	LANDFORM: TOPOGRAPHY	LANDFORM: SLOPES (degrees)	COMMENTS
		man-made terrain	diamicton, rubble, gravel, sand	>2	plain	0-3	landfill
I		glacier ice	ice and snow	>20	rolling, sloping, crevassed	1-30	steep slopes occur in areas of ice falls
O	O	organic terrain	peat, muck	<15	plain	0-3	bogs, fens, swamps
	Ob	organic blanket	peat, muck	>1	takes form of underlying surface	0-10	
	Ov	organic veneer	peat, muck	0.5-1	takes form of underlying surface	0-15	
C	* Ch Cm	landslide	diamicton; blocks and rubble of local bedrock	>3	hummocky, rolling	0-35 0-15	includes landslides involving bedrock and landslides involving unconsolidated Quaternary sediments
	Cf	avalanche fan, debris-flow fan	gravel, diamicton	>5	fan	5-30	includes fans with entrenched channels and fans close to local base level
	Cs	talus	blocks and rubble of local bedrock	>2	apron, sheet	25-35	little or no vegetation on presently active slopes
	* Cb	colluvial blanket	colluvium	>1	takes form of underlying surface	1-35	includes slopewash, minor talus, talus stabilized by vegetation
	Cv	colluvial veneer	colluvium	0.5-1	takes form of underlying surface	1-40	includes slopewash, minor talus, talus stabilized by vegetation
A	Af	alluvial fan	gravel and sand	>5	fan	1-20	includes terraced fan remnants (Af1), fans with entrenched channels, and fans close to local base level
	Ap	floodplain	gravel and sand	>2	plain with shallow channels	0-3	includes low benches subject to occasional flooding
	Ax	valley floor complex	alluvium and colluvium	>2	plain, fan, terraces, lower valley walls	0-35	includes Ap, At, Af, and Cf; differentiation of these units is not possible at scale of map
	* Av	alluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	At	river terrace	gravel and sand	>2	terrace and scarp	0-3	generally one to several metres of sand overlying gravel
	* Ad	delta	gravel and sand	>5	terrace	0-5	marine delta
A[c]	* Am Ah	kames, ice stagnation terrain	gravel and sand	>10	rolling, hummocky	0-15 0-30	unit deposited in contact with stagnant glacier ice; interbeds of diamicton commonly present in unit
	* Ar	esker	gravel and sand	>10	ridge	0-30	unit deposited beneath and within stagnant glacier ice
	* Ab	glaciofluvial blanket	gravel and sand	>1	takes form of underlying surface	0-20	
	* Av	glaciofluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	* Af	glaciofluvial fan	gravel and sand	>10	fan	1-20	ice-contact feature, commonly with kettles
	Ak	kame terrace	gravel and sand	>10	terrace and scarp	0-3	ice-contact feature, commonly with kettles
	* Ad	delta	gravel and sand	>10	terrace, fan	0-20	proglacial and ice-contact lacustrine and marine deltas
L[c]	* L[c]m	rolling glaciolacustrine terrain	silt, clay, minor sand (locally with dropstones)	>2	rolling	0-10	ice-marginal depositional environment; relict lake floor
	* L[c]t	glaciolacustrine terrace	silt, clay, minor sand (locally with dropstones)	>2	terrace	0-3	
	* L[c]b	glaciolacustrine blanket	silt, clay, minor sand (locally with dropstones)	>1	takes form of underlying surface	0-10	
	* L[c]v	glaciolacustrine veneer	silt, clay, minor sand (locally with dropstones)	0.5-1	takes form of underlying surface	0-15	
W[g]	* W[g]m	rolling glaciomarine terrain	silt, clay (locally with dropstones)	>2	rolling	0-10	proglacial depositional environment; relict seafloor
	* W[g]p	glaciomarine plain	silt, clay (locally with dropstones)	>2	plain	0-2	proglacial depositional environment
	* W[g]b	glaciomarine blanket	silt, clay (locally with dropstones)	>1	takes form of underlying surface	0-15	
	* W[g]v	glaciomarine veneer	silt, clay (locally with dropstones)	0.5-1	takes form of underlying surface	0-20	
M	* Mm	ground moraine	till	>2	rolling	0-15	constructional morainic topography (not controlled by form of underlying unit)
	* Mb	till blanket	till	>1	takes form of underlying surface	0-20	
	* Mv	till veneer	till	0.5-1	takes form of underlying surface	0-25	
D	Df Dm	drift	till, gravel, and colluvium	>2	ridged, rolling	0-15	constructional drift topography (not controlled by form of underlying unit)
	Db	drift blanket	till, gravel, and colluvium	>1	takes form of underlying surface	0-25	
	Dv	drift veneer	till, gravel, and colluvium	0.5-1	takes form of underlying surface	0-30	
*	Us	terrace scarps, river banks	all types of unconsolidated Quaternary sediments	>20 (scarp height)	steep erosional slopes	>30	unit consists of several stratigraphic units of contrasting lithologies, in places with a blanket or veneer of colluvium
R	R	bedrock			rolling, sloping, hummocky, ridged	0-60	thin (<0.5 m) or no cover of unconsolidated Quaternary sediments
	* Rs	canyon walls, river banks			steep slopes	>45	Rs used mainly in conjunction with Us for canyon walls

* Does not occur as a dominant unit on this sheet

Explanation of letter notation

A combination of letters is used to designate each map unit or component of compound map units, e.g. Ap. The upper case letter indicates the broad genetic class. The lower case letter(s) that generally follows indicates morphology. The texture of most map units is implicit in the genetic type (see 'material' in above table), in such cases no specific textural symbol is used. Where the texture of a unit is different from the dominant or expected texture indicated in the table, a lower case textural symbol precedes the upper case genetic symbol, e.g. fCm. Postdepositional modification or erosion of a unit is indicated by an upper case letter which follows the lower case morphological symbol and is separated from it by a dash, e.g. Cv—A. Compound map units are designated by more than one group of letters separated by a colon, e.g. Ap:At. These areas consist of more than one component that could not be separated at the scale of the map. The component to the left of the colon is dominant to that to the right. One term placed above another, e.g. $\frac{Ac}{Cb}$, indicates a stratigraphic succession within the unit. No compound symbolization is used for sediment veneers overlying bedrock – unless otherwise indicated, the presence of the veneer symbol, e.g. Dv, indicates that the underlying unit is rock.

ELUC (1976) provides a complete description of a letter notation system similar to the one used here.

ELUC (1976) Terrain classification system; Victoria, British Columbia, 56p. (available from Assessment and Planning Division, Ministry of Environment, Parliament Buildings, Victoria).

Texture	Genetic class		Morphologic subdivision		Process or form modifiers
g – gravel	X – man-made	L[c] – glaciolacustrine	a – apron	p – plain	A – avalanched
s – sand	I – ice	W[g] – glaciomarine and marine	b – blanket	r – ridged	H – kettled
f – silt and clay	O – organic	M – morainal	d – delta	s – steep slopes	V – gullied
ß – silt	C – colluvial	D – drift	f – fan	t – terraced	F – failing
	A – alluvial	U – undifferentiated	h – hummocky	v – veneer	
	A[c] – glaciofluvial	R – bedrock	m – rolling	x – complex	

Environment	Facies			
	Water	Water > Ice	Ice > Water	Ice
Marine		W[g]		
Lacustrine	L[c]			
Fluvial	A		A[c]	
Glacial				D,M

Environment-facies classification of deposits

Stratigraphic sections

- Covered
- Peat
- Estuarine pebbly silt, sand
- Beach gravel
- Glaciomarine and marine clay, silt, sand
- Glaciolacustrine clay, silt, sand
- Deltaic sand and sandy subaqueous outwash
- Deltaic gravel and gravelly subaqueous outwash
- Glaciofluvial and fluvial sand
- Glaciofluvial and fluvial gravel
- Ice-contact sand, minor diamicton
- Ice contact gravel, minor diamicton
- Till, minor ice-contact sand, gravel
- Bedrock
- Gradational contact
- Elevation in metres 100
- Radiocarbon sample number GSC-2083

* Unit does not occur on this sheet

- Geological boundary (defined, approximate, assumed)
- Glacial striae (direction of ice movement known, unknown)
- Drumlins
- Drumlinoid ridges, flutings
- Crag and tail
- Cirque
- Ice-contact face
- Moraine ridge
- Esker (direction of flow known, unknown)
- Kettle hole (small, large)
- Abandoned channel (small, large)
- Beach
- Escarpment
- Landslide scar (small, large)
- Avalanche track
- Debris flow track
- Major gravel pit
- Location of representative stratigraphic section ..... 17 +
- Radiocarbon date

Date	Material
Lab no.	Elevation

Geology by J.J. Clague, 1975-1977

Geological cartography by L.A. Daley, Geological Survey of Canada

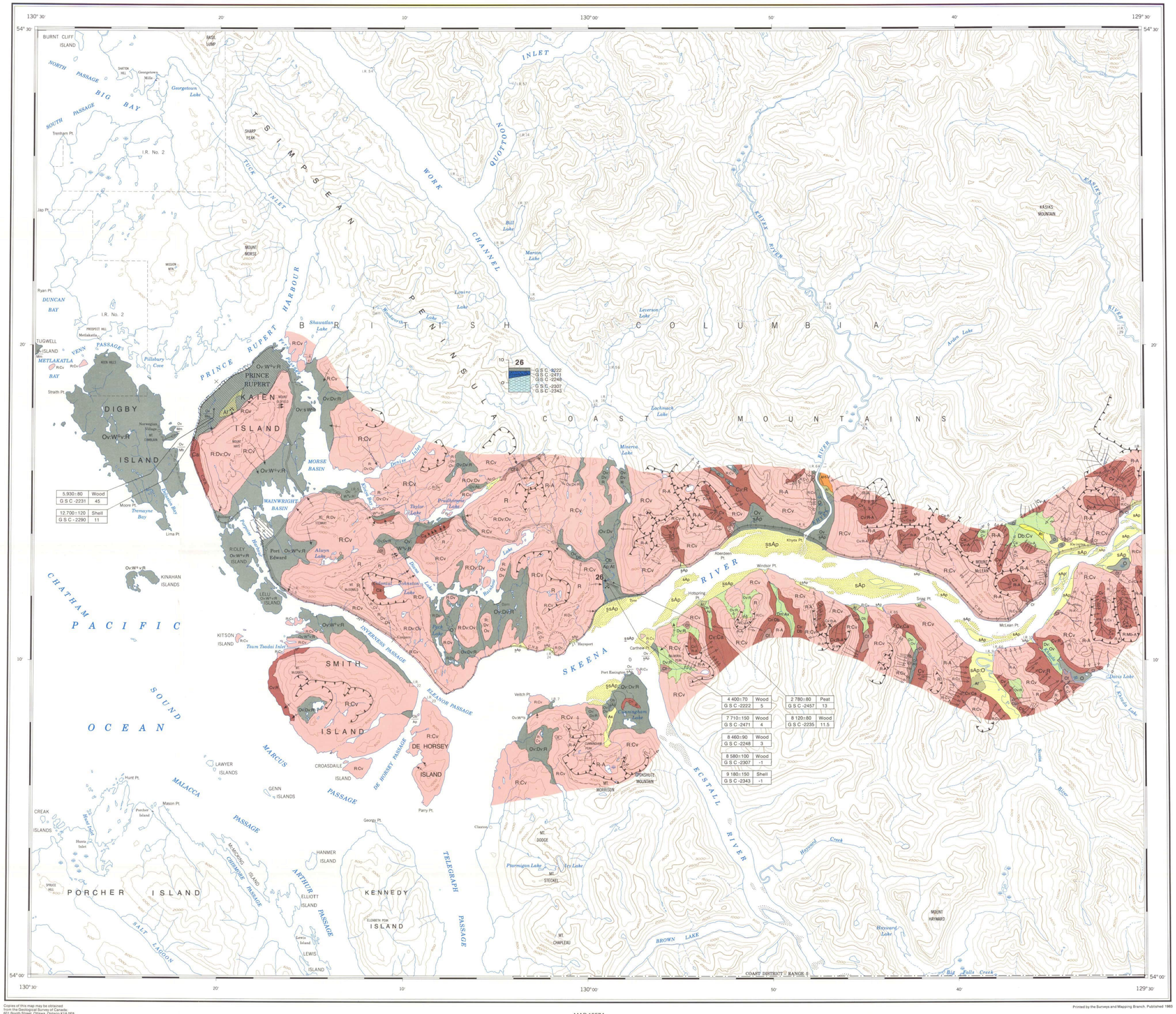
Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

Base map cartography by the Geological Survey of Canada from 1:50 000 scale maps 103-I/4, 103-I/5, 103-J/1 and 103-J/8 published by the Surveys and Mapping Branch in 1954, 1955 and 1961

Copies of the various topographical editions of this map may be obtained from the Canada Map Office, 615 Booth Street, Ottawa, Ontario, K1A 0E9

Approximate magnetic declination 1981, 25°46.7' East, decreasing 7.7' annually

Elevations in feet above mean sea level



Copies of this map may be obtained from the Geological Survey of Canada:
601 Booth Street, Ottawa, Ontario K1A 0E9
3303-33rd Street N.W., Calgary, Alberta T2L 2A7
100 West Pender Street, Vancouver, B.C. V6B 1R8

INDEX MAP

Printed by the Surveys and Mapping Branch. Published 1983

MAP 1557A

SURFICIAL GEOLOGY

SKEENA RIVER – BULKLEY RIVER AREA

SHEET 1

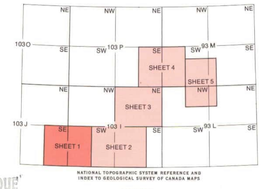
BRITISH COLUMBIA

Scale 1:100 000

Kilometres 2 0 2 4 6 8 Kilometres

Miles 2 0 2 4 Miles

Universal Transverse Mercator Projection



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO GEOLOGICAL SURVEY OF CANADA MAPS

MAP 1557A
SKEENA RIVER – BULKLEY RIVER AREA
BRITISH COLUMBIA

Canada

GEOLOGICAL SURVEY OF CANADA COMMISSION GÉOLOGIQUE DU CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES
MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES

LEGEND AND DESCRIPTION OF TERRAIN UNITS

SYMBOL		NAME	SURFICIAL DEPOSITS		LANDFORM		COMMENTS
			MATERIAL	THICKNESS (metres)	TOPOGRAPHY	SLOPES (degrees)	
		man-made terrain	diamicton, rubble, gravel, sand	>2	plain	0-3	landfill
I		glacier ice	ice and snow	>20	rolling, sloping, crevassed	1-30	steep slopes occur in areas of ice falls
O	Of	organic terrain	peat, muck	<15	plain	0-3	bogs, fens, swamps
	Ob	organic blanket	peat, muck	>1	takes form of underlying surface	0-10	
	* Ov	organic veneer	peat, muck	0.5-1	takes form of underlying surface	0-15	
C	Cb Cm	landslide	diamicton; blocks and rubble of local bedrock	>3	hummocky, rolling	0-35 0-15	includes landslides involving bedrock and landslides involving unconsolidated Quaternary sediments
	Cf	avalanche fan, debris-flow fan	gravel, diamicton	>5	fan	5-30	includes fans with entrenched channels and fans close to local base level
	Ca	talus	blocks and rubble of local bedrock	>2	apron, sheet	25-35	little or no vegetation on presently active slopes
	Cb	colluvial blanket	colluvium	>1	takes form of underlying surface	1-35	includes slopewash, minor talus; talus stabilized by vegetation
	Cv	colluvial veneer	colluvium	0.5-1	takes form of underlying surface	1-40	includes slopewash, minor talus, talus stabilized by vegetation
A	Af	alluvial fan	gravel and sand	>5	fan	1-20	includes terraced fan remnants (Aft); fans with entrenched channels, and fans close to local base level
	Ap	floodplain	gravel and sand	>2	plain with shallow channels	0-3	includes low benches subject to occasional flooding
	Ax	valley floor complex	alluvium and colluvium	>2	plain, fan, terraces, lower valley walls	0-35	includes Ap, At, Af, and Cf; differentiation of these units is not possible at scale of map
	Av	alluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	At	river terrace	gravel and sand	>2	terrace and scarp	0-3	generally one to several metres of sand overlying gravel
	Ad	delta	gravel and sand	>5	terrace	0-5	marine delta
A^G	AFm Afl	kames, ice stagnation terrain	gravel and sand	>10	rolling, hummocky	0-15 0-30	unit deposited in contact with stagnant glacier ice; interbeds of diamicton commonly present in unit
	* AFr	esker	gravel and sand	>10	ridge	0-30	unit deposited beneath and within stagnant glacier ice
	AFb	glaciofluvial blanket	gravel and sand	>1	takes form of underlying surface	0-20	
	AFv	glaciofluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	* AFf	glaciofluvial fan	gravel and sand	>10	fan	1-20	ice-contact feature, commonly with kettles
	AFt	kame terrace	gravel and sand	>10	terrace and scarp	0-3	ice-contact feature, commonly with kettles
	AFd	delta	gravel and sand	>10	terrace, fan	0-20	proglacial and ice-contact lacustrine and marine deltas
L^G	* Lfm	rolling glaciolacustrine terrain	silt, clay, minor sand (locally with dropstones)	>2	rolling	0-10	ice-marginal depositional environment; relict lake floor
	* Lfl	glaciolacustrine terrace	silt, clay, minor sand (locally with dropstones)	>2	terrace	0-3	
	* Lfb	glaciolacustrine blanket	silt, clay, minor sand (locally with dropstones)	>1	takes form of underlying surface	0-10	
	* Lfv	glaciolacustrine veneer	silt, clay, minor sand (locally with dropstones)	0.5-1	takes form of underlying surface	0-15	
W^G	Wfm	rolling glaciomarine terrain	silt, clay (locally with dropstones)	>2	rolling	0-10	proglacial depositional environment; relict seafloor
	* Wfp	glaciomarine plain	silt, clay (locally with dropstones)	>2	plain	0-2	proglacial depositional environment
	Wfb	glaciomarine blanket	silt, clay (locally with dropstones)	>1	takes form of underlying surface	0-15	
	Wfv	glaciomarine veneer	silt, clay (locally with dropstones)	0.5-1	takes form of underlying surface	0-20	
M	* Mm	ground moraine	till	>2	rolling	0-15	constructional morainic topography (not controlled by form of underlying unit)
	* Mb	till blanket	till	>1	takes form of underlying surface	0-20	
	* Mv	till veneer	till	0.5-1	takes form of underlying surface	0-25	
D	Dr Dm	drift	till, gravel, and colluvium	>2	ridged, rolling	0-15	constructional drift topography (not controlled by form of underlying unit)
	Db	drift blanket	till, gravel, and colluvium	>1	takes form of underlying surface	0-25	
	Dv	drift veneer	till, gravel, and colluvium	0.5-1	takes form of underlying surface	0-30	
Us		terrace scarps, river banks	all types of unconsolidated Quaternary sediments	>20 (scarp height)	steep erosional slopes	>30	unit consists of several stratigraphic units of contrasting lithologies, in places with a blanket or veneer of colluvium
R	R	bedrock			rolling, sloping, hummocky, ridged	0-60	thin (<0.5m) or no cover of unconsolidated Quaternary sediments
	* Rs	canyon walls, river banks			steep slopes	>45	Rs used mainly in conjunction with Us for canyon walls

* Does not occur as a dominant unit on this sheet

Explanation of letter notation

A combination of letters is used to designate each map unit or component of compound map units, e.g. Ap. The upper case letter indicates the broad genetic class. The lower case letter(s) that generally follows indicates morphology. The texture of most map units is implicit in the genetic type (see 'material' in above table); in such cases no specific textural symbol is used. Where the texture of a unit is different from the dominant or expected texture indicated in the table, a lower case textural symbol precedes the upper case genetic symbol, e.g. fCm. Postdepositional modification or erosion of a unit is indicated by an upper case letter which follows the lower case morphological symbol and is separated from it by a dash, e.g. Cv – A. Compound map units are designated by more than one group of letters separated by a colon, e.g. Ap:At. These areas consist of more than one component that could not be separated at the scale of the map. The component to the left of the colon is dominant to that to the right. One term placed above another, e.g. $\frac{Ap}{Dr}$, indicates a stratigraphic succession within the unit. No compound symbolization is used for sediment veneers overlying bedrock – unless otherwise indicated, the presence of the veneer symbol, e.g. -Dv, indicates that the underlying unit is rock.

ELUC (1976) provides a complete description of a letter notation system similar to the one used here.

ELUC (1976) Terrain classification system. Victoria, British Columbia, 56p. (available from Assessment and Planning Division, Ministry of Environment, Parliament Buildings, Victoria).

Texture

g – gravel
s – sand
f – silt and clay
$\frac{g}{s}$ – silt

Genetic class

X – man-made
I – ice
O – organic
C – colluvial
A – alluvial
A^G – glaciofluvial
L^G – glaciolacustrine
W^G – glaciomarine and marine
M – morainal
D – drift
U – undifferentiated
R – bedrock

Morphologic subdivision

a – apron
b – blanket
d – delta
f – fan
h – hummocky
m – rolling
p – plain
r – ridged
s – steep slopes
t – terraced
v – veneer
x – complex

Process or form modifiers

A – avalanched
H – kettled
V – gullied
F – failing

Environment	Facies				
	Water	Water > Ice		Ice > Water	Ice
Marine		W^G			
Lacustrine	L^G				
Fluvial	A		A^G		
Glacial			D,M		

Environment-facies classification of deposits

Stratigraphic sections

* Covered
* Peat
* Estuarine pebbly silt, sand
* Beach gravel
* Glaciomarine and marine clay, silt, sand
* Glaciolacustrine clay, silt, sand
Deltaic sand and sandy subaqueous outwash
Deltaic gravel and gravelly subaqueous outwash
* Glaciofluvial and fluvial sand
Glaciofluvial and fluvial gravel
* Ice-contact sand, minor diamicton
Ice-contact gravel, minor diamicton
Till, minor ice-contact sand, gravel
* Bedrock
Gradational contact
Elevation in metres 100
Radiocarbon sample number GSC-2083

* Unit does not occur on this sheet
** Unit thickness are approximate. Information supplied by J.E. Armstrong (unpublished notes)

Geological boundary (defined, approximate, assumed)
Glacial striae (direction of ice movement known, unknown)
Drumlins
Drumlinoid ridges, flutings
Crag and tail
Cirque
Ice-contact face
Moraine ridge
Esker (direction of flow known, unknown)
Kettle hole (small, large)

Abandoned channel (small, large)
Beach
Escarpment
Landslide scar (small, large)
Avalanche track
Debris flow track
Major gravel pit
Location of representative stratigraphic section ..... 17 +

Date	Material
Lab. no.	Elevation

Radiocarbon date

Geology by J.J. Clague, 1975-1977

Geological cartography by R.Y. Potvin, Geological Survey of Canada

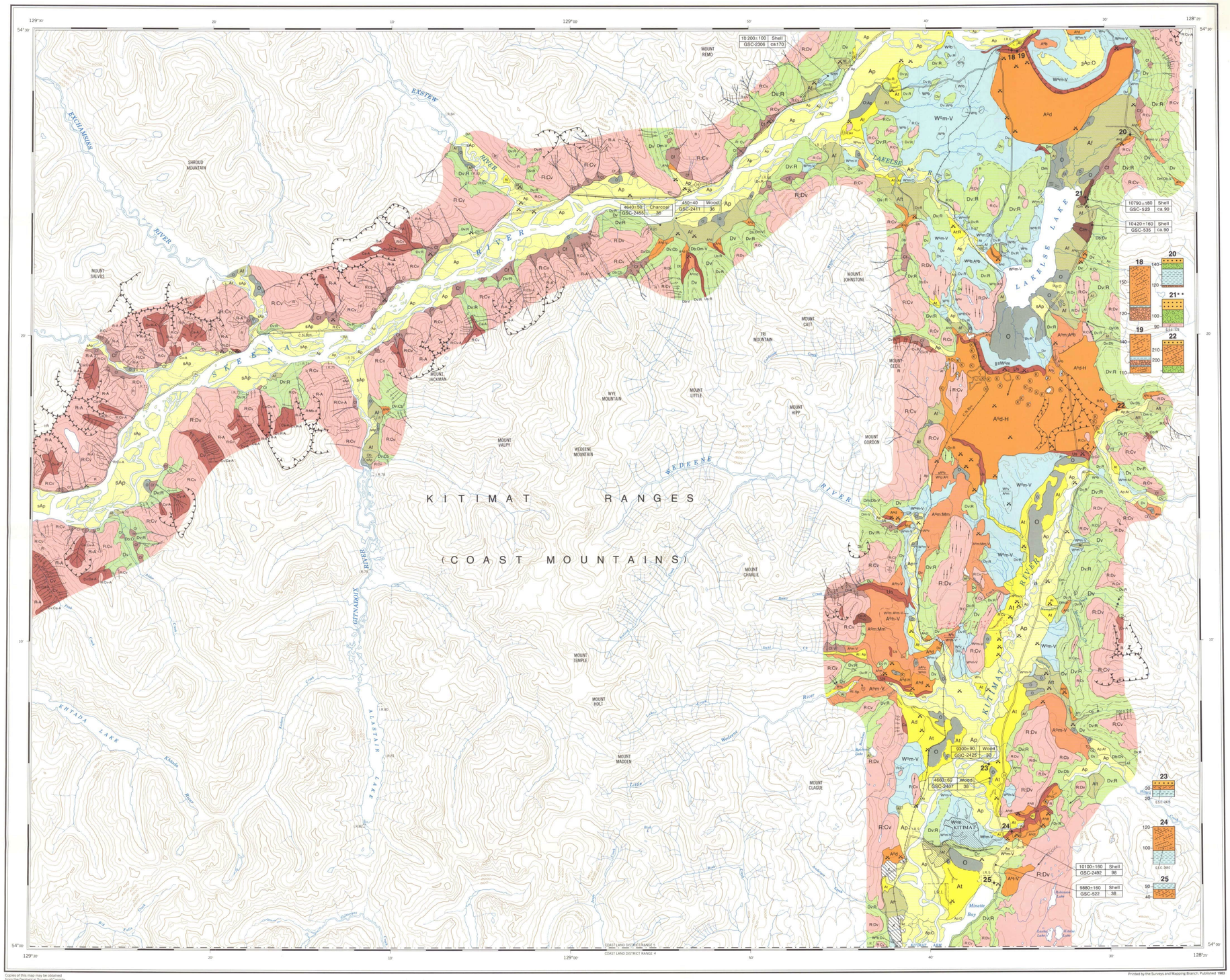
Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

Base map cartography by the Geological Survey of Canada from 1:50 000 scale maps 103-I/2, 103-I/3, 103-I/6, 103-I/7 and parts of 103-I/1 and 103-I/8 published by the Surveys and Mapping Branch in 1956, 1961, 1965 and 1974

Copies of the various topographical editions of this map may be obtained from the Canada Map Office, 615 Booth Street, Ottawa, Ontario, K1A 0E9

Approximate magnetic declination 1981, 25°50.6' East, decreasing 8.0' annually

Elevations in feet above mean sea level



Copies of this map may be obtained from the Geological Survey of Canada
601 Booth Street, Ottawa, Ontario K1A 0E8
3303-33rd Street, N.W., Calgary, Alberta T2L 2A7
100 West Pender Street, Vancouver, B.C. V6B 1R8

Printed by the Surveys and Mapping Branch. Published 1983

INDEX MAP

MAP 1557A

SURFICIAL GEOLOGY

SKEENA RIVER – BULKLEY RIVER AREA

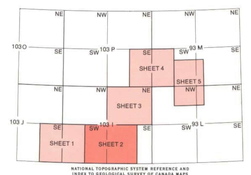
SHEET 2

BRITISH COLUMBIA

Scale 1:100 000

Kilometres 2 0 2 4 6 8 Kilometres
Miles 2 0 2 4 Miles

Universal Transverse Mercator Projection



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO GEOLOGICAL SURVEY OF CANADA MAPS

MAP 1557A
SKEENA RIVER – BULKLEY RIVER AREA
BRITISH COLUMBIA

Canada

GEOLOGICAL SURVEY OF CANADA COMMISSION GÉOLOGIQUE DU CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES
MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES

LEGEND AND DESCRIPTION OF TERRAIN UNITS

SYMBOL		NAME	SURFICIAL DEPOSITS: MATERIAL	SURFICIAL DEPOSITS: THICKNESS (metres)	LANDFORM: TOPOGRAPHY	LANDFORM: SLOPES (degrees)	COMMENTS
		man-made terrain	damicton, rubble, gravel, sand	>2	plain	0-3	landfill
I		glacier ice	ice and snow	>20	rolling, sloping, crevassed	1-30	steep slopes occur in areas of ice falls
O	O	organic terrain	peat, muck	<15	plain	0-3	bogs, fens, swamps
	Ob	organic blanket	peat, muck	>1	takes form of underlying surface	0-10	
	Ov	organic veneer	peat, muck	0.5-1	takes form of underlying surface	0-15	
C	Cb/Cm	landslide	diamicton; blocks and rubble of local bedrock	>3	hummocky, rolling	0-35 0-15	includes landslides involving bedrock and landslides involving unconsolidated Quaternary sediments
	Cf	avalanche fan, debris flow fan	gravel, diamicton	>5	fan	5-30	includes fans with entrenched channels and fans close to local base level
	Cs	talus	blocks and rubble of local bedrock	>2	apron, sheet	25-35	little or no vegetation on presently active slopes
	*Cb	colluvial blanket	colluvium	>1	takes form of underlying surface	1-35	includes slopewash, minor talus, talus stabilized by vegetation
	*Cv	colluvial veneer	colluvium	0.5-1	takes form of underlying surface	1-40	includes slopewash, minor talus, talus stabilized by vegetation
A	Af	alluvial fan	gravel and sand	>5	fan	1-20	includes terraced fan remnants (Afi), fans with entrenched channels, and fans close to local base level
	Ap	floodplain	gravel and sand	>2	plain with shallow channels	0-3	includes low benches subject to occasional flooding
	*Ax	valley floor complex	alluvium and colluvium	>2	plain, fan, terraces, lower valley walls	0-35	includes Ap, At, Af, and Cf, differentiation of these units is not possible at scale of map
	*Av	alluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	At	river terrace	gravel and sand	>2	terrace and scarp	0-3	generally one to several metres of sand overlying gravel
	*Ad	delta	gravel and sand	>5	terrace	0-5	marine delta
A^G	A^{Gm} A^{Gh}	kames, ice stagnation terrain	gravel and sand	>10	rolling, hummocky	0-15 0-30	unit deposited in contact with stagnant glacier ice; interbeds of diamicton commonly present in unit
	*A^{Gr}	esker	gravel and sand	>10	ridge	0-30	unit deposited beneath and within stagnant glacier ice
	A^{Gb}	glaciofluvial blanket	gravel and sand	>1	takes form of underlying surface	0-20	
	A^{Gv}	glaciofluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	A^{Gf}	glaciofluvial fan	gravel and sand	>10	fan	1-20	ice-contact feature, commonly with kettles
	A^{Gt}	kame terrace	gravel and sand	>10	terrace and scarp	0-3	ice-contact feature, commonly with kettles
	A^{Gd}	delta	gravel and sand	>10	terrace, fan	0-20	proglacial and ice-contact lacustrine and marine deltas
L^G	L^{Gm}	rolling glaciolacustrine terrain	silt, clay, minor sand (locally with dropstones)	>2	rolling	0-10	ice-marginal depositional environment; relict lake floor
	*L^{Gt}	glaciolacustrine terrace	silt, clay, minor sand (locally with dropstones)	>2	terrace	0-3	
	*L^{Gb}	glaciolacustrine blanket	silt, clay, minor sand (locally with dropstones)	>1	takes form of underlying surface	0-10	
	*L^{Gv}	glaciolacustrine veneer	silt, clay, minor sand (locally with dropstones)	0.5-1	takes form of underlying surface	0-15	
W^G	W^{Gm}	rolling glaciomarine terrain	silt, clay (locally with dropstones)	>2	rolling	0-10	proglacial depositional environment; relict seafloor
	W^{Gp}	glaciomarine plain	silt, clay (locally with dropstones)	>2	plain	0-2	proglacial depositional environment
	W^{Gb}	glaciomarine blanket	silt, clay (locally with dropstones)	>1	takes form of underlying surface	0-15	
	W^{Gv}	glaciomarine veneer	silt, clay (locally with dropstones)	0.5-1	takes form of underlying surface	0-20	
M	Mm	ground moraine	till	>2	rolling	0-15	constructional morainic topography (not controlled by form of underlying unit)
	*Mb	till blanket	till	>1	takes form of underlying surface	0-20	
	*Mv	till veneer	till	0.5-1	takes form of underlying surface	0-25	
D	Dr Dm	drift	till, gravel, and colluvium	>2	ridged, rolling	0-15	constructional drift topography (not controlled by form of underlying unit)
	Db	drift blanket	till, gravel, and colluvium	>1	takes form of underlying surface	0-25	
	Dv	drift veneer	till, gravel, and colluvium	0.5-1	takes form of underlying surface	0-30	
Us		terrace scarps, river banks	all types of unconsolidated Quaternary sediments	>20 (scarp height)	steep erosional slopes	>30	unit consists of several stratigraphic units of contrasting lithologies, in places with a blanket or veneer of colluvium
R	R	bedrock			rolling, sloping, hummocky, ridged	0-60	thin (<0.5m) or no cover of unconsolidated Quaternary sediments
	Rs	canyon walls, river banks			steep slopes	>45	Rs used mainly in conjunction with Us for canyon walls

* "Does not occur as a dominant unit on this sheet"

Explanation of letter notation

A combination of letters is used to designate each map unit or component of compound map units, e.g. Ap. The upper case letter indicates the broad genetic class. The lower case letter(s) that generally follows indicates morphology. The texture of most map units is implicit in the genetic type (see 'material' in above table); in such cases no specific textural symbol is used. Where the texture of a unit is different from the dominant or expected texture indicated in the table, a lower case textural symbol precedes the upper case genetic symbol, e.g. fCm. Postdepositional modification or erosion of a unit is indicated by an upper case letter which follows the lower case morphological symbol and is separated from it by a dash, e.g. Cv – A. Compound map units are designated by more than one group of letters separated by a colon, e.g. Ap:At. These areas consist of more than one component that could not be separated at the scale of the map. The component to the left of the colon is dominant to that to the right. One term placed above another, e.g. $\frac{W^{Gm}}{L^{G}}$, indicates a stratigraphic succession within the unit. No compound symbolization is used for sediment veneers overlying bedrock – unless otherwise indicated, the presence of the veneer symbol, e.g. Dv, indicates that the underlying unit is rock.

ELUC (1976) provides a complete description of a letter notation system similar to the one used here.

ELUC (1976) Terrain classification system, Victoria, British Columbia, 56p. (available from Assessment and Planning Division, Ministry of Environment, Parliament Buildings, Victoria).

Texture
g – gravel
s – sand
f – silt and clay
$ – silt

Genetic class
X – man-made
I – ice
O – organic
C – colluvial
A – alluvial
^{A} – glaciofluvial
^{L} – glaciolacustrine
^{W} – glaciomarine and marine
M – morainal
D – drift
U – undifferentiated
R – bedrock

Morphologic subdivision
a – apron
b – blanket
d – delta
f – fan
h – hummocky
m – rolling
p – plain
r – ridged
s – steep slopes
t – terraced
v – veneer
x – complex

Process or form modifiers
A – avalanched
H – kettled
V – gullied
F – failing

Environment-facies classification of deposits

Environment	Facies: Water	Water > Ice	Ice > Water	Ice
Marine		W^G		
Lacustrine		L^G		
Fluvial	A	A^G		
Glacial				D,M

Stratigraphic sections

- Covered
- Peat
- Estuarine pebbly silt, sand
- Beach gravel
- Glaciomarine and marine clay, silt, sand
- Glaciolacustrine clay, silt, sand
- Deltaic sand and sandy subaqueous outwash
- Deltaic gravel and gravelly subaqueous outwash
- Glaciofluvial and fluvial sand
- Glaciofluvial and fluvial gravel
- Ice-contact sand, minor diamicton
- Ice-contact gravel, minor diamicton
- Till, minor ice-contact sand, gravel
- Bedrock

* Unit does not occur on this sheet

Gradational contact
Elevation in metres 100
Radiocarbon sample number GSC-2083

Geological boundary (defined, approximate, assumed)
Glacial striae (direction of ice movement known, unknown)
Drumlins
Drumlinoid ridges, flutings
Crag and tail
Cirque
Ice-contact face
Moraine ridge
Esker (direction of flow known, unknown)
Kettle hole (small, large)

Abandoned channel (small, large)
Beach
Escarpment
Landslide scar (small, large)
Avalanche track
Debris flow track
Major gravel pit
Location of representative stratigraphic section ..... 17 +
Radiocarbon date ..... Date / Lab no. / Material / Elevation

Geology by J.J. Clague, 1975-1977

Geological cartography by P.P. Hermann, Geological Survey of Canada

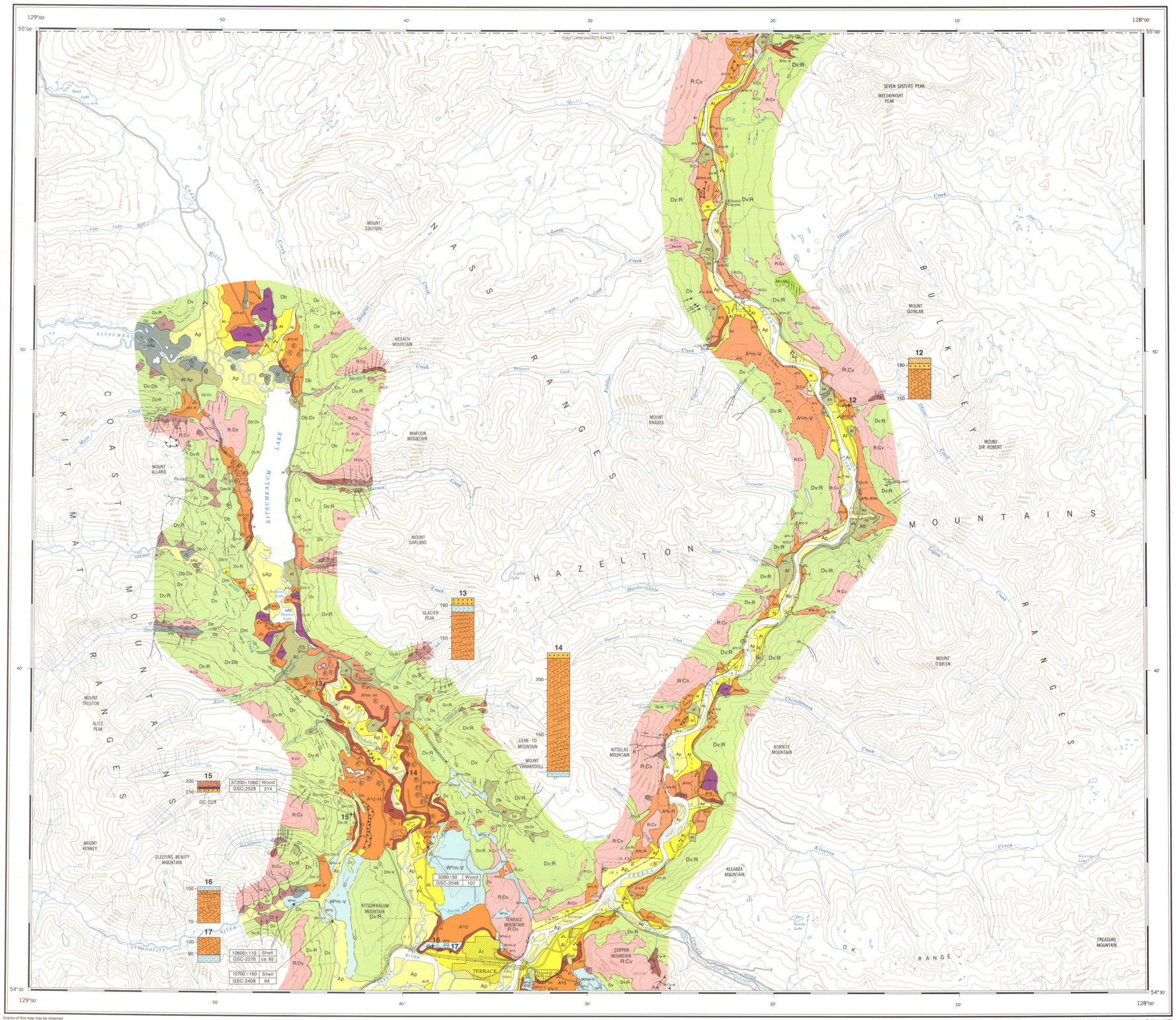
Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

Base map cartography by the Geological Survey of Canada from 1:50 000 scale maps 103-I/9, 103-I/15 and 103-I/16 published by the Surveys and Mapping Branch in 1966 and 1975

Copies of the various topographical editions of this map may be obtained from the Canada Map Office, 615 Booth Street, Ottawa, Ontario, K1A 0E9

Approximate magnetic declination 1981, 26°12.5' East, decreasing 8.4' annually

Elevations in feet above mean sea level



Copies of this map may be obtained
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3303-33rd Street N.W., Calgary, Alberta T2L 2A7
100 West Pender Street, Vancouver, B.C. V6B 1R8

INDEX MAP

MAP 1557A
SURFICIAL GEOLOGY

SKEENA RIVER – BULKLEY RIVER AREA

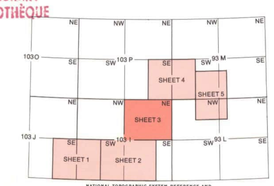
SHEET 3
BRITISH COLUMBIA

Scale 1:100 000

Kilometres 2 0 2 4 6 8 Kilometres
Miles 2 0 2 4 Miles

Universal Transverse Mercator Projection

Printed by the Surveys and Mapping Branch. Published 1983



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO GEOLOGICAL SURVEY OF CANADA MAPS

MAP 1557A
SKEENA RIVER – BULKLEY RIVER AREA
BRITISH COLUMBIA

Canada

GEOLOGICAL SURVEY OF CANADA COMMISSION GÉOLOGIQUE DU CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES
MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES

LEGEND AND DESCRIPTION OF TERRAIN UNITS

SYMBOL	NAME	SURFICIAL DEPOSITS: MATERIAL	SURFICIAL DEPOSITS: THICKNESS (metres)	LANDFORM: TOPOGRAPHY	LANDFORM: SLOPES (degrees)	COMMENTS
^	man-made terrain	diamicton, rubble, gravel, sand	>2	plain	0-3	landfill
I	glacier ice	ice and snow	>20	rolling, sloping, crevassed	1-30	steep slopes occur in areas of ice falls
O	organic terrain	peat, muck	<15	plain	0-3	bogs, fens, swamps
* Ob	organic blanket	peat, muck	>1	takes form of underlying surface	0-10	
* Ov	organic veneer	peat, muck	0.5-1	takes form of underlying surface	0-15	
C Cb/Cm	landslide	diamicton; blocks and rubble of local bedrock	>3	hummocky, rolling	0-35 0-15	includes landslides involving bedrock and landslides involving unconsolidated Quaternary sediments
Cf	avalanche fan, debris-flow fan	gravel, diamicton	>5	fan	5-30	includes fans with entrenched channels and fans close to local base level
Cs	talus	blocks and rubble of local bedrock	>2	apron, sheet	25-35	little or no vegetation on presently active slopes
* Cb	colluvial blanket	colluvium	>1	takes form of underlying surface	1-35	includes slopewash, minor talus, talus stabilized by vegetation
* Cv	colluvial veneer	colluvium	0.5-1	takes form of underlying surface	1-40	includes slopewash, minor talus, talus stabilized by vegetation
A Af	alluvial fan	gravel and sand	>5	fan	1-20	includes terraced fan remnants (Aft), fans with entrenched channels, and fans close to local base level
Ap	floodplain	gravel and sand	>2	plain with shallow channels	0-3	includes low benches subject to occasional flooding
* Ax	valley floor complex	alluvium and colluvium	>2	plain, fan, terraces, lower valley walls	0-35	includes Ap, At, Af, and Cf, differentiation of these units is not possible at scale of map
* Av	alluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
At	river terrace	gravel and sand	>2	terrace and scarp	0-3	generally one to several metres of sand overlying gravel
* Ad	delta	gravel and sand	>5	terrace	0-5	marine delta
A^G Afm/Amh	kames, ice stagnation terrain	gravel and sand	>10	rolling, hummocky	0-15 0-30	unit deposited in contact with stagnant glacier ice; interbeds of diamicton commonly present in unit
Ar	esker	gravel and sand	>10	ridge	0-30	unit deposited beneath and within stagnant glacier ice
Afb	glaciofluvial blanket	gravel and sand	>1	takes form of underlying surface	0-20	
Afv	glaciofluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
Afl	glaciofluvial fan	gravel and sand	>10	fan	1-20	ice-contact feature, commonly with kettles
Afk	kame terrace	gravel and sand	>10	terrace and scarp	0-3	ice-contact feature, commonly with kettles
Afd	delta	gravel and sand	>10	terrace, fan	0-20	proglacial and ice-contact lacustrine and marine deltas
L^G * Lrm	rolling glaciolacustrine terrain	silt, clay, minor sand (locally with dropstones)	>2	rolling	0-10	ice-marginal depositional environment; relict lake floor
* Llt	glaciolacustrine terrace	silt, clay, minor sand (locally with dropstones)	>2	terrace	0-3	
* Llb	glaciolacustrine blanket	silt, clay, minor sand (locally with dropstones)	>1	takes form of underlying surface	0-10	
* Llv	glaciolacustrine veneer	silt, clay, minor sand (locally with dropstones)	0.5-1	takes form of underlying surface	0-15	
W^G * W²m	rolling glaciomarine terrain	silt, clay (locally with dropstones)	>2	rolling	0-10	proglacial depositional environment; relict seafloor
* W²p	glaciomarine plain	silt, clay (locally with dropstones)	>2	plain	0-2	proglacial depositional environment
* W²b	glaciomarine blanket	silt, clay (locally with dropstones)	>1	takes form of underlying surface	0-15	
* W²v	glaciomarine veneer	silt, clay (locally with dropstones)	0.5-1	takes form of underlying surface	0-20	
M Mm	ground moraine	till	>2	rolling	0-15	constructional morainic topography (not controlled by form of underlying unit)
Mb	till blanket	till	>1	takes form of underlying surface	0-20	
Mv	till veneer	till	0.5-1	takes form of underlying surface	0-25	
D Dr/Dm	drift	till, gravel, and colluvium	>2	ridged, rolling	0-15	constructional drift topography (not controlled by form of underlying unit)
Db	drift blanket	till, gravel, and colluvium	>1	takes form of underlying surface	0-25	
Dv	drift veneer	till, gravel, and colluvium	0.5-1	takes form of underlying surface	0-30	
Us	terrace scarps, river banks	all types of unconsolidated Quaternary sediments	>20 (scarp height)	steep erosional slopes	>30	unit consists of several stratigraphic units of contrasting lithologies, places with a blanket or veneer of colluvium
R Rr	bedrock			rolling, sloping, hummocky, ridged	0-60	thin (<0.5 m) or no cover of unconsolidated Quaternary sediments
Rs	canyon walls, river banks			steep slopes	>45	Rs used mainly in conjunction with Us for canyon walls

* Does not occur as a dominant unit on this sheet

Explanation of letter notation

A combination of letters is used to designate each map unit or component of compound map units, e.g. Ap. The upper case letter indicates the broad genetic class. The lower case letter(s) that generally follows indicates morphology. The texture of most map units is implicit in the genetic type (see 'material' in above table), in such cases no specific textural symbol is used. Where the texture of a unit is different from the dominant or expected texture indicated in the table, a lower case textural symbol precedes the upper case genetic symbol, e.g. fCm. Postdepositional modification or erosion of a unit is indicated by an upper case letter which follows the lower case morphological symbol and is separated from it by a dash, e.g. Cv--A. Compound map units are designated by more than one group of letters separated by a colon, e.g. Ap:At. These areas consist of more than one component that could not be separated at the scale of the map. The component to the left of the colon is dominant to that to the right. One term placed above another, e.g. $\frac{Mm}{Mb}$, indicates a stratigraphic succession within the unit. No compound symbolization is used for sediment veneers overlying bedrock--unless otherwise indicated, the presence of the veneer symbol, e.g. Dv, indicates that the underlying unit is rock.

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g -- gravel
s -- sand
f -- silt and clay
fl -- silt

Genetic class
X -- man-made
I -- ice
O -- organic
C -- colluvial
A -- alluvial
A^G -- glaciofluvial
L^G -- glaciolacustrine
W^G -- glaciomarine and marine
M -- morainal
D -- drift
U -- undifferentiated
R -- bedrock

Morphologic subdivision
a -- apron
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p -- plain
r -- ridged
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Process or form modifiers
A -- avalanched
H -- kettled
V -- gullied
F -- failing

Stratigraphic sections

Covered
Peat
Estuarine pebbly silt, sand
Beach gravel
Glaciomarine and marine clay, silt, sand
Glaciolacustrine clay, silt, sand
Deltaic sand and sandy subaqueous outwash
Deltaic gravel and gravelly subaqueous outwash
* Unit does not occur on this sheet

Glaciofluvial and fluvial sand
Glaciofluvial and fluvial gravel
Ice-contact sand, minor diamicton
Ice-contact gravel, minor diamicton
Till, minor ice-contact sand, gravel
Bedrock
Gradational contact
Elevation in metres 100
Radiocarbon sample number..... GSC-2083

Environment	Facies				
	Water	Water > Ice		Ice > Water	Ice
Marine		W^G			
Lacustrine		L^G			
Fluvial	A		A^G		
Glacial					D,M

Environment-facies classification of deposits

Geological boundary (defined, approximate, assumed)
Glacial striae (direction of ice movement known, unknown)
Drumlins
Drumlinoid ridges, flutings
Crag and tail
Cirque
Ice-contact face
Moraine ridge
Esker (direction of flow known, unknown)
Kettle hole (small, large)

Abandoned channel (small, large)
Beach
Escarpment
Landslide scar (small, large)
Avalanche track
Debris flow track
Major gravel pit
Location of representative stratigraphic section ..... 17 +
Radiocarbon date

Date	Material
Lab no.	Elevation

Geology by J.J. Clague, 1975-1977

Geological cartography by M.L. Enright, Geological Survey of Canada

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

Base map cartography by the Geological Survey of Canada from 1:50 000 scale maps 93 M/4, 93 M/5, 103 P/1 and 103 P/8 published by the Surveys and Mapping Branch in 1969, 1970 and 1975

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Approximate magnetic declination 1981, 26°35.9' East, decreasing 8.4' annually

Elevations in feet above mean sea level

Printed by The Surveys and Mapping Branch. Published 1983

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3303-33rd Street, N.W., Calgary, Alberta T2L 2A7
100 West Pender Street, Vancouver, B.C. V6B 1R8

INDEX MAP

MAP 1557A
SURFICIAL GEOLOGY

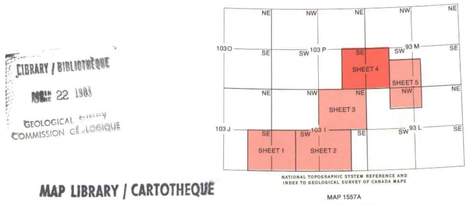
SKEENA RIVER -- BULKLEY RIVER AREA

SHEET 4
BRITISH COLUMBIA

Scale 1:100 000

Kilometres 2 0 2 4 6 8 Kilometres
Miles 2 0 2 4 Miles

Universal Transverse Mercator Projection



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO GEOLOGICAL SURVEY OF CANADA MAPS

MAP 1557A
SKEENA RIVER -- BULKLEY RIVER AREA
BRITISH COLUMBIA

GEOLOGICAL SURVEY OF CANADA — COMMISSION GÉOLOGIQUE DU CANADA
DEPARTMENT OF ENERGY, MINES AND RESOURCES
MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES

LEGEND AND DESCRIPTION OF TERRAIN UNITS

SYMBOL		NAME	SURFICIAL DEPOSITS		LANDFORM		COMMENTS
			MATERIAL	THICKNESS (metres)	TOPOGRAPHY	SLOPES (degrees)	
X		man-made terrain	diamicton, rubble, gravel, sand	>2	plain	0-3	landfill
I		glacier ice	ice and snow	>20	rolling, sloping, crevassed	1-30	steep slopes occur in areas of ice falls
O	O	organic terrain	peat, muck	<15	plain	0-3	bogs, fens, swamps
	* Ob	organic blanket	peat, muck	>1	takes form of underlying surface	0-10	
	* Ov	organic veneer	peat, muck	0.5-1	takes form of underlying surface	0-15	
C	Ch Cm	landslide	diamicton; blocks and rubble of local bedrock	>3	hummocky, rolling	0-35 0-15	includes landslides involving bedrock and landslides involving unconsolidated Quaternary sediments
	* Cf	avalanche fan, debris-flow fan	gravel, diamicton	>5	fan	5-30	includes fans with entrenched channels and fans close to local base level
	* Ca	talus	blocks and rubble of local bedrock	>2	apron, sheet	25-35	little or no vegetation on presently active slopes
	* Cb	colluvial blanket	colluvium	>1	takes form of underlying surface	1-35	includes slopewash, minor talus, talus stabilized by vegetation
	* Cv	colluvial veneer	colluvium	0.5-1	takes form of underlying surface	1-40	includes slopewash, minor talus, talus stabilized by vegetation
A	Af	alluvial fan	gravel and sand	>5	fan	1-20	includes terraced fan remnants (Aft), fans with entrenched channels, and fans close to local base level
	Ap	floodplain	gravel and sand	>2	plain with shallow channels	0-3	includes low benches subject to occasional flooding
	* Ax	valley floor complex	alluvium and colluvium	>2	plain, fan, terraces, lower valley walls	0-35	includes Ap, At, Af, and Cf; differentiation of these units is not possible at scale of map
	* Av	alluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	At	river terrace	gravel and sand	>2	terrace and scarp	0-3	generally one to several metres of sand overlying gravel
	* Ad	delta	gravel and sand	>5	terrace	0-5	marine delta
A^G	A^Gm A^Gh	kames, ice stagnation terrain	gravel and sand	>10	rolling, hummocky	0-15 0-30	unit deposited in contact with stagnant glacier ice; interbeds of diamicton commonly present in unit
	A^Gr	esker	gravel and sand	>10	ridge	0-30	unit deposited beneath and within stagnant glacier ice
	* A^Gb	glaciofluvial blanket	gravel and sand	>1	takes form of underlying surface	0-20	
	* A^Gv	glaciofluvial veneer	gravel and sand	0.5-1	takes form of underlying surface	0-20	
	* A^Gf	glaciofluvial fan	gravel and sand	>10	fan	1-20	ice-contact feature, commonly with kettles
	A^Gt	kame terrace	gravel and sand	>10	terrace and scarp	0-3	ice-contact feature, commonly with kettles
	A^Gd	delta	gravel and sand	>10	terrace, fan	0-20	proglacial and ice-contact lacustrine and marine deltas
L^G	* L^Gm	rolling glaciolacustrine terrain	silt, clay, minor sand (locally with dropstones)	>2	rolling	0-10	ice-marginal depositional environment; relict lake floor
	L^Gt	glaciolacustrine terrace	silt, clay, minor sand (locally with dropstones)	>2	terrace	0-3	
	L^Gb	glaciolacustrine blanket	silt, clay, minor sand (locally with dropstones)	>1	takes form of underlying surface	0-10	
	L^Gv	glaciolacustrine veneer	silt, clay, minor sand (locally with dropstones)	0.5-1	takes form of underlying surface	0-15	
W^G	* W^Gm	rolling glaciomarine terrain	silt, clay (locally with dropstones)	>2	rolling	0-10	proglacial depositional environment; relict seafloor
	* W^Gp	glaciomarine plain	silt, clay (locally with dropstones)	>2	plain	0-2	proglacial depositional environment
	* W^Gb	glaciomarine blanket	silt, clay (locally with dropstones)	>1	takes form of underlying surface	0-15	
	* W^Gv	glaciomarine veneer	silt, clay (locally with dropstones)	0.5-1	takes form of underlying surface	0-20	
M	Mm	ground moraine	till	>2	rolling	0-15	constructional morainic topography (not controlled by form of underlying unit)
	Mb	till blanket	till	>1	takes form of underlying surface	0-20	
	Mv	till veneer	till	0.5-1	takes form of underlying surface	0-25	
D	Dr Dm	drift	till, gravel, and colluvium	>2	ridged, rolling	0-15	constructional drift topography (not controlled by form of underlying unit)
	Db	drift blanket	till, gravel, and colluvium	>1	takes form of underlying surface	0-25	
	Dv	drift veneer	till, gravel, and colluvium	0.5-1	takes form of underlying surface	0-30	
Us		terrace scarps, river banks	all types of unconsolidated Quaternary sediments	>20 (scarp height)	steep erosional slopes	>30	unit consists of several stratigraphic units of contrasting lithologies, in places with a blanket or veneer of colluvium
R	R	bedrock			rolling, sloping, hummocky, ridged	0-60	thin (<0.5 m) or no cover of unconsolidated Quaternary sediments
	Rs	canyon walls, river banks			steep slopes	>45	Rs used mainly in conjunction with Us for canyon walls

* Does not occur as a dominant unit on this sheet

Explanation of letter notation

A combination of letters is used to designate each map unit or component of compound map units, e.g. Ap. The upper case letter indicates the broad genetic class. The lower case letter(s) that generally follows indicates morphology. The texture of most map units is implicit in the genetic type (see 'material' in above table); in such cases no specific textural symbol is used. Where the texture of a unit is different from the dominant or expected texture indicated in the table, a lower case textural symbol precedes the upper case genetic symbol, e.g. fCm. Postdepositional modification or erosion of a unit is indicated by an upper case letter which follows the lower case morphological symbol and is separated from it by a dash, e.g. Cv–A. Compound map units are designated by more than one group of letters separated by a colon, e.g. Ap:At. These areas consist of more than one component that could not be separated at the scale of the map. The component to the left of the colon is dominant to that to the right. One term placed above another, e.g. $\frac{Ov}{Mm}$ indicates a stratigraphic succession within the unit. No compound symbolization is used for sediment veneers overlying bedrock – unless otherwise indicated, the presence of the veneer symbol, e.g. Dv, indicates that the underlying unit is rock.

ELUC (1976) provides a complete description of a letter notation system similar to the one used here.

ELUC (1976) Terrain classification system; Victoria, British Columbia, 56p. (available from Assessment and Planning Division, Ministry of Environment, Parliament Buildings, Victoria).

Texture
g – gravel
s – sand
f – silt and clay
s̲ – silt

Genetic class
X – man-made
I – ice
O – organic
C – colluvial
A – alluvial
A^G – glaciofluvial
L^G – glaciolacustrine
W^G – glaciomarine and marine
M – morainal
D – drift
U – undifferentiated
R – bedrock

Morphologic subdivision
a – apron
b – blanket
d – delta
f – fan
h – hummocky
m – rolling
p – plain
r – ridged
s – steep slopes
t – terraced
v – veneer
x – complex

Process or form modifiers
A – avalanched
H – kettled
V – gullied
F – failing

Environment	Facies			
	Water	Water > Ice	Ice > Water	Ice
Marine		W^G		
Lacustrine		L^G		
Fluvial	A		A^G	
Glacial				D,M

Environment-facies classification of deposits

Stratigraphic sections

Covered
* Peat
* Estuarine pebbly silt, sand
* Beach gravel
* Glaciomarine and marine clay, silt, sand
Glaciolacustrine clay, silt, sand
Deltaic sand and sandy subaqueous outwash
Deltaic gravel and gravelly subaqueous outwash
* Glaciofluvial and fluvial sand
Glaciofluvial and fluvial gravel
* Ice-contact sand, minor diamicton
* Ice-contact gravel, minor diamicton
Till, minor ice-contact sand, gravel
Bedrock

Gradational contact ....
Elevation in metres 100
Radiocarbon sample number..........GSC-2083

* Unit does not occur on this sheet

Geological boundary (defined, approximate, assumed)
Glacial striae (direction of ice movement known, unknown)
Drumlins
Drumlinoid ridges, flutings
Crag and tail
Cirque
Ice-contact face
Moraine ridge
Esker (direction of flow known, unknown) ..... <<<<< ><><
Kettle hole (small, large)
Abandoned channel (small, large)
Beach
Escarpment
Landslide scar (small, large)
Avalanche track
Debris flow track
Major gravel pit
Location of representative stratigraphic section 17
Radiocarbon date ..... Date | Material / Lab no. | Elevation

Geology by J.J. Clague, 1975-1977

Geological cartography by R.D. Fairfield, Geological Survey of Canada

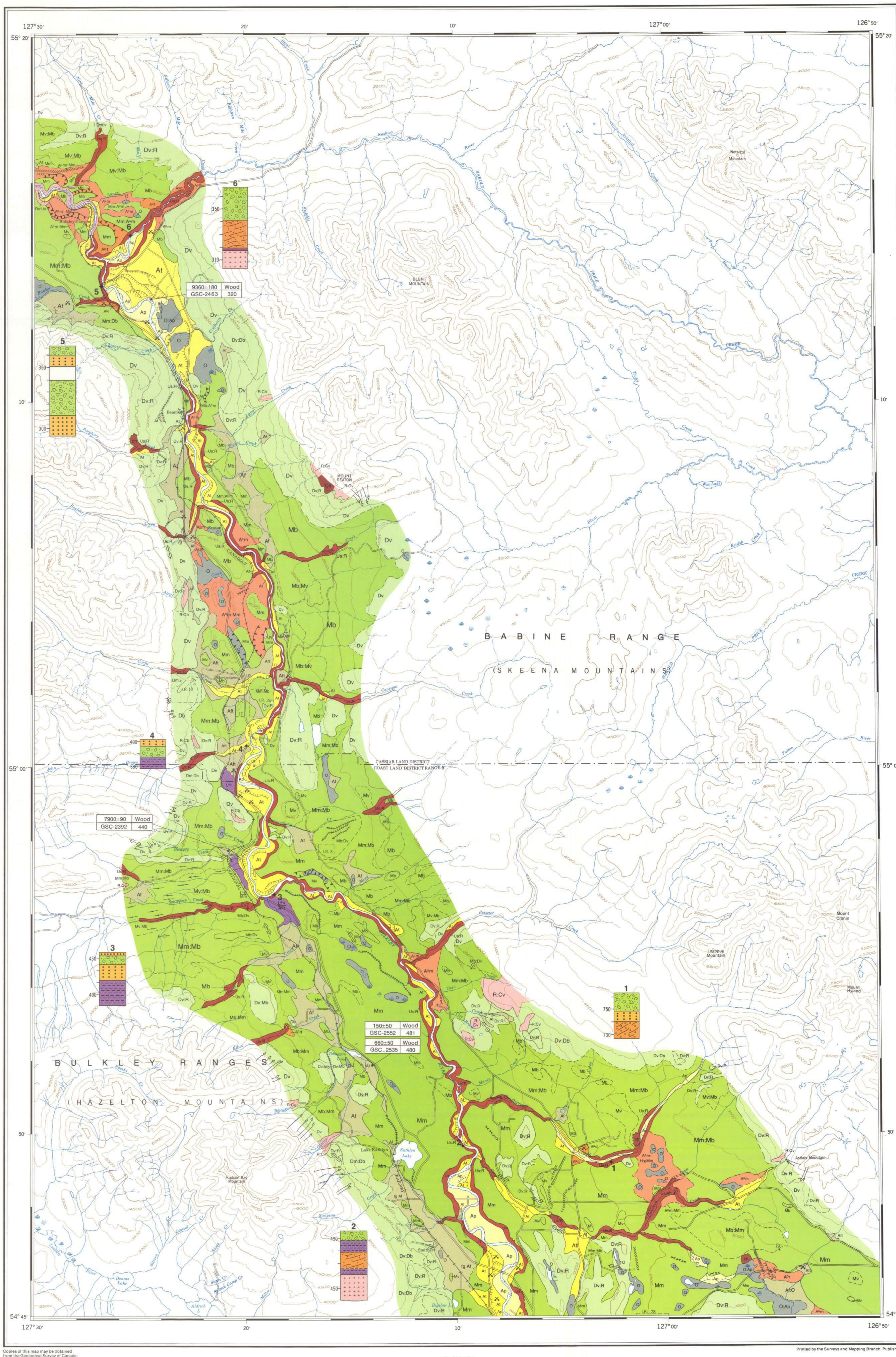
Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

Base-map cartography by the Geological Survey of Canada from 1:50,000 scale-maps 93 L/14, 93 M/3 and parts of 93 L/15, 93 M/2, 93 M/6 and 93 M/7 published by the Surveys and Mapping Branch in 1970, 1971 and 1975

Copies of the various topographical editions of this map may be obtained from the Canada Map Office, 615 Booth Street, Ottawa, Ontario, K1A 0E9

Approximate magnetic declination 1981, 26°22.5′ East, decreasing 8.7′ annually

Elevations in feet above mean sea level



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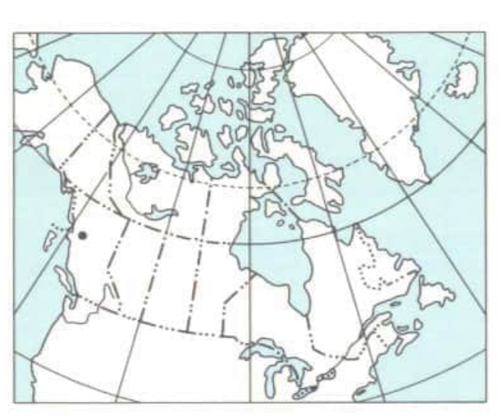
100 West Pender Street, Vancouver, B.C. V6B 1R8

Printed by the Surveys and Mapping Branch. Published 1983



INDEX MAP

MAP 1557A

SURFICIAL GEOLOGY

SKEENA RIVER – BULKLEY RIVER AREA

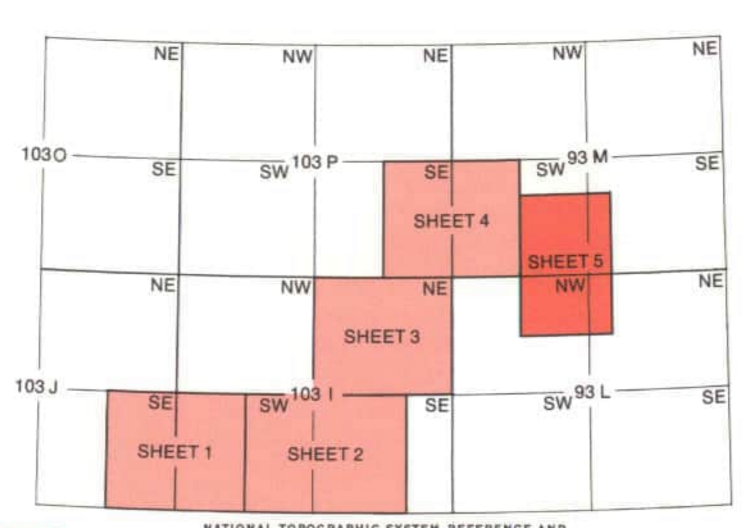
SHEET 5

BRITISH COLUMBIA

Scale 1:100 000

Kilometres 2 0 2 4 6 8 Kilometres
Miles 2 0 2 4 Miles

Universal Transverse Mercator Projection



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO GEOLOGICAL SURVEY OF CANADA MAPS

MAP 1557A
SKEENA RIVER – BULKLEY RIVER AREA
BRITISH COLUMBIA

Canada

Columbia River

PGL
ENVIRONMENTAL CONSULTANTS

BLAEBERRY

KOOTENAY DISTRICT
BRITISH COLUMBIA
WEST OF FIFTH MERIDIAN

SCALE 1:50,000

1 25 inches to 1 mile approximately

1 0 1 2 3 Miles
1000 500 0 1000 2000 3000 4000 Metres
1000 500 0 1000 2000 3000 4000 Yards

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Universal Transverse Mercator Projection

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa at 25 cents each

Produced and printed by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1959, from air photographs taken in 1951.

MAGNETIC DECLINATION 22°51′ EAST
AT CENTRE OF MAP 1959
Annual magnetic change 4′ westerly

REFERENCE

Roads:
- hard surface, all weather — more than 2 lanes / dual
- hard surface, all weather — 2 lanes / 1 lane
- loose surface, all weather — 2 lanes or more / less than 2 lanes
- loose surface, dry weather
- winter; cart track — Winter road
- trail, cut line or portage

Railways:
- normal gauge, multiple track — Station
- normal gauge, single track — Siding / Stop
- narrow gauge, single track
- abandoned or under construction
- Bridges: road; railway
- Cutting; Embankment

Boundaries:
- international, with monument
- provincial
- township surveyed; unsurveyed
- park, reserve, etc
- section line, with number — 20
- Lot number — L 15
- Horizontal control point, with elevation — 454 △
- Bench mark, with elevation — BM 157

REFERENCE

- Mine or Open cut
- Building; Barn
- Church
- Built up area
- Telephone line
- Power transmission line
- Streams
- intermittent or dry
- indefinite
- Lake intermittent; indefinite
- Inundated land, seasonal
- Marsh or Swamp
- Foreshore flats — Sand
- Wharf or Pier; Breakwater
- Glacier or Snowfield
- Small island, rock bare or awash
- Contours:
- elevation — 7500
- depression
- approximate
- Cliff
- Forest
- Lighthouse
- School; Post Office — P
- Cemetery — C

118°00 51°45
82N/12 82N/
BEAVERMOU
82 N/5 82N
GLACIER BLAEBERR
82 N/4 82N
ILLECILLEWAET MOUNT WHEELER
51°00 118°00
INDEX TO ADJOINI

HE BLAEBE
82 N/6 E

NATIONAL TOPOGRAPHIC SYSTEM 1:50,000 **CANADA** FIRST EDITION SHEET 82 N/6 WEST

BLAEBERRY

KOOTENAY DISTRICT
BRITISH COLUMBIA
WEST OF FIFTH MERIDIAN

SCALE 1:50,000

1.25 inches to 1 mile approximately

1 0 1 2 3 Miles

1000 500 0 1000 2000 3000 4000 Metres

1000 500 0 1000 2000 3000 4000 Yards

CONTOUR INTERVAL 100 FEET

Elevations in Feet above Mean Sea Level
North American Datum 1927
Universal Transverse Mercator Projection

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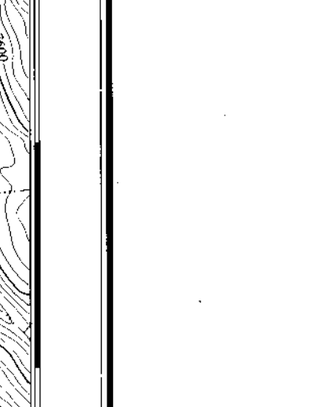
MAGNETIC DECLINATION 23°00' EAST
AT CENTRE OF MAP 1959
Annual magnetic change 4' westerly

REFERENCE

Roads.
loose surface, dry weather
winter; cart track — Winter road
trail, cut line or portage
Railways:
normal gauge, multiple track. . . — Station
normal gauge, single track. . . . . — Siding — Stop
narrow gauge, single track. . . . . .
abandoned or under construction. . . . . .
Bridges: road, railway. . . . . .
Cutting, Embankment . . . . . .
Boundaries
international, with monument
provincial
township surveyed; unsurveyed.
park, reserve, etc. . . . . — 20
section line, with number. . . . . .
Lot number. L15
Horizontal control point, with elevation 454
Bench mark, with elevation BM 157

REFERENCE

Mine or Open cut
Building; Barn. . . . . — School, Post Office. . . P
Church. . . . . — Cemetery. C
Streams:
intermittent or dry . . . . . .
indefinite . . . . . .
Lake intermittent; indefinite . . . .
Inundated land, seasonal. . . . . .
Marsh or Swamp. . . . . .
Foreshore flats . . . . . Sand
Wharf or Pier; Breakwater. . . . . .
Glacier or Snowfield. . . . . .
Small island, rock bare or awash. . . . . .
Contours.
elevation. 7500
depression. . . . . .
approximate. . . . . .
Cliff . . . . . .
Esker. . . . . .
Forest. . . . . .
Lighthouse. . . . . .



INDEX TO ADJOINING S

HW BLAEBERR
82 N/6 WES

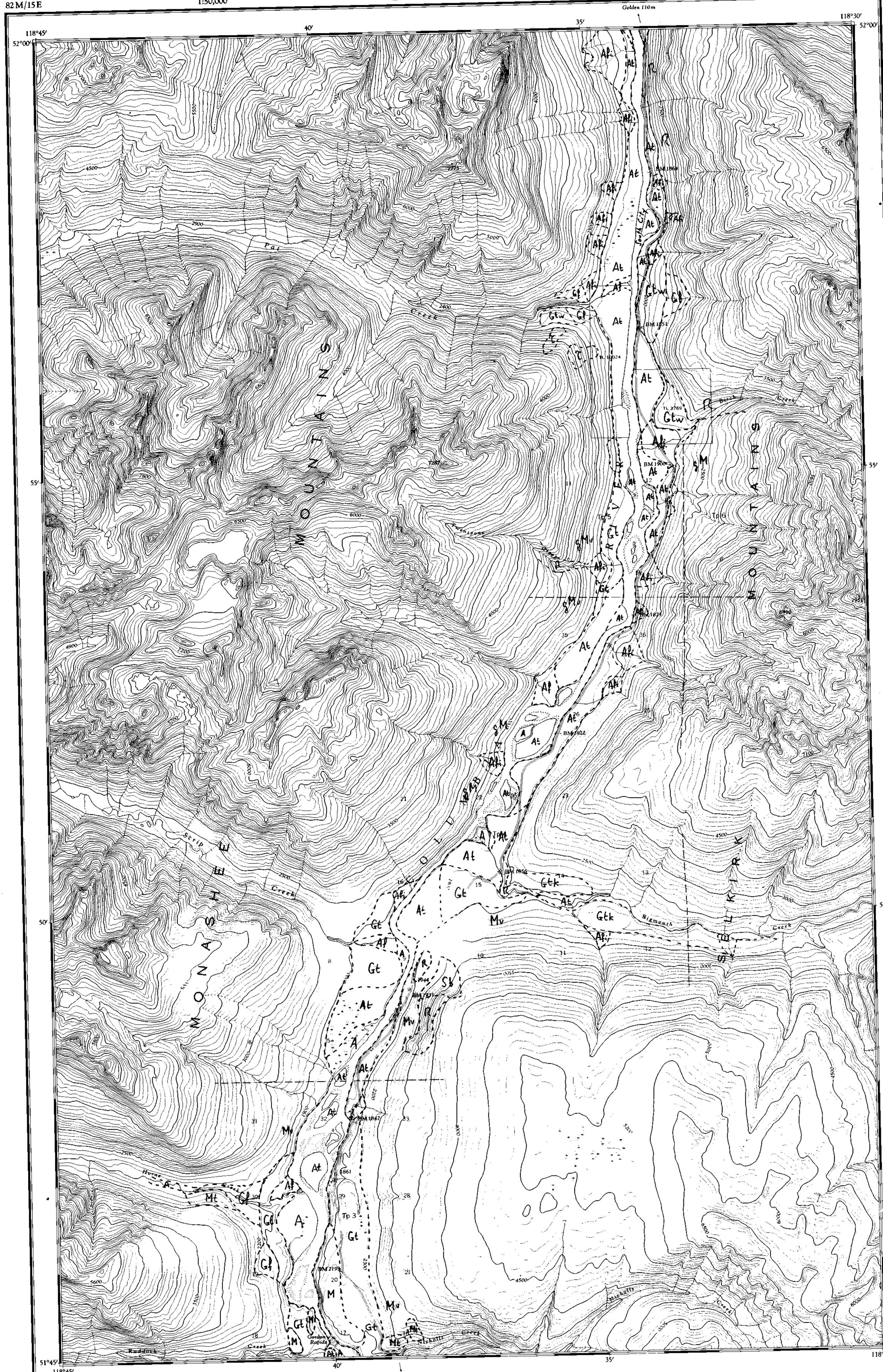
OE
82 M/15 E

CANADA

EDITION 1

82 M/15 E

1:50,000



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SCRIP CREEK

KOOTENAY DISTRICT

BRITISH COLUMBIA

SCALE 1:50,000 ÉCHELLE

Miles 0 1 2 3 Miles

Metres 1000 500 0 1000 2000 3000 4000 Mètres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

MAGNETIC DECLINATION 23°57′ EAST
AT CENTRE OF MAP 1963
Annual change (decreasing) 3.4′

Some names on this map are not yet official. Corrections or additions are invited by the Surveys and Mapping Branch.

ÉQUIDISTANCE DES COURBES: 100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Réseau géodésique nord-américain unifié (1927)
Projection transverse de Mercator

DÉCLINAISON MAGNÉTIQUE AU CENTRE DE LA FEUILLE EN 1963: 23°57′ EST
Variation annuelle (décroissante) 3.4′

Certains noms inscrits sur cette carte ne sont pas encore officiels. La Direction des levés et de la cartographie saurait gré au public de lui signaler corrections et additions.

Roads	Routes
hard surface all weather	pavée, toute saison
hard surface all weather	pavée toute saison
loose surface all weather	de gravier, toute saison
loose surface dry weather	de gravier, période sèche
cart track	de terre
trail or portage	sentier ou portage
Railway, normal gauge single track	Chemin de fer voie unique écartement normal
Horizontal control point with elevation	Point géodésique avec cote
Bench mark, with elevation	Repère de nivellement avec cote

454
BM 757

Building	Bâtiment	Barn	Grange
School	École	Post Office	Bureau de poste
Church	Église	Cemetery	Cimetière
Mine or Quarry		Mine ou fosse à ciel ouvert	
Lighthouse		Pier	
Power transmission line		Light, beacon or range	
River with bridge		Rapids	
Stream intermittent or dry		Coulée peu intermittente ou asséchée	
Lake intermittent or reservoir		Lac intermittent ou réservoir	
Marsh or Swamp		Marais ou marécage	
Depression contours		Courbes de cuvette	

OE

P3681 ADVANCE PRINT

83N/4(E½)

NAGLE CREEK

BRITISH COLUMBIA

1:40,000

SCALE OF MILES

1 3/4 1/2 1/4 0 1 2 Miles

CONTOUR INTERVAL 100 FEET

Compiled 1965 Photos Spartan 1951

Advance Information
Subject to Revision

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OPEN FILE
156
June 1973
GEOLOGICAL SURVEY
OTTAWA

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KINBASKET LAKE

KOOTENAY DISTRICT

BRITISH COLUMBIA

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Miles

Metres 1000 500 0 1000 2000 3000 4000 Metres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

MAGNETIC DECLINATION 23°46' EAST
AT CENTRE OF MAP 1964
Annual change (decreasing) 3.4'

ÉQUIDISTANCE DES COURBES: 100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Réseau géodésique nord-américain unifié (1927)
Projection transverse de Mercator

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1964: 23°46' EST
Variation annuelle (décroissante) 3.4'

Roads	Routes
hard surface, all weather	payée, toute saison
hard surface, all weather	payée, toute saison
loose surface, all weather	de gravier, toute saison
loose surface, dry weather	de gravier, période sèche
cart track	de terre
trail or portage	sentier ou portage
Railway, normal gauge, single track	Chemin de fer voie unique, écartement normal
Horizontal control point with elevation	Point géodésique avec cote
Bench mark, with elevation	Repère de nivellement avec cote

Building	Bâtiment	Barn	Grange	
School	École	Post Office	Bureau de poste	P
Church	Église	Cemetery	Cimetière	
Mine or Open cut	Mine ou fosse à ciel ouvert			
Lighthouse	Phare			
Power transmission line	Ligne de transport d'énergie			
River with bridge	Rivière avec pont			
Stream, intermittent or dry	Cours d'eau, intermittent ou à sec			
Lake, intermittent, indefinite	Lac intermittent, rive imprécise			
Marsh or Swamp	Marais ou marécage			
Depression contours	Courbes de cuvette			

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PROVISIONAL MAP

82 M/8 E

1:50,000

CANADA

CARTE PROVISOIRE

EDITION 1

82 M/8 E

DOWNIE CREEK

KOOTENAY DISTRICT

BRITISH COLUMBIA

WEST OF SIXTH MERIDIAN - OUEST DU SIXIÈME MÉRIDIEN

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Miles

Metres 1000 500 0 1000 2000 3000 4000 Metres

Yards 1000 500 0 1000 2000 3000 4000 Yerges

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

ÉQUIDISTANCE DES COURBES : 100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Réseau géodésique nord-américain unifié (1927)
Projection transverse de Mercator

MAGNETIC DECLINATION 23°32' EAST
AT CENTRE OF MAP 1962
Annual change (decreasing) 3.3'

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1962 : 23°32' EST
Variation annuelle (décroissante) 3.3'

The nomenclature on this map has not been submitted to the Canadian Board on Geographical Names and may be subject to revision. Information on names is invited by the Surveys and Mapping Branch.

La nomenclature de la présente carte n'a pas été soumise à la Commission canadienne des noms géographiques et, par conséquent, elle pourrait faire l'objet d'une revision. Tous renseignements sur les noms seront bien accueillis par la Direction des levés et de la cartographie.

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Railways / Chemins de fer
Roads / Routes
Power transmission line / Ligne de transport d'énergie
Mine or Quarry / Mine ou carrière
Bench mark / Repère de nivellement
Elevation / Altitude
454
BM 157

Building / Bâtiment
School / École
Church / Église
Lighthouse / Phare
River with rapids / Rivière avec rapides
Stream / Cours d'eau
Lake intermittent / Lac intermittent
Marsh or Swamp / Marais ou marécage
Depression contours / Courbes de dépression
Bar / Barre
Post Office / Bureau de poste
Cemetery / Cimetière

NATIONAL TOPOGRAPHIC SYSTEM
SYSTÈME DE RÉFÉRENCE CARTOGRAPHIQUE NATIONAL

This map has been reprinted from a scanned version of the original map

Reproduction par numérisation d'une carte sur papier

OPEN FILE
156
June 1973
GEOLOGICAL SURVEY
OTTAWA

CANADA

82 M/10 E

1:50,000

EDITION 1

82 M/10 E

HOSKINS CREEK
BRITISH COLUMBIA

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Compilée en 1959-60, par la **DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES**, d'après les photographies aériennes prises en 1955. Travaux exécutés sur le terrain et vérification des ouvrages 1958. Imprimée en 1962

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Milles

Metres 1000 500 0 1000 2000 3000 4000 Metres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

MAGNETIC DECLINATION 23 53' EAST
AT CENTRE OF MAP, 1962

Some names on this map are not yet official. Corrections or additions are invited by the Surveys and Mapping Branch.

ÉQUIDISTANCE DES COURBES: 100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Réseau géodésique nord-américain unifié (1927)
Projection transverse de Mercator

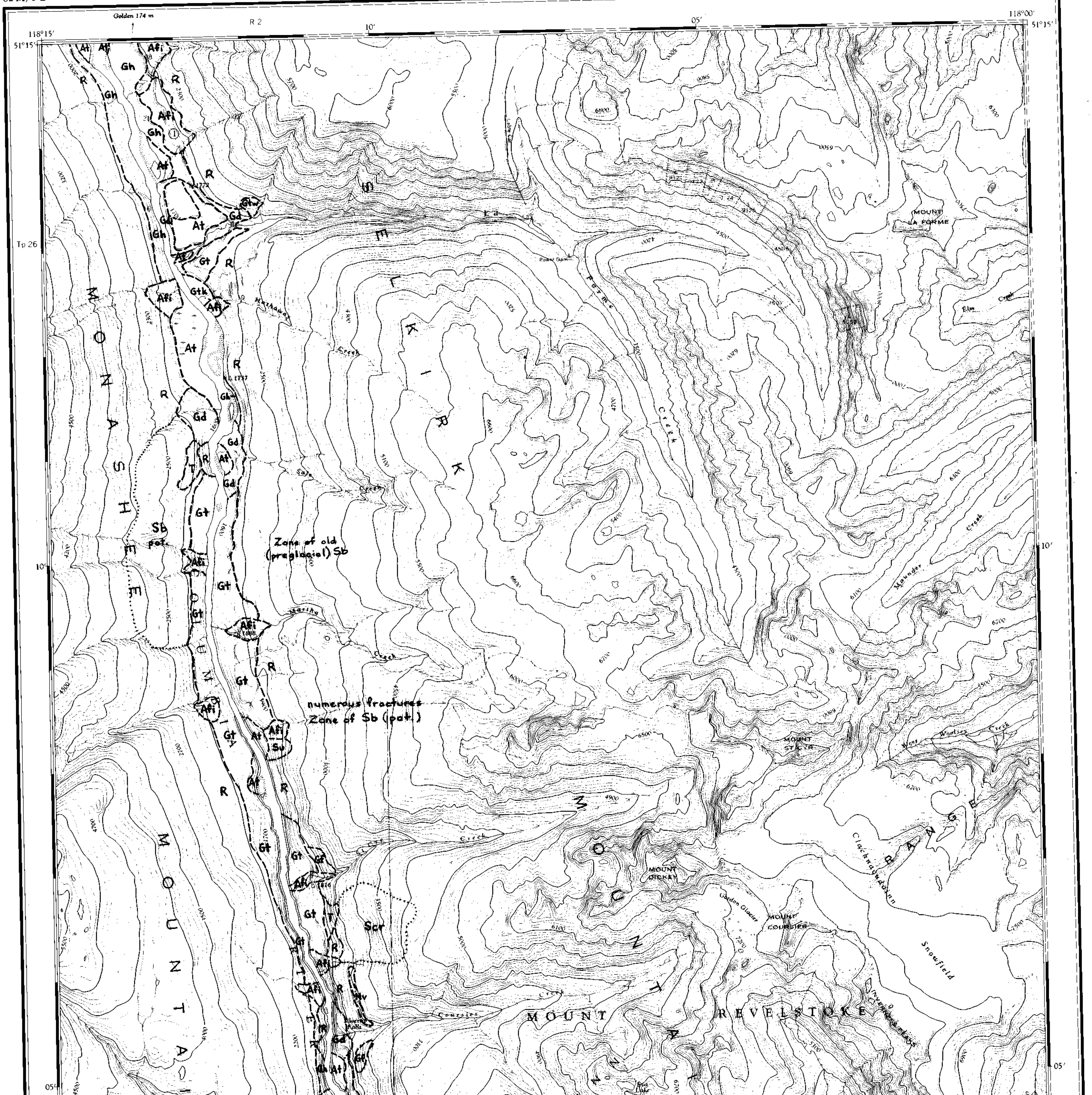
DÉCLINAISON MAGNÉTIQUE AU CENTRE DE LA FEUILLE EN 1962 : 23 53' E

Certains noms inscrits sur cette carte ne sont pas encore officiels. La Direction des levés et de la cartographie saurait gré au public de lui signaler corrections et additions.

82 M/1 E 1:50,000

CANADA

EDITION 1 82 M/1 E



Produced and printed by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1962, from air photographs taken in 1951 and 1952.

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa, at 25 cents each.

MOUNT REVELSTOKE

KOOTENAY DISTRICT

BRITISH COLUMBIA

WEST OF SIXTH MERIDIAN - OUEST DU SIXIÈME MÉRIDIEN

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Miles

Metres 1000 500 0 1000 2000 3000 4000 Metres

Yards 1000 500 0 1000 2000 3000 4000 Verges

Établie et imprimée par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES en 1962 d'après les photographies aériennes prises en 1951 et 1952.

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa. Prix de l'exemplaire: 25 cents.

Roads	Routes	
hard surface, all weather	pavée, toute saison	
hard surface, all weather	pavée, toute saison	
loose surface, all weather	de gravier, toute saison	
loose surface, dry weather	de gravier, temps sec	
cart track	de terre	
trail or portage	sentier ou portage	
Railway, normal gauge, single track	Chemin de fer, voie unique, écartement normal	
Horizontal control point, with elevation	Point géodésique avec cote	454
Bench mark, with elevation	Repère de nivellement avec cote	BM 157

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

MAGNETIC DECLINATION 23°10′ EAST AT CENTRE OF MAP 1961
Annual change decreasing 4′

ÉQUIDISTANCE DES COURBES: 100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Réseau géodésique nord-américain unifié (1927)
Projection transverse de Mercator

DÉCLINAISON MAGNÉTIQUE AU CENTRE DE LA FEUILLE EN 1961: 23°10′ EST
Variation annuelle (décroissante) 4′

Building	Bâtiment	Barn	Grange
School	École	Post office	Bureau de poste
Church	Église	Cemetery	Cimetière
Mine or Open cut	Mine ou fosse à ciel ouvert		
Lighthouse	Phare		
Power transmission line	Ligne de transport d'énergie		
River with rapids	Rivière avec rapides		
Marsh or swamp	Marais ou marécage		
Depression contours	Courbes de cuvette		

OPEN FILE 156

June 1973

GEOLOGICAL SURVEY OTTAWA

82 N/13 W

1:50,000

CANADA

EDITION 1

82 N/13 W

SULLIVAN RIVER

KOOTENAY DISTRICT

BRITISH COLUMBIA

SCALE 1:50.000 ÉCHELLE

Miles 1 0 1 2 3 Milles

Metres 1000 500 0 1000 2000 3000 4000 Metres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

MAGNETIC DECLINATION 23°44' EAST
AT CENTRE OF MAP 1963
Annual change (decreasing) 3.4'

Some names on this map are not yet official. Corrections or additions are invited by the Surveys and Mapping Branch.

ÉQUIDISTANCE DES COURBES:100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Réseau géodésique nord-américain unifié (1927)
Projection transverse de Mercator

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1963: 23°44' EST
Variation annuelle (décroissante) 3.4'

Certains noms inscrits sur cette carte ne sont pas encore officiels. La Direction des levés et de la cartographie saurait gré au public de lui signaler corrections et additions.

Roads / Routes

- hard surface, all weather — Pavée, toute saison
- hard surface, all weather — Pavée, toute saison
- loose surface, all weather — De gravier, toute saison
- loose surface, dry weather — De gravier, utilisable par temps sec
- cart track — De terre
- trail or portage — Sentier ou portage
- Railway, normal gauge, single track — Chemin de fer, voie unique, écartement normal
- Horizontal control point with elevation — Point géodésique avec cote — 454
- Bench mark with elevation — Repère de nivellement avec cote — BM 157

Building / Bâtiment
School / École
Church / Église
Mine or Open cut
Lighthouse
Power transmission line
River with bridge
Intermittent or dry stream
Lake, permanent or intermittent
Marsh or Swamp
Depression contours

Barn
Post Office / Bureau de poste
Cemetery / Cimetière
Mine au puits ou à ciel ouvert
Phare
Ligne de transport d'énergie
Rivière avec pont
Cours d'eau intermittent ou à sec
Lac permanent ou intermittent
Marais ou marécage
Courbes de cuvette

OPEN FILE
156
June 1973
GEOLOGICAL SURVEY
OTTAWA

Compiled, 1961, by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, from air photographs taken in 1955. Field surveys and culture check 1958. Printed 1963.

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

Compilée en 1961, par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES, d'après les photographies aériennes prises en 1955. Travaux exécutés sur le terrain et vérification des ouvrages en 1958. Imprimée en 1963.

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

This map has been reprinted from a scanned version of the original map
Reproduction par numérisation d'une carte sur papier

82 N 13 E | 1:50,000 | EDITION 1 | 82 N/13 E

CANADA

117°45′ | 40′ | 35′ | 117°30′ | 52°00′

ROCKY MOUNTAINS

SOLITUDE MOUNTAIN

VERTEBRATE MOUNTAIN

SELKIRK MOUNTAINS

Sullivan River

Prairie Creek

Chatter Creek

Bush River

Bush Lake

Icefield

Falls

Rapids

Flow Recorder

BM 2325

BM 2503

BM 2428

BM 2375

BM 2448

Golden 44 m

Revelstoke 140 m

51°45′ | 40′ | 35′ | 117°30′ | 50′

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Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

SULLIVAN RIVER

KOOTENAY DISTRICT

BRITISH COLUMBIA

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Miles

Metres 1000 500 0 1000 2000 3000 4000 Mètres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

MAGNETIC DECLINATION 23°41′ EAST AT CENTRE OF MAP 1963
Annual change (decreasing) 3.4′

Some names on this map are not yet official. Corrections or additions are invited by the Surveys and Mapping Branch.

ÉQUIDISTANCE DES COURBES:100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Réseau géodésique nord-américain unifié (1927)
Projection transverse de Mercator

DÉCLINAISON MAGNÉTIQUE AU CENTRE DE LA FEUILLE EN 1963 : 23°41′ EST
Variation annuelle (décroissante) 3.4′

Certains noms inscrits sur cette carte ne sont pas encore officiels. La Direction des levés et de la cartographie saurait gré au public de lui signaler corrections et additions.

Compilée en 1961, par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES, d'après les photographies aériennes prises en 1955. Travaux exécutés sur le terrain et vérification des ouvrages en 1958. Imprimée en 1963.

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

Roads	Routes		
Hard surface all weather	Route à revêtement dur toute saison		
Hard surface all weather	Route à revêtement dur		
Loose surface all weather	Route de gravier toute saison		
Loose surface dry weather	Route de gravier utilisable par beau temps		
Cart track	Chemin de ferme		
Trail or portage	Sentier ou portage		
Railway, normal gauge single track	Chemin de fer à voie unique écartement normal		
Horizontal control point with elevation	Point géodésique avec cote		454
Benchmark with elevation	Repère de nivellement avec cote		BM 157

Building	Bâtiment	Barn	Grange
School	École	Post Office	Bureau de poste
Church	Église	Cemetery	Cimetière
Mine or Open cut	Mine ou fosse à ciel ouvert		
Lighthouse	Phare		
Power transmission line	Ligne de transmission d'énergie		
River with bridge	Rivière avec pont		
Stream intermittent or dry	Cours d'eau intermittent ou sec		
Lake intermittent or indefinite	Lac intermittent ou imprécise		
Marsh or Swamp	Marais ou marécage		
Depression contours	Courbes de cuvette		

OPEN FILE
156
June 1973
GEOLOGICAL SURVEY
OTTAWA

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Reproduction par numérisation d'une carte sur papier

NATIONAL TOPOGRAPHIC SYSTEM

1:50,000

CANADA

FIRST EDITION

SHEET 82 N/11 WEST

117°30′ — 117°15′ — 51°45′ — 51°30′ — 25′ — 20′ — R 25 — R 24 — Tp 31 — Tp 30 — Tp 29 — 40′ — 35′

BLACKWATER MOUNTAIN — CHAPERON MOUNTAIN — FELICCA MOUNTAIN — BLACKWATER RANGE — HAMBER PROVINCIAL PARK — COLUMBIA MOUNTAINS

Aid Lake — Help Lake — Comfort Lake — Blackwater Lake — Schlichting Creek — Carrol Creek — Maxhill Creek — Beaver Canon — Beaver River — Whitepine Creek — Redgrave Creek — Blackwater Creek — Clearwater Creek — Groundhog Creek

BM 3187 — BM 3238 — BM 3215 — BM 3166 — BM 3176 — BM 3066 — BM 3025 — BM 2622 — BM 2552 — BM 2432 — BM 2493 — BM 2501 — BM 2452

05520 Fire Lookout Tower — Bridgmans Tower Ranch — Beavermouth — The Gateway — CANADIAN — Redgrave — Tunnel

To Revelstoke — To Golden — Revelstoke 155m — Golden 21m

MAGNETIC DECLINATION 23°17′ EAST
AT CENTRE OF MAP 1959
Annual magnetic change 4′ westerly

Produced and printed by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1959, from air photographs taken in 1952.

BEAVERMOUTH

KOOTENAY DISTRICT
BRITISH COLUMBIA
WEST OF FIFTH MERIDIAN

SCALE 1:50,000

1.25 inches to 1 mile approximately

3 Miles — 4000 Metres — 4000 Yards

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Universal Transverse Mercator Projection

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa, at 25 cents each.

REFERENCE

Roads: more than 2 lanes; dual; 2 lanes; 1 lane; hard surface, all weather; 2 lanes or more; less than 2 lanes; loose surface, all weather; loose surface, dry weather; winter; cart track (Winter road); trail, cut line or portage

Railways: Station; normal gauge, multiple track; normal gauge, single track (Siding; Stop); narrow gauge, single track; abandoned or under construction; Bridges: road; railway; Cutting, Embankment

Boundaries: international, with monument; provincial; township surveyed; unsurveyed; park, reserve, etc; section line, with number (20); Lot number (L 15); Horizontal control point, with elevation (454); Bench mark, with elevation (BM 157)

REFERENCE

Mine or Open cut; Tank; water, oil etc.; Building, Barn; School; Post Office (P); Church; Cemetery (C); Built up area; Telephone line; Power transmission line; Streams; intermittent or dry; indefinite; Lake intermittent, indefinite; Inundated land, seasonal; Marsh or Swamp; Foreshore flats (Sand); Wharf or Pier; Breakwater; Glacier or Snowfield; Small island, rock bare or awash; Contours; elevation (5000); depression; approximate; Cliff; Forest

118°00′ — 52°00′ — 51°15′ — 118°00′

82 N/13 — 82 N/12 — 82 N/5 — GLACIER — BEAVERM

INDEX TO ADJOI

BEAVER
82 N/11

P3679

83%(E½)

6956

SCALE OF MILES

1 ¾ ½ ¼ 0 1 2 Miles

CONTOUR INTERVAL 100 FEET

BOAT ENCAMPMENT

BRITISH COLUMBIA

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa

Compiled 1965 Photos AERO 1955

Advance Information Subject to Revision

OPEN FILE
156
June 1973
GEOLOGICAL SURVEY
OTTAWA

NATIONAL TOPOGRAPHIC SYSTEM | 1:50,000 | # CANADA | FIRST EDITION | SHEET 82 N/11 EAST

117°15′ 10′ 05′ 117°00′ 51°45′

FRIGHTE MOUNTAIN

MOUNT ALAN CAMPBELL

Campbell Icefield

H A M B E R Creek

Bluewater Creek

P R O V I N C I A L P A R K

Mary Creek

White Creek

Cooper Creek

Abetibie Lake

Colepitts Cr.

Chaboillez Cr.

BLUEWATER CREEK

COLUMBIA RIVER

Wallabie Creek

BM 2607

40′ 35′

Tp 30 Tp 29

Revelstoke 172m

Golden 17m

51°30′ 117°15′ R 24 R 23 R 22 117°00′

To Revelstoke To Golden

MAGNETIC DECLINATION 23°06′ EAST
AT CENTRE OF MAP 1959
Annual magnetic change 4′ westerly

Produced and printed by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, 1959. from air photographs taken in 1952.

BEAVERMOUTH

KOOTENAY DISTRICT
BRITISH COLUMBIA
WEST OF FIFTH MERIDIAN

SCALE 1:50,000

1.25 inches to 1 mile approximately

1 0 1 2 3 Miles
1000 500 0 1000 2000 3000 4000 Metres
1000 500 0 1000 2000 3000 4000 Yards

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Universal Transverse Mercator Projection

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa, at 25 cents each.

REFERENCE

Roads:
- hard surface, all weather — more than 2 lanes / dual
- hard surface, all weather — 2 lanes / 1 lane
- loose surface, all weather — 2 lanes or more / less than 2 lanes
- loose surface, dry weather
- winter, cart track — Winter road
- trail, cut line or portage

Railways:
- normal gauge, multiple track — Station
- normal gauge, single track — Siding / Stop
- narrow gauge, single track
- abandoned or under construction
- Bridges: road, railway
- Cutting: Embankment

Boundaries:
- international, with monument
- provincial
- township surveyed; unsurveyed
- park, reserve, etc
- section line, with number — 20
- Lot number — L 15
- Horizontal control point, with elevation — 454 ⊿
- Bench mark, with elevation — BM 157 —

REFERENCE

- Mine or Open cut
- Building: Barn
- Church
- Built up area
- Telephone line
- Power transmission line
- Lighthouse
- School, Post Office — P
- Cemetery — C
- Streams
  - intermittent or dry
  - indefinite
- Lake intermittent, indefinite
- Inundated land, seasonal
- Marsh or Swamp
- Foreshore flats — Sand
- Glacier or Snowfield
- Dry river bed
- Small island, rock bare or awash
- Contours
  - elevation — 5000
  - depression
  - approximate
- Cliff
- Forest

118°00′ 52°00′
82 N/13 82 N/14
82 N/12 82 N/11 BEAVERMOUTH
82 N/5 82 N/6
GLACIER BLAEBERRY
51°15′ 118°00′
INDEX TO ADJOINING

ME BEAVERMO 82 N/11 EA

MOUNT SIR SANDFORD

KOOTENAY DISTRICT

BRITISH COLUMBIA

WEST OF FIFTH MERIDIAN - OUEST DU CINQUIÈME MÉRIDIEN

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Miles

Metres 1000 500 0 1000 2000 3000 4000 Mètres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

MAGNETIC DECLINATION 23°28' EAST
AT CENTRE OF MAP 1964
Annual change (decreasing) 3.4'

Some names on this map are not yet official. Corrections or additions are invited by the Surveys and Mapping Branch.

ÉQUIDISTANCE DES COURBES: 100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Réseau géodésique nord-américain unifié (1927)
Projection transverse de Mercator

DÉCLINAISON MAGNÉTIQUE AU CENTRE DE LA FEUILLE EN 1964: 23°28' EST
Variation annuelle (décroissante) 3.4'

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Compiled, 1961, by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS, from air photographs taken in 1956. Field surveys 1958. Printed 1964.

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Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

Roads	Routes
hard surface, all weather	payée, toute saison
hard surface, all weather	payée, toute saison
loose surface, all weather	de gravier, toute saison
loose surface, dry weather	de gravier, période sèche
cart track	de terre
trail or portage	sentier ou portage
Railway, normal gauge, single track	Chemin de fer voie unique écartement normal
Horizontal control point, with elevation	Point géodésique avec cote 454 △
Bench mark, with elevation	Repère de nivellement avec cote BM 157

Building	Bâtiment	•	Barn	Grange	
School	École		Post Office	Bureau de poste	P.O.
Church	Église		Cemetery	Cimetière	
Mine or Open cut	Mine ou fosse à ciel ouvert				
Lighthouse	Phare				
Power transmission line	Ligne de transport d'énergie				
River with bridge	Rivière avec pont				
Stream, intermittent or dry	Cours d'eau, intermittent ou à sec				
Lake, intermittent, indefinite	Lac intermittent, rive imprécise				
Marsh or Swamp	Marais ou marécage				
Depression contours	Courbes de cuvette				

PROVISIONAL MAP

82 M/8 W

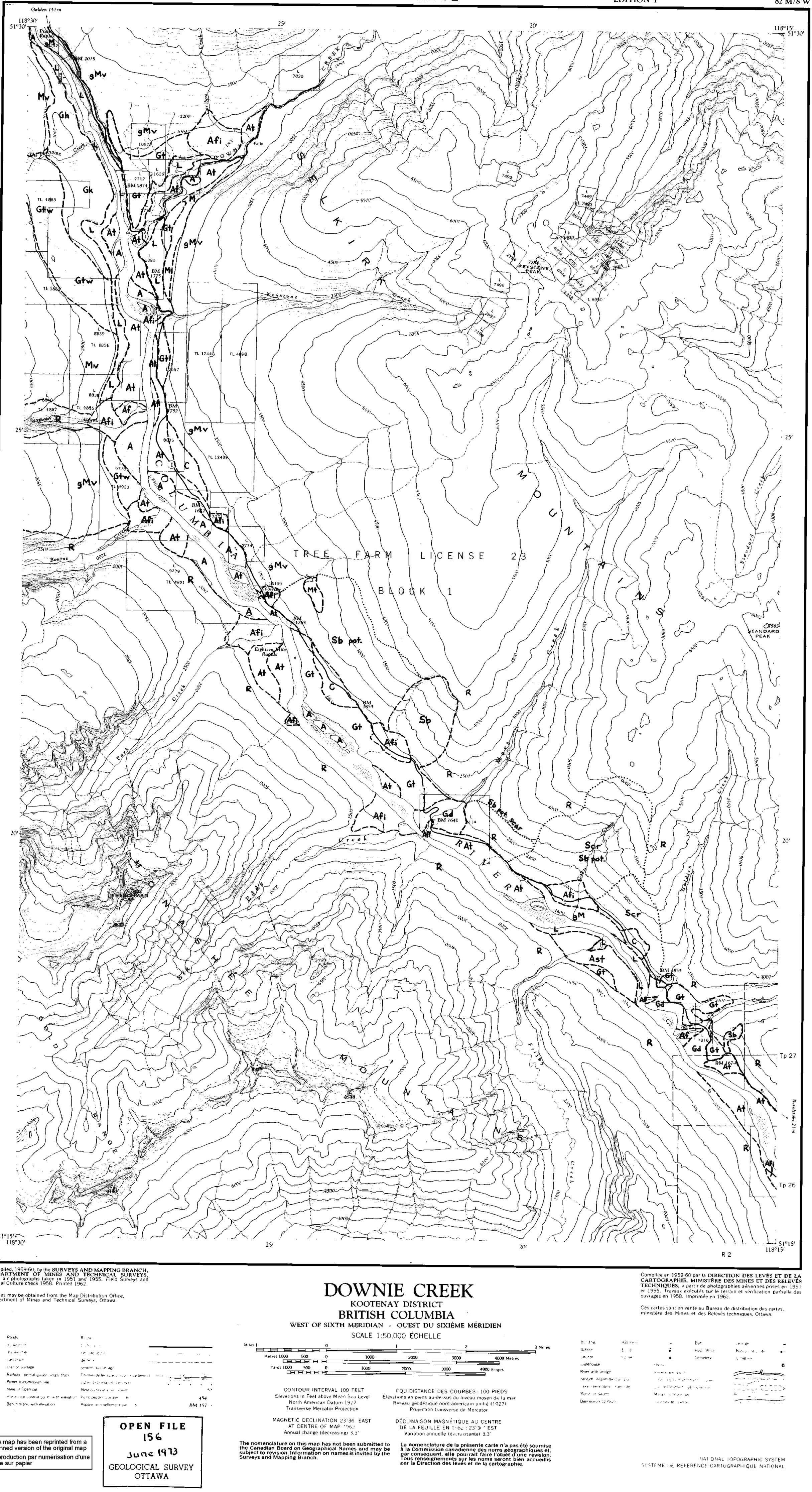
1:50,000

CANADA

CARTE PROVISOIRE

EDITION 1

82 M/8 W



Compiled, 1959-60, by the **SURVEYS AND MAPPING BRANCH, DEPARTMENT OF MINES AND TECHNICAL SURVEYS,** from air photographs taken in 1951 and 1955. Field Surveys and Partial Culture check 1958. Printed 1962.

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa

Roads / Routes
Railway (normal gauge, single track) / Chemin de fer (voie normale, une piste)
Power transmission line / Ligne de transmission d'énergie
Mine or Open cut / Mine ou chantier à ciel ouvert
Bench mark, with elevation / Repère de nivellement avec cote — BM 157

DOWNIE CREEK

KOOTENAY DISTRICT

BRITISH COLUMBIA

WEST OF SIXTH MERIDIAN - OUEST DU SIXIÈME MÉRIDIEN

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Miles

Metres 1000 500 0 1000 2000 3000 4000 Metres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

ÉQUIDISTANCE DES COURBES : 100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Réseau géodésique nord-américain unifié (1927)
Projection transverse de Mercator

MAGNETIC DECLINATION 23°36' EAST
AT CENTRE OF MAP 1962
Annual change (decreasing) 3.3'

DÉCLINAISON MAGNÉTIQUE AU CENTRE DE LA FEUILLE EN 1962 : 23°36' EST
Variation annuelle (décroissante) 3.3'

The nomenclature on this map has not been submitted to the Canadian Board on Geographical Names and may be subject to revision. Information on names is invited by the Surveys and Mapping Branch.

La nomenclature de la présente carte n'a pas été soumise à la Commission canadienne des noms géographiques et, par conséquent, elle pourrait faire l'objet d'une revision. Tous renseignements sur les noms seront bien accueillis par la Direction des levés et de la cartographie.

Compilée en 1959-60 par la **DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DES MINES ET DES RELEVÉS TECHNIQUES,** à partir de photographies aériennes prises en 1951 et 1955. Travaux exécutés sur le terrain et vérification partielle des ouvrages en 1958. Imprimée en 1962.

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

Boarding / Hôtel
School / École
Church / Église
Lighthouse / Phare
River with bridge / Rivière avec pont
Stream, intermittent / Cours d'eau, intermittent
Marsh or Swamp / Marais ou marécage
Depression contours / Courbes de dépression
Bar / Barre
Post Office / Bureau de poste
Cemetery / Cimetière

NATIONAL TOPOGRAPHIC SYSTEM
SYSTÈME DE RÉFÉRENCE CARTOGRAPHIQUE NATIONAL

GSC-1258

GSC-172?

SCALE OF MILES
1 3/4 1/2 1/4 0 1 2 Miles
25

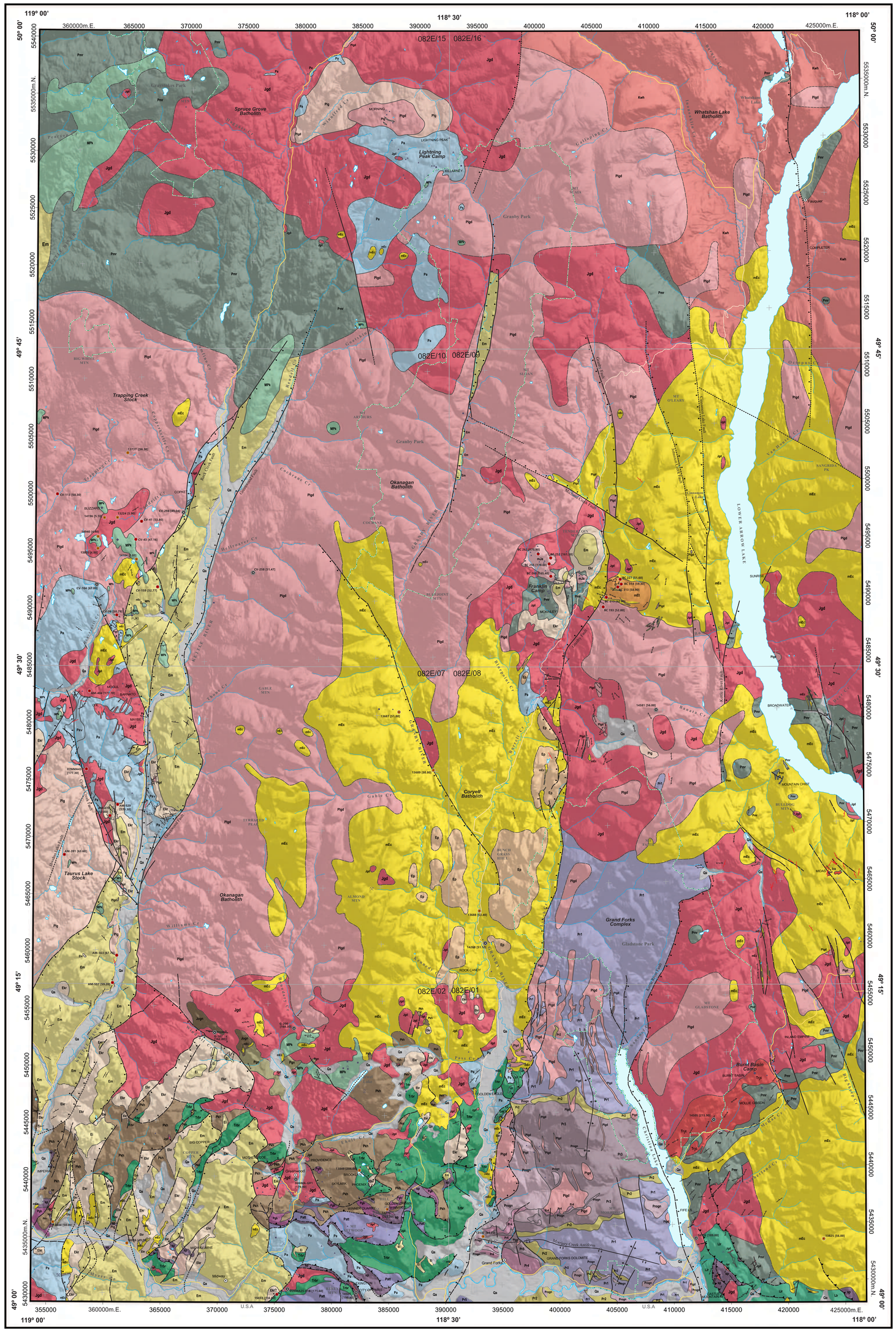
BOAT ENCAMPMENT
BRITISH COLUMBIA

OPEN FILE
156
June 1973
GEOLOGICAL SURVEY
OTTAWA

Compiled 1965 Photos AERO 1955
Advance Information
Subject to Revision

Penticton

PGL
ENVIRONMENTAL CONSULTANTS



GEOSCIENCE BC MAP 2019-04

GEOLOGY
of the
PENTICTON MAP SHEET (east half)

NTS 082E/01/02/07/08/09/10/15/16

SCALE 1:150 000

0 4 8 12 16 20

KILOMETRES

Geology and Compilation by Trygve Höy

Cartography by Wayne Jackaman

LEGEND

CENOZOIC

QUATERNARY

- Qa — unconsolidated sediments

NEOGENE

Pliocene/Miocene

- MPk — Kallis Formation: plateau basalt; locally olivine phyric

PALEOGENE

Eocene

- mEc — Coryell intrusions: alkalic intrusive rocks; syenite, monzonite (bx - breccia)
- mEt — Tenderloin complex: alkalic intrusive rocks; syenite, monzonite, diorite; pyroxenite
- Ei — Alkalic intrusions; syenite, diorite, rhomb porphyry, quartz monzonite (in part, equivalent to mEc)

Penticton Group

- Ep — Undifferentiated alkalic volcanic rocks, sandstone, grit
- Em — Marron Formation: trachyte, alkali basalt, tuff; minor shale or slate
- Ekr — Kettle River Formation: sandstone, conglomerate; feldspathic grit, minor shale, tuff

Paleocene

- Plgd — Massive, leucocratic granodiorite, "white" granite; locally porphyritic
- Plg — Porphyritic granite, magacrystic K-spar granite

MESOZOIC

Late Cretaceous

- Kwh — Whatshan Lake Batholith: quartz monzonite, granite; leucocratic, K-feldspar magacrystic

Early? - Middle Jurassic

- Jgd — Nelson intrusions: granodiorite, granite, minor diorite; locally porphyritic
- Jogn — Orthogneiss: granodiorite, diorite; may include Pgn
- mJa — Averill Complex: granodiorite, diorite, monzodiorite, monzonite, pyroxenite
- IJr — Rossland Group: andesite, phonolite, minor shale, siltstone

Late Triassic

- Trjc — Josh Creek diorite: diorite, granodiorite; actinolite-feldspar schist
- Trbr — Brooklyn Formation: massive greenstone, mafic volcanics; chert and limestone; related intrusions

PALEOZOIC

Late Devonian to Early Permian

- Pkh — Knob Hill Complex: mafic volcanic rocks, chert, argillite, greenstone
- Pgb — Greenwood gabbro: gabbro, diabase dykes, minor pegmatite
- sp — Serpentinite
- Patt — Attwood Formation: siltstone, argillite, minor volcanic rocks
- Pa — Anarchist schist, complex: argillaceous quartzite, schists, metavolcanics; white dolomite (Pav - mafic lava)
- Pmr — Mount Roberts Formation: mafic metavolcanics, siltstone, slate, marble; minor ultramafic rocks (includes Monashee gneiss of unknown age)

AGE UNKNOWN

- Pgn — Paragneiss; schist, quartzite; minor amphibolite, marble

PRECAMBRIAN

PROTEROZOIC

Mesoproterozoic

- Progn — Orthogneiss; hornblende granodiorite, syenitic, granitic
- Pr5 — Hornblende schist, amphibolite
- Pr4 — Amphibolite, calcareous schist, minor marble, calcsilicate gneiss
- Pr3 — Paragneiss, sillimanite schist, calcsilicate gneiss, minor marble
- Pr2 — Quartzite, marble, calcsilicate gneiss, minor pegmatite, amphibolite

Paleoproterozoic

- Pr1 — Core gneiss; paragneiss and schist, marble, calcsilicate gneiss and

SYMBOLS

- CONTACT OF ALLUVIUM
- CONTACT: DEFINED, APPROXIMATE, ASSUMED
- FAULT: DEFINED, APPROXIMATE, ASSUMED
- NORMAL FAULT: DEFINED, APPROXIMATE, ASSUMED
- THRUST FAULT: DEFINED, APPROXIMATE, ASSUMED
- ANTIFORM
- ANTIFORM, OVERTURNED
- BEDDING
- FOLIATION, CLEAVAGE
- VEIN
- MINERAL OCCURRENCE - PRODUCER (NAME)
- MINERAL OCCURRENCE - PAST PRODUCER
- MINERAL OCCURRENCE - DEVELOPED PROSPECT
- MINERAL OCCURRENCE - PROSPECT
- MINERAL OCCURRENCE - SHOWING
- U-Pb AGE DATES (Ma) (ID [DATE])
- Ar/Ar AGE DATES (Ma) (ID [DATE])
- K/Ar AGE DATES (Ma) (ID [DATE])
- CITY
- HIGHWAY, ROAD
- STREAM, RIVER, LAKE
- PARK BOUNDARY

BASE MAP INFORMATION

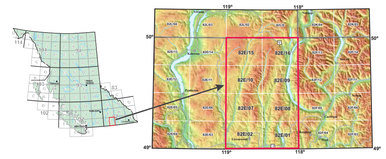
NAD 1983 UTM ZONE 11
TRANSVERSE MERCATOR
PROJECTION

APPROXIMATE MEAN DECLINATION 2017
FOR CENTRE OF MAP 082E/EAST HALF
ANNUAL CHANGE 8.9'/YEAR WEST

National Topographic Data Base (NTDB)
URL http://www.geogratis.ca
Natural Resources Canada, Centre for Topographic Information

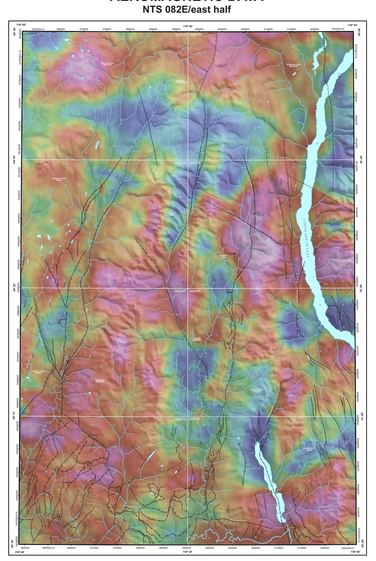
Canadian Digital Elevation Data (CDED)
URL http://www.geobase.ca
Base Mapping and Geomatic Services - B.C. Government

LOCATION MAP



AEROMAGNETIC DATA

NTS 082E/east half



AGE DATES

SAMPLE ID	UTME	UTMN	ROCK TYPE	UNIT	COLLECTOR (REF)	DATED BY	METHOD - MINERAL	AGE
Grand Forks (082E/01)								
13147	393461	5434341	leucocyenite		Stevens et al. (1984)	GSC	K/Ar hb	64.20
14506	412060	5433810	diorite		Acton et al. (2002)	U of Alta	U-Pb zr	189.00
14505	413870	5444010	diorite	Josh Creek	Acton et al. (2002)	U of Alta	U-Pb zr	215.90
13825	423195	5433535	syenite		Baadsgaard et al. (1961)	U of Alta	K/Ar hb	56.00
Greenwood (082E/02)								
13834	355769	5436363	volcanic ash	Marron Fm	Mathews (1964)	U of Alta	K/Ar bi	50.00
13836	362174	5434345	porphyry sill		Mathews (1964)	U of Alta	K/Ar bi	49.00
15033	375226	5429526	pyroxenite	Sapho	Massey et al. (2009)	Queen's U	Ar/Ar	156.00
14507	382299	5429616	qtz-hbl porphyry	Lexington	Dostal et al. (2001)	UBC	U-Pb zr	199.40
13849	382771	5440359	microdiorite		Church (1986)	UBC	K/Ar hb	206.00
14373	385155	5438824	clinopyroxenite	Pgb	Church (1986)	UBC	K/Ar wr	223.00
06MMA-GR1	377299	5439604	granodiorite	Greenwood	Massey et al. (2010)	J. Gabbes, UBC	U-Pb zr	179.90 ± 3.8
G-167	370256	5452583	hb gneiss	Jogn	T. Höy (2018)	R. Friedman, UBC	U-Pb zr	162.80 ± 1.2
G-200	377013	5452662	granodiorite	Jgd	T. Höy (2018)	R. Friedman, UBC	U-Pb zr	168.30 ± 1.2
05NMA25-01B	376036	5429850	qtz-hbl porphyry	Gidon Cr porph	Massey et al. (2010)	J. Gabbes, UBC	U-Pb zr	171.60 ± 2.3
Almond Mountain (082E/07)								
13687	386902	5480310	syenite	Coryell	Hunt et al. (1991)	GSC	K/Ar bi	51.80
13686	389819	5475163	syenite	Coryell	Hunt et al. (1991)	GSC	K/Ar bi	50.80
07MMA43-010	359462	5475794	hb diorite	Jgd	Massey et al. (2010)	J. Gabbes, UBC	Ar-Ar hb	177.30 ± 1.0
AM-470	361491	5471677	latite	Marron Fm	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar pl	57.80 ± 2.1
AM-391	357272	5458643	granite	Plg	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar bi	63.60 ± 1.3
AM-563	361875	5459547	granite	Plg	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar ksp	67.70 ± 8.0
AM-579	349520	5477452	granodiorite	Jgd	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar hb	168.40 ± 1.6
AM-404	359863	5452877	granodiorite	Jgd	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar mu	177.70 ± 3.0
AM-529	362117	5472621	hb granite	Jgd	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar hb	179.30 ± 4.5
Deer Park (082E/08)								
13688	359939	5462752	syenite	Coryell	Hunt and Roddick (1991)	GSC	K/Ar bi	53.40
14268	393960	5459964	syenite	Coryell	Carr and Parkinson (1989)	U of Cal	U-Pb zr	51.10
14581	409320	5480361	granite	Ladybird	Parrish (1992)	GSC	U-Pb zr	56.00
Burrell Creek (082E/09)								
BC 180	404902	5489113	hb granite	Ladybird	T. Höy (2018)	J. Gabbes, UBC	Ar/Ar hb	52.80 ±1.6
BC 213	405233	5490010	pyroxenite	Tenderloin Cx	T. Höy (2018)	J. Gabbes, UBC	Ar/Ar bi	50.60 ±0.6
BC 227	406834	5491346	qtz monzonite	Tenderloin Cx	T. Höy (2018)	J. Gabbes, UBC	Ar/Ar bi	51.60 ±0.6
BC 252	406651	5493199	monzonite	Averill Cx	T. Höy (2018)	J. Gabbes, UBC	Ar/Ar hb	161.30 ±2.4
BC 255	400355	5492907	monzodiorite	Averill Cx	T. Höy (2018)	J. Gabbes, UBC	Ar/Ar hb	176.00 ±2.5
BC 260	400452	5491937	syenite	Averill Cx	T. Höy (2018)	J. Gabbes, UBC	Ar/Ar bi	165.40 ±1.9
BC 262	399332	5493885	monzogabbro	Averill Cx	T. Höy (2018)	J. Gabbes, UBC	Ar/Ar bi	175.90 ±2.1
BC 313	406496	5490971	diorite	Tenderloin Cx	T. Höy (2018)	J. Gabbes, UBC	Ar/Ar bi	58.90 ±0.7
BC 314	406619	5491078	monzodiorite	Tenderloin Cx	T. Höy (2018)	J. Gabbes, UBC	Ar/Ar bi	59.30 ±0.7
Christian Valley (082E/10)								
13655	360753	5495225	basalt	Kallis Fm	Sun et al. (1991)	J. Harakal, UBC	K/Ar wr	4.80 ±0.4
14940	360519	5496209	basalt	Kallis Fm	Boyle (1982)	GSC, Ottawa?	K/Ar wr	4.40 ±0.6
14196	361469	5497766	basalt	Kallis Fm	Mathews (1988)	J. Harakal, UBC	K/Ar wr	5.10 ±1.0
13224	362672	5497735	basalt	Kallis Fm	Stevens et al. (1982)	GSC, Ottawa	K/Ar wr	5.90 ±0.6
13737	363719	5503408	bi granite	Pgd	Hunt, Roddick (1992)	GSC, Ottawa	K/Ar bi	56.30 ±2.5
14184	364386	5493984	basalt	Kallis Fm	Mathews (1988)	J. Harakal, UBC	K/Ar wr	3.60 ±2.8
CV-06	382462	5489153	hb granodiorite	Pgd	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar hb	50.79 ±0.69
CV-43	364772	5497380	hp porphyry	Marron Fm	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar fsp	53.80 ±1.8
CV-43	364297	5495884	granite	Pgd	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar bi	47.16 ±0.36
CV-104	360839	5491943	bi granite	Pgd	T. Höy (2018)	R. Friedman,UBC	U-Pb zr	67.00 ±0.46
CV-113	357626	5499999	bi granodiorite	Pgd	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar bi	50.30 ±0.19
CV-159	365902	5491657	mafic lava	Marron Fm	T. Höy (2018)	J. Gabbes, UBC	Ar-Ar bi	52.77 ±0.38
CV-256	374323	5492821	qtz monzonite	Pgd	T. Höy (2018)	R. Friedman,UBC	U-Pb zr	51.47 ±0.45
CV-294	369478	5498093	andesite dyke	Marron?	T. Höy (2018)	R. Friedman,UBC	U-Pb zr	49.40 ±0.77

SOURCES OF DATA

GEOLOGY

Christopher, P.A. (1978): East Okanagan Uranium area, south-central B.C.; B.C. MEMPR, Preliminary map 29.

Church, B.N. (1986): Geological setting and mineralization in the Mount Attwood–Phoenix area of the Greenwood camp; MEMPR, Paper 1986-2.

Drysdale, C.W. (1915): Geology of the Franklin mining camp, southern British Columbia; GSC, Memoir 15.

Fyles, J.T. (1990): Geology of the Greenwood–Grand Forks area, British Columbia; MEMPR, Open File 1990-25.

Höy, T. and Jackaman, W. (2005): Geology of the Grand Forks map sheet, British Columbia (NTS 082E/01); MEMPR, Geoscience Map 2005-2, scale 1:50 000.

Höy, T. and Jackaman, W. (2010): Geology of the Deer Park map sheet (NTS 82E/08); Geoscience BC, Map 2010-7-1, scale 1:50 000.

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Höy, T. and Jackaman, W. (2016): Geology of the Almond Mountain map sheet (NTS 82E/07); Geoscience BC, Map 2016-07-1, scale 1:50 000.

Höy, T. and Jackaman, W. (2017): Geology of the Christian Valley map sheet (NTS 82E/10); Geoscience BC, Map 2017-10, scale 1:50 000.

Little, H.W. (1957): Kettle River (East half); Geological Survey of Canada, Map 6-1957, scale 1:253,440.

Little, H.W. (1979): Geology of the Greenwood map area, British Columbia; GSC, Paper 79-29.

Massey, N. (2007a): Geology and mineral deposits of the Rock Creek area, British Columbia; BC MEMPR, BC Geological Survey, Open File 2007-7.

Massey, N. and Duffy, A. (2008): Geology and mineral deposits of the area east of Beaverdell, British Columbia; MEMPR, Open file 2008-9.

Preto, V.A. (1970): Structure and petrology of the Grand Forks Group, BC; GSC, Paper 69-22.

Reinecke, L (1915): Ore deposits of the Beaverdell map area; GSC, Memoir 79, 172 p.

Tempelman-Kluit, D. J. (1989): Geology, Penticton, British Columbia; GSC, Map 1736A, scale 1:250 000.

OTHER

BC Geological Survey (2017): MINFILE BC mineral deposits database; BC Ministry of Energy and Mines, BC Geological Survey, URL <http://Minfile.ca/> [September 2011]. (update December 2017 with date of data download)

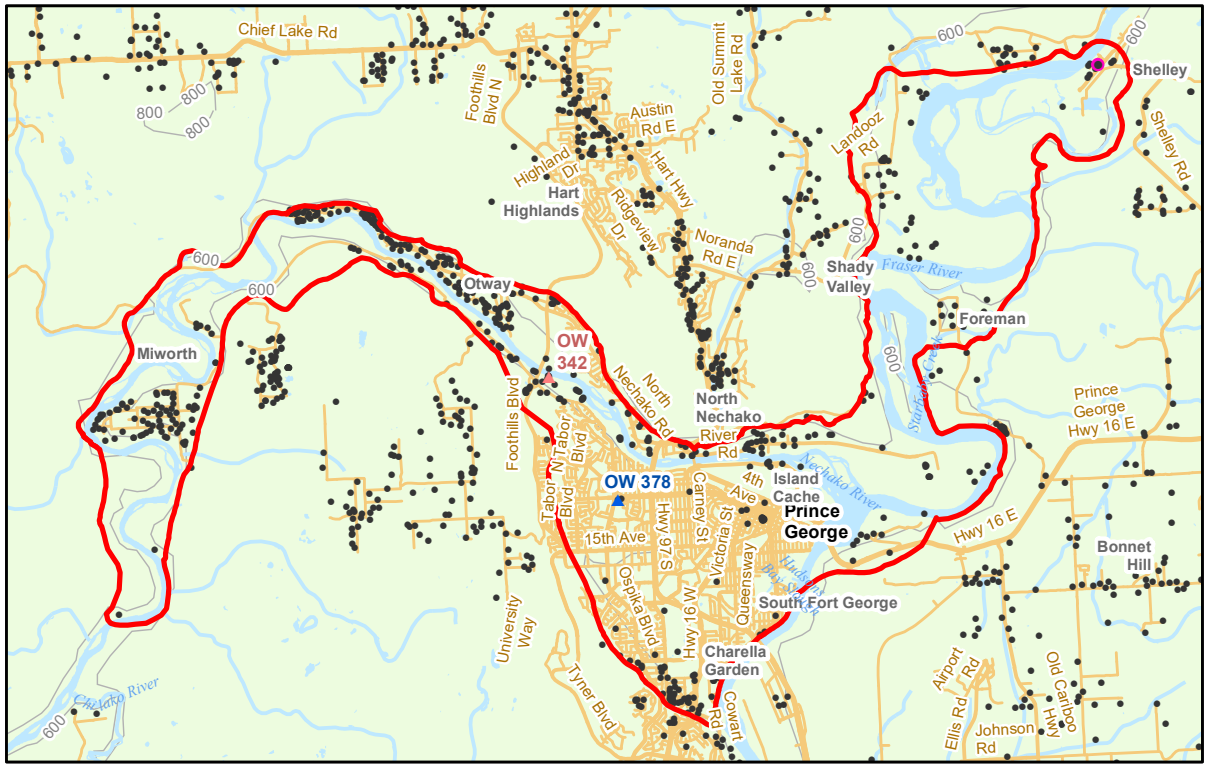
Canadian Aeromagnetic Data Base (2010): Geoscience Data Repository, Geological Survey of Canada, Earth Sciences Sector, Natural Resources Canada, Government of Canada.

Appendix 3

Aquifer Fact Sheets

PGL
ENVIRONMENTAL CONSULTANTS

Aquifer #92
Lower Nechako River



Legend

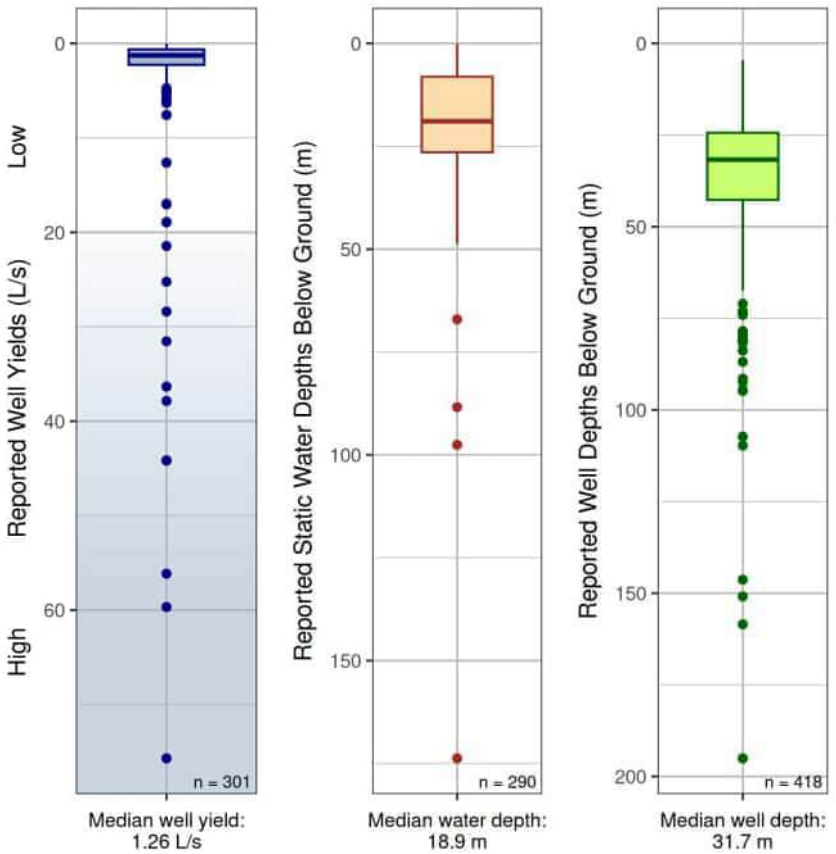
- Registered Water Well - Artesian
- Registered Water Well
- Active Observation Well
- Inactive Observation Well
- Aquifer Boundary

Aquifer Description (Mapping Report - 2017): Predominantly unconfined fluvial or glacio-fluvial sand and gravel aquifer found along rivers of moderate stream order with the potential to be hydraulically influenced by the river (subtype = 1b).

Aquifer Details	
Region	Omineca
Water District	Prince George
Aquifer Area	94 km^2
No. Wells Correlated	424
Vulnerability to Contamination	High
Productivity	High
Aquifer Classification	IA
Hydraulic Conductivity *	Unknown
Transmissivity *	Unknown
Storativity *	Unknown
No. Water Licences Issued to Wells	38
Observation Wells (**Active**, Inactive)	**378**, 342

* min - max

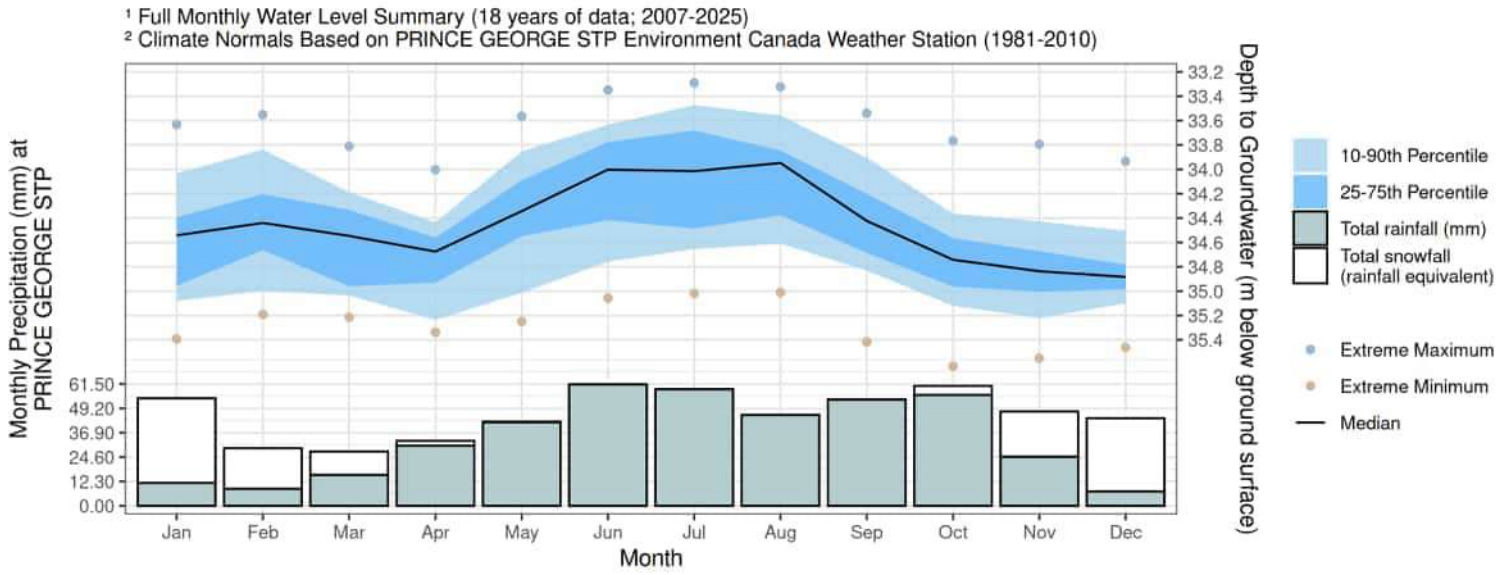
For Hydraulic Connection see guidance document



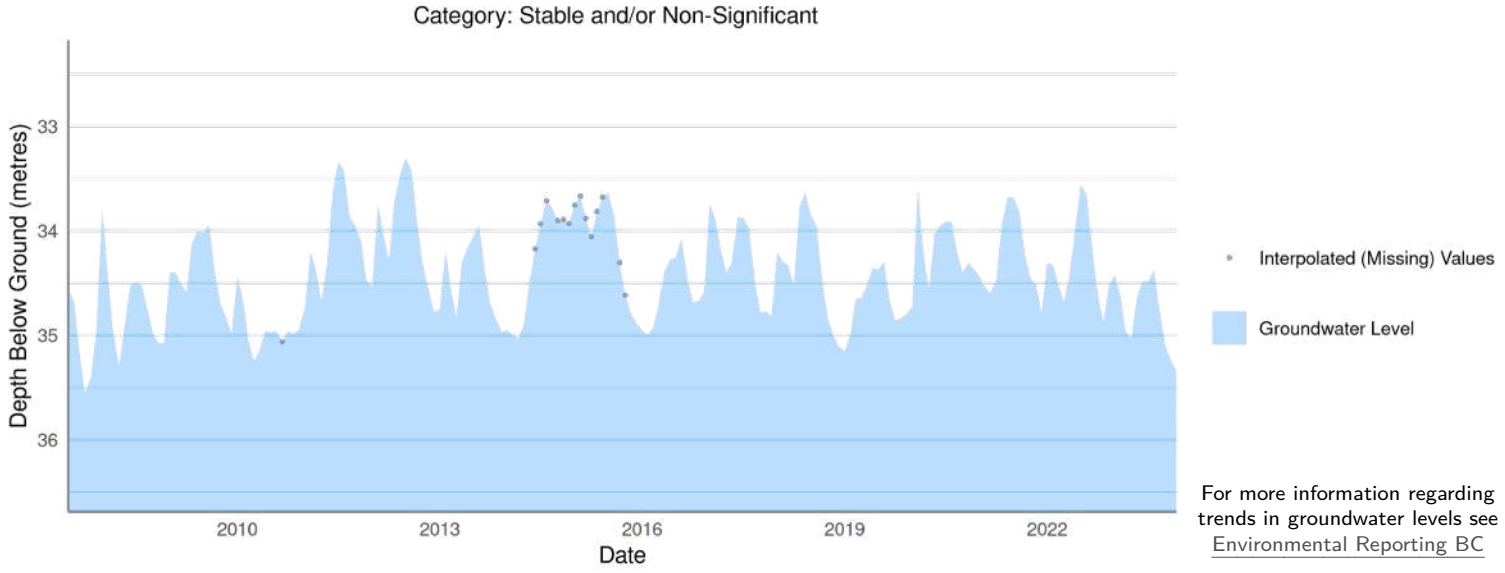
Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).

Factsheet generated: 2025-03-26. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.

Monthly Groundwater Level[1] with Precipitation from Climate Normals[2]

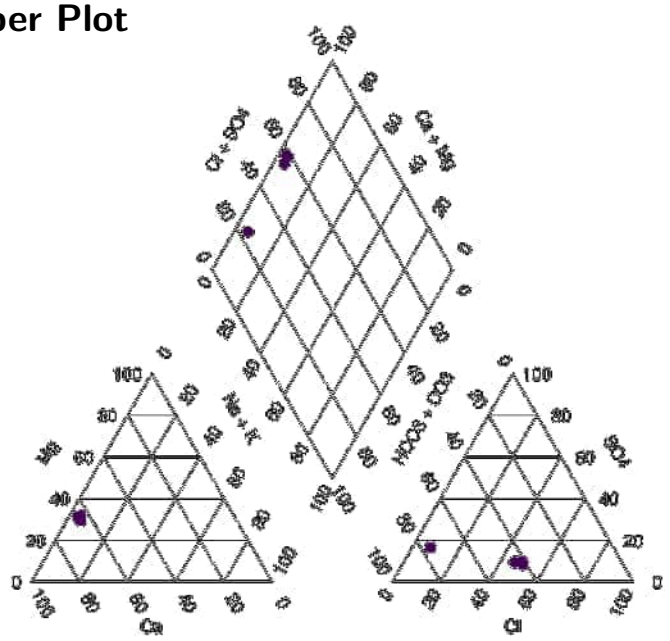


Groundwater Levels and Long-term Trend



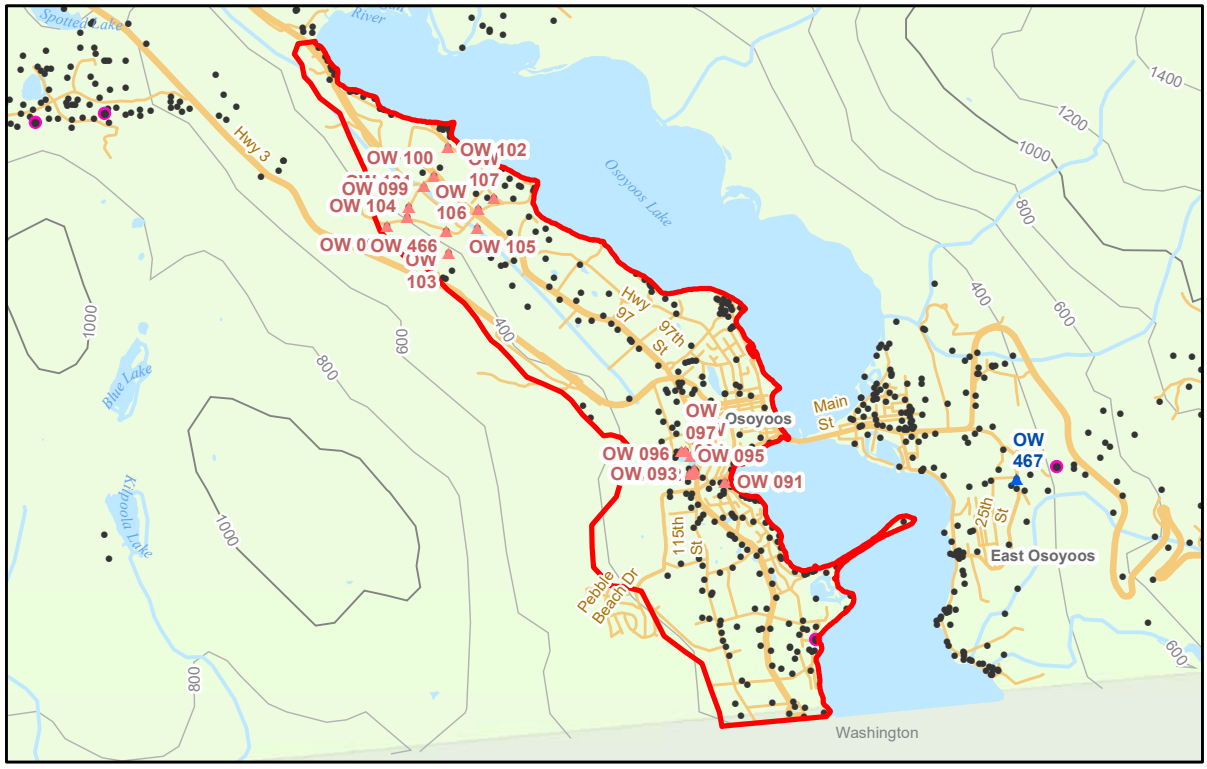
For more information regarding trends in groundwater levels see Environmental Reporting BC

Piper Plot



The groundwater samples are typically of the Ca-Mg-Cl-HCO3 & Ca-Mg-HCO3 type. Ca & Mg are the dominant cations, which indicates a less evolved/short flow path recharge area type of groundwater. The fact that HCO3 is the dominant anion shows the source is primarily recent precipitation in the shallow alluvial sand and gravel aquifer #92. Cl enrichment could be attributed to anthropogenic activities such as application of chemical fertilizers, road salt and/or sewage effluents in the area. For EMS water chemistry data, see EMS ID E269903.

Aquifer #193
Osoyoos West



Legend
- Registered Water Well - Artesian
- Registered Water Well
- Active Observation Well
- Inactive Observation Well
- Aquifer Boundary

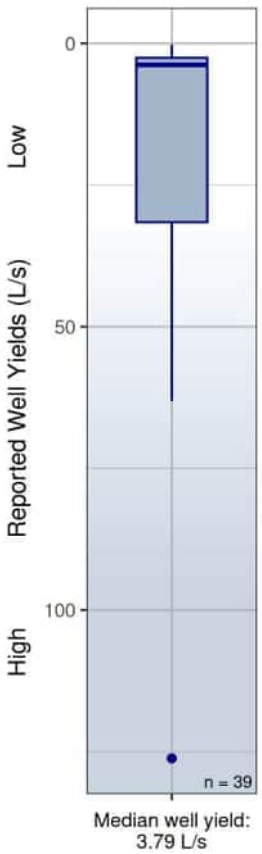
0 1 2 km

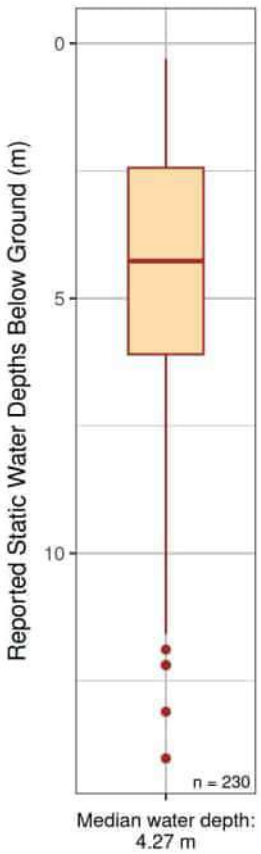
N

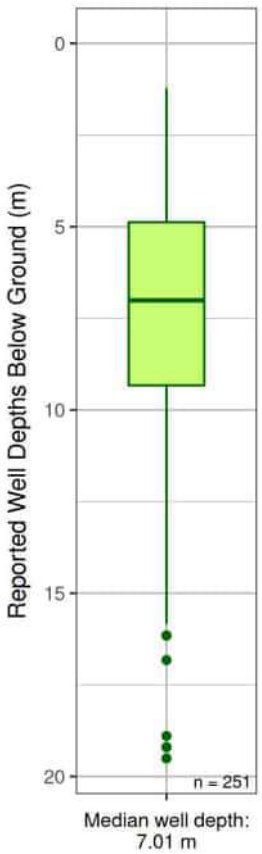
Aquifer Description (Mapping Report - 2012): Unconfined glacio-fluvial outwash or ice contact sand and gravel aquifer generally formed near or at the end of the last period of glaciation (sub-type = 4a).

Aquifer Details	
Region	Thompson-Okanagan
Water District	Penticton
Aquifer Area	14 km^2
No. Wells Correlated	252
Vulnerability to Contamination	High
Productivity	High
Aquifer Classification	IA
Hydraulic Conductivity *	1.3x10^{-3} - 4.1x10^{-3} m/s (n=6)
Transmissivity *	8.3x10^{-3} - 3.6x10^{-2} m^2/s (n=6)
Storativity *	4.9x10^{-2} - 8.6x10^{-2} (n=4)
No. Water Licences Issued to Wells	1
Observation Wells (**Active**, Inactive)	14 inactive wells

* min - max
For Hydraulic Connection see guidance document

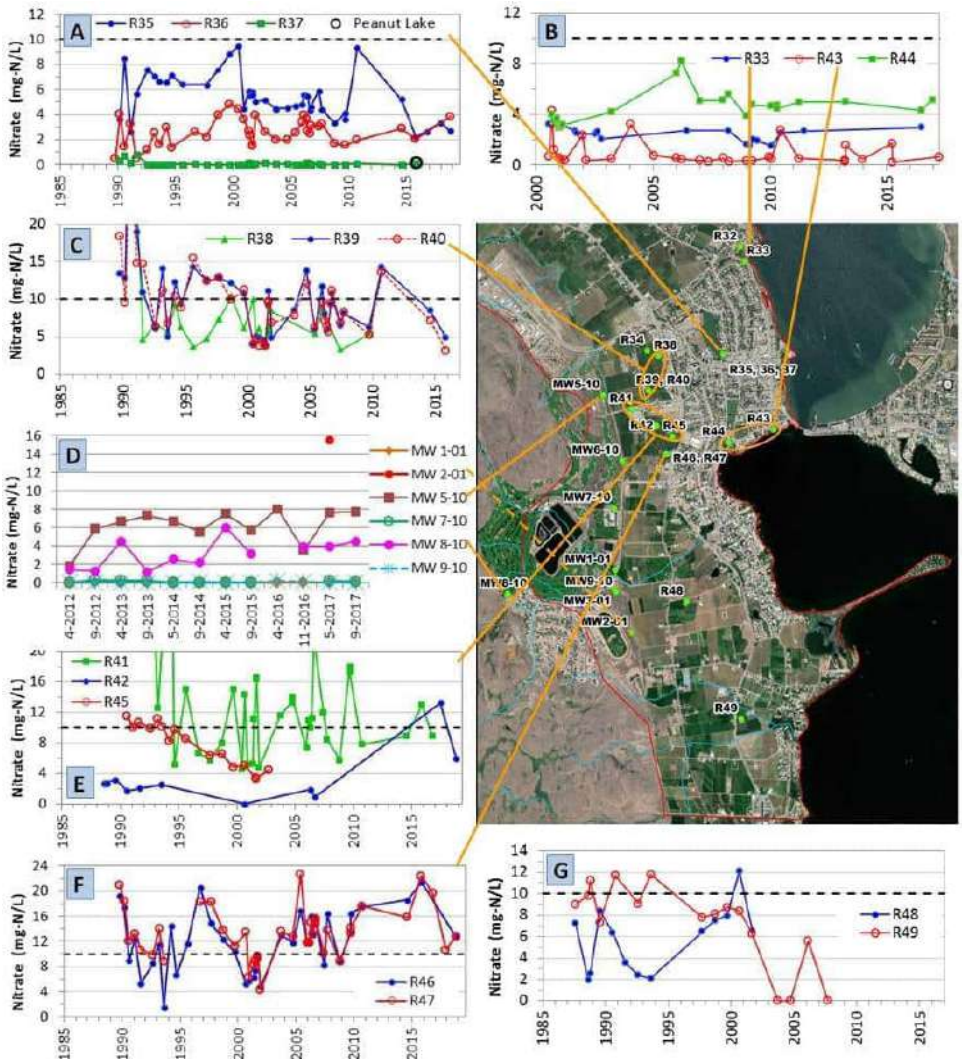






Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).
Factsheet generated: 2025-03-26. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.

Water Quality



Nitrate time series plots from wells in the southern portion of the Osoyoos Aquifer #193. The horizontal dashed line is the Health Canada drinking water MAC.

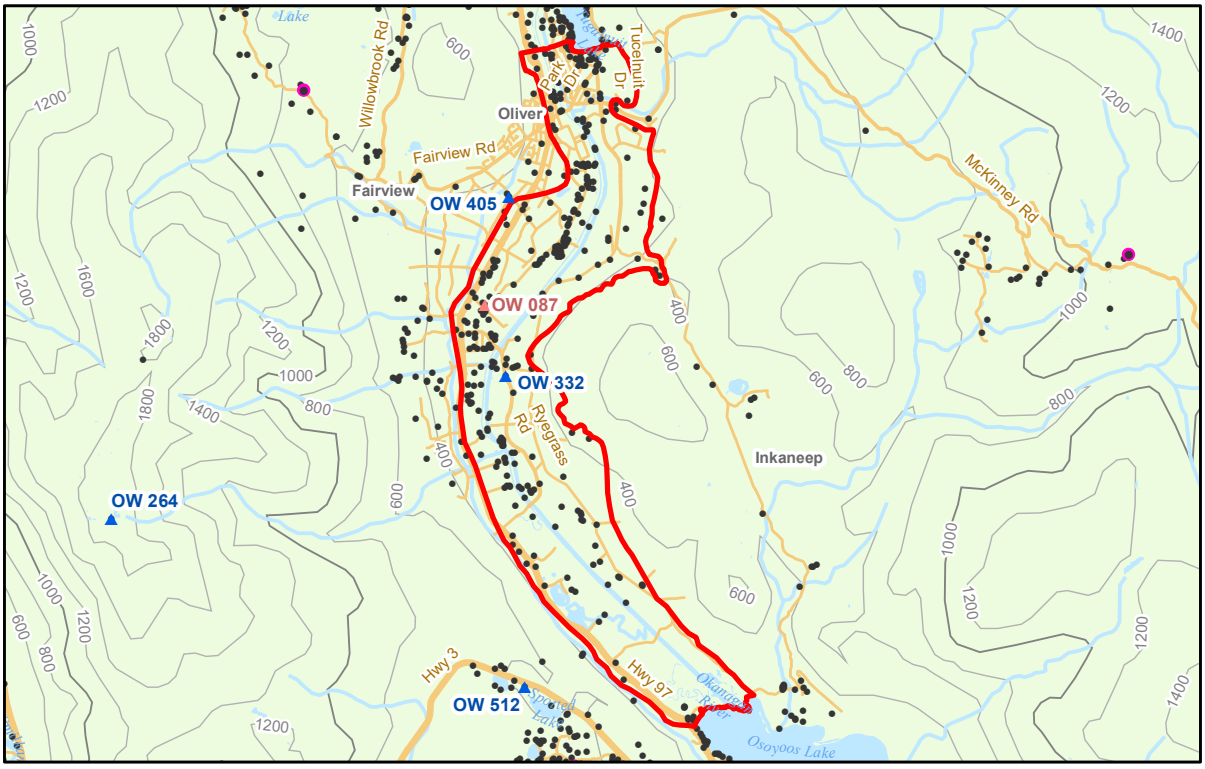
Groundwater monitoring data for nitrate are available from 43 wells throughout the aquifer spanning over three decades. Samples were typically collected once per year, generally in the late summer and fall, but there is no consistency in the collection timing.

Groundwater monitoring wells in the southern portion of the aquifer are influenced by a variety of land use activities, including urban development (wells R35, R36, R37), agricultural areas (wells R42, R45, R48, R49), wastewater irrigation (R41, MW5-10), or a combination of these activities.

Wells R35, R36 and R37 are closely spaced wells located in residential areas adjacent to Peanut Lake. These wells are designed to assess groundwater quality at three depth intervals: shallow (R37, 8.6 m), intermediate (R36, 10.6 m) and deep (R35, 13.4 m). Monitoring results show a strong association between nitrate concentration and sampling depth, with smallest nitrate concentrations measured in the shallow well (R37) and highest nitrate concentrations (~3 to 10 mg-N/L) in the deep well (R35). Increasing nitrate levels with depth suggests groundwater monitoring results are influenced by mixing and dilution with lake water from Peanut Lake, with more dilution occurring in the shallower well. The nitrate levels in the deeper and intermediate wells are consistently below the drinking water MAC, but generally in a moderate range (~2 to 6 mg-N/L) indicating persistent anthropogenic inputs. The potential upgradient sources include urban, agricultural and wastewater irrigation land uses.

Reference: Rathfelder, K. and L. Gregory, 2019. Groundwater quality assessment and proposed objectives for the Osoyoos Aquifer, Water Science Series: WSS2019-06, Province of British Columbia, Victoria.

Aquifer #254



Legend

- Registered Water Well - Artesian
- Registered Water Well
- Active Observation Well
- Inactive Observation Well
- Aquifer Boundary

0 1.5 3 km

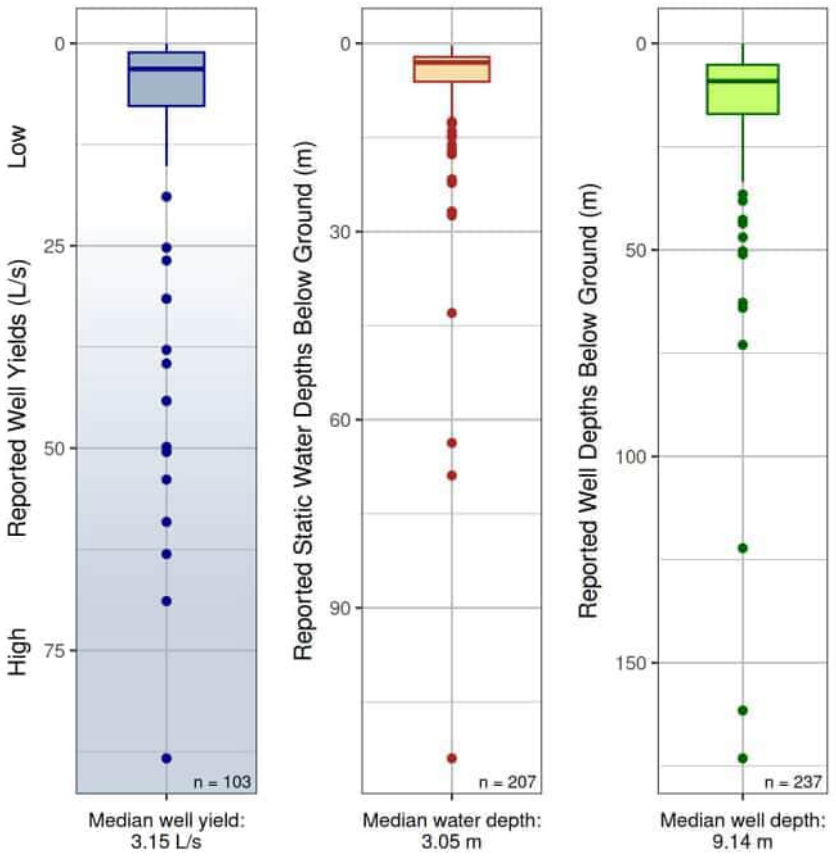
N

Aquifer Description (Mapping Report - 2016): Predominantly unconfined fluvial or glacio-fluvial sand and gravel aquifer found along major rivers of higher stream order with the potential to be hydraulically influenced by the river (subtype = 1a).

Aquifer Details	
Region	Thompson-Okanagan
Water District	Penticton
Aquifer Area	29.4 km^2
No. Wells Correlated	238
Vulnerability to Contamination	High
Productivity	High
Aquifer Classification	IIA
Hydraulic Conductivity *	6x10^{-3} - 3.9x10^{-2} m/s (n=5)
Transmissivity *	2.2x10^{-2} - 1.5x10^{-1} m^2/s (n=6)
Storativity *	2.6x10^{-1} - 2.9x10^{-1} (n=2)
No. Water Licences Issued to Wells	17
Observation Wells (**Active**, Inactive)	**332**, 87

* min - max

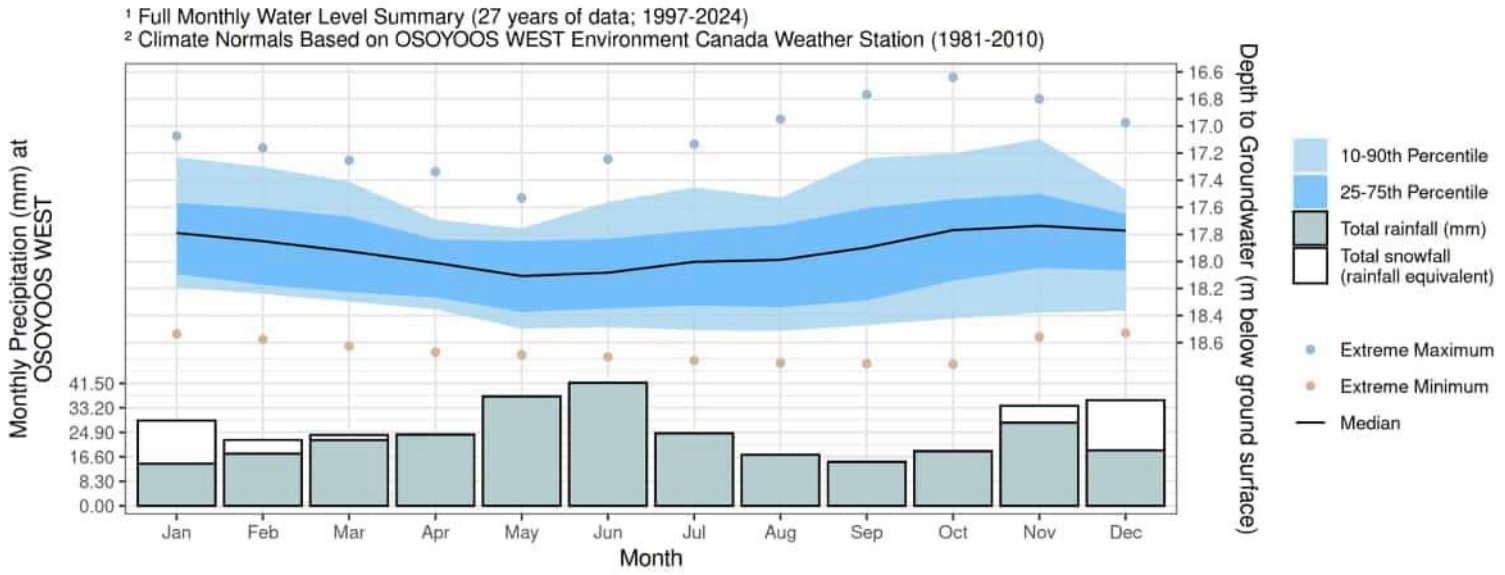
For Hydraulic Connection see guidance document



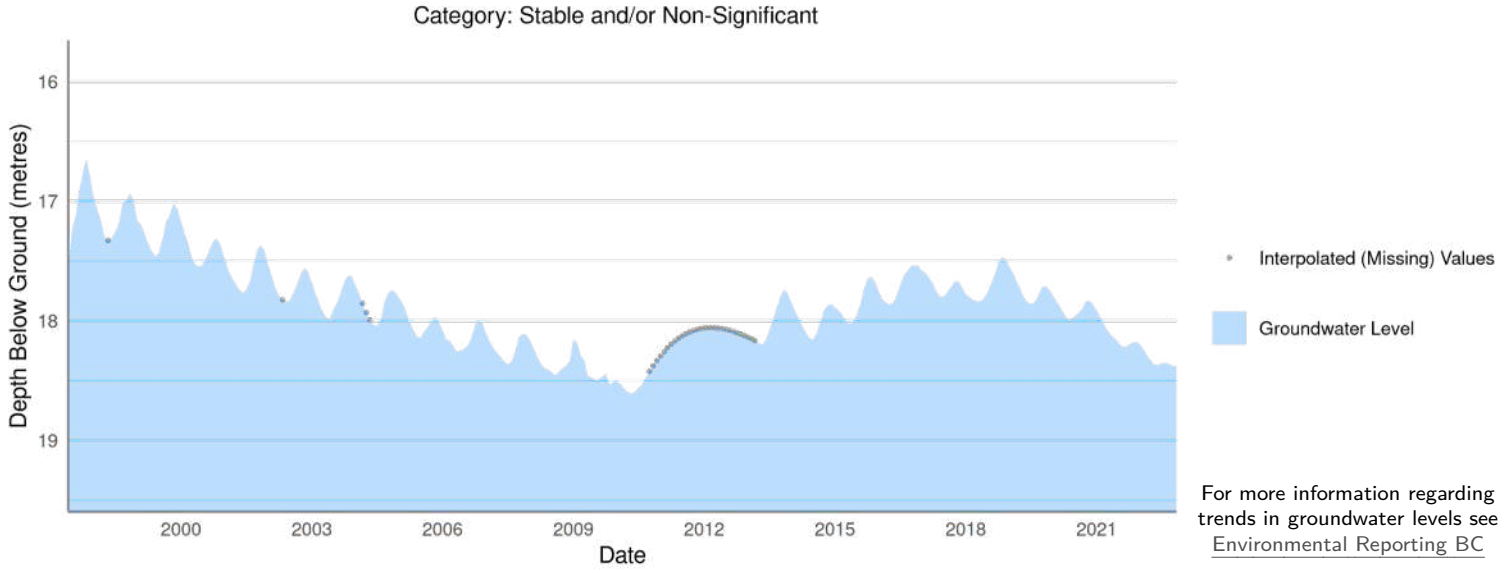
Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).

Factsheet generated: 2025-03-26. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.

Monthly Groundwater Level[1] with Precipitation from Climate Normals[2]

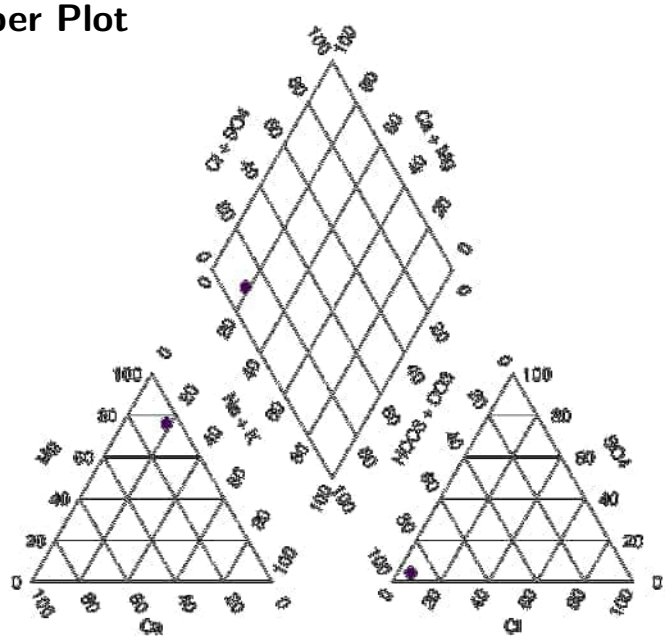


Groundwater Levels and Long-term Trend



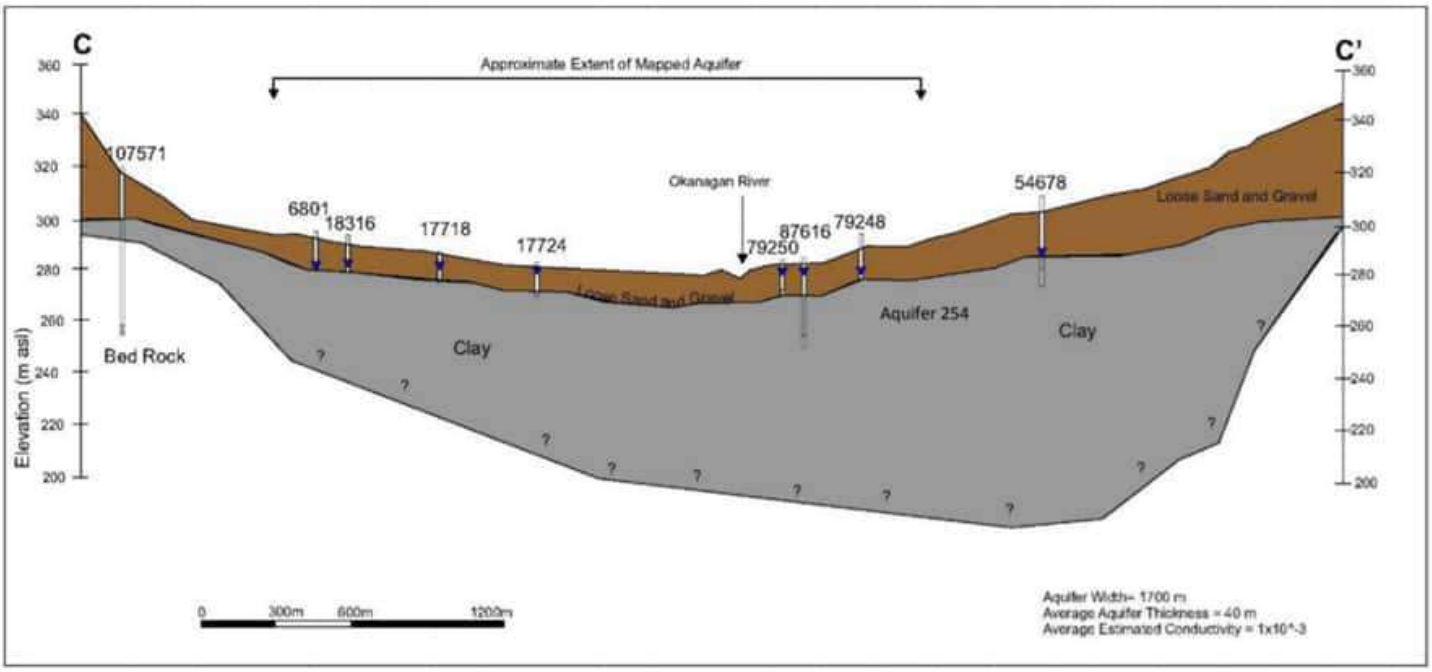
For more information regarding trends in groundwater levels see Environmental Reporting BC

Piper Plot



The groundwater samples are typically of the Mg-HCO3 type. Mg is the dominant cation, which indicates a less evolved/short flow path recharge area type of groundwater. The fact that HCO3 is the dominant anion shows the source is primarily recent precipitation in the shallow predominantly unconfined fluvial or glacio-fluvial sand and gravel aquifer #254. For EMS water chemistry data, see EMS ID E232063.

Water Budget

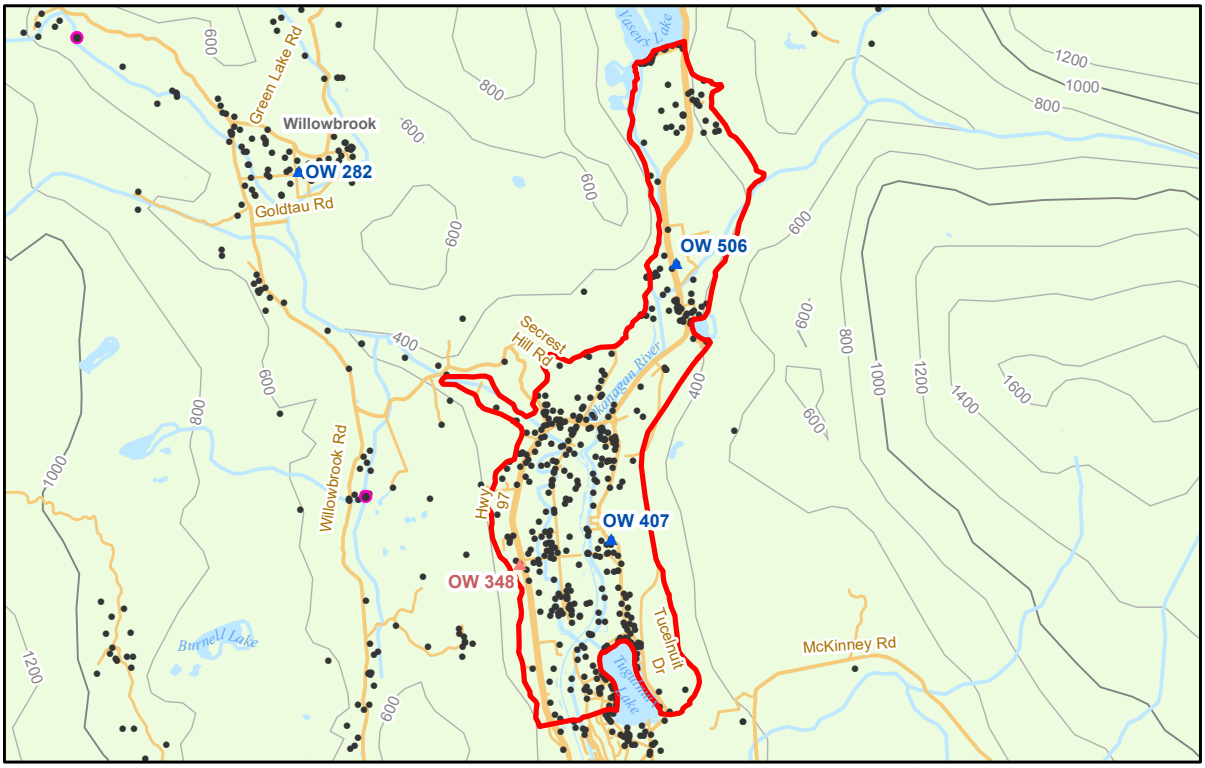


Aquifer 254 is thought to be the southern continuation of Aquifer 255 and extends south from Tuc-El-Nuit Lake to Osoyoos Lake. The mostly unconfined aquifer is composed of Okanagan River floodplain deposits, and in places, glacio-fluvial deposits and is thought to be connected to adjacent Aquifer 256. Aquifer 254 is believed to have the main characteristics:

- Also a highly productive aquifer supporting a number of municipal wells;
- Located within historically agricultural and urban areas; and
- Likely the second most heavily used aquifer in the study area (Aquifer 254, 255, 256).

Reference: Geller, D. and B. Manwell. 2016. Monthly Water Budgets for Aquifers in the Oliver, B.C. Area (Aquifers 254, 255 and 256). Water Science Series, WSS2016-07. Prov. B.C., Victoria B.C.

Aquifer #255



Legend

- Registered Water Well - Artesian
- Registered Water Well
- Active Observation Well
- Inactive Observation Well
- Aquifer Boundary

0 1 2 km

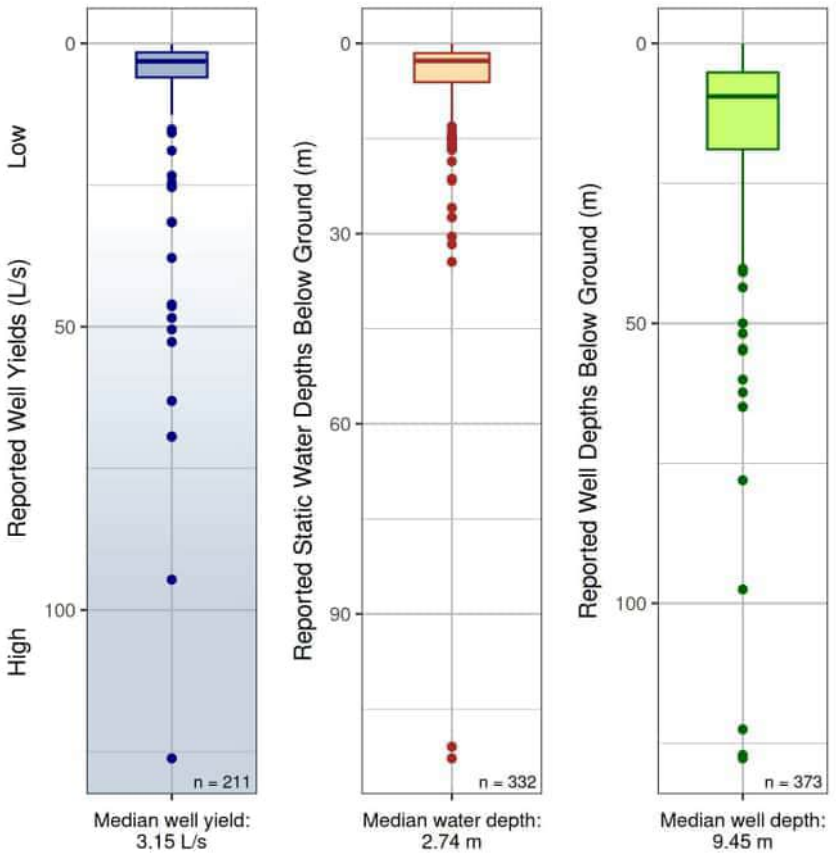
N

Aquifer Description (Mapping Report - 2016): Predominantly unconfined fluvial or glacio-fluvial sand and gravel aquifer found along major rivers of higher stream order with the potential to be hydraulically influenced by the river (subtype = 1a).

Aquifer Details	
Region	Thompson-Okanagan
Water District	Penticton
Aquifer Area	13.7 km^2
No. Wells Correlated	380
Vulnerability to Contamination	High
Productivity	Moderate
Aquifer Classification	IA
Hydraulic Conductivity *	Unknown
Transmissivity *	Unknown
Storativity *	Unknown
No. Water Licences Issued to Wells	31
Observation Wells (**Active**, Inactive)	**407**, **506**, 348

* min - max

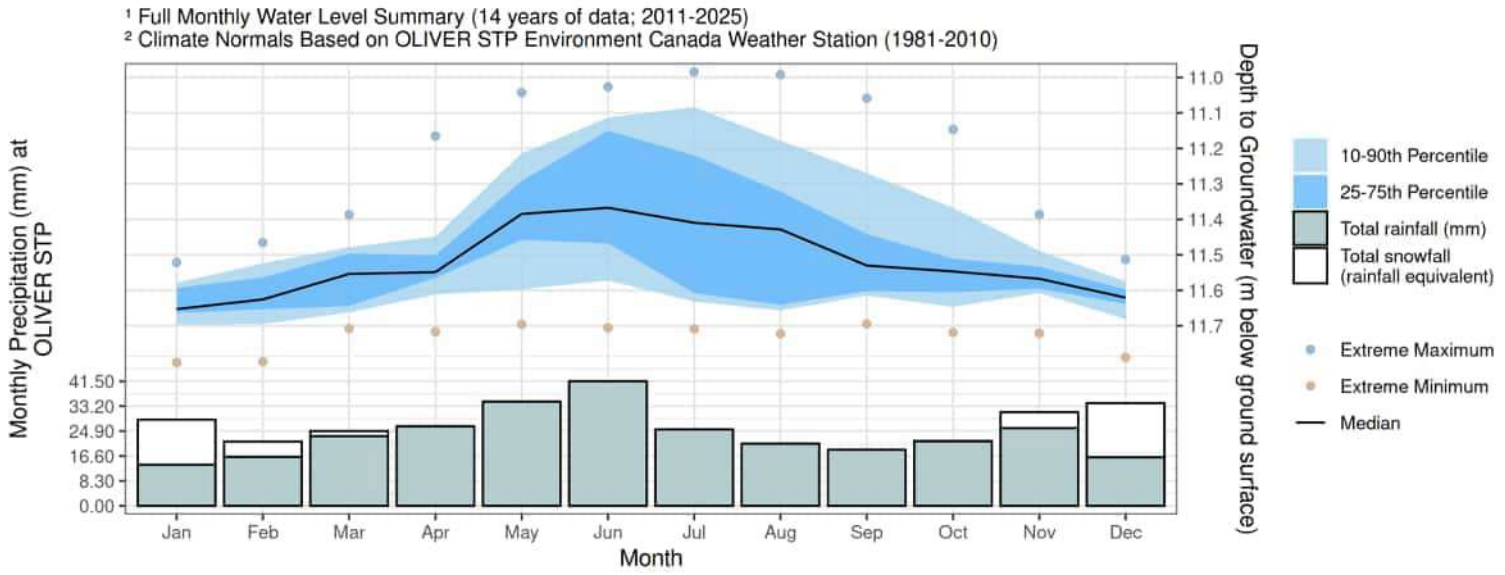
For Hydraulic Connection see guidance document



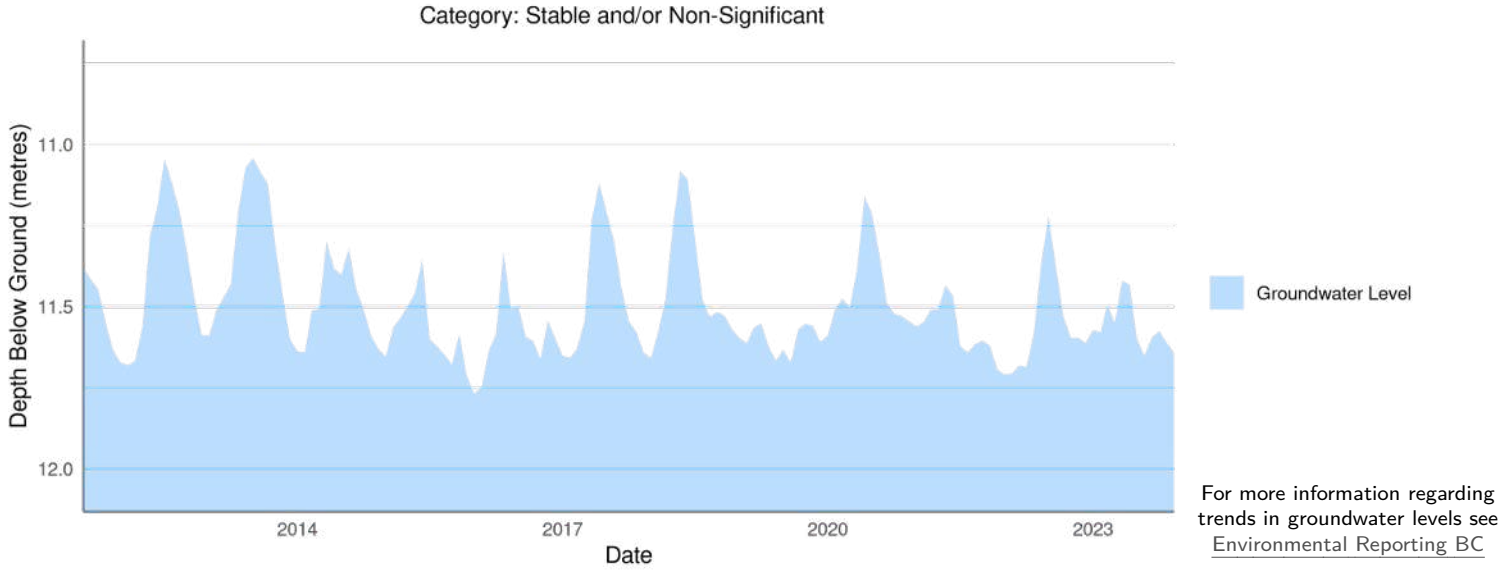
Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).

Factsheet generated: 2025-03-26. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.

Monthly Groundwater Level[1] with Precipitation from Climate Normals[2]

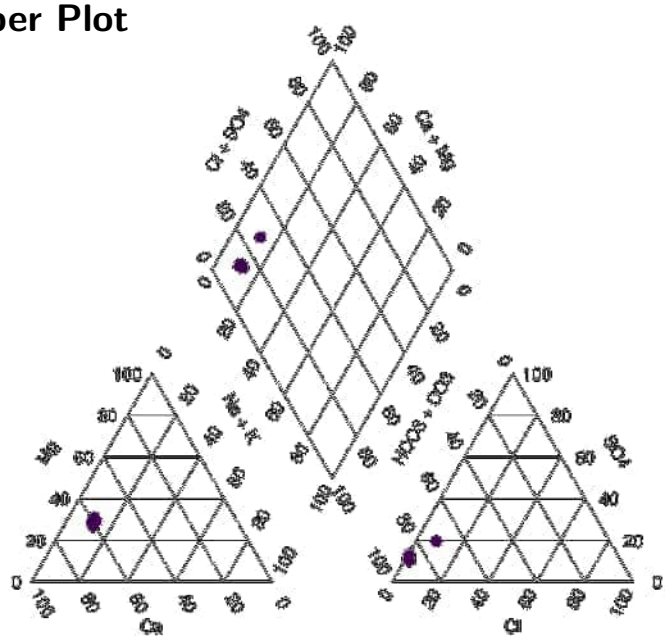


Groundwater Levels and Long-term Trend



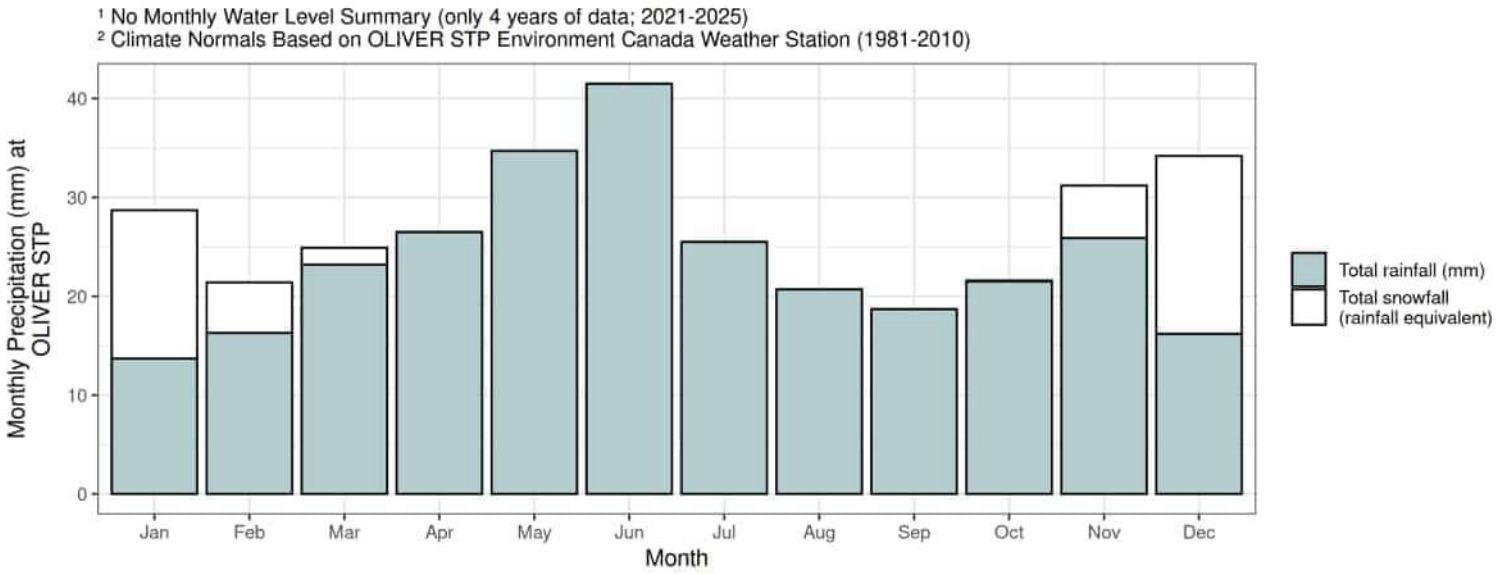
For more information regarding trends in groundwater levels see Environmental Reporting BC

Piper Plot



The groundwater samples are typically of the Ca-Mg-HCO3 type. Ca & Mg are the dominant cations, which indicates a less evolved/short flow path recharge area type of groundwater. The fact that HCO3 is the dominant anion shows the source is primarily recent precipitation in the unconfined sand and gravel #255. For EMS water chemistry data, see EMS ID E284853.

Monthly Groundwater Level[1] with Precipitation from Climate Normals[2]

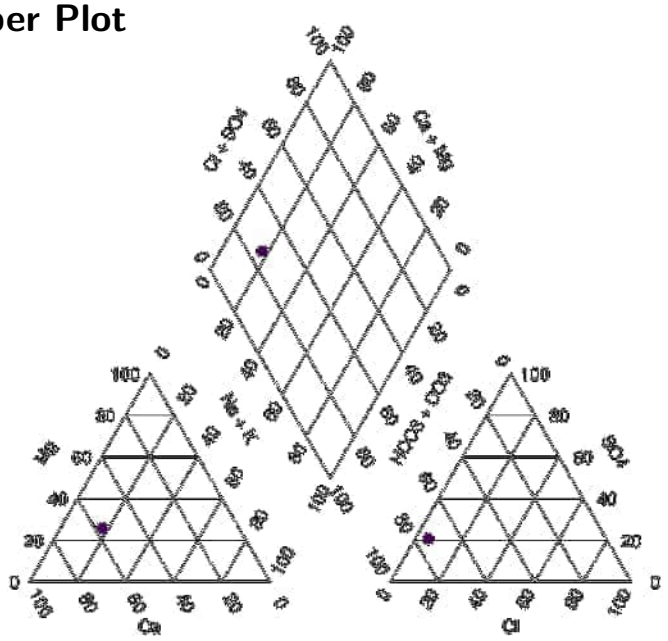


Groundwater Levels and Long-term Trend

Graph not available
(Not enough data)

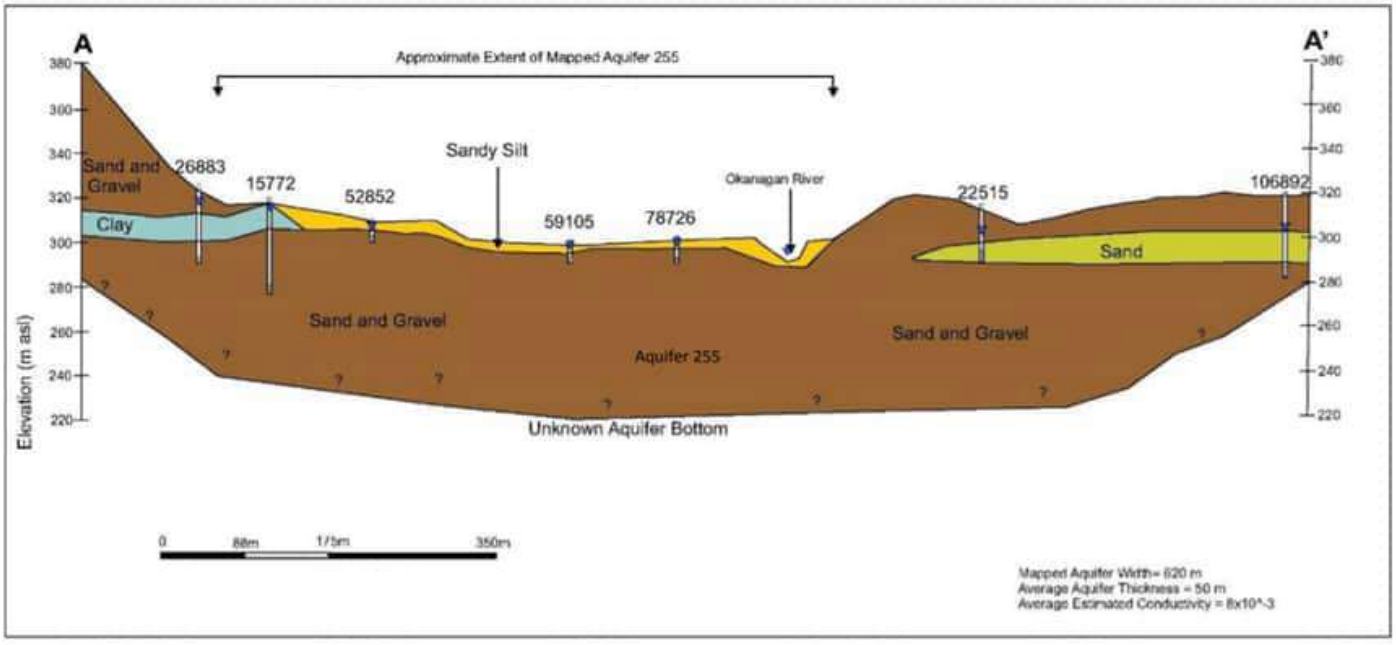
For more information regarding trends in groundwater levels see Environmental Reporting BC

Piper Plot



The groundwater samples are typically of the Ca-Mg-HCO3-SO4 type. The groundwater facies signify less evolved water in the shallow predominantly unconfined sand and gravel aquifer #255. SO4 enrichment could be attributed to anthropogenic activities such as application of chemical fertilizers and/or sewage effluents in the area. For EMS water chemistry data, see EMS ID E326591.

Water Budget

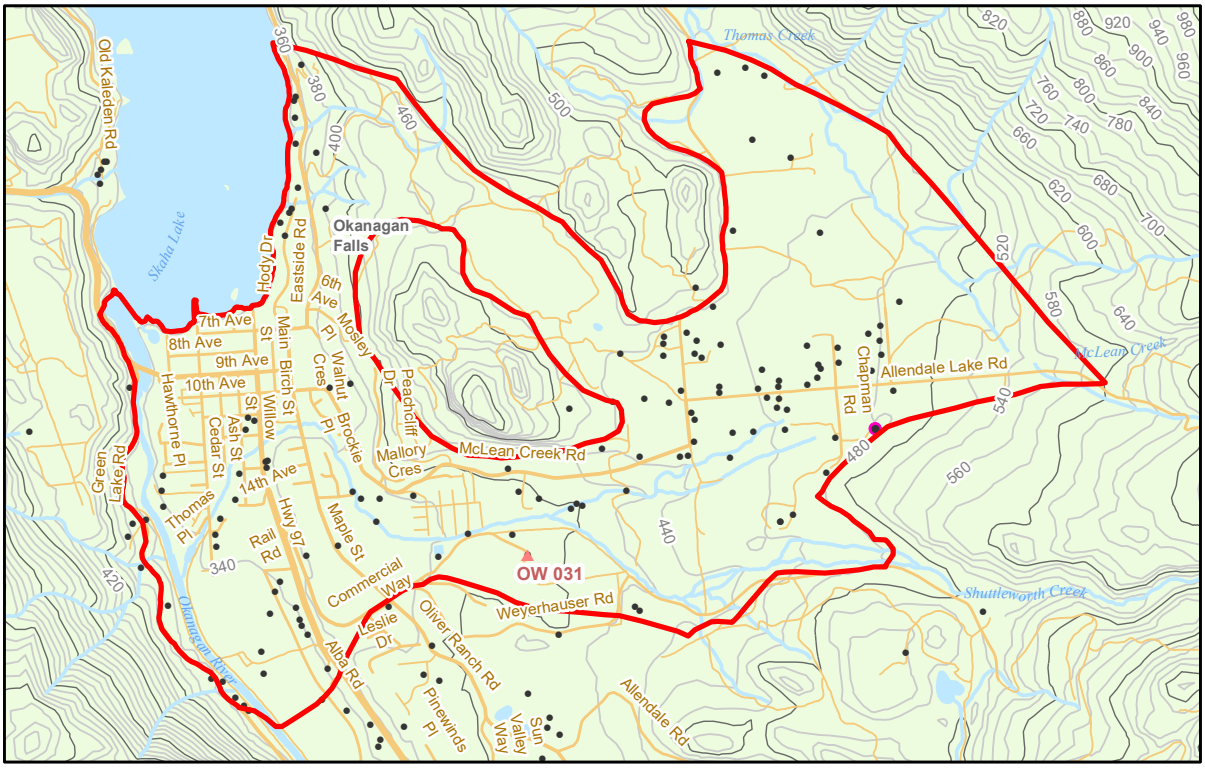


Aquifer 255 extends from the south end of Vaseux Lake to Tuc-El-Nuit Lake and is composed of a combination of deeper glacio-fluvial and terrace deposits and shallower Okanagan River floodplain deposits. The aquifer occurs under unconfined to semi-confined conditions and ranges in thickness to 40 m or more north of Oliver. Aquifer 255 is believed to have the following main characteristics:

- Potentially the most productive of the study area aquifers (254, 255, 256);
- Discharges to Aquifer 254, which we consider the southern extension of the same aquifer;
- Located proximal to the above described major sources of surface water recharge, and with better water quality than aquifers to the south; and
- Potentially the most heavily used of the study area aquifers.

Reference: Geller, D. and B. Manwell. 2016. Monthly Water Budgets for Aquifers in the Oliver, B.C. Area (Aquifers 254, 255 and 256). Water Science Series, WSS2016-07. Prov. B.C., Victoria B.C.

Aquifer #264



Legend

- Registered Water Well - Artesian
- Registered Water Well
- Inactive Observation Well
- Aquifer Boundary

0 0.5 1 km

N

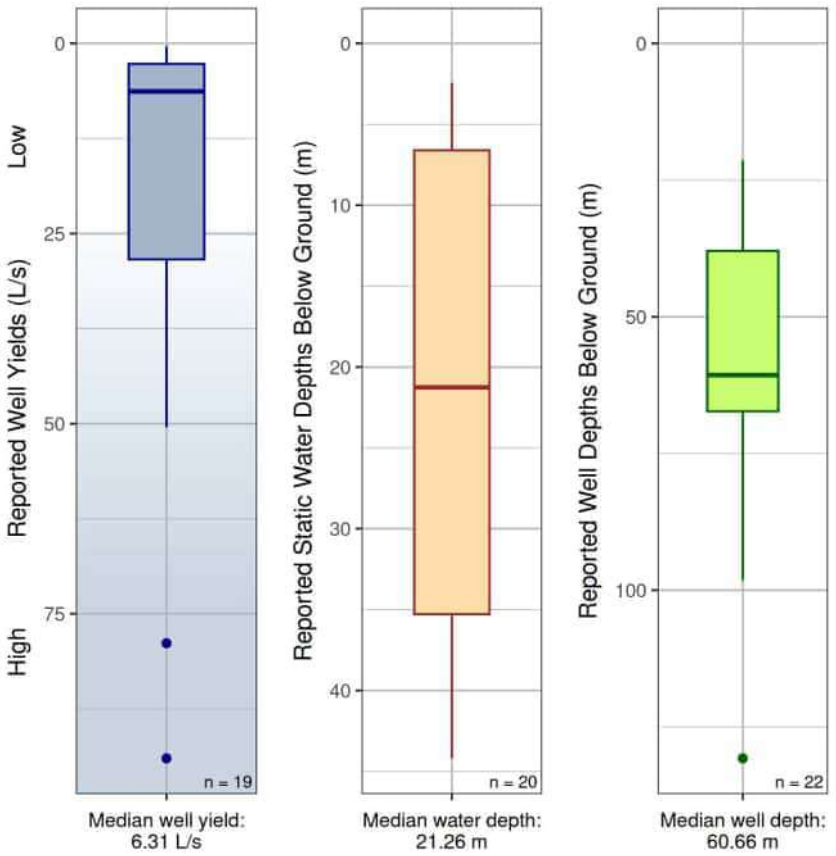
Aquifer Description (Mapping Report - 1997): Unconfined glacio-fluvial outwash or ice contact sand and gravel aquifer generally formed near or at the end of the last period of glaciation (sub-type = 4a).

Aquifer Details

Region	Thompson-Okanagan
Water District	Penticton
Aquifer Area	9.1 km^2
No. Wells Correlated	22
Vulnerability to Contamination	Moderate
Productivity	Moderate
Aquifer Classification	IIB
Hydraulic Conductivity *	3.4x10^{-4} m/s (n=1)
Transmissivity *	4.2x10^{-3} m^2/s (n=1)
Storativity *	Unknown
No. Water Licences Issued to Wells	17
Observation Wells (**Active**, Inactive)	None

* min - max

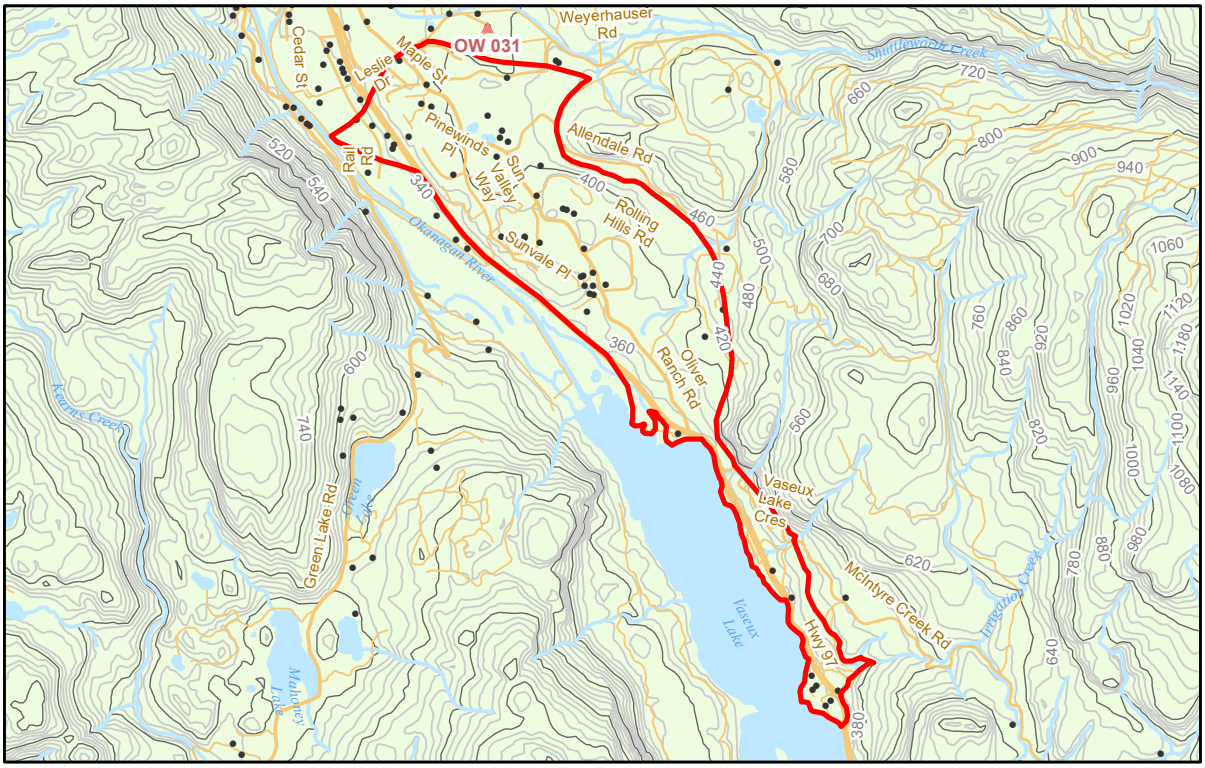
For Hydraulic Connection see guidance document



Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).

Factsheet generated: 2025-03-26. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.

Aquifer #265



Legend

- Registered Water Well
- Inactive Observation Well
- Aquifer Boundary

0 0.75 1.5 km

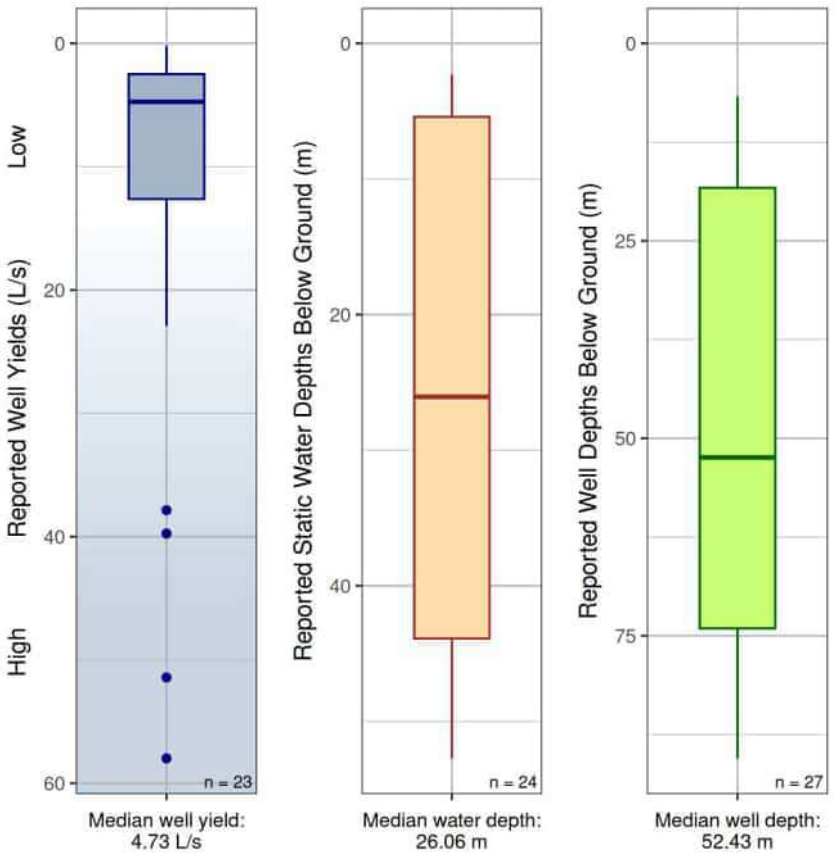
N

Aquifer Description (Mapping Report - 2016): Predominantly unconfined fluvial or glacio-fluvial sand and gravel aquifer found along major rivers of higher stream order with the potential to be hydraulically influenced by the river (subtype = 1a).

Aquifer Details	
Region	Thompson-Okanagan
Water District	Penticton
Aquifer Area	5.4 km^2
No. Wells Correlated	28
Vulnerability to Contamination	High
Productivity	High
Aquifer Classification	IIIA
Hydraulic Conductivity *	2.6x10^{-3} - 6x10^{-3} m/s (n=2)
Transmissivity *	2.4x10^{-2} - 5.6x10^{-2} m^2/s (n=2)
Storativity *	Unknown
No. Water Licences Issued to Wells	15
Observation Wells (**Active**, Inactive)	None

* min - max

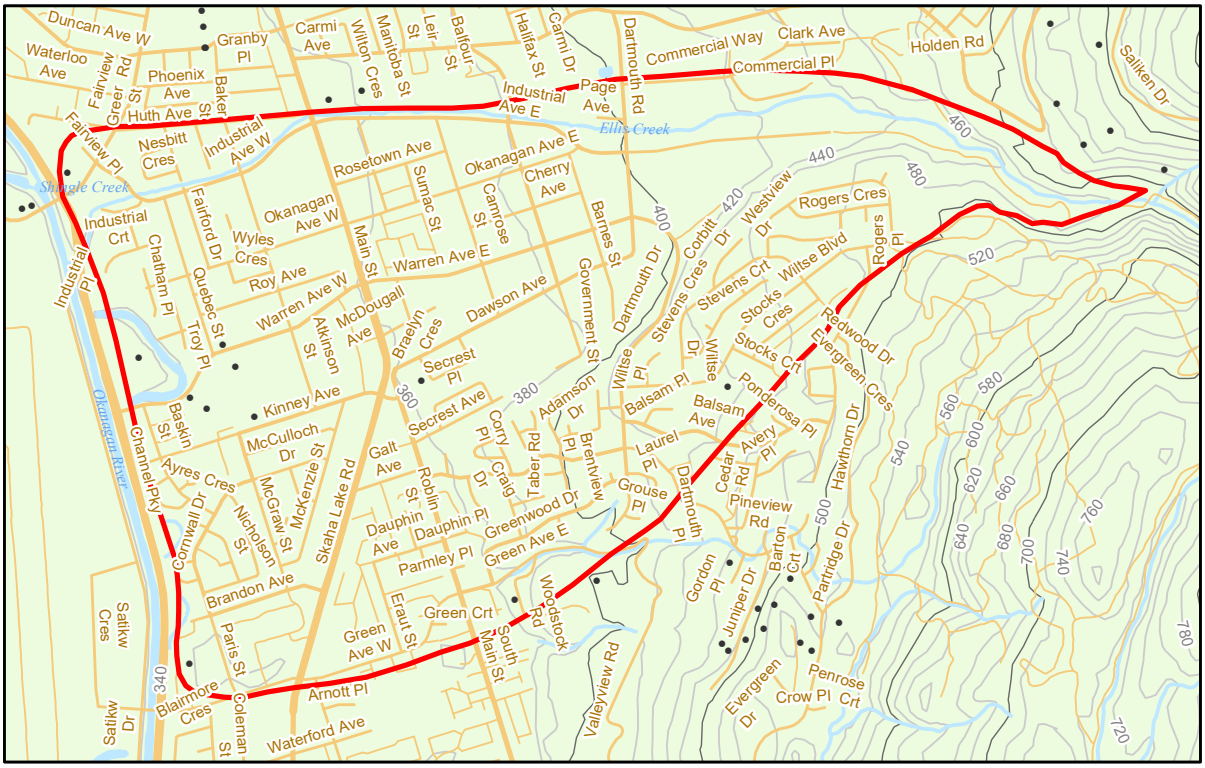
For Hydraulic Connection see guidance document



Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).

Factsheet generated: 2025-03-26. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.

Aquifer #270



Legend

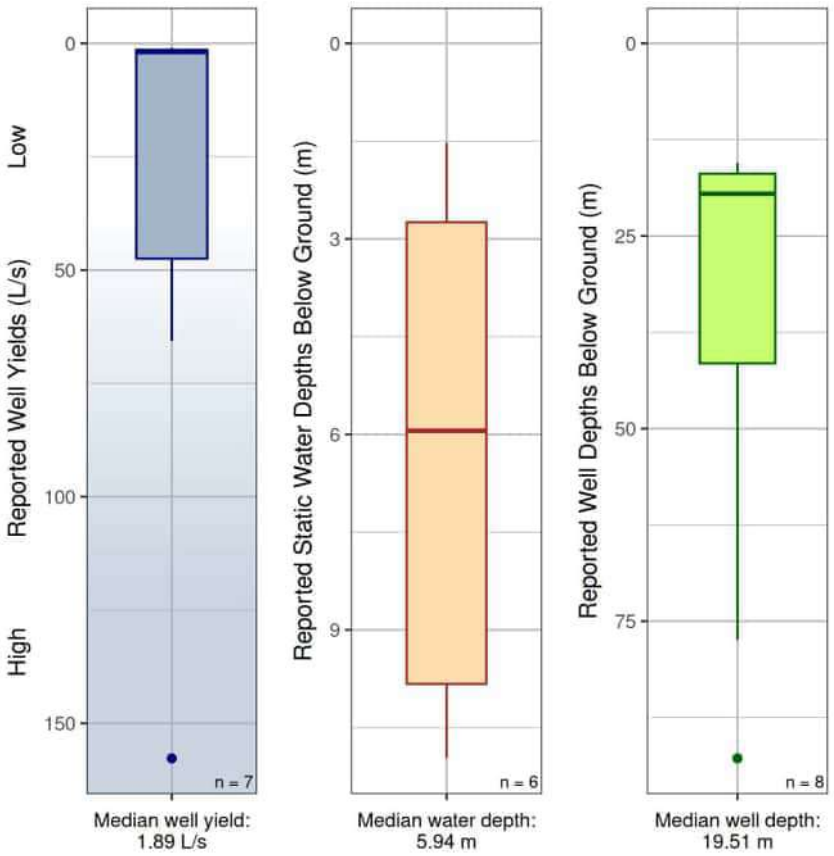
- Registered Water Well
- Aquifer Boundary

0 0.3 0.6 km

N

Aquifer Description (Mapping Report - 1997): Alluvial or colluvial fan sand and gravel aquifer typically occurring at or near the base of mountain slopes, either along the side of valley bottoms, or if formed during the last period of glaciation, raised above the valley bottoms (subtype = 3).

Aquifer Details	
Region	Thompson-Okanagan
Water District	Penticton
Aquifer Area	4.7 km^2
No. Wells Correlated	8
Vulnerability to Contamination	Moderate
Productivity	High
Aquifer Classification	IIB
Hydraulic Conductivity *	1.3x10^{-3} m/s (n=1)
Transmissivity *	1.3x10^{-2} m^2/s (n=1)
Storativity *	Unknown
No. Water Licences Issued to Wells	1
Observation Wells (**Active**, Inactive)	None



* min - max

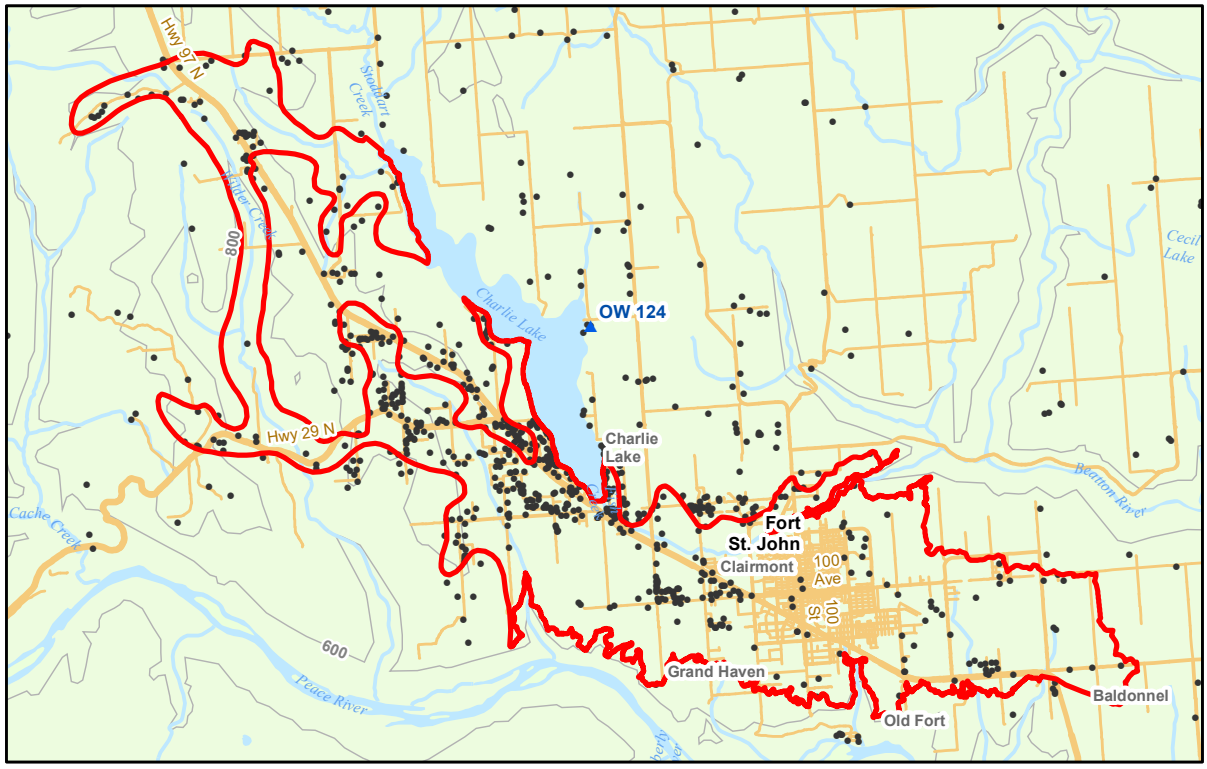
For Hydraulic Connection see guidance document

Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).

Factsheet generated: 2025-03-26. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.

Aquifer #444

Fort St. John Overburden Aquifer System



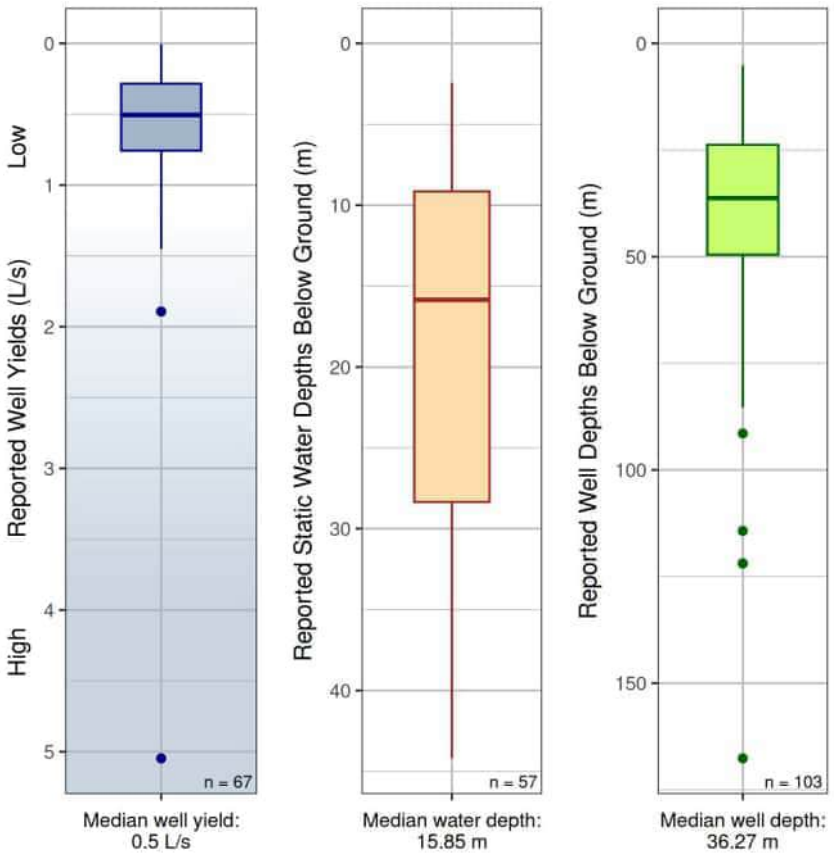
Legend

- Registered Water Well
- Active Observation Well
- Aquifer Boundary

Aquifer Description (Mapping Report - 2022): Unconfined glacio-fluvial outwash or ice contact sand and gravel aquifer generally formed near or at the end of the last period of glaciation (sub-type = 4a).

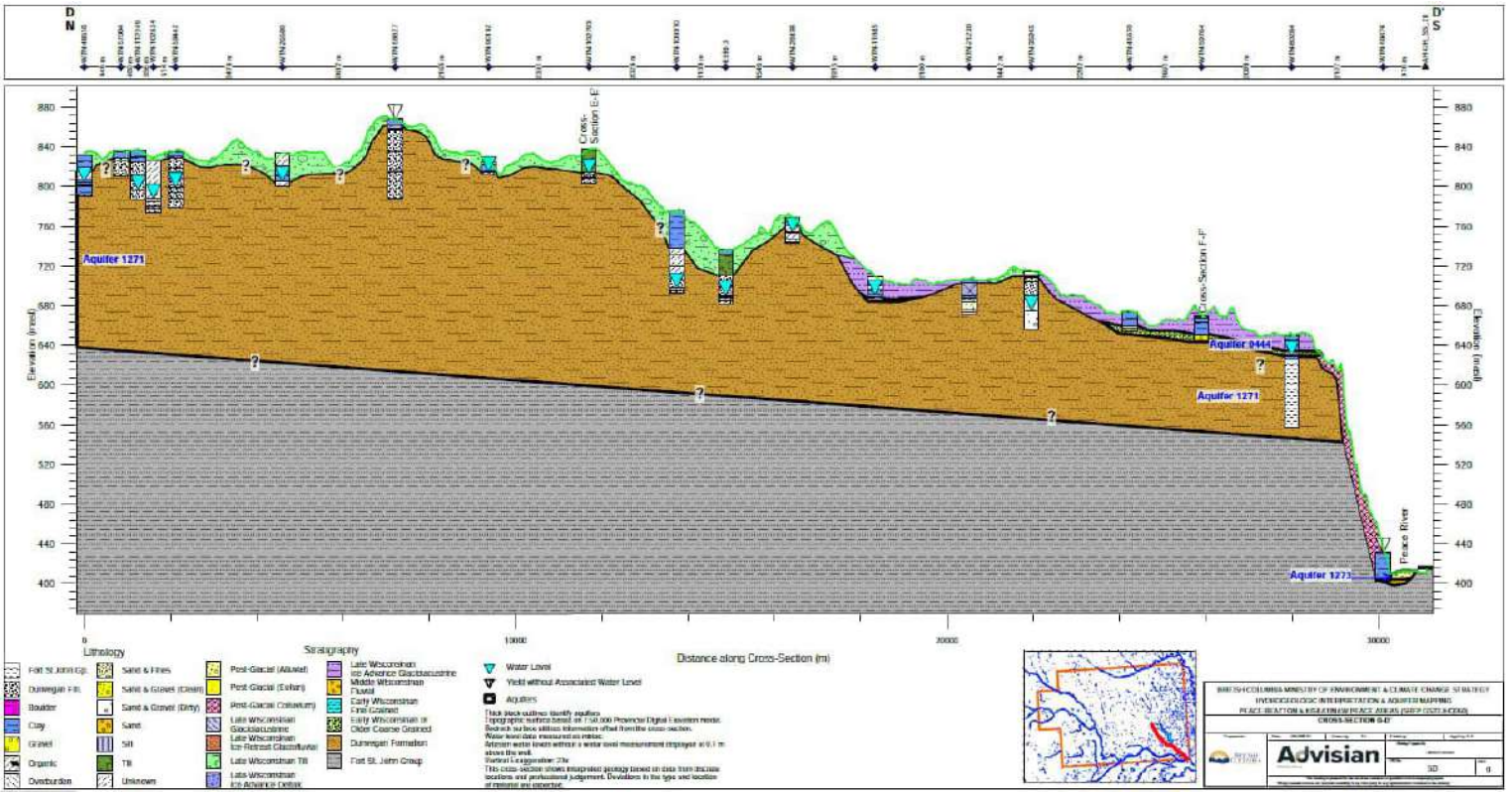
Aquifer Details	
Region	Northeast
Water District	Peace River
Aquifer Area	178.6 km^2
No. Wells Correlated	103
Vulnerability to Contamination	High
Productivity	Moderate
Aquifer Classification	IIIA
Hydraulic Conductivity *	Unknown
Transmissivity *	Unknown
Storativity *	Unknown
No. Water Licences Issued to Wells	3
Observation Wells (**Active**, Inactive)	None

* min - max
For Hydraulic Connection see guidance document



Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).
Factsheet generated: 2025-03-26. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.

Cross-Section



Fort St. John Overburden Aquifer System 444 is a two layered aquifer system comprised of unconfined and confined glaciofluvial sediments. The upper portion of the aquifer appears to be comprised of smaller, localized, unconfined permeable units (lenses) communicating through channels hundreds of meters wide. The lower portion of the aquifer is comprised of smaller, localized intra-till and below-till permeable lenses with a more continuous permeable unit at the base of the buried valley in the south.

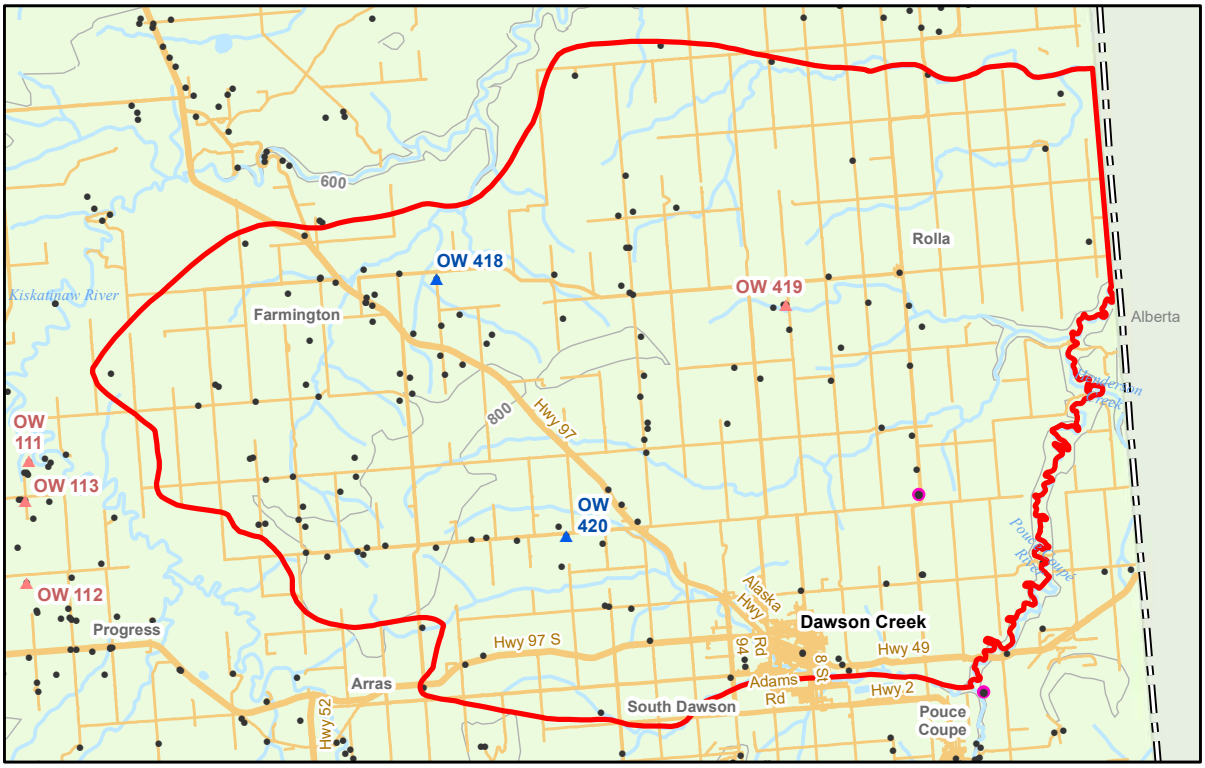
Where the aquifer is close to the surface or at a topographically elevated position, recharge could occur via distributed infiltration of precipitation and snowmelt. The southeastern portion of the aquifer may be directly recharged by Charlie Lake, while other portions of the aquifer may also be directly recharged by various other minor surface water bodies (e.g., Fish, Tea, and Wilder creeks). Groundwater is interpreted to flow primarily towards Wilder Creek and Charlie Lake in the northern portion of the aquifer (west of Charlie Lake), and towards Fish Creek, Montney Creek, and Peace River in the southern portion of the aquifer (southeast of Charlie Lake).

Groundwater is inferred to be hydraulically connected to Charlie Lake and may also be hydraulically connected with the other smaller surface water bodies. Groundwater is also inferred to be hydraulically connected with the underlying bedrock aquifer (1271).

Reference: T. Lengyel, Hinnell, A.C., and J.J Clague 2022. Peace-Beatton Aquifer Mapping and Hydrostratigraphic Characterization, Water Science Series, WSS2022-04. Province of British Columbia, Victoria.

Aquifer #851

Dawson Creek Overburden Aquifer



Legend

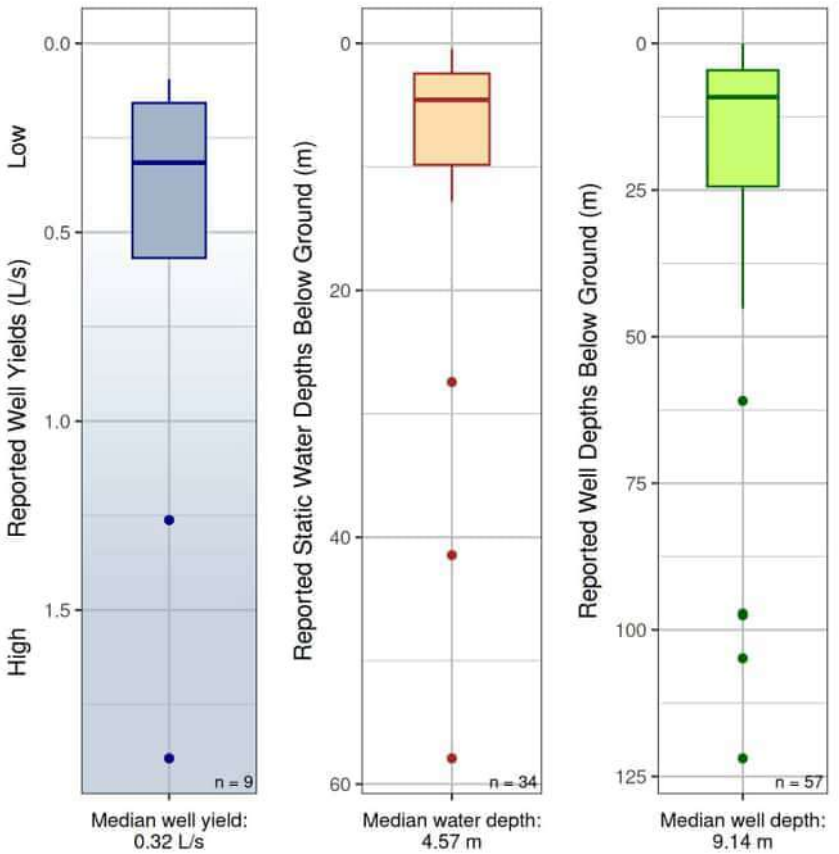
- Registered Water Well - Artesian
- Registered Water Well
- Active Observation Well
- Inactive Observation Well
- Aquifer Boundary

Aquifer Description (Mapping Report - 2023): Confined glacio-fluvial sand and gravel aquifer underneath till, in between till layers, or underlying glacio-lacustrine deposits (subtype = 4b).

Aquifer Details	
Region	Northeast
Water District	Peace River
Aquifer Area	866.3 km^2
No. Wells Correlated	61
Vulnerability to Contamination	Moderate
Productivity	Moderate
Aquifer Classification	IIIB
Hydraulic Conductivity *	Unknown
Transmissivity *	Unknown
Storativity *	Unknown
No. Water Licences Issued to Wells	2
Observation Wells (**Active**, Inactive)	None

* min - max

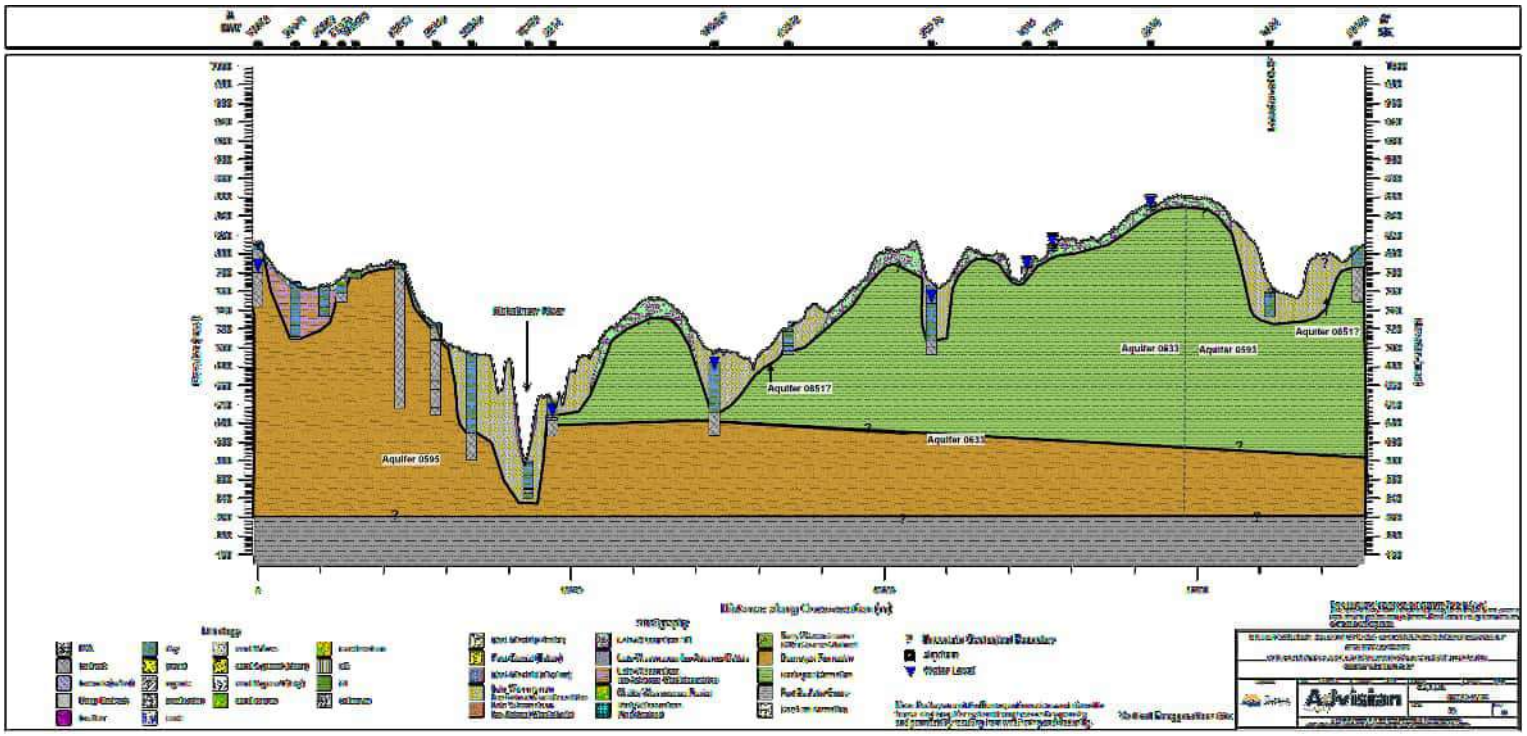
For Hydraulic Connection see guidance document



Detailed methods for all figures are described in the companion document (Aquifer Factsheet - Companion Document.pdf).

Factsheet generated: 2025-03-26. Aquifers online: https://apps.nrs.gov.bc.ca/gwells/aquifers.

Cross-Section



Dawson Creek Overburden Aquifer 851 is primarily a low conductivity unit comprised of glaciolacustrine clay/glacial till with localized discontinuous coarse-grained sediments (fine- to medium-grained sand) that may locally support lower intensity groundwater production. Permeability is interpreted to be associated with secondary porosity (through fracturing).

Recharge to the aquifer could occur via distributed infiltration of precipitation and snowmelt through the thin overburden. Much of the recharge is expected to occur in the spring associated with snowmelt. Groundwater is interpreted to flow primarily towards the Kiskatinaw and Pouce Coupé rivers.

Groundwater may be hydraulically connected with minor tributaries of the Kiskatinaw and Pouce Coupé rivers. Groundwater is also inferred to be hydraulically connected with the underlying bedrock aquifers 593 and 633.

Reference: Lengyel, T., J. Deri-Takacs, A.C. Hinnell, and J.J Clague, 2023. Kiskatinaw-Peace Aquifer Mapping and Hydrostratigraphic Characterization, Water Science Series, WSS2023-04. Province of British Columbia, Victoria.