## MARGINAL NOTES

The Village of Mayo is located in central Yukon, within the Stewart River Plateau. The physiography is characterized by rolling uplands with steep slopes leading into U-shaped valleys about 1000 m below the upland surface. The Village of Mayo is at the confluence of the Mayo and Stewart rivers, in the broad Stewart River valley. The Stewart and Mayo rivers are incised into the Stewart Plateau to a depth of 490 m a.s.l.; most of the Village of Mayo is >500 m a.s.l. on the floodplain of the Stewart River.

Vegetation in the region is dominantly a northern mixed deciduous and coniferous forest (boreal forest), consisting predominantly of white spruce (*Picea glauca*) and minor amounts of black spruce (*Picea mariana*) and paper birch (*Betula papyrifera*). Aspen (*Populus tremuloides*), balsam (*Populus balsamifera*) and poplar (*Populous*) are common and the northern limit of the lodgepole pine (*Picea contorta*) is located near Mayo in the Stewart River valley. South-facing slopes commonly have artemesia grasslands or steppe vegetation. The understory consists of feathermoss, willows, sagewort and ericaceous shrubs; sphagnum mosses are present in wetter terrain.

Surficial geology in Mayo reflects a glaciated landscape that has undergone significant modification from fluvial, eolian and permafrost processes. The Village of Mayo is located just inside the limit of the maximum extent of the last glaciation that occurred in Yukon, known as the McConnell Glaciation. This glacial advance occurred approximately 20 000 years before present, leaving behind morainal deposits on the slopes above the town site (Fig. 1). Deglacial lakes, deltas and terraces filled the valley as the glacier retreated, leaving thick deposits of fine-grained lacustrine (Fig. 2) and coarse-grained glaciofluvial (Figs. 3 and 4) materials across the valley.

Glacial limits in the Mayo region were originally noted by Bostock (1966) and later the surficial geology was mapped by Hughes (1983). Bostock (1966) recognized four advances of the Cordilleran Ice Sheet: Nansen, Klaza, Reid and McConnell (from oldest to youngest respectively). However, subsequent authors have rarely distinguished between events that are older than the Reid advance, and collectively refer to these older glacial episodes as the 'Pre-Reid' glaciation, which represents up to seven glacial advances.

Only the most recent two glacial advances are easily distinguishable in the Mayo region. The Reid advance was more extensive than the McConnell advance, and reached its westward limit ~80 km west of Mayo at Reid Lakes. This advance likely took place ~130 000 years before present and inundated all but the highest peaks around Mayo (Ward *et al*., 2008; Stroeven *et al*., 2010). Late Wisconsin McConnell-age glacial deposits are readily recognizable and well preserved in the Mayo region. The McConnell advance was the least extensive Cordilleran advance in Yukon and the western limit in central Yukon occurs ~20 km west of Mayo in the Stewart River valley. This less-extensive advance only reached elevations of ~700 m in the Mayo area and left most of the uplands ice-free.

The late Quaternary history of the Mayo region was outlined by Giles (1993) based on his work at various exposures around the town site:

1. Mid-Wisconsinan Interglacial (~30 000 years before present): A large wandering gravel-bed river flowed south through the Mayo River valley and into the Stewart River valley, similar in appearance to the modern Stewart River downstream of Mayo. The Stewart River at this time was likely a small tributary to the Mayo River and would have formed a wide braidplain at its confluence with the larger Mayo River.

2. Proglacial: As ice advanced down the Stewart River valley, a pro-glacial lake formed in the Mayo River valley and discharged along the northwest margin of the ice in the Stewart River valley. The outlet of this lake incised deep meltwater channels in bedrock – one of which is currently being used by the Mayo River (the Wareham Dam is built in one of these channels). The discharge from this lake also contributed to thick gravel terrace deposits on the north side of the Stewart River valley. When this southern outlet was blocked by advancing ice, water was diverted west through Minto Creek and formed a deeply incised meltwater channel near Minto Lake.

3. Glacial (~20 000 - 25 000 years before present): Ice in the Stewart River valley advanced past Mayo, forming a lateral or re-advance moraine across lower Mayo River valley (*i.e.*, near 5 Mile Lake). Deposition of till was limited at this time and ice-marginal drainage was likely maintained along the north margin of the ice sheet.

4. Postglacial: As the ice sheet began to retreat, an ice mass blocked drainage below the Village of Mayo and impounded a lake to ~550 m in the Stewart River valley. Meanwhile, retreat of the Stewart River valley ice allowed the lake in the Mayo River valley to begin draining south into the Stewart River valley, forming high glaciofluvial terraces against the ice front (*i.e.*, the Cemetery Road bench). A minor readvance likely formed a lateral moraine across the Mayo Valley and dammed water in the Wareham Lake basin to ~610 m.

5. Holocene (~10 000 years ago until present): After ice retreated and the remaining lakes drained, a large volume of fine-grained glaciolacustrine and glacially scoured material was available to be transported and reworked by eolian processes. The transport of fine-grained eolian material likely remained a dominant sedimentary process until moister conditions prevailed and vegetation became established ~9000 years ago (Wolfe *et al*., 2011). Since this time, eolian deposition has been limited to cliff-top loess deposition above unvegetated sediment bluffs. Permafrost processes may have taken over as the dominant landscape-forming process around this time (Burn *et al*., 1986). The growth of permafrost in poorly drained fine-grained materials in the area is responsible for shifts in vegetation cover and the establishments of thermokarst lakes and ponds over much of eastern Mayo. Finally, ongoing incision of glacial sediments by the Stewart and Mayo rivers continues to transport large volumes of sediment within the map area.

The materials making up the surficial geology in and around Mayo are, for the most part, stable. However, geological, hydrological and climatological processes operating on these materials can pose a hazard to existing and future development. Mayo has abundant gravel and sand-rich landforms that are stable, well drained, and ice free. Many of these landforms also occur above the floodplains of both the Mayo and Stewart rivers. These are ideal building sites for future infrastructure. Less stable landforms in the Mayo region include those that contain glaciolacustrine materials, moraine deposits, and some point bar deposits along the Stewart River.

## FIGURES

Figure 1. Moraine ridge on the east side of the map area (dashed line). Photo was taken beside the Silver Trail Highway ~0.5 km south of Five Mile Lake.

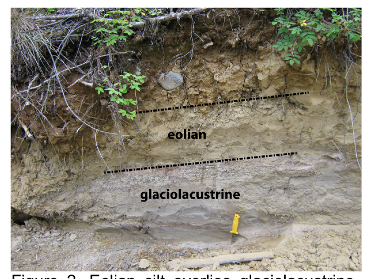



Figure 2. Eolian silt overlies glaciolacustrine sand, silt and clay in many low elevation exposures near the Village of Mayo.

Figure 3. Surficial materials in the Airport Subdivision are composed of glaciofluvial gravel and sand with interbedded silt and fine sand that were deposited in back-channel environments.

Figure 4. The First Nation of Nacho-Nyak Dun Government Building is built on a large glaciofluvial terrace and delta landform composed predominantly of well-drained gravel and sand.

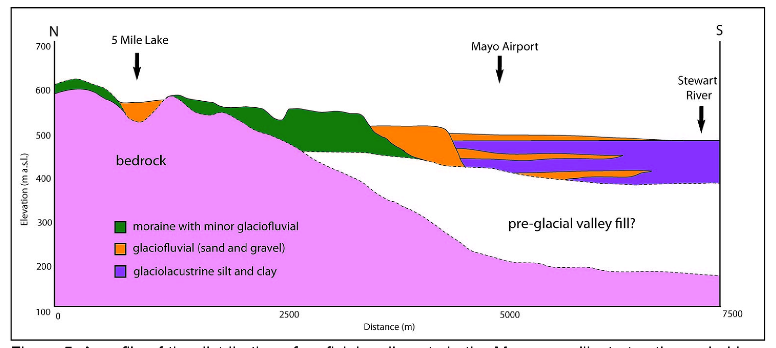
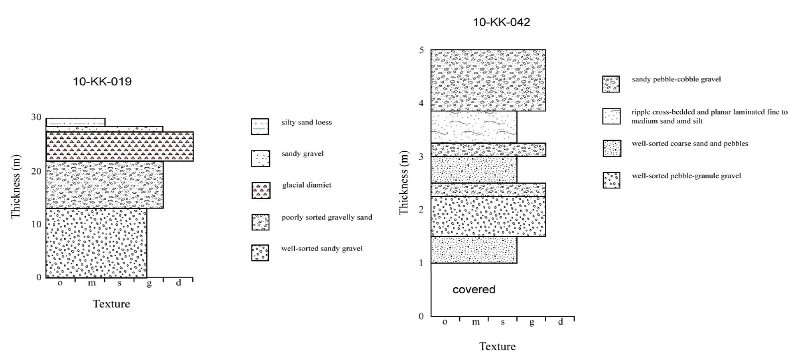
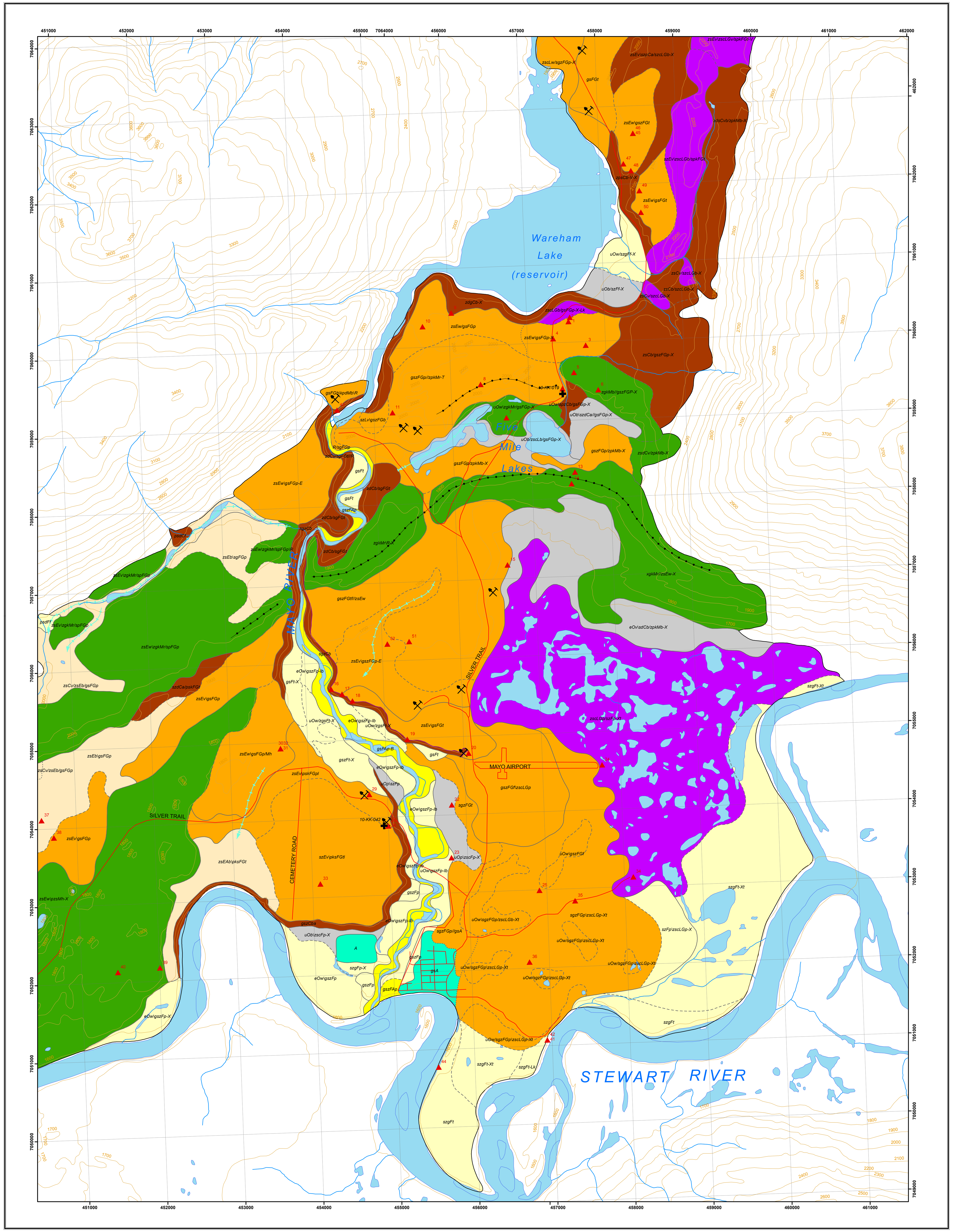
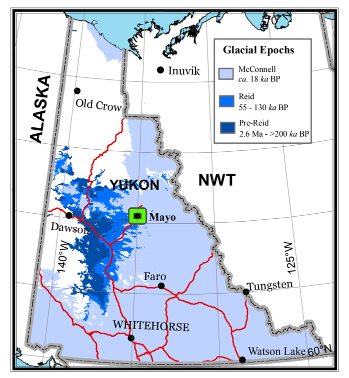


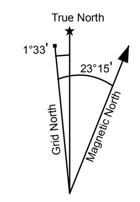

Figure 5. A profile of the distribution of surficial sediments in the Mayo area illustrates the probable subsurface contacts between unconsolidated materials and underlying bedrock.

## STRATIGRAPHY




Use diagram only to obtain numerical values
APPROXIMATE MEAN DECLINATION
FEBRUARY 2011 FOR CENTRE OF MAP

SURFICIAL GEOLOGY
**VILLAGE OF MAYO**
YUKON
part of NTS 105M/12

SCALE 1:20 000

kilometres

1:50 000-scale topographic base data produced by CENTRE FOR TOPOGRAPHIC INFORMATION NATURAL RESOURCES CANADA

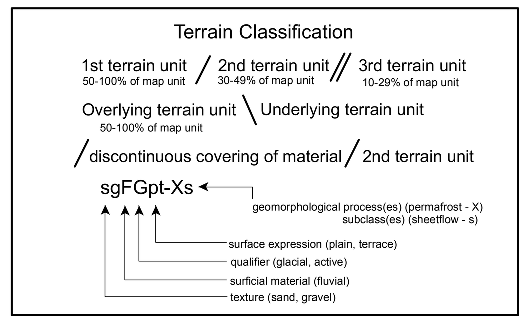
ONE THOUSAND METRE GRID
Universal Transverse Mercator Projection

CONTOUR INTERVAL 100 FEET
Elevations in feet above Mean Sea Level

| | | |
|---|---|---|
| 115P/16 SEATTLE CREEK | 105M/13 MOUNT HALDANE | 105M/14 KENO HILL |
| 115P/09 MINTO LAKE | 105M/12 MAP LOCATION | 105M/11 WILLIAMSON LAKE |
| 115P/08 ETHEL LAKE | 105M/05 FRANCIS LAKE | 105M/06 NOGOLD CREEK |

## SURFICIAL GEOLOGY MAP

This surficial geology map was classified using the Terrain Classification System for British Columbia (Howes and Kenk, 1997), with modification to meet standards set by the Yukon Geological Survey. For example, we have added permafrost process subclasses to further account for the breadth of permafrost features on the landscape. Linework for the map was produced from interpretations of 1:40 000-scale aerial photos (1989). Subsequent field checking of the map area was completed in the summer of 2010.




## SURFICIAL MATERIAL

Surficial materials are non-lithified, unconsolidated sediments. They are produced by weathering, sediment deposition, biological accumulation, human and volcanic activity. In general, surficial materials are of relatively young geological age and they constitute the parent material of most (pedological) soils. On the map, surficial materials form the core of the polygon label. They are symbolized with a single upper case letter, with texture written to the left, and surface expression or glacial qualifier to the right. The glacial qualifier "G" is used to describe glacially modified materials. If actual activity state is different than the assumed activity state (indicated in brackets next to the surficial material name below), a qualifier A (active) or I (inactive) must be used as a superscript following the surficial material designator. Note that a single polygon will be coloured only by the dominant surficial material, but other materials may exist in that unit.

**A** — Anthropogenic (active): Artificial materials, or geological materials so modified by human activities that their original physical properties (<ITA>e.g.</ITA>, structure, cohesion and compaction) have been drastically altered. This map unit has been used for the downtown core of the Village of Mayo and the sewage lagoon.

**C** — Colluvium (active): Colluvial deposits include materials that have reached their present positions as a result of direct, gravity-induced movement involving no agent of transportation such as water or ice (Howes and Kenk, 1997). Colluvial deposits in the Mayo region generally consist of massive to moderately well-stratified, non-sorted to poorly-sorted sediments containing any range of particle sizes from clay to boulders. Colluvial deposits commonly form near the bottom of moderate to steep slopes, where materials have been moved downslope due to gravity. Colluvial deposits in the map area occur along steep banks of both the Mayo and Stewart rivers, as well as at the base of escarpments formed by glaciofluvial terraces and moraine ridges. Colluvial deposits are gravity-modified versions of pre-existing deposits, and as such, are reflective of regional deposit types. In the Mayo region, most colluvial deposits are formed from glaciofluvial and morainal deposits and grain sizes are similar to the original deposit types. On north and east-facing aspects, colluvial deposits are likely to be affected by permafrost.

**E** — Eolian (inactive): Eolian deposits include materials transported and deposited by wind. These deposits generally consist of medium to fine sand and well sorted coarse silt that is uncompacted and may contain internal structures such as cross-bedding or ripple laminae, or may be massive (Howes and Kenk, 1997). Much of the map area around Mayo is covered with a thin veneer of wind-deposited silt and fine sand. Eolian deposits are thickest in the southwest part of the map area, where they reach thicknesses of >1 m in some areas. Thinner deposits (~10-30 cm thick) are found overlying many moraine and glaciofluvial deposits that have not undergone significant alteration since deposition. In a few areas, where fine-grained glaciolacustrine or fluvial materials are at surface (east of Wareham Lake), local reworking of the original deposit make overlying eolian materials difficult to distinguish from underlying deposits (Fig. 2). Modern (active) eolian deposition is limited to localized pockets above bare sediment cliffs (such as the south end of Cemetery Road).

**F** — Fluvial (inactive): Fluvial deposits are materials that have been transported and deposited by streams and rivers. Fluvial sediments mapped in the Mayo area are predominantly those associated with floodplains, fluvial terraces and channels of the Mayo River. These deposits generally consist of stratified beds of gravel and/or sand with sand and silt and/or organic deposits (and rarely clay). Gravel consists of interstitial sand and clasts that are typically rounded. These deposits are commonly moderately to well sorted and display stratification. Silt, sand and organic deposits make up thinly laminated or massive overbank deposits that are commonly interbedded with coarser gravel deposits. Fine-grained lenses and beds in these fluvial deposits commonly contain ice, although it may be discontinuous over relatively small areas.

**FA** — Fluvial (active): Fluvial deposits are materials that have been transported and deposited by streams and rivers. Active fluvial sediments mapped in the Mayo area are predominantly those associated with floodplains and channels of the Mayo River. These deposits generally consist of stratified beds of gravel and/or sand with sand and silt and/or organic deposits (and rarely clay). Gravel deposits contain interstitial sand and clasts that are typically rounded. These deposits are commonly moderately to well sorted and display stratification. Silt, sand and organic deposits make up thinly laminated or massive overbank deposits that are rarely interbedded with coarser gravel deposits in active fluvial environments.

**FG** — Glaciofluvial (inactive): Glaciofluvial deposits include materials that have been deposited by glacial meltwater either directly in front of, or in contact with, glacier ice (Howes and Kenk, 1997). Glaciofluvial materials typically range from non-sorted and non-bedded gravel made up of a wide range of particle sizes, associated with very rapid aggradation at an ice front, to moderately to well sorted, stratified gravel. Slump structures such as hummocky or irregular terrain are indicative of collapse of the material due to melting of supporting ice. Glaciofluvial materials are abundant in the Mayo region. They typically form kettled and hummocky plain surfaces, but are also present as ridged and undulating landforms when deposited along a glacier margin. There are generally two categories of glaciofluvial deposits in the Mayo region: those that formed in close proximity to the ice margin, and those that formed more distal to the ice in a dominantly fluvial environment (<ITA>e.g.</ITA> Fig. 4).

**L** — Lacustrine (inactive): Sediments that have settled from suspension and underwater gravity flows (<ITA>i.e.</ITA> turbidity currents) in bodies of standing fresh water, or sediments that have accumulated at their margins through the action of waves. Lacustrine materials in the Mayo area are limited to small lakes near the 5 Mile Lake area.

**LG** — Glaciolacustrine (inactive): Glaciolacustrine materials are deposited in, or along, the margins of glacial (ice-dammed) lakes and include sediments that were released by the melting of floating ice. Glaciolacustrine materials are common in the Mayo region and are represented by deposits consisting of stratified fine sand, silt and/or clay with rare lenses of till and/or glaciofluvial deposits. These materials were deposited in two glacially dammed lakes in the Mayo area. Coarse-grained sediments coming out of the Mayo River valley during and after deposition of the glacial lake sediments in the Stewart River valley deposited fan and delta landforms at the north end of the lake (near the airport). Coarse-grained sediments in these landforms are often interbedded with fine-grained glaciolacustrine sediments, but are generally less ice rich and more stable than landforms to the south and east that lack the coarse-grained component.

**M** — Moraine (inactive): Moraine deposits include materials that have been deposited directly by a glacier or ice sheet without modification by any other agent of transportation. Moraine deposits are typically highly variable and depend upon both the source of material incorporated by the glacier and the mode of deposition (Howes and Kenk, 1997). Moraine deposits in the Mayo region are characterized by poorly sorted, weakly compacted material lacking stratification and containing a heterogeneous mixture of particle sizes, which is usually in a matrix of sand, silt and clay. Moraines in the map area are found in lateral and terminal moraines and moraine complex landforms. Moraines are located on surrounding hillsides (Fig. 1) at elevations of ~700 m a.s.l. and occur as broad west-trending linear features in the Mayo River valley. Steep-sided ridges and deep kettle holes are common in moraine complex landforms, creating abundant surface topography and locally high variation in overlying surface veneers of eolian and colluvial deposits.

**O** — Organic (active): Organic materials in the Mayo region are commonly found in low-lying areas where wet ground conditions have facilitated a thick accumulation of vegetative matter. Organic deposits contain at least 30% organic matter by weight and are commonly saturated with water and consist of the accumulated remains of mosses, sedges, or other hydrophytic vegetation (Howes and Kenk, 1997). In the map area, organic deposits form blankets (>1 m) and veneers (<1 m) over inorganic materials that commonly have poor drainage capacity due to a high percentage of silt and clay. Thick organic deposits occur on floodplains of the Mayo and Stewart rivers, in poorly drained areas affected by thermokarst processes, and in abandoned meltwater channels such as along 5 Mile Lake and adjacent water bodies. Ice-rich permafrost conditions are common in these deposits.

**R** — Bedrock: Bedrock outcrops in the map area are limited to a few small areas around Wareham Dam and in the canyonized part of the Mayo River below the dam. The bedrock contact drops sharply south of Wareham dam and is approximately 300 m below surface at the Village of Mayo (Fig. 5; Stanley and Associates, 1990).

## SURFACE EXPRESSION

Surface expression refers to the form (assemblage of slopes) and pattern of forms expressed by a surficial material at the land surface. This three-dimensional shape of the material is equivalent to 'landform' used in a non-genetic sense (e.g., ridges, plain, etc.). Surface expression symbols also describe the manner in which unconsolidated surficial materials relate to the underlying substrate (e.g., veneer). Surface expression is indicated by up to three lower case letters, placed immediately following the surficial material designator, listed in order of decreasing importance.

a - apron: A wedge-like slope-toe complex of laterally coalescent colluvial fans and blankets. Longitudinal slopes are generally less than 15° (26%) from apex to toe with flat or gently convex/concave profiles.

b - blanket: A layer of unconsolidated material thick enough (>1 m) to mask minor irregularities of the surface of the underlying material, but still conforms to the general underlying topography; outcrops of the underlying unit are rare.

f - fan: Sector of a cone with a slope gradient less than 15° (26%) from apex to toe; longitudinal profile is smooth and straight, or slightly concave/convex.

h - hummock: Steep-sided hillock(s) and hollow(s) having multidirectional slopes dominantly between 15-35° (26-70%) if composed of unconsolidated materials, whereas bedrock slopes may be steeper. Local relief is >1 m. In plan view, these surface expressions make up an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile. This surface expression is commonly applied to knob-and-kettle glaciofluvial terrain.

l - delta: Landform created at the mouth of a river or stream where it flows into a body of water. Deltas have gently sloping surfaces between 0-3° (0-5%), and moderate to steeply sloping fronts between 16-35° (27-70%). Glaciofluvial deltas in the map area are typically coarse grained, have steep sides, and gently inclined kettled or channeled surfaces.

p - plain: A level or very gently sloping, unidirectional (planar) surface with slopes 0-3° (0-5%); relief of local surface irregularities are generally <1 m. This surface expression is applied to (glacio)fluvial floodplains, organic deposits, lacustrine deposits and till plains.

r - ridge: Elongate hillock(s) with slopes dominantly 15-35° (26-70%) if composed of unconsolidated materials; bedrock slopes may be steeper. Local relief is >1 m. In plan view, this surface expression makes up an assemblage of parallel or sub-parallel linear forms. This term is commonly applied to drumlinized till plains, eskers, morainal ridge crests, crevasse fillings and ridged bedrock.

t - terrace: A single or assemblage of step-like forms where each step-like form consists of a scarp face and a horizontal or gently inclined surface above it. This surface expression is applied to fluvial and lacustrine terraces and stepped bedrock topography.

v - veneer: A layer of unconsolidated material too thin (10 cm - 1 m in thickness) to mask the minor irregularities of the surface of the underlying material. This surface expression is commonly applied to eolian/loess veneers and colluvial veneers.

w - mantle of variable thickness: A layer or discontinuous layer of surficial material of variable thickness (0-3 m) that fills or partly fills depressions in an irregular substrate.

## SYMBOLS

- water courses
- roads
- elevation contours (feet a.s.l.)
- moraine ridge
- meltwater channel (direction indicated)
- stratigraphic sections
- texture samples
- gravel pit

**Geological Boundaries**

- defined boundary
- approximate boundary
- assumed boundary
- limit of geological mapping

## TEXTURE

Texture refers to the size, shape and sorting of particles in clastic sediments, and the proportion and degree of decomposition of plant fibre in organic material.

Specific clastic textures:
a - blocks: angular particles >256 mm in size
b - boulders: rounded particles >256 mm in size
k - cobbles: rounded particles between 64 and 256 mm in size
p - pebbles: rounded particles between 2 and 64 mm in size
s - sand: particles between 0.0625 and 2 mm in size
z - silt: particles between 2 μm and 0.0625 mm in size
c - clay: particles <2 μm in size

Common clastic textural groupings:
d - mixed fragments: a mixture of rounded and angular particles >2 mm in size
x - angular fragments: a mixture of angular fragments >2 mm in size (*i.e.*, a mixture of blocks and rubble)
g - gravel: a mixture of two or more size ranges of rounded particles >2 mm in size (*eg.*, a mixture of boulders, cobbles and pebbles); may include interstitial sand
r - rubble: angular particles between 2 and 256 mm; may include interstitial sand
m - mud: a mixture of silt and clay; may also contain a minor fraction of fine sand
y - shells: a sediment consisting dominantly of shells and/or shell fragments

Organic terms:
o - organic: unclassified organic materials
e - fibric: the least decomposed of all organic materials; it contains amounts of well-preserved fibre (40% or more) that can be identified as to botanical origin upon rubbing
u - mesic: organic material at a stage of decomposition intermediate between fibric and humic
h - humic: organic material at an advanced stage of decomposition; it has the lowest amount of fibre, the highest bulk density, and the lowest saturated water-holding capacity of the organic materials; fibres that remain after rubbing constitute less than 10% of the volume of the material

## GEOMORPHOLOGICAL PROCESSES

Geomorphological processes are natural mechanisms of weathering, erosion and deposition that result in the modification of the surficial materials and landforms at the earth's surface. Unless a qualifier (A (active) or I (inactive)) is used, all processes are assumed to be active, except for deglacial processes. Process is indicated by up to three upper case letters, listed in order of decreasing importance, placed after the surface expression symbol, and separated from the surface expression by a dash (-).

Subclasses can be used to provide more specific information about a general geomorophological process, and are represented by lower case letter(s) placed after the related process designator. Up to three subclasses can be attached to each process. Process subclasses used on this map are defined with the related process below.

### EROSIONAL PROCESSES

V - gully erosion: Running water, mass movement and/or snow avalanching, resulting in the formation of parallel and sub-parallel long, narrow ravines.

### FLUVIAL PROCESSES

I - irregularly sinuous channel: A clearly defined main channel displaying irregular turns and bends without repetition of similar features. Backchannels may be common, and minor side channels and a few bars and islands may be present, but regular and irregular meanders are absent.

Subclasses: (b) - backchannels: Small channels that may or may not be connected to the main channel.

### MASS MOVEMENT PROCESSES

L - landslide processes: Slow or rapid downslope movement of masses of cohesive or non-cohesive surficial material and/or bedrock by falling, sliding, rolling, flowing, or creeping of dry, moist or saturated debris.

Subclasses: (k) - tension cracks: Open fissures that are commonly near the crest of a slope.

### PERIGLACIAL PROCESSES

X - permafrost: Processes controlled by the presence of permafrost, and permafrost aggradation or degradation.

Subclasses: (t) - thermokarst: Subsidence or ground-surface depressions created by the thawing of ice-rich permafrost and associated soil subsidence.

### DEGLACIAL PROCESSES

E - channeled by meltwater: Erosion and channel formation by meltwater alongside, beneath, or in front of, a glacier or ice sheet.

## ACKNOWLEDGEMENTS

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## RECOMMENDED CITATION

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*Digital cartography and drafting by Kristen Kennedy with the Yukon Geological Survey using ArcMap. Mapping based on digital air photo interpretation using 1:40 000-scale photos. Field checking was performed in summer 2010. Linework for map is based on aerial photography from 1989 and may not match basedata (contours, streams) derived from 1:50 000-scale topographic maps.*

*Any revisions or additional geological information known to the user would be welcomed by the Yukon Geological Survey.*

*Paper copies of this map may be purchased from Geoscience Information and Sales, c/o Yukon Geological Survey, Energy, Mines and Resources, Yukon Government, Room 102 - 300 Main St., Whitehorse, Yukon, Y1A 2B5. Ph. 867-667-3207, Fx. 867-667-3198, Email geosales@gov.yk.ca.*

*A digital PDF (Portable Document File) file of this map may be downloaded free of charge from the Yukon Geological Survey website: http://www.geology.gov.yk.ca.*

Yukon Geological Survey
Energy, Mines and Resources
Government of Yukon

Open File 2011-3

# Surficial Geology of the Village of Mayo (part of NTS 105M/12) Yukon (1:20 000-scale)

by

Kristen E. Kennedy