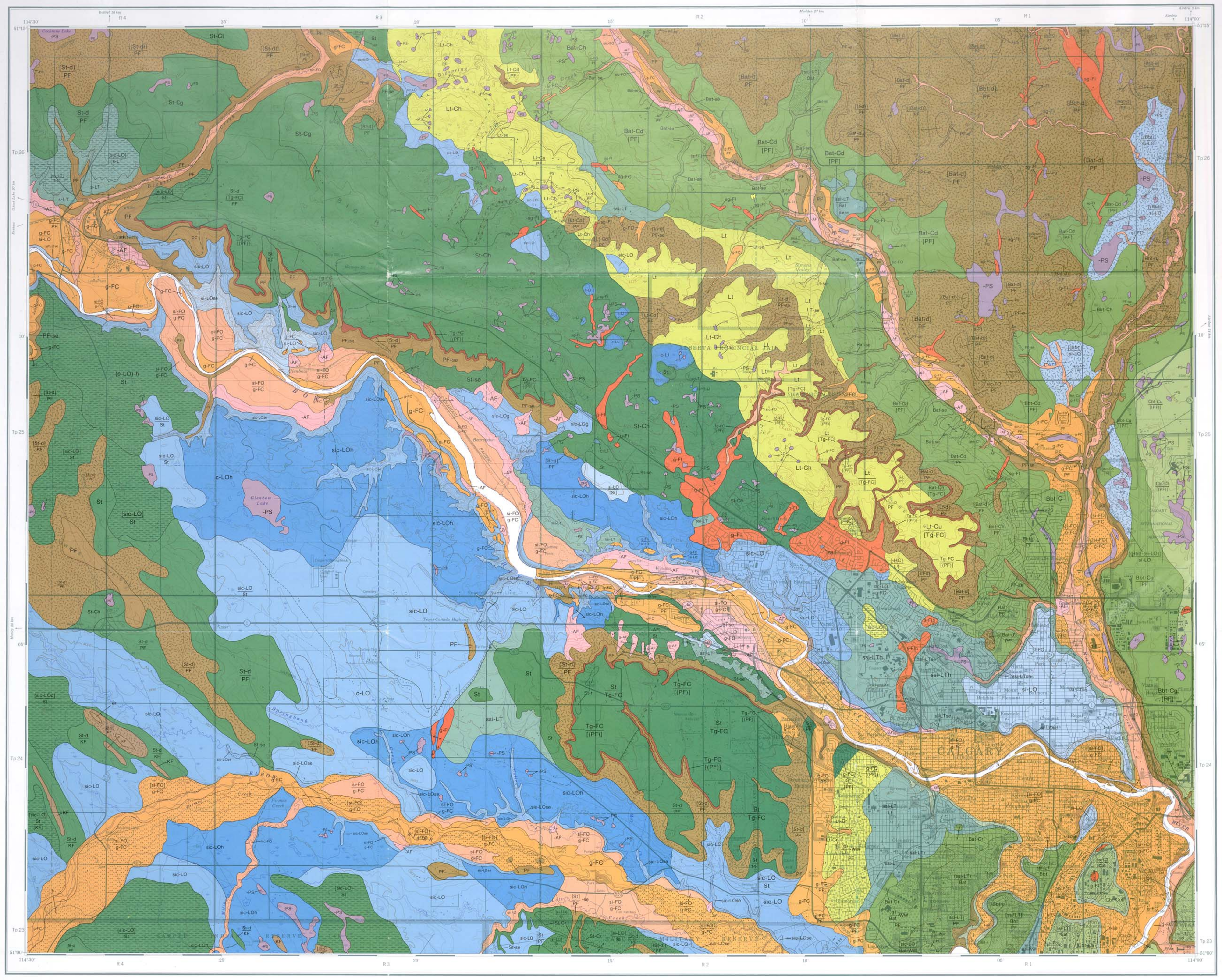
SYMBOL	STRATIGRAPHIC UNIT	LITHOLOGY (Material)	LITHOGENESIS (Origin of material)	MORPHOLOGY (Descriptive and/ or genetic)	COMMENT
MF	–	diverse lithology; boulders to clay; recompacted pebble-loam (till) most common material	material deposited by man include both compacted and uncompacted fills	variable; generally flat to undulating	fill is of variable thickness and limited areal extent
PS	–	poorly sorted silt, sand, clay and organic sediment; organic loam	sediment deposited in ponds of all origins	flat to gently undulating	sediment is commonly overlain by water for at least part of the year Includes peat deposits in the western part of the area.
-AF	–	silt, sand, gravel with minor clay	sediment deposited at or beyond the toe of a slope by ephemeral streams	flat to undulating and surface inclined downslope, generally fan shaped	–
g-AF	–	Poorly sorted gravel and sand	fluvial-channel facies of fluvial-fan	flat to undulating and surface inclined downslope, generally fan shaped	–
-AF / PF	Holocene sediment overlying Porcupine Hills Formation	silt, sand, gravel with minor clay overlying sandstone, siltstone and shale	sediment deposited at or beyond the toe of a slope by ephemeral streams overlying nonmarine bedrock	flat to undulating and surface inclined downslope, generally fan shaped	fan sediment is generally 2 to 4 metres thick, channel and overbank facies have not been differentiated
s-FC	–	sand; generally medium grained, moderately well sorted	fluvial-channel sediment	not included in unit definition	
s-FC / PF	Quaternary sediment overlying Porcupine Hills Formation	sand overlying sandstone and siltstone	fluvial channel sediment overlying nonmarine bedrock	not included in unit definition	
g-FC	–	gravel, minor sand	fluvial-channel sediment	not included in unit definition	thickness of gravel is generally unknown
g-FC / si-LO	–	sandy gravel overlying silt	fluvial-channel sediment overlying lacustrine offshore sediment	flat to undulating, capping small erosional remnants	
[si-FO] / g-FC	–	silt overlying gravel	fluvial-overbank sediment overlying fluvial-channel sediment	not included in unit definition	–
[ssi-FO] / g-FC	–	sand and silt overlying gravel	fluvial-overbank sediment overlying fluvial-channel sediment	not included in unit definition	–
g-FC / PF	Quaternary sediment overlying Porcupine Hills Formation	gravel, minor sand overlying sandstone and siltstone	fluvial-channel sediment overlying nonmarine bedrock	not included in unit definition	–
s-FI	–	sand, minor gravelly sand	fluvial-channel sediment deposited on, within, or beneath glacial ice	flat to hummocky; commonly occurs in discontinuous, sinuous ridges a few 10's of metres across and a few metres high	–
s-FIh	–	sand, minor gravelly sand	fluvial-channel sediment deposited on, within, or beneath glacial ice	hummocky, commonly occurs in discontinuous, sinuous ridges a few 10's of metres across and a few metres high	–
sg-FI	–	sand, gravelly sand, gravel	fluvial-channel sediment deposited on, within, or beneath glacial ice	flat to hummocky; commonly occurs in discontinuous, sinuous ridges a few 10's of metres across and a few metres high	potential source for fill-gravel and road maintenance
g-FI	–	gravel, minor sand; poorly sorted, contains inclusions of unsorted material	fluvial-channel sediment deposited on, within, or beneath glacial ice	flat to hummocky; commonly occurs in discontinuous, sinuous ridges a few 10's of metres across and a few metres high	potential source for fill-gravel and road maintenance
si-FO	–	silt	fluvial-overbank sediment	flat to undulating	–
si-FO / g-FC	–	silt overlying gravel	fluvial-overbank sediment overlying fluvial-channel sediment	not included in unit definition	–
sic-FO	–	silt and clay	fluvial-overbank sediment	not included in unit definition	–
sic-FO / PF	Quaternary sediment overlying Porcupine Hills Formation	silt and clay overlying sandstone, siltstone and shale	fluvial-overbank sediment overlying nonmarine bedrock	not included in unit definition	fluvial sediment is generally 2 to 4 metres thick
c-LI	–	clay	sediment deposited in an ice-walled lake	not included in unit definition	–
c-LO	–	clay	lacustrine-offshore sediment	not included in unit definition	–
c-LOh	–	clay	lacustrine-offshore sediment	hummocky topography resulting from deposition on stagnant ice and subsequent melting of ice	–
sic-LO	–	silt and clay	lacustrine-offshore sediment	not included in unit definition	–
sic-LOg	–	silt and clay	lacustrine-offshore sediment	gently undulating	–
sic-LOse	–	silt and clay	lacustrine-offshore sediment	sediment has undergone post-depositional erosion to form a slope	–
sic-LOh	–	silt and clay	lacustrine-offshore sediment	hummocky topography resulting from deposition on stagnant ice and subsequent melting of ice	–
sic-LO / g-FC	–	silt and clay overlying minor sand and gravel	lacustrine-offshore sediment overlying fluvial-channel sediment	not included in unit definition	–
sic-LO / St	Quaternary sediment overlying Spy Hill Drift	silt and clay overlying pebble-loam (till)	lacustrine-offshore sediment overlying undivided glacial sediment	not included in unit definition	–
si-LO / (St)	Silt overlying Spy Hill Drift	silt overlying pebble-loam (till)	lacustrine-offshore sediment overlying glacial sediment	flat to undulating	silt is generally 4 to 6 metres thick
si-LOse	–	silt	lacustrine-offshore sediment	sediment has undergone post-depositional erosion to form a slope	–
[(Bbt)] / si-LO	Balzac Drift (unit b)	pebble-loam (till) overlying silt	discontinuous glacial sediment overlying lacustrine-offshore sediment	not included in unit definition	discontinuous till is 0 to 2 metres thick
[(Bbt)-(si-LO)] / si-LO	Balzac Drift (unit b)	pebble-loam (till) and/or silt overlying silt	complex of discontinuous glacial sediment and contorted lacustrine-offshore sediment overlying lacustrine-offshore sediment	not included in unit definition	till and upper lacustrine sediment are both 0 to 2 metres thick and discontinuous
si-LTse	–	silt	lacustrine traction-load sediment	eroded slope	highly erodable where vegetation has been removed
ssi-LT	–	sand and silt	lacustrine traction-load sediment	not included in unit definition	highly erodable where vegetation has been removed
ssi-LTh	–	sand and silt	lacustrine traction-load sediment	hummocky topography resulting from deposition on stagnant ice and subsequent melting of ice	highly erodable where vegetation has been removed
ssi-LTse	–	sand and silt	lacustrine traction-load sediment	sediment eroded to form a slope	highly susceptible to erosion where vegetation has been removed
ssi-LTr	–	sand and silt	lacustrine traction-load sediment	broad ridges formed at glacier margins may include some ice thrust sediment in places	highly susceptible to erosion where vegetation has been removed
ssi-LT / Lt	Quaternary sediment overlying Lochend Drift	sand and silt overlying pebble-loam (till)	lacustrine traction-load sediment overlying glacial sediment	not included in unit definition	–
ssi-LT / Bat	Quaternary sediment overlying Balzac Drift (unit a)	sand and silt overlying pebble-loam (till)	lacustrine traction-load sediment overlying undivided glacial sediment	not included in unit definition	–
ssi-LT / Bbt	Quaternary sediment overlying Balzac Drift (unit b)	sand and silt overlying pebble-loam (till)	lacustrine traction-load sediment overlying glacial sediment	not included in unit definition	–
ssi-LT / Bbt-WW	Quaternary sediment overlying Balzac Drift (unit b)	sand and silt overlying pebble-loam (till)	lacustrine traction-load sediment overlying wave-washed glacial sediment	not included in unit definition	–
s-LT	–	fine sand	lacustrine traction-load sediment	not included in unit definition	–
[sic-LO] / s-LT	–	silt and clay overlying sand	lacustrine-offshore sediment overlying lacustrine traction-load sediment	not included in unit definition	–
t-se	–	pebble-loam (till)	glacial sediment	eroded slope commonly valley side	dominant lithology is till of varying stratigraphic units. Also includes fluvial and lacustrine sediment in places interbedded with the till. Bedrock occurs in lower part of slope in places.
Cat-Ch / (g-FC)	Crossfield Drift (unit a)	pebble-loam (till) overlying gravel	superglacial-mudflow sediment overlying fluvial-channel sediment	hummocky glacial-collapse terrain	–
[ssi-LT] / Cat	Quaternary sediment overlying Crossfield Drift (unit a)	sand and silt overlying pebble-loam (till)	lacustrine traction-load sediment overlying glacial sediment	flat to undulating	susceptible to erosion where vegetation has been removed
Cbt-Cuh	Crossfield Drift (unit b)	pebble-loam (till)	superglacial-mudflow sediment	undulating to hummocky glacial-collapse terrain	contains isolated bodies of poorly sorted ice-contact fluvial-channel sediment
Cbt-Ch	Crossfield Drift (unit b)	pebble-loam (till)	superglacial-mudflow sediment	hummocky glacial-collapse terrain	–
Cbt-C	Crossfield Drift (unit b)	pebble-loam (till)	superglacial-mudflow sediment	glacial-collapse terrain	–
Cbt-Cr	Crossfield Drift (unit b)	pebble-loam (till)	superglacial-mudflow sediment	glacier margin collapse ridge	contains isolated bodies of poorly sorted ice-contact fluvial-channel sediment
Cbt-Ct / [(PF)]	Crossfield Drift (unit b) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and siltstone	superglacial-mudflow and englacial meltout sediment overlying nonmarine bedrock	transverse disintegration ridges (washboard moraine)	till is generally more than 6 metres thick but in places is 4 to 6 metres thick
Cbt-Cu / [(PF)]	Crossfield Drift (unit b) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone, and shale	superglacial mudflow sediment overlying nonmarine bedrock	undulating glacial-collapse sediment overlying bedrock	till is generally 4 to 6 metres thick but in places the thickness exceeds 6 metres
[ssi-LT] / Cbt	Quaternary sediment overlying Crossfield Drift (unit b)	sand and silt overlying pebble-loam (till)	lacustrine traction-load sediment overlying glacial sediment	not included in unit definition	–
Bat-Cr	Balzac Drift (unit a)	pebble-loam (till)	superglacial-mudflow sediment	glacier margin collapse ridge	contains isolated bodies of poorly sorted ice-contact fluvial channel sediment
Bat-se	Balzac Drift (unit a)	pebble-loam (till)	glacial sediment	eroded slopes	–
Bat-Cd / (PF)	Balzac Drift (unit a) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone, and shale	superglacial-mudflow sediment overlying nonmarine bedrock	eroded bedrock surface draped by glacial-collapse sediement	–
Bat-Ch / (Tg-FC)	Balzac Drift (unit a) overlying Tertiary gravel	pebble-loam (till) overlying gravel	superglacial-mudflow sediment overlying fluvial-channel gravel	hummocky glacial-collapse terrain	–
Bat / PF	Balzac Drift (unit a) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and shale	glacial sediment overlying nonmarine bedrock	not included in unit definition	–
Bat-Ch / PF	Balzac Drift (unit a) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone, and shale	superglacial-mudflow sediment overlying nonmarine bedrock	hummocky glacial-collapse terrain	–
Bat-Cd / PF	Balzac Drift (unit a) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone, and shale	superglacial-mudflow sediment overlying nonmarine bedrock	eroded bedrock surface draped by glacial-collapse sediment	–
(g) / Bat / [(PF)] -WW	Balzac Drift (unit a) overlying Porcupine Hills Formation	gravel overlying pebble-loam (till) overlying sandstone, siltstone and shale	wave-washed glacial sediment overlying nonmarine bedrock	not included in unit definition	discontinuous gravel overlies till which is generally 4 to 6 metres thick, in places bedrock occurs within 6 metres of the surface
(g) / Bat / PF -WW	Balzac Drift (unit a) overlying Porcupine Hills Formation	gravel overlying pebble-loam (till) overlying sandstone, and shale	wave-washed glacial sediment overlying nonmarine bedrock	not included in unit definition	sequence of discontinuous gravel overlying till is generally 2 to 4 metres thick; bedrock commonly occurs at depths 4 to 6 metres beneath the surface



Scale 1:50 000

Miles 1 0 1 2 3 Miles

Kilometres 1 0 1 2 3 4 5 Kilometres

Surface Materials of the Calgary Urban Area: Calgary Sheet

NTS 82-O/1

S.R. Moran

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Any revisions or additional geological information would be welcomed by the Alberta Research Council.

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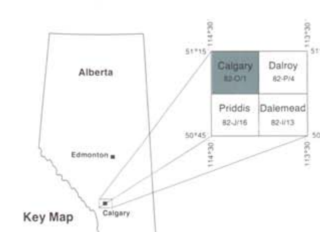


Key Map

The general legend appearing below relates to all maps in this series. All symbols and map units do not necessarily appear on each sheet.

LEGEND

- Buried valley visible at surface
- Buried sand
- Geologic contact, definite
- Geologic contact, inferred
- Minor meltwater channel
- Minor transverse ridges, "washboard moraine"
- Scarp, buried
- Scarp, fresh
- Spring
- Streamlined glacial landform (drumlins and flutes)

EXPLANATION OF MAP SYMBOL STRUCTURE

The basic map symbol consists of 4 elements that describe (1) the stratigraphic unit, (2) the lithology, (3) the lithogenesis, and (4) the morphology of the unit respectively. A given map unit may be described by a symbol that consists of only one of the elements where the others are unknown or not considered significant for definition of the unit. The generalized unit symbol has the form:

Ax-By

where

A represents the stratigraphic designation
x represents the lithology
B represents the lithogenesis, and
y represents the morphological description

STRATIGRAPHIC SYMBOL: used for Tertiary and Cretaceous bedrock, for Tertiary gravel, and for all till units. It has not been applied to glacial fluvial or glacial lacustrine units because of difficulties in identifying stratigraphic relationships in all cases. It has not been applied to Holocene fluvial or lacustrine sediment because of difficulties in definition of the lower boundary of the Holocene and the absence of stratigraphic framework within which to treat these units.

LITHOLOGIC SYMBOL: used for nearly all units throughout the map area. Exceptions include the Cretaceous and Tertiary bedrock, some alluvial fans, landslides and other units formed by mass wasting, Holocene pond sediment, and manmade fills. In these cases morphology constituted the principal means of identification of the map units. It was felt that the characteristics of the units were generally similar regardless of lithology and as a result separation of the basis of lithology was not attempted.

LITHOGENETIC SYMBOL: used for nearly every unit with the exception of the Cretaceous and Tertiary bedrock. This element of the explanation allows communication of a maximum of descriptive characterization of the material in each map unit without requiring a great deal of verbage to be repeated on a unit by unit basis.

MORPHOLOGIC MODIFIER: the least systematically utilized element of the explanation. It provides data on descriptive morphology or morphogenesis. This information has been presented only where it is significant in the identification, description, and characterization of the map unit. In other cases it has been omitted.

Multiple Units

In many instances, more than one material occurs in the upper 6 m of the landscape. Where a second material is thin and not considered significant, it was lumped into the dominant material and disregarded (example a). However, where a second, third or in rare cases, a fourth material unit occurs in the upper 6 m, it has been included in the symbol for the map unit description (examples b - g). Additional units are shown by placing the four-character symbol for the second unit beneath that for the surface unit and separating them with a horizontal line.

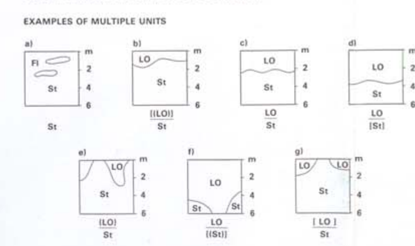
Thin and Discontinuous Units

In many places, units that are thin or discontinuous occur at the top of or within the upper 6 m (examples b, e, g). In other places, the surface unit is only slightly less than 6 m thick and therefore only a small amount of a thick, underlying unit is present in the upper 6 m (examples d, f). In order to describe these relationships, paired parentheses and brackets have been utilized to enclose the symbols. Where a unit is less than 2 m thick, or where less than 2 m of a thicker unit extends up to within 6 m of the surface, the symbol for that material is enclosed in brackets(examples b, d). For example, the symbol, [si-LO]/St, states that less than 2 m of silty lacustrine offshore sediment overlies till of the Spy Hill drift; the symbol, Ct-Cr/(PF), states that from 4 m to 6 m of till of the Crossfield drift overlies bedrock of the Porcupine Hills Formation, and that the till is glacial collapse sediment characterized by transverse ridges. In a three unit sequence the symbol, [si-FO]/g-FC/(Bbt), states that less than 2 m of fluvial overbank silt overlies fluvial channel gravel, which in turn rests on till of the b unit of the Balzac drift. The aggregate thickness of the silt and gravel is 4 to 6 m.

The continuity of units is shown by the use of parentheses in the following way: Where parentheses are absent, as in the examples in the preceding paragraph and examples a and c, the unit is expected to be encountered in at least 75 percent of the map unit. To put this in another way, one might expect not to find the described material in one out of four places within the unit, but not more frequently. If the unit is less continuous, so that it is expected to be present in between 75 percent and 25 percent of the places within the unit, the symbol is enclosed in parentheses. If the unit is present in less than one of four sites within the map unit, that is less than 25 percent, it is not included in the map unit description. The following examples should clarify the use of the parentheses to describe continuity. The symbol, sic-LO/(St), states that the clay and silt is continuous over the entire unit (or more precisely more than 75% of the unit) and that in between 75 and 25 percent of the map unit the silt and clay is from 2 m to 4 m thick overlying till of the Spy Hill drift. In the remainder of the area the silt and clay unit is more than 6m thick.

By combining brackets and parentheses, information on thickness and continuity is conveyed as shown by the following symbols. The symbol, [(Lt-se)]/PF, states that discontinuous patches of till of the Lochend drift less than 2 m thick overlie bedrock of the Porcupine Hills Formation on an eroded slope, (see example g). The symbol, St-Ch/[(Tg-FC)], states that till of the Spy Hill drift, which is from 4 m to more than 6 m thick, is hummocky glacial collapse sediment.

EXAMPLES OF MULTIPLE UNITS



St = Spy Hill till
Fl = Fluvial Ice Contact sediment
LO = Lacustrine offshore sediment

COLOUR CONVENTION

The colour of a map unit reflects the material at a depth of 2m below the surface. Where this material is overlain by another, which is less than 2m thick, a pattern indicates the composition of the veneer.

- silt and clay, clay
- silt
- till
- sand and silt
- gravel

DESCRIPTION OF STRATIGRAPHIC UNITS

C CROSSFIELD DRIFT
Glacial till and associated stratified drift. The till has a texture of 30-35 percent sand, 30-40 percent silt and 25-30 percent clay. Pebbles generally common to abundant granitic and gneissic rocks. Two units have been differentiated in the southern part of the area on the basis of morphologic features. In a few sections compositional differences in the till support this split of the drift. Till of unit B contains proportionally more granitic pebbles than does unit A. Along the ancestral Bow River valley in most of the southern part of the area, the Crossfield drift overlies a 10-25 m thick unit of silt and sand, which separated it from older units. Its margin is marked by a prominent marginal disintegration ridge in the northern part of the area and parts of the south and by a meltwater channel in the south. The Crossfield drift forms the surface unit in the eastern third of the Calgary area.

B BALZAC DRIFT
Glacial till and associated stratified drift. Till of the Balzac drift is characteristically silty with a grain-size composition of 10-20 percent sand, 45-60 percent silt, and 20-40 percent clay. It is commonly stoney and contains abundant tan and yellow limestone and quartzite rocks in addition to rocks similar to the underlying Spy Hill drift. Red and purple banded quartzite rocks are less abundant than in the Spy Hill drift. Granitic and gneissic rocks are present but rare. Lithologically the Balzac drift is very similar to the underlying Lochend drift. The two drifts included within the Balzac drift have not been differentiated on a lithologic basis. The separation of the area underlain by silty drift into three units, the Lochend drift and the A and B units of the Balzac drift, is based almost entirely on the existence of two morphologically defined ice-marginal positions that have been traced across the entire area. In the north, these margins are marked primarily by marginal ridges, across which the morphological character of the landscape changes. In the south, however, marginal meltwater channels border much of the length of the margins. The two units of the Balzac drift occupy most of the north-central part of the study area and extend as a narrow belt southward through the center of the area.

L LOCHEND DRIFT
Glacial till and associated stratified drift. Till of the Lochend drift is characteristically silty, with a grain-size composition of 10-20 percent sand, 45-60 percent silt and 20-40 percent clay. It is commonly stoney and contains abundant fragments of Tertiary and Cretaceous sandstone and siltstone. The pebble fraction contains abundant tan and yellow limestone and quartzite rocks in addition to rocks similar to the underlying Spy Hill drift. Granitic and gneissic rocks are present but rare. The Lochend drift is recognized in a narrow zone along the top and eastern flank of the Big Hill upland. To the south it is even narrower, and in places, is overlapped by the younger Balzac drift. The western margin of the Lochend drift is marked by a simple sharp disintegration ridge along most of the Big Hill upland and by marginal meltwater channels in the south.

S SPY HILL DRIFT
The Spy Hill drift is the oldest of the surface stratigraphic units in the Calgary area. In the western part of the area, it consists of till and associated stratified drift that was deposited from a glacier that flowed into the Calgary area from the west via the valley of the Bow River. The till is generally heavy textured with a grain size composition of 15-20 percent sand, 40-45 percent silt and 40-45 percent clay. Pebbles are abundant along the Bow River valley. Further to the south the pebble content decreases. The pebble fraction is characterized by dark grey to black limestone and purple and pink banded quartzite. Granitic and gneissic rock types are absent. Till of the Spy Hill drift is recognized beneath lake sediment throughout the Calgary area. It occurs along the buried ancestral Bow Valley as far east as DeWinton beneath younger drifts.
In the eastern part of the area west of the mapped limit of the Lochend drift, the Spy Hill includes a younger unit of till and associated stratified drift that was deposited by a glacier that advanced from the east. The composition of the till is gradational to that of the Lochend drift, of which it is a lateral equivalent.

T TERTIARY
This is the chronostratigraphic designation for all the sub till upland gravel in the Calgary area. Well sorted, rounded gravel containing abundant carbonate rock and quartzite clasts and no granitic or gneissic rocks. In many places it crops out and is cemented with secondary carbonate. Tertiary gravel caps the Big Hill and Broadcast Hill uplands.

PF PORCUPINE HILLS FORMATION
Series of crossbedded sandstone and calcareous bentonitic shale. The maximum preserved thickness of the formation is probably in the order of 3,000 feet. In the type area, the Porcupine Hills contain abundant freshwater molluscan remains of Paleocene age.

KF CRETACEOUS FORMATIONS
Brazeau Formation: sandstone, mudstone, siltstone and conglomerate (non-marine).
Alberta Group: Wapiabi Formation: shale, siltstone and minor sandstone (marine).

DESCRIPTION OF LITHOLOGIC SYMBOLS

SYMBOL	DESCRIPTION
c clay:	Sediment containing more than 40% material finer than 0.004 mm and less than 45% material coarser than 0.062 mm (sand) and less than 40% of material coarser than 0.004 mm but finer than 0.0625 mm (silt). Also includes units of interbedded clay and silt (as defined above and below) in which the proportions of beds of clay meet the same criteria.
si silt:	Sediment containing less than 50% material coarser than 0.0625 mm (sand) and less than 25%, material finer than 0.004 mm (clay). Also includes units of interbedded silt (as defined above) and clay (as defined above) or sand (as defined below) in which the proportions of beds of silt meet these same criteria.
s sand:	Sediment containing less than 15% material finer than 0.004 mm (clay) and less than 30% material coarser than 0.004 mm but finer than 0.062 mm (silt). Also includes units of interbedded sand and silt (as defined above) in which the proportions of beds of sand meet these same criteria.
sic silt and clay:	A mixture of silt and clay, as defined above, in which clay content is greater than 30% but less than 50%. In some places it consists of interbedded silt and clay beds in the above proportions; in other places it consists of an intimate mixture of silt-size and clay-size sediment in the above proportions.
ssi sand and silt:	A mixture of sand and silt, as defined above, in which sand content is greater than 50% but less than 75%. In some places it consists of interbedded sand and silt in the above proportions; in other places it consists of an intimate mixture of sand-size and silt-size sediment in the above proportions.
sg sand and gravel:	A mixture of sand, as defined above, and gravel, in which the gravel content is less than 30%. In some places it consists of interbedded sand and gravel; in other places it consists of an intimate mixture of sand and gravel-size material.
g gravel:	Sediment containing more than 30% of material greater than 8.0 mm in diameter and less than 50% silt or clay as defined above.
t till or pebble loam:	A poorly-sorted, intimate mixture of sand, silt- and clay-size material that contains minor pebbles, cobbles and boulders. The sediment is generally unbedded although partings and poorly developed laminations do occur. In many places, contains inclusions of gravel, sand, silt, or clay that are commonly contorted. In the Calgary area, sand content generally ranges from 15% to 35%, silt content from 35% to 55%, and clay content from 20% to 45% of the matrix.

DESCRIPTION OF MORPHOLOGIC SYMBOLS

d -	draped: surface material is thin enough that the underlying topography is observable.
g -	gently undulating: 1° to 2° maximum slope angle.
u -	undulating: 2° to 4° maximum slope angle.
h -	hummocky: more than 4° slope angle.
l -	lag: concentration of pebbles, cobbles and boulders left by water erosion of underlying material.
r -	marginal disintegration ridge: ridge formed at the margin of a glacier; generally 1 to 3 metres high commonly composed of till and poorly sorted sand and gravel.
t -	transverse ridge: glacially deposited ridges oriented perpendicular to the direction of glacial flow, commonly referred to as "washboards."
f -	fan
se -	slope eroded: slope eroded by a combination of slopewash and mass wasting.

DESCRIPTION OF LITHOGENETIC SYMBOLS

ANTHROPOGENIC SEDIMENT

-MF Manmade fill
A highly diverse unit that can have any composition from clay to boulders. Generally poorly sorted loamy material consisting of silt, sand and clay. Recompacted pebble loam is a common material, which makes identification difficult in some cases. Commonly contains refuse such as fragments of concrete pavement and drainage tiles. In many places, other refuse such as car bodies and household or industrial waste is incorporated. Ranges from structureless to bedded. Ranges from loose to dense where it has been compacted. The gently inclined planar layering in some compacted fill can be very difficult to differentiate from natural sedimentary bedding even on close examination although it is generally more evidently composed of granules of material that have been pressed together. Brown to grey colour.

-MP Manmade pond sediment
Sediment in pond may be absent if sediment influx is prevented. Sediment is a poorly sorted mixture of sand, silt and clay if natural sedimentation is allowed after pond excavation. Sediment may be diverse if man has been adding sediment to pond; may include sand, silt, clay, stones and household and industrial waste.

HILLSLOPE SEDIMENT

Includes a wide range of sediment types from clay to boulders. Composition of material at any site is directly related to the material upslope. Abrupt compositional variation is common. Colour generally grey to brown, locally rusty red. Tough when dry; soft when wet.

-HC Hillslope colluvium
Sediment is mainly completely eroded and reconstituted material moved to deposition site by creep, or channel or sheet wash. In places clasts of recognizable upslope sediment are present.

-HL Hillslope landslide sediment
Includes a wide range of sediment type from clay to boulders. Composition of material at any site is directly related to composition of material upslope. Sediment of this unit varies from blocks of the original material that have slid or fallen to reconstituted sediment that bears no evidence of original form. Abrupt compositional variation is common.

EOLIAN SEDIMENT

-EB Eolian bed-load sediment
Medium to very fine grained sand; very well sorted, loose, unbedded to obscurely bedded in places. Organic matter may form discrete layers usually with a diffuse lower boundary. Light grey to light brown, locally reddish brown. Commonly in dunes and blowouts.

-ES Eolian suspended-load sediment
Silt and very fine sand; very well sorted, loose, unbedded to very obscurely bedded in some places. Organic matter is disseminated throughout the unit or appears as discrete layers, generally with a diffuse lower boundary. Light grey to light brown, locally reddish brown. Wind blown dust, loess.

POND SEDIMENT

-PS Pond Sediment
Poorly sorted mixture of silt, clay and sand. Loamy and silty material most common. Commonly contains considerable disseminated organic matter. Bedding generally obscure. Colour black to grey, in places, rusty brown. Extemely hard when dry, tough to soft when wet. Fossils commonly include mollusks, especially gastropods. (slough sediment).

FLUVIAL SEDIMENT

-AF Fluvial fan sediment
Bedded silt, sand and gravel with minor clay. Generally loamy mixtures. Bedding distinct to obscure, bedding commonly cut by overlying beds in cut and fill relationship. Organic matter accumulations occur in discrete bands within the unit. Bedding dips uniformly away from fan source. Grey to brown, locally reddish brown. In most fans, channel and overbank facies have not been distinguished. However, along the northern edge of the Broadcast Hill upland several large fans are sufficiently well developed that the channel facies could be separated out. Numerous small gravel pits are developed in this facies.

-FC Fluvial channel sediment
Gravel, sandy gravel, gravelly sand, with minor sand inclusions. Bedding generally very obscure, but includes plane bedding, very large scale dunes, or single slipface cross bedding. Poorly sorted to moderately well sorted but with little silt or clay in most places. Grey to brown.

-FI Fluvial ice contact sediment
Gravel, sandy gravel, gravelly sand and sand. Generally very poorly sorted with large variation in grain size both within individual beds and between adjacent beds. Bedding is distinct to obscure with planer bedding, large-and-small scale trough cross bedding. Generally contains inclusions of unsorted material. Bedding commonly contorted by folds and faults. Grey to light brown.

-FO Fluvial overbank sediment
Poorly sorted silt, sand and clay. Generally a loamy mixture. Contains pebbles in thin lenses near streams. Bedding present but obscure in many places. Organic matter present generally in discrete layers although disseminated throughout unit in places. Plant roots and branches are common inclusion. Grey to light grey. Hard to moderately hard when dry; moderately hard to soft when wet.

LACUSTRINE SEDIMENT

-LI Lacustrine ice contact sediment
Silt, silty clay and clay with local minor sand and gravel. Consists of either thin or flat bedded sediment elevated above surrounding area or massive to thin bedded deformed sediment with a hummocky topography. Generally grey. Hard to moderately hard when dry; moderately hard to soft when wet.

-LO Lacustrine offshore sediment
Silt, clayey silt, silty clay, or clay. Thinly bedded with plane bedding in fine-grained beds; ripple bedding in places in coarse silt beds. Generally soft when wet and more dense when dry. Generally grey.

-LT Lacustrine traction-load sediment
Very fine sand, silt and minor clay. Moderately well sorted within individual beds but adjacent beds vary from clay to fine sand in some places. Small scale trough-shaped cross bedding and ripple bedding dominate in the sand and coarse silt beds. Generally light grey in the subsurface but oxidizes readily to yellow or light brown upon exposure. Soft where saturated.

-WW Wave-washed sediment
Thin sandy gravel lag formed by wave erosion of underlying glacial sediment.

GLACIAL SEDIMENT

Mainly till; a mixture of sand, silt, clay and a few pebbles, cobbles and boulders; in places may include discontinuous layers of stratified sediment - usually sand or gravel. Bedding is generally absent in the till although obscure foliation is locally present and the upper contact of this sediment may be gradational with alternating layers of till and of the overlying sediment. Sediment generally overconsolidated and dense to very dense. Brown near surface, grey in the subsurface.

-C Glacial collapse sediment
Till deposited by meltout of superglacial or englacial sediment generally followed by some mass wasting in superglacial position. Sediment is mainly till but locally includes gravel, sand, silt or clay of glaciofluvial or glaciolacustrine origin. Characterized by irregular, undulating to hummocky topography with linear disintegration features.

M Glacial moulded sediment
Thin glacial sediment draped over pre-existing material that has been subglacially moulded into streamlined longitudinal ridges and grooves.

T Glacial thrust sediment
Masses of originally subglacial sediment incorporated, transported and deposited by the glacier more or less intact. Deposits may include syngenetic till and masses of pre-existing till, stratified sediment and/or bedrock.

SYMBOL	STRATIGRAPHIC UNIT	LITHOLOGY (Material)	LITHOGENESIS (Origin of material)	MORPHOLOGY (Descriptive and/ or genetic)	COMMENT
[-HC] / Bat	Balzac Drift (unit a)	clay to boulders overlying pebble-loam (till)	colluvium overlying glacial sediment	undulating to rolling terrain near the base of slopes	–
[(si-LO)] / Bat-WW	Quaternary sediment overlying Balzac Drift (unit a)	silt overlying pebble-loam (till)	lacustrine-offshore sediment overlying wave-washed glacial sediment	not included in unit definition	–
[ssi-LT] / Bat	Quaternary sediment overlying Balzac Drift (unit a)	sand and silt overlying pebble-loam (till)	lacustrine traction-load sediment overlying glacial sediment	not included in unit definition	–
Bbt-r	Balzac Drift (unit b)	pebble-loam (till)	superglacial-mudflow sediment	glacier margin ridge	contains isolated bodies of poorly sorted ice-contact fluvial-channel sediment
Bbt-se	Balzac Drift (unit b)	pebble-loam (till)	glacial sediment	eroded slope	highly susceptible to erosion where vegetation has been removed
Bbt-C	Balzac Drift (unit b)	pebble-loam (till)	superglacial-mudflow sediment	glacial-collapse terrain	contains isolated bodies of poorly sorted ice-contact fluvial-channel sediment
Bbt-Ch	Balzac Drift (unit b)	pebble-loam (till)	superglacial-mudflow sediment	hummocky glacial-collapse terrain	may contain isolated bodies of poorly sorted ice-contact fluvial-channel sediment
Bbt-Cd / (PF)	Balzac Drift (unit b) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and shale	superglacial-mudflow sediment overlying nonmarine bedrock	eroded bedrock surface draped by glacial-collapse sediment	–
Bbt-Cg / (PF)	Balzac Drift (unit b) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and shale	superglacial-mudflow sediment overlying nonmarine bedrock	gently undulating glacial-collapse terrain	–
Bbt-Cd / g-FC	Balzac Drift (unit b)	pebble-loam (till) overlying gravel	superglacial-mudflow sediment overlying fluvial-channel sediment	glacial-collapse terrain draped over fluvial-channel sediment	–
Bbt-d / PF	Balzac Drift (unit b) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone, and shale	glacial sediment overlying nonmarine bedrock	eroded bedrock draped by veneer of glacial sediment	–
[ssi-LT] / Bbt / PF	Balzac Drift (unit b) overlying Porcupine Hills Formation	sand and silt overlying pebble-loam (till) overlying sandstone and shale	lacustrine traction-load sediment overlying glacial sediment overlying nonmarine bedrock	not included in unit definition	bedrock commonly occurs 4 to 6 metres beneath the surface
Lt	Lochend Drift	pebble-loam (till)	glacial sediment	not included in unit definition	–
Lt-Ch	Lochend Drift	pebble-loam (till)	superglacial-mudflow sediment	hummocky glacial-collapse terrain	–
Lt-Cr	Lochend Drift	pebble-loam (till)	superglacial-mudflow sediment	glacier margin collapse ridge	contains isolated bodies of poorly sorted ice-contact fluvial-channel sediment
Lt-se	Lochend Drift	pebble-loam (till)	undivided glacial sediment	eroded slope	–
Lt / (Tg-FC)	Lochend Drift overlying Tertiary gravel	pebble-loam (till) overlying gravel	glacial sediment overlying fluvial channel sediment	not included in unit definition	–
Lt-Cu / (Tg-FC)	Lochend Drift overlying Tertiary gravel	pebble-loam (till) overlying gravel	superglacial-mudflow sediment overlying fluvial-channel sediment	undulating glacial-collapse sediment	–
Lt-Cd / PF	Lochend Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and shale	superglacial-mudflow sediment overlying nonmarine bedrock	eroded bedrock surface draped by glacial-collapse sediment	–
Lt-Ch / PF	Lochend Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone, and shale	superglacial-mudflow sediment overlying nonmarine bedrock	eroded bedrock surface overlain by hummocky glacial-collapse sediment	–
Lt-d / PF	Lochend Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and shale	glacial sediment overlying nonmarine bedrock	eroded bedrock surface draped by glacial sediment	–
Lt / g-FC / [(PF)]	Lochend Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying gravel overlying sandstone, siltstone and shale	glacial sediment overlying fluvial-channel sediment overlying nonmarine bedrock	not included in unit definition	in places bedrock occurs within 6 metres of the surface
[-HC] / Lt	Lochend Drift	clay to boulders overlying pebble-loam (till)	colluvium overlying undivided glacial sediment	undulating to rolling terrain near the base of slopes	–
[ssi-LT] / Lt	Quaternary sediment overlying Lochend Drift	sand and silt overlying pebble-loam (till)	lacustrine traction-load sediment overlying undivided glacial sediment	not included in unit definition	–
[sic-LO] / Lt	Quaternary sediment overlying Lochend Drift	silt and clay overlying pebble-loam (till)	lacustrine offshore sediment overlying undivided glacial sediment	not included in unit definition	–
St	Spy Hill Drift	pebble-loam (till)	glacial sediment	not included in unit definition	–
St-se	Spy Hill Drift	pebble-loam (till)	glacial sediment	eroded slope	–
St-Ch	Spy Hill Drift	pebble-loam (till)	superglacial-mudflow sediment	hummocky glacial-collapse terrain	–
St-Cr	Spy Hill Drift	pebble-loam (till)	superglacial-mudflow sediment	glacier margin collapse ridge	contains isolated bodies of poorly sorted ice-contact fluvial-channel sediment
St-Cg	Spy Hill Drift	pebble-loam (till)	superglacial-mudflow sediment	flat to gently undulating glacial-collapse sediment	–
St-Ct	Spy Hill Drift	pebble-loam (till)	superglacial-mudflow sediment	transverse disintegration ridges (washboard moraine)	–
St-r	Spy Hill Drift	pebble-loam (till)	glacial sediment	glacier margin ridge	–
St / PF	Spy Hill Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and siltstone	glacial sediment overlying nonmarine bedrock	not included in unit definition	–
St-d / PF	Spy Hill Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and siltstone	glacial sediment overlying nonmarine bedrock	eroded bedrock surface draped by glacial sediment	–
St-d / KF	Spy Hill Drift overlying Brazeau or Wapiabi Formation	pebble-loam (till) overlying sandstone, siltstone, and mudstone	glacial sediment overlying nonmarine bedrock	eroded bedrock surface draped by glacial sediment	–
St / Tg-FC	Spy Hill Drift overlying Tertiary gravel	pebble-loam (till) overlying gravel	glacial sediment overlying Tertiary fluvial-channel sediment	not included in unit definition	–
St-d / (Tg-FC) / PF	Spy Hill Drift overlying Tertiary gravel overlying Porcupine Hills Formation	pebble-loam (till) overlying gravel overlying sandstone and siltstone	glacial sediment overlying fluvial-channel sediment overlying nonmarine bedrock	flat to undulating	till is generally 2 to 4 metres thick; gravel is generally 0 to 2 metres thick and is absent in as much as 50% of the area
[-AF] / St	Spy Hill Drift	bedded gravelly loam overlying pebble-loam (till)	alluvial-fan sediment overlying glacial sediment	sloping fans at the base of slopes	–
[sic-LO] / St	Spy Hill Drift	silt and clay overlying pebble-loam (till)	lacustrine-offshore sediment overlying undivided glacial sediment	not included in unit definition	–
[si-LO] / St	Spy Hill Drift	silt overlying pebble-loam (till)	lacustrine-offshore sediment overlying undivided glacial sediment	not included in unit definition	silt is less than 2 metres thick
[c-LO] / St	Spy Hill Drift	clay overlying pebble-loam (till)	superglacial lacustrine-offshore sediment overlying undivided glacial sediment	hummocky	clay varies in thickness from 0 to more than 6 metres and can be expected at the surface in 25% of the area
[g-FC] / St / [(PF)]	Spy Hill Drift overlying Porcupine Hills Formation	gravel overlying pebble-loam (till) overlying sandstone and shale	fluvial-channel sediment overlying undivided glacial sediment overlying nonmarine bedrock	not included in unit definition	gravel is generally less than 2 metres thick; bedrock generally lies 4 to 6 metres beneath the surface
[sic-LO] / St / [(KF)]	Spy Hill Drift overlying Brazeau or Wapiabi Formation	silt and clay overlying pebble-loam (till) overlying sandstone, siltstone and mudstone	lacustrine-offshore sediment overlying undivided glacial sediment overlying nonmarine bedrock	not included in unit definition	lacustrine sediment is less than 2 metres thick; bedrock generally lies 4 to 6 metres beneath the surface
Tg-FC / [(PF)]	Tertiary gravel overlying Porcupine Hills Formation	gravel and minor sand overlying sandstone and siltstone	fluvial-channel sediment overlying nonmarine bedrock	not included in unit definition	gravel is generally more than 6 metres thick but in places is 4 to 6 metres thick
PF	Porcupine Hills Formation	cherty, calcareous sandstone and calcareous mudstone; thick bedded, pale grey	nonmarine bedrock	not included in unit definition	bedrock crops out
PF-e	Porcupine Hills Formation	sandstone and mudstone	nonmarine bedrock	eroded bedrock	bedrock crops out
PF-se	Porcupine Hills Formation	sandstone and mudstone	nonmarine bedrock	eroded slope	bedrock crops out
[(Bat-d)] / PF	Balzac Drift (unit a) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone, and shale	glacial sediment overlying nonmarine bedrock	eroded bedrock draped by discontinuous veneer of glacial sediment	till is less than 2 metres thick, in places bedrock crops out
[(g-FC)] / PF	Quaternary sediment overlying Porcupine Hills Formation	gravel and minor sand overlying sandstone and siltstone	fluvial-channel sediment overlying nonmarine bedrock	not included in unit definition	–
[(ssi-LT)] / PF	Quaternary sediment overlying Porcupine Hills Formation	sand and silt overlying sandstone and shale	lacustrine traction-load sediment overlying nonmarine bedrock	not included in unit definition	–
[(Bat-du)] / PF	Balzac Drift (unit a) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and shale	glacial sediment overlying nonmarine bedrock	stream eroded bedrock draped by veneer of undulating glacial sediment	–
[(Bat-d)] / PF	Balzac Drift (unit a) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone and shale	glacial sediment overlying nonmarine bedrock	eroded bedrock draped by veneer of glacial sediment	–
[(Bbt-d)] / PF	Balzac Drift (unit b) overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone and shale	glacial sediment overlying nonmarine bedrock	eroded bedrock draped by veneer of glacial sediment	–
[(Lt-d)] / PF-se	Lochend Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone and shale	glacial sediment overlying nonmarine bedrock	eroded bedrock slope draped by veneer of glacial sediment	till is generally less than 2 metres thick; may include minor colluvium
[(Lt-Cd)] / PF	Lochend Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone and shale	superglacial mudflow sediment overlying nonmarine bedrock	glacial-collapse sediment draped over bedrock	–
[(Lt-d)] / PF	Lochend Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone and shale	undivided glacial sediment overlying nonmarine bedrock	eroded bedrock surface draped by veneer of glacial sediment	–
[(St-d)] / PF	Spy Hill Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone and shale	glacial sediment overlying nonmarine bedrock	eroded bedrock surface draped by veneer of glacial sediment	–
[(St-d)] / PF	Spy Hill Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone and shale	glacial sediment overlying nonmarine bedrock	eroded bedrock surface draped by veneer of glacial sediment	–
[(St)-se] / PF	Spy Hill Drift overlying Porcupine Hills Formation	pebble-loam (till) overlying sandstone, siltstone and shale	glacial sediment overlying nonmarine bedrock	bedrock slopes covered with till, which has been further eroded	till is less than 2 metres thick, in places bedrock crops out
[(si-FO) / g-FC / (Bbt)] / PF	Quaternary sediment overlying Porcupine Hills Formation	silt overlying gravel overlying sandstone, siltstone and shale	fluvial-overbank sediment overlying fluvial-channel sediment overlying nonmarine bedrock	not included in unit definition	bedrock is generally from 1 to 4 metres beneath the surface
KF	Brazeau and Wapiabi Formations (undivided)	Brazeau sandstone, siltstone, mudstone and Wapiabi siltstone, shale and minor sandstone	Brazeau nonmarine and Wapiabi marine bedrock	not included in unit definition	bedrock crops out
[(St-d)] / KF	Spy Hill Drift overlying Brazeau or Wapiabi Formation	pebble-loam (till) overlying sandstone, siltstone and mudstone	glacial sediment overlying marine bedrock	eroded bedrock surface draped by veneer of glacial sediment	–