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Aggregate potential mapping centred on Yukon communities and highway corridors

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Yukon

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Cover photo: McLean Lake Road gravel pit. Photo by Panya Lipovsky.

Introduction

The population and economic growth in Yukon necessitates the exploitation of aggregate resources for the construction and maintenance of infrastructure including roads, and residential and commercial buildings. While many local-scale aggregate mapping projects have been completed to identify aggregate resources on a project-specific basis, few regional studies exist (Kennedy, 2009; Smith *et al.*, 2009). The purpose of this aggregate potential mapping is to generate a database of prospective aggregate resources near Yukon communities and highway corridors using existing surficial geology mapping (YGS, 2020a). This database should be used as a preliminary guide for identifying new resources. Additional detailed desktop and field investigations are recommended.

Study Area

Aggregate potential analysis is presented for two areas of study (Fig. 1). The first area is a four-kilometre wide corridor centred on Yukon highway network lines (1:250k CanVec). The second area includes a 20 km radius around each Yukon community excluding Whitehorse. Remapping of surficial geology in the Whitehorse area is currently underway; maps are expected to be published in 2021 (Lipovsky, *personal communication*).

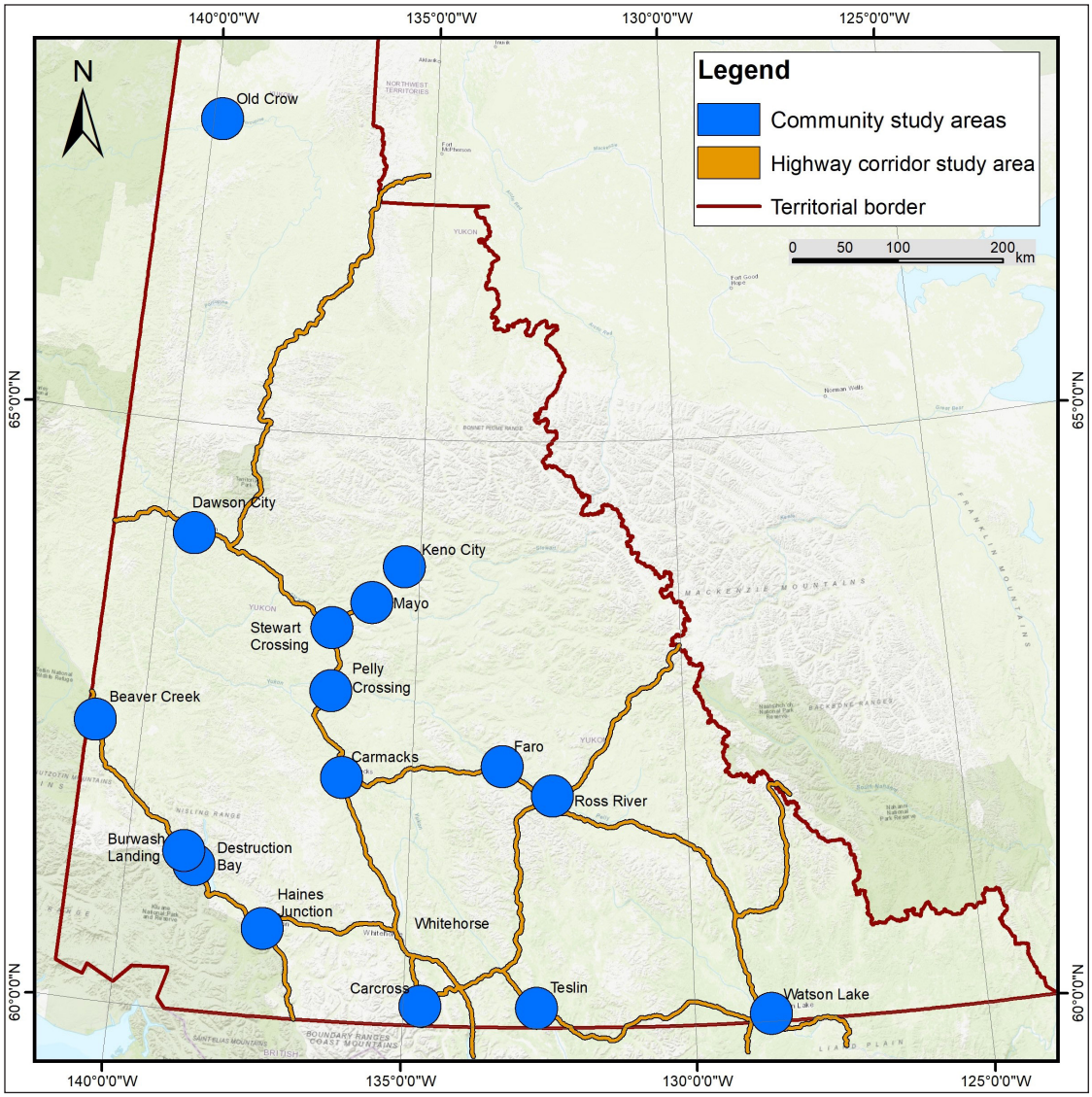

Figure 1. *Overview of aggregate potential mapping highway corridor and community study areas.*

Methodology

More detailed mapping is utilized in areas where multiple scales of mapping overlap within the Yukon surficial geology compilation; the result is a continuous single-layer of coverage displaying the highest resolution mapping available. Newer mapping is selected for analyses where two maps of the same scale overlap. Surficial geology polygons are ranked by surficial material type, surface expression, and texture with weighting applied for material abundance. Materials containing gravel with minimal silt and clay are the most desirable. Ranking penalties are applied to buried deposits that require stripping and to materials where permafrost is present (Table 1; Fig. 2). Definitions for surficial materials, expression and textures are derived from Yukon Geological Survey's (YGS) modifications (YGS, 2020b) to the Terrain Classification System for British Columbia (Howse and Kenk, 1997; Table 2). The equation used to calculate the aggregate potential score for each polygon is as follows:

$$\textit{Aggregate Potential Score} = \textit{Max Value}\left(\left(\textit{Material A Proportion} \times \textit{Material A Suitability}\right) \textit{ or } \left(\textit{Material B Proportion} \times \textit{Material B Suitability}\right)\right) - 0.25 \times \textit{Stripping Value} - 0.25 \times \textit{Permafrost Value}$$

Yukon aggregate potential scores range from 0–3, with higher scores representing better potential for an aggregate resource. Scores are a guideline only as surficial geology polygon classification is based on little or no ground investigation, and considerable variability may be present within a polygon. Waterbodies (1:50k CanVec) are superimposed on the surficial geology mapping and given an aggregate potential score of 0. Within the mapped corridor or buffer area, no ranking is given for proximity to the road or community.

Table 1. *Calculation values of aggregate potential.*

Material A Proportions	**Value**
Partial cover: "\"	0.5
Full cover	1
Material B Proportions	**Value**
Relation_AB: "."	0.5
Relation_AB: "/"	0.3
Relation_AB: "//"	0.1
If Material A has partial cover: "\"	1
Material Suitability[1]	**Value**
Material = F, F^A, F^G, A and Texture 1 or 2 = g	3
Material = M and Surface Expression = h	2
Material = C and Surface Expression = c or f	2
Material = other	1
Stripping Value	**Value**
Relation AB = "\" and Material A Suitability = 1 and Material A Surface Expression = "v" or "x"	1
Relation AB = "\" and Material A Suitability = 1 and Material A Surface Expression = "b"	2
Relation AB = "\" and Material A Suitability = 1 and Material A Surface Expression = other	3
Permafrost	**Value**
Indicated (-X)	1
Not Indicated	0

[1] Material code definitions in Table 2.

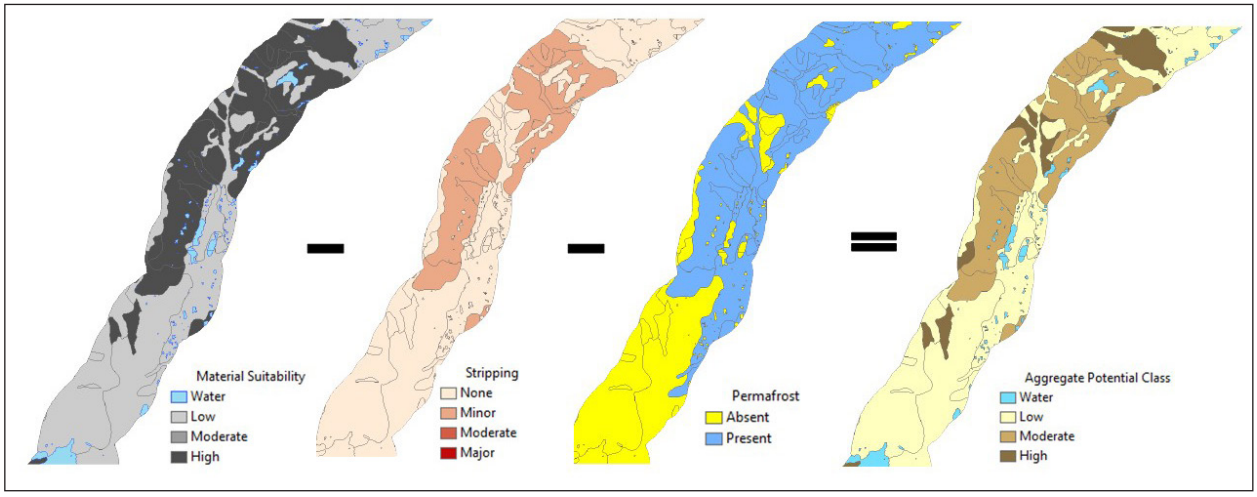

Figure 2. *Schematic representation of aggregate potential classification input and outputs layers for a portion of the highway corridor study area.*

Table 2. *Surficial material, expression and texture definitions of codes used in the aggregate potential classification.*

Surficial Material	
A	Anthropogenic — material deposited by human activity
F	Fluvial — material transported and deposited by streams and rivers
F^{A}	Fluvial — material transported and deposited by streams and rivers within the active floodplain
F^{G}	Glaciofluvial — material transported and deposited by glacial meltwater
M	Morainal (Till) — material deposited directly by glacier ice
C	Colluvial — material deposited by gravity
Surface Expression	
h	Hummock — steep sided hills and hollows with slopes between 15 and 35°
c	Cone — a semi-conical landform with a slope gradient greater than 15°
f	Fan — a semi-conical landform with slope gradient less than 15°
v	Veneer — a thin layer of material 10 cm – 1 m in thickness
x	Thin veneer — a very thin layer of material 2 – 20 cm in thickness
b	Blanket — a layer of material thick generally greater than 1 m thick conforming to the general underlying topography
Texture	
g	Gravel — rounded particles with a range of sizes greater than 2 mm

Example Calculations

For further clarification on aggregate potential score determination, example calculations are shown below that evaluate resources of high, moderate and low potential.

High Aggregate Potential

Surficial Geology Label: gsFGtd

$$\text{Aggregate Potential Score} = \text{Max Value}\left((1 \times 3) \text{ or } (0 \times 0)\right) - 0.25 \times 0 - 0.25 \times 0 = 3$$

Moderate Aggregate Potential

Surficial Geology Label: euOv\dsMh

$$\text{Aggregate Potential Score} = \text{Max Value}\left((1 \times 1) \text{ or } (1 \times 2)\right) - 0.25 \times 1 - 0.25 \times 0 = 1.75$$

Low Aggregate Potential

Surficial Geology Label: euOv-X

$$\text{Aggregate Potential Score} = \text{Max Value}\left((1 \times 1) \text{ or } (0 \times 0)\right) - 0.25 \times 0 - 0.25 \times 1 = 0.75$$

Qualitative Classification

For ease of interpretation, a qualitative classification of aggregate potential scores is recommended; this classification is provided in Table 3. High potential sources represent those with good material suitability (moderately sorted or better) and limited or no constraints from permafrost or overburden. Moderate potential sources represent good material suitability with significant overburden, or moderate overburden and permafrost, and sources of moderate material suitability (poorly sorted or worse). Low potential sources represent those with undesirable materials or materials of moderate potential with considerable extraction constraints from permafrost and/or overburden. Scores of 1.25 may contain a small proportion of suitable material, but are subject to considerable constraint from overburden and permafrost. Aggregate potential scores of 1 or lower are unlikely to contain any suitable aggregate material.

Table 3. *Qualitative classification of aggregate potential scores.*

Aggregate Potential Classification	Aggregate Potential Score
Low	≤1.25
Moderate	>1.25–2.5
High	>2.5–3

Highways regional overview

In order to display the classified polygons regionally, a generalized overview of potential resources, within the highway corridor, was created by converting aggregate potential polygons to raster format. A 1 km^2 cell size was created, allowing for aggregation of detailed polygons with the same qualitative classification and generalization to a resolution more reasonably displayed on 1:1 000 000 scale or coarser maps. The raster was then converted back to polygons.

Results

Aggregate potential ratings were assigned to all polygons within the study areas. The GIS files containing the full results of the aggregate potential mapping for both study areas are provided in an ESRI geodatabase in Appendix A.

Approximately one quarter of the Yukon highway corridor study area contains material with moderate or high aggregate potential (Table 4). The surficial material in the remainder of the corridor is unlikely to be suitable. A regional overview map of the highway corridor aggregate potential is shown in Appendix B. This map can be used to determine "at-a-glance" if potential aggregate resources exist within the highway corridor along a given length of road. The detailed mapping files (Appendix A) should be consulted to determine the characteristics and precise location of the potential resource and supplemented with field investigations.

Aggregate potential maps for Yukon communities are presented in Appendix C.

Limitations

Aggregate potential mapping is based on pre-existing surficial geology mapping that has been validated with limited field-checking at many but not all map polygons. Despite best efforts, significant variability can exist within map units that may not be reflected in the polygon label and ultimately the aggregate potential scoring. This is of particular concern where 1:250 000-scale mapping is used for the surficial geology input. Source map details are appended to each aggregate potential polygon in Appendix A. Aggregate potential classifications do not consider environmental or social constraints on resource suitability.

Table 4. *Yukon highways corridor aggregate potential distribution.*

Aggregate Potential Classification	% of highway corridor by area	Total area (ha)
Low	72.2	1 107 104
Moderate	4.2	64 622
High	23.7	361 353

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References

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Appendices

Appendix A

Yukon community transportation aggregate potential. Contains GIS files in an Esri geodatabase.

Appendix B

Aggregate potential along Yukon highway, regional overview. Scale 1:1 500 000.

Appendix C

Community aggregate potential maps. Sixteen maps, scale 1:60 000.