Appendix V8-1A

Archaeological Sites within the LSA and TCWR Winter Road Connector Assessment Area

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GOLD & SILVER CORP.

Appendix V8-1A. Archaeological Sites within the LSA and TCWR Winter Road Connector Assessment Area

Borden Number	Antiquity	Site Type	Contents	Terrain	Artifacts	Site Significance	Permit Number
LfNn-1	Prehistoric	Campsite	Stone Oval, Lithic Scatter	The site is located on a small island on the east side of a lake.	The site consists of a 2 m diameter stone oval with 25 stones and a lithic scatter of 10 clear quartz flakes.	Moderate	NUNAVUT 2013-20A
LfNo-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a small knoll on the south side of a stream between to lakes to the east and west.	The site consists of a lithic scatter with approximately 200 white and grey quartzite flakes and 20 black basalt flakes.	Low-moderate	NUNAVUT 2013-20A
LfNo-2	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a knoll on the south side of a stream between to lakes to the east and west.	The site consists of two lithic scatter one containing over 200 white and grey quartzite flakes and the other with a white quartzite scraper and 9 white quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-3	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on two small knolls and the area between to the south a creek that runs between lakes to the east and west.	The site consists of two lithic scatters with a low density of flakes between them. One scatter contains 30 grey quartzite flakes and the other contains between 30 and 40 grey quartzite flakes.	Low-moderate	NUNAVUT 2013-20A
LfNo-4	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the south side of a stream between to lakes to the east and west.	The site contains three lithic scatters containing a white chert burin indicative of the Arctic Small Tool tradition, a grey quartzite scraper, and over 100 grey chert, and white and grey quartzite flakes.	Moderate-high	NUNAVUT 2013-20A
LfNo-5	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on top of a large knoll on the south side of a stream between to lakes to the east and west.	The site consists of over 200 white and grey quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-6	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an east-west trending esker overlooking a small pond to the northeast and a lake to the south.	The site consists of a quartzite biface fragment, and over 250 grey and white quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-7	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an east-west trending esker overlooking a small pond to the north and a lake to the south.	The site consists of a quartzite point, a quartz blade, and over 50 white and grey quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-8	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on top of a knoll surrounded by a boulder field.	The site consists of a lithic scatter of 10 white quartzite flakes.	Low	NUNAVUT 2013-20A
LfNo-9	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on top of a knoll surrounded by a boulder field.	The site consists of a lithic scatter of 20 white and grey quartzite flakes	Low	NUNAVUT 2013-20A
LfNo-10	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on top of a knoll surrounded by a boulder field.	The site consists of a lithic scatter of one grey chert flake, one grey chert nodule, and over 100 grey quartzite flakes.	Low-moderate	NUNAVUT 2013-20A
LfNo-11	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on top of a knoll surrounded by a boulder field.	The site consists of a lithic scatter containing 15 grey quartzite flakes.	Low	NUNAVUT 2013-20A
LfNo-12	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a knoll to the overlooking a creek the south that runs between lakes to the east and west.	The site consist of a very dense lithic scatter containing thousands of white quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-13	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the west shore of a lake.	The site consists of two lithic scatters one with three white quartzite bifaces, bipolar cores and hundreds of white quartzite and brown siltstone and chert flakes and the other lithic scatter with over 200 white and grey quartzite flakes.	Moderate-high	NUNAVUT 2013-20A
LfNo-14	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll overlooking and lake to the south and outlet to the east.	The site consists of a lithic scatter of over 40 grey quartzite flakes.	Low-moderate	NUNAVUT 2013-20A
LfNo-15	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on top of a knoll overlooking a creek to the south that connects lakes to the east and west.	The site contains two lithic scatters with one containing over 50 grey quartzite flakes and the other 20-30 grey quartzite flakes.	Low-moderate	NUNAVUT 2013-20A
LfNo-16	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on top of a knoll overlooking a creek to the south that connects lakes to the east and west.	The site contains a quartzite bifacial scraper and over 100 grey quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNp-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located in a sand exposure overlooking a lake to the south.	The site consists of a clear quartzite point fragment and 2 white quartzite flakes.	Low-moderate	NUNAVUT 2013-20A
LfNp-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker with low-lying land the east and west.	The site consists of two white-clear quartz flakes.	Low	NUNAVUT 2013-20A
LfNp-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker with low-lying land to the east and west.	The site consists of 10-15 white quartzite flakes.	Low	NUNAVUT 2013-20A
LfNp-4	Prehistoric	Lithic Workshop	Stone Circle, Lithic Scatter	The site is located at the end of an esker that extends out into a lake to the north.	The site consists of a stone circle of 22 stones and 2 lithic scatters containing over 50 grey quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNp-5	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a sandy beach on the south shore of a lake.	The site consists of a lithic scatter that includes two white quartz biface fragments and 5 white quartz flakes.	Low-moderate	NUNAVUT 2013-20A
LfNq-3	Undetermined	Marker	Cairn	The site is located on an island in Pellet Lake.	The site consists of a cairn constructed of 10 stones with an additional four stones on the ground nearby.	Low	NUNAVUT 2013-20A
LgNm-1	Prehistoric	Marker	Inuksuk	The site is located on a bedrock outcrop on top of a prominent landform.	The site consists of an inuksuk/cairn constructed of 6 stones set atop a large boulder.	Low	NUNAVUT 2013-20A
LgNm-2	Prehistoric	Marker	Inuksuk	The site is located in a bedrock exposure on a high knoll.	The site consists of a collapsed inuksuk/cairn of 9 stones.	Low	NUNAVUT 2013-20A
LgNm-3	Prehistoric	Marker	Inuksuk	The site is located on the edge of bluff overlooking a small lake to the north.	The site consists of two cairns/inuksuit of stones set on top of boulders.	Low	NUNAVUT 2013-20A
LgNm-4	Prehistoric	Resource Gathering	Cairn, Cache	The site is located to the west of a lake.	The site consists of two cairns one next to a stone lined pit 0.50 x 0.40 m and 0.10 m deep.	Low-moderate	NUNAVUT 2013-20A

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Borden Number	Antiquity	Site Type	Contents	Terrain	Artifacts	Site Significance	Permit Number
LgNm-5	Historic / Undetermined	Campsite	Stone Rectangle, Stone Circle, Hearth, Historic Scatter, Faunal Material	The site is located on low benches overlooking a pond.	The site consists of a stone rectangle, a stone circle with a hearth in the centre surrounded by tin cans, oil drums, caribou antlers, and metal debris.	Moderate	NUNAVUT 2013-20A
LgNm-6	Undetermined	Marker	Inuksuk	The site is located on a bedrock exposure overlooking a pond to the north.	The site consists of an inuksuk/cairn constructed from 6 stones	Low	NUNAVUT 2013-20A
LhNk-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located towards the eastern end of a prominent ridge in a large sand exposure.	The site consists of a lithic scatter of over 50 white quartzite flakes.	Low-moderate	NUNAVUT 2013-20A
LhNk-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a deflated esker along the west bank of Back River.	The site consists of 6 flakes of clear and over 20 white quartz.	Low	NUNAVUT 2013-20A
LhNk-3	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a terrace overlooking Back River to the east.	The site consists of a lithic scatter including several bifaces and unifacial scrapers as well as over 200 flakes of white and grey quartzite.	Moderate-high	NUNAVUT 2013-20A
LhNk-4	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a rocky terrace overlooking Back Rover to the east.	The site consists of a low density lithic scatter containing 10 white quartzite flake and 3 pieces of microdebitage.	Low	NUNAVUT 2013-20A
LhNk-5	Undetermined	Marker	Inuksuk, Cairn	The site is located on a rocky terrace overlooking Back Rover to the east.	The site consists of an inuksuk/cairn constructed from 4 stones.	Low	NUNAVUT 2013-20A
LhNk-6	Prehistoric / Historic	Campsite	Lithic Scatter, Stone Rectangle, Historic Material	The site is located in a sand exposure on a rocky terrace overlooking Back River to the east.	The site consists of a bifacially flaked core and a small lithic scatter of over 50 white quartzite flakes, four stone rectangle and historic debris including green glass bottle fragment, metal tin can, wooden stakes for mining and a tent peg.	Moderate-high	NUNAVUT 2013-20A
LhNk-7	Historic / Undetermined	Campsite	Stone Circle, Cache, Historic Scatter	The site is located on a low terrace near base of slope from next terrace above Back River and overlooking Back River to the east.	The site consists of a stone circle, 5 small pits filled with tin cans and garbage, a Coleman stove and a fuel drum (shot with shotgun).	Moderate	NUNAVUT 2013-20A
LiNj-2	Prehistoric	Campsite	Stone Circle	The site is located on a terrace overlooking Back River to the south and southwest with an inlet stream to the east.	The site consists of two stone circles. The larger of the two has an entrance tunnel similar to those found in some Dorset and Thule habitation features.	Moderate	NUNAVUT 2013-20A
LiNj-3	Prehistoric / Historic	Burial	Burial, Hunting Blind, Cache, Lithic Scatter, Faunal Material, Inuksuk, Historic Scatter	The site is located to the north of Back River.	The site consists of stone structures that are possible chamber burials, hunting blinds, caches, inuksuit/cairns lithic material, bone, and historic debris.	High	NUNAVUT 2013-20A
LiNj-4	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a terrace overlooking Back River to the west.	The site consists of a biface fragment and white quartzite flakes.	Low-moderate	NUNAVUT 2013-20A
LiNk-1	Prehistoric	Resource Gathering	Cache	The site is located on a terrace within a boulder field overlooking Back River to the east.	The site consists of two cache pits.	Low-moderate	NUNAVUT 2013-20A
LjNh-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a bedrock outcrop surrounded by marsh and uneven rocky terrain. The site has a good outlook over Llama Lake to the southeast.	The site consists of 3 pink quartzite flakes, 147 white quartzite flakes (includes 100 pieces micro-debitage), and 3 pieces white quartzite block shatter. No diagnostic artifacts were found at the site.	Low	NUNAVUT 2010-024A
LjNh-2	Prehistoric	Lithic Isolated Find	Lithic Isolated Find	The site is located on a bedrock outcrop surrounded by marsh and uneven rocky terrain. The site has a good outlook over Llama Lake to the southeast.	The site consists of 1 isolated pink quartzite retouched flake. No diagnostic artifacts found to determine cultural affiliation.	Low	NUNAVUT 2010-024A
LjNh-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a bedrock outcrop on a ridge. The ridge overlooks Llama Lake to the east, an unnamed lake to the south, and a valley to the west. The ridge continues to the north.	The site consists of 2 quartzite cores (1 grey and 1 pink; collected) and 2 grey quartzite flakes (left in situ).	Low	NUNAVUT 2010-024A
LjNh-4	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a bedrock outcrop approximately 20 m east of a small unnamed pond.	The site consists of 4 grey quartz flakes and 2 unifacially retouched flakes from the surface of the site area.	Low	NUNAVUT 2011-022A
LjNh-5	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll overlooking the outlet of an unnamed creek flowing into Goose Lake, approximately 320 m north.	The site consists of 1 white chert and 3 white quartz flakes observed on the ground at the site (left in situ). No formed tools or diagnostic artifacts were observed.	Low	NUNAVUT 2011-022A
LjNi-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located at the end of a bedrock outcrop overlooking a marsh to the north.	The site consists of 100 + white quartzite flakes and a quartzite outcrop with flake scars. No diagnostic artifacts were found. All artifacts were left in situ.	Moderate	NUNAVUT 2010-024A
LjNi-3	Undetermined	Resource Gathering	Drive Lane, Inuksuk	The site is located on a rise in topography overlooking marshy low-lying areas to north and south.	This site consists of 34 cairns aligned northwest to southeast for 156 m.	Moderate-high	NUNAVUT 2013-20A
LjNi-4	Historic	Resource Gathering	Cache, Historic Material	The site is located in a boulder field with marshy ground and a lake to the south.	The site consists of a cache pit with a tobacco tin located approximately 20 m to the north.	Moderate	NUNAVUT 2013-20A
LjNj-2	Historic / Unknown	Campsite	Stone Circle, Hearth, Faunal Material	The site is located on a broad plateau several hundred metres west of a stream that flows into Back River.	The site consists of a stone circle with a large scatter of caribou skulls, and a hearth.	Moderate	NUNAVUT 2013-20A
LjNj-3	Prehistoric / Historic	Campsite	Stone Circle, Hunting Blind, Cache, Historic Scatter, Faunal Material, Lithic Scatter	The site is located on a north-south ridge top towards south end of feature.	This site consists of stone circles, caches, hunting blinds, a large dense scatter of bone, wood, and historic debris. ASTt artifacts were collected. This campsite is likely the one mentioned in TK study.	High	NUNAVUT 2013-20A
LjNj-4	Undetermined	Campsite	Stone Circle, Faunal Material	The site is located on a bedrock outcrop ridge sloping south towards Beechey Lake.	The site consists of a stone circle and a stone cache with bone inside.	Moderate	NUNAVUT 2013-20A
LjNj-5	Undetermined	Campsite	Stone Circle, Hunting Blind, Inuksuk	The site is located on a west sloping bedrock outcrop above Beechey Lake to the south.	The site consists of a stone circle, 2 hunting blinds, and an inuksuk/cairn.	Moderate-high	NUNAVUT 2013-20A

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LjNj-6	Prehistoric / Historic	Campsite	Stone Circle, Stone Rectangle, Hunting Blind, Lithic Scatter, Faunal Material, Historic Scatter	The site is located on a broad prominent hill with extensive bedrock outcrops.	The site consists of stone circles, stone rectangles, hunting blinds, caches, Arctic Small Tool tradition artifacts, bone, and historic debris. This is a large site with extensive landscape modification through movement of boulders.	High	NUNAVUT 2013-20A
LkNh-5	Prehistoric	Lithic Isolated Find	Lithic Isolated Find	The site is located on a bedrock outcrop with soil exposures overlooking a small lake.	The site consists of one orange and white banded chert flake.	Low	NUNAVUT 2013-20A
LkNj-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an esker 120 m to the south of a small lake.	The site consists of over 75 white quartzite flakes and block shatter. No formed tools or diagnostic artifacts were observed.	Low	NUNAVUT 2010-024A
LkNj-2	Undetermined	Marker	Cairn	The site is located on a bedrock outcrop.	The site consists of 1 cairn constructed with 2 large stones.	Low	NUNAVUT 2012-12A
LlNj-1	Prehistoric	Campsite	Stone Circle, Lithic Scatter, Faunal Material, Other	The site is located on the western shore of an unnamed lake.	The site consists of 5 stone features including 4 stone circles and a stone semi-circle. Five pink quartzite flakes, 2 pink quartzite cores and 1 red quartzite core were observed at the site and left in situ. No diagnostic tools were observed. Additionally, a muskox skull, scatter of bone, and a piece of soap stone were observed at the site.	High	NUNAVUT 2010-024A
LlNk-1	Prehistoric	Resource Gathering	Cache	The site is located on a prominent knoll overlooking a fast flowing creek to the south.	The site consists of a cache. The cache pit feature consists of several flat rocks surrounding a shallow cultural depression with differential vegetation. No artifacts were identified in the area.	Moderate	NUNAVUT 2010-024A
LlNk-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker overlooking a marshy area to the southeast.	The site consists of 1 white quartzite core and 1 piece of block shatter collected from the site. No diagnostic artifacts were found.	Low	NUNAVUT 2010-024A
LlNk-3	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a deflated end of an esker 300 m to the south of one lake and 160 m to the northeast of a second lake.	The site consists of 1 white quartzite biface preform, 1 white quartzite core fragment, 2 pink quartzite utilized flakes, and 1 pink, 5 white, and 1 yellow quartzite flakes (collected). Some additional artifacts are still visible on the surface.	Moderate	NUNAVUT 2010-024A
LlNk-4	Prehistoric	Resource Gathering	Stone Alignment, Lithic Scatter	The site is located on a bedrock ridge 300 m northwest of a small lake.	The site consists of 2 stone features. One is a linear feature made of 8 large rocks and the second is an L-shaped feature made of 9 rocks. The linear feature has a large pink quartzite core at the northern end.	Moderate	NUNAVUT 2010-024A
LlNk-5	Prehistoric	Lithic Workshop	Lithic Scatter	This site is located along the top on an esker.	The site consists of 1 white quartzite biface fragment, 3 white quartzite flakes and one piece white quartzite block shatter collected from site.	Moderate	NUNAVUT 2010-024A
LlNk-6	Prehistoric / Historic	Campsite	Stone Circle, Cache, Hearth, Faunal Material, Historic Material	The site is located on a small esker 640 m south of a small lake.	Site consists of a hearth, 2 stone circles and a rectangular stone feature (likely an emptied cache). A scatter of broken bones is on the east side of site with a metal can lid in it. No other artifacts were observed. All artifacts left in situ.	High	NUNAVUT 2010-024A
LlNk-7	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a surface exposure between two bedrock outcrops.	The site consists of 1 white quartzite lithic scatter, 5 x 5 m diameter with 101-200 flakes. No diagnostic tools observed.	Moderate-high	NUNAVUT 2012-12A
LlNk-8	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on a gravel exposure.	The site consists of 1 shouldered point fragment. The point is suggestive of the early to middle Taltheilei period.	Moderate	NUNAVUT 2012-12A
LlNk-9	Prehistoric	Resource Gathering	Cache	The site is located on a small bench.	The site consists of 1 stone cache.	Low-moderate	NUNAVUT 2012-12A
LlNk-10	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a small bench.	The site consists of 3 lithic scatters 100s of white quartzite flakes and several white quartzite biface fragments.	Moderate-high	NUNAVUT 2012-12A
LlNk-11	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a knoll 200 m west-southwest of Long Lake.	The site consists of 1 lithic scatter with 30 + white quartzite flakes and 1 white quartzite graver.	Moderate	NUNAVUT 2012-12A
LlNk-12	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on a terrace on the northwestern shore of George Lake.	The site consists of 1 grey quartzite scraper.	Low-moderate	NUNAVUT 2012-12A
LlNk-13	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll on an island in the middle of Long Lake.	The site consists of 2 lithic scatters of approximately 40 white quartzite flakes.	Low-moderate	NUNAVUT 2012-12A
LlNk-14	Prehistoric	Campsite	Stone Circle	The site is located on a knoll 170 m northeast of Long Lake.	The site consists of 1 stone circle.	Moderate	NUNAVUT 2012-12A
LlNk-15	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a gravel exposure on the northern shore of Long Lake.	The site consists of 1 white quartzite lithic scatter with 51-100 flakes.	Low-moderate	NUNAVUT 2012-12A
LlNk-16	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on an esker 45 m east of Long Lake.	The site consists of 1 purple slate chithos (left in situ).	Low-moderate	NUNAVUT 2012-12A
LlNk-17	Prehistoric	Resource Gathering	Cache, Faunal Material	The site is located on a bedrock knoll on the southern shore of Long Lake.	The site consists of 1 rectangular stone cache with fragments of bone inside.	Moderate	NUNAVUT 2012-12A
LlNk-18	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll on the shore of Long Lake.	The site consists of a lithic scatter with about 15 white quartzite flakes.	Low	NUNAVUT 2012-12A
LlNk-19	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a northwest trending esker along Long Lake.	The site consists of 2 lithic scatters of nine white and grey quartzite flakes.	Low-moderate	NUNAVUT 2012-12A
LlNk-20	Prehistoric	Campsite	Stone Circle, Faunal Material	The site is located on an esker approximately 3 km south of Dragon Lake.	The site consists of 1 small stone circle with broken caribou bone around it.	Moderate	NUNAVUT 2012-12A
LlNk-21	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker approximately 3 km south of Dragon Lake.	The site consists of a lithic scatter with 4 white quartzite flakes.	Low	NUNAVUT 2012-12A
LlNk-22	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on an esker approximately 3 km south of Dragon Lake.	The site consists of 1 light pink quartzite scraper observed and left in situ at the site.	Low-moderate	NUNAVUT 2012-12A

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LlNl-14	Prehistoric	Resource Gathering	Lithic Scatter, Cairn	The site is located on a terrace 500 m southwest of Upper Long Lake.	The site consists of 1 cairn and 1 white quartzite lithic scatter with 11-20 flakes.	Moderate	NUNAVUT 2012-12A
LlNl-15	Prehistoric	Campsite	Stone Circle	The site is located on a ridge 650 m south of Upper Long Lake.	The site consists of 1 stone circle.	Moderate	NUNAVUT 2012-12A
MaNj-1	Prehistoric	Campsite	Stone Circle, Stone Alignment, Cache, Lithic Scatter	The site is located on a high knoll above the tundra.	The site consists of 8 stone features including 2 caches, 2 stone circles, 2 rock alignments, 1 rock pile and 1 anvil stone and a lithic scatter that includes 1 piece of flaked slate and 2 quartzite flakes. No diagnostic artifacts or formed tools were observed. Broken caribou bones were observed in one of the caches (found disassembled).	High	NUNAVUT 2010-024A
MaNj-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a small exposed knoll, 130 m NW of site MaNj-1.	The site consists of 40 to 50 pink and white quartzite flakes. No diagnostic or formed tools were observed.	Low	NUNAVUT 2010-024A
MaNj-3	Prehistoric	Campsite	Stone Circle, Hearth	The site is located on a low topographic rise surrounded by several small lakes and streams, approximately 10 km south of Bathurst Lake.	The site consists of a stone circle, 3 m in diameter with 16 stones and a hearth.	Low	NUNAVUT 2011-022A
MaNj-5	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a deflated esker overlooking a lake to the west and a pond to the east.	The site consists of a lithic scatter of 50 - 100 white and pink quartzite flakes.	Low-moderate	NUNAVUT 2013-20A
MaNj-6	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on soil exposures along the slope of a prominent knoll/ridge that extends into a small lake to the north.	The site consists of a lithic scatter of approximately 50 white quartzite flakes.	Low-moderate	NUNAVUT 2013-20A
MaNj-7	Prehistoric / Historic	Campsite	Stone Circle, Stone Oval, Hunting Blind, Cache, Cairn, Hearth, Inuksuk, Faunal Material, Historic Scatter	The site is located on a high bedrock knoll overlooking a lake to the southwest.	The site consists of a cache, 2 hunting blinds, a stone oval, a stone circle, a double stone circle, 2 cairns, an inuksuk, a hearth, wood, a D.C. Co. shell cartridge, and a scatter of caribou bone.	Moderate-high	NUNAVUT 2013-20A
MaNl-1	Prehistoric / Historic	Campsite	Hearth, Lithic Scatter, Historic Material	The site is located on an exposure beside an unnamed creek.	The site has a historic component with a fire pit containing a piece of metal with a rivet and some broken bottle glass and a prehistoric component consisting of materials found about 20 m north of the historic fire pit including 1 flake fragment and 1 piece of shatter, both of white chert.	Low-moderate	NUNAVUT 2001-019A
MaNl-2	Prehistoric / Historic	Resource Gathering	Inuksuk, Drive Lane, Lithic Scatter	The site is located on an extensive bedrock ridge north of Tikiraq Lake.	The site consists of an alignment of upright elongate boulders set on top of bedrock outcropping. This caribou drive lane, begins at a larger inuksuk and extends south for over 200 m. At approximately 200 m, 4 more markers were observed spaced between 20 and 30 m apart. Lithics were recovered from a single concentration.	High	NUNAVUT 2001-019A
MaNl-3	Prehistoric	Campsite	Stone Alignment, Lithic Scatter, Other	The site is located on top of an esker ridge on the east side of an unnamed stream.	The site consists of a lithic scatter of quartz artifacts and 3 stone features. Lithics include 1 end scraper, 1 retouched flake, and 1 burin, 1 core fragment, 1 core platform, 2 primary flakes, 4 secondary flakes, and 2 flake fragments (collected). A semicircular arrangement of flat rocks, approximately 0.6 m across, is 8 m north of the artifact concentration. Two more features occur down slope and on a lower bench to the north and east of the scatter. One consists of a large semicircular arrangement (1 m diameter) of rocks similar to a tent ring. The other consists of an elongate arrangement (2 m long) of flat rocks. All rocks appear to have been removed from a large erratic embedded in the esker.	High	NUNAVUT 2001-019A
MaNl-4	Historic	Marker	Cairn, Survey Marker	The site is located at the mouth of an unnamed stream southwest of Bathurst Lake and north of Upper Long Lake.	The site consists of an inuksuk. A CLS survey marker located immediately northeast of the inuksuk suggests that it is of recent age built to identify the position of the survey marker.	Low-moderate	NUNAVUT 2001-019A
MaNl-5	Prehistoric / Historic	Lithic Workshop	Lithic Scatter, Cairn, Stone Alignment	The site is located on a ridge 100 m west of Upper Long Lake.	The site consists of 1 lithic scatter with 101-200 white quartzite flakes.	Moderate	NUNAVUT 2012-12A
MaNl-6	Prehistoric	Resource Gathering	Lithic Scatter, Hearth	The site is located on an esker 100 m west of Upper Long Lake.	The site consists of 1 stone hearth, 1 lithic scatter with 9 white quartzite flakes.	Moderate	NUNAVUT 2012-12A
MaNl-7	Prehistoric	Resource Gathering	Lithic Scatter, Cache	The site is located on the top of a ridge overlooking Upper Long Lake to the north.	The site consists of 1 cache, 1 lithic scatter with 11-20 large biface reduction flakes of banded brown siltstone.	Moderate-high	NUNAVUT 2012-12A
MaNl-8	Prehistoric	Marker	Inuksuk	The site is located on a rocky knoll 366 m south of Upper Long Lake.	The site consists of 1 collapsed inuksuk.	Low	NUNAVUT 2012-12A
MaNl-9	Prehistoric / Historic	Campsite	Stone Circle, Hearth, Lithic Scatter. Faunal Material	The site is located on a knoll 100 m north of the northern end of Upper Long Lake.	The site consists of 1 stone circle, 1 hearth, 1 lithic scatter with 51-100 white quartzite flakes and scatter of broken caribou bone.	Moderate-high	NUNAVUT 2012-12A
MbNj-1	Undetermined	Campsite	Stone Circle, Stone Rectangle, Stone Alignment, Cairn, Lithic Isolated Find, Faunal Material, Other	The site is located on a terrace on the eastern shore of Bathurst Lake.	The site consists of 5 stone features, 2 pieces of bone, 2 pieces of wood (possible plank fragments), and 1 possible quartzite core.	High	NUNAVUT 2010-024A
MbNj-2	Undetermined	Campsite	Stone Circle, Stone Alignment	The site is located on an esker on the northern shore of Bathurst Lake.	The site consists of 2 stone circles and 1 stone alignment.	High	NUNAVUT 2010-024A

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Borden Number	Antiquity	Site Type	Contents	Terrain	Artifacts	Site Significance	Permit Number
MbNj-3	Prehistoric	Campsite	Stone Circle, Stone Alignment, Hunting Blind, Cache	The site is located along a ridge on the eastern shore of Bathurst Lake. A caribou migration route runs along the ridge.	The site consists of 13 features, including 6 stone circles, 4 caches, 1 oval stone alignment, 1 rectangular stone alignment, and 1 hunting blind. No artifacts were identified.	High	NUNAVUT 2010-024A
MbNj-4	Prehistoric	Campsite	Stone Circle, Cairn, Lithic Scatter	The site is located along a ridge on the eastern shore of Bathurst Lake. A substantial caribou trail runs along the ridge.	The site consists of 3 white quartzite flakes found near the centre of a stone circle. No artifacts collected from site. No diagnostic artifacts found at site. A small white chert flake and a collapsed cairn were located in revisit.	Moderate	NUNAVUT 2010-024A
MbNj-5	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located along a ridge on the eastern shore of Bathurst Lake. A substantial caribou trail runs along the ridge.	The site consists of 1 bifacial endscraper suggestive of the Dorset tradition and 3 flakes (2 chert, 1 quartzite) were found at the site.	High	NUNAVUT 2010-024A
MbNj-6	Prehistoric	Campsite	Stone Oval	The site is located along a ridge on the eastern shore of Bathurst Lake. A substantial caribou trail runs along the ridge.	The site consists of 1 oval stone feature. No diagnostic artifacts were found.	Moderate	NUNAVUT 2010-024A
MbNj-7	Prehistoric / Historic	Campsite	Stone Circle, Hearth, Kayak Stand, Cultural Depression, Historic Material	The site is located on western shore of Bathurst Lake.	The site consists of 18 features including 10 stone circles, 1 stone semi-circle, 2 hearths, 3 rock features, 1 cultural depression, and 1 kayak stand. A heavily corroded tin can was observed at the site.	High	NUNAVUT 2010-024A
MbNj-8	Prehistoric	Campsite	Stone Circle, Stone Alignment	The site is located on western shore of Bathurst Lake.	The site consists of 2 stone circles and 2 stone alignments.	Moderate	NUNAVUT 2010-024A
MbNj-9	Prehistoric / Historic	Campsite	Stone Circle, Cache, Cairn, Faunal Material, Claim Marker	The site is located on the western shore of Bathurst Lake.	The site consists of a stone circle, a stone cache, and a rock cairn. Caribou bone was located in the vicinity of the cache and a claim marker for claim B3796 was located 2 m west of the cairn.	Moderate	NUNAVUT 2010-024A
MbNj-10	Prehistoric	Campsite	Stone Circle, Stone Oval	The site is located on a small knoll between a small body of water and Bathurst Lake.	The site consists of 1 small oval stone feature that is open at one end and 1 stone circle. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
MbNj-11	Prehistoric	Resource Gathering	Cache	The site is located on a small knoll between a small body of water and Bathurst Lake.	The site consists of 2 oval stone features.	Moderate	NUNAVUT 2010-024A
MbNj-12	Prehistoric	Campsite	Stone Circle, Cairn	The site is located on a knoll 240 m southwest of the western shore of Bathurst Lake.	The site consists of 4 stone features but no artifacts.	Moderate	NUNAVUT 2010-024A
MbNj-13	Prehistoric	Campsite	Stone Circle	The site is located on a small terrace on the western shore of Bathurst Lake.	The site consists of 1 stone circle. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
MbNj-14	Prehistoric	Campsite	Stone Oval	The site is located on a bedrock ridge on the western shore of Bathurst Lake.	The site consists of 3 stone ovals.	Moderate	NUNAVUT 2010-024A
MbNj-15	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a ridge top overlooking Bathurst Lake, approximately 300 m west.	The site consists of chert, siltstone and quartz debitage and 1 retouched grey chert flake that were left in situ.	Moderate	NUNAVUT 2011-022A
MbNj-16	Prehistoric	Campsite	Stone Rectangle, Lithic Scatter	The site is located on a ridge top overlooking Bathurst Lake, approximately 300 m west.	The site consists of a square stone alignment (Feature 1) and lithic scatter of tools and debitage from the surface of the site area. Material types observed were chert, basalt and quartz.	Moderate-high	NUNAVUT 2011-022A
MbNj-17	Prehistoric	Campsite	Stone Circle, Cairn, Cache, Drive Lane, Inuksuk	The site is located to the north of a small pond,.	The site consists of 2 stone circles, 2 cairns, 1 cache pit, 4 inuksuit (possibly a caribou drive lane).	High	NUNAVUT 2012-12A
MbNj-18	Prehistoric	Resource Gathering	Drive Lane, Inuksuk	The site is located 3.8 km west-northwest of the southern end of Bathurst Lake.	The site consists of 3 inuksuit in a line that maybe part of a drive lane.	Moderate-high	NUNAVUT 2012-12A
MbNj-19	Prehistoric	Resource Gathering	Drive Lane, Inuksuk	The site is located 4.3 km west-northwest of the southern end of Bathurst Lake.	The site consists of 4 inuksuit which were constructed with upright slabs of stone, maybe part of a drive lane.	Moderate-high	NUNAVUT 2012-12A
MbNj-20	Prehistoric	Campsite	Stone Circle, Stone Alignment, Hunting Blind	The site is located 3.8 km south-southeast of the southern corner of Bathurst Inlet.	The site consists of 5 hunting blinds, 1 stone circle, 1 stone alignment.	Moderate-high	NUNAVUT 2012-12A
MbNj-21	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a gravel exposure overlooking a lake to the west.	The site consists of a low density lithic scatter with one small white chert point base indicative of the Arctic Small Tool tradition and basalt, chert, and quartzite flakes.	Moderate	NUNAVUT 2013-20A
McNj-15	Historic	Campsite	Stone Rectangle, Historic Material	The site is located at the southwest end of Bathurst Inlet, on point of land on the western shore of Bathurst Inlet, near the far south end.	The site consists of 1 sub rectangular tent ring about 70 m from shore. Surface collected. No native-made artifacts were found on this site. Note: This site is almost certainly the McNk-1 reported by Campbell (1976) but incorrectly located by him on the first large peninsula north of its true location. (Morrison 1978).	Moderate	NWT 78-432 NUNAVUT 2011 022A
McNj-16	Prehistoric / Historic	Campsite	Stone Circle, Cache, Historic Material	The site is located on a bench on the southwestern tip of Bathurst Inlet.	A tent ring site situated about 30 m from shore. Two caches were found along with one artifact, a notched and grooved handle.	Moderate-high	NWT 78-432 NUNAVUT 2011 022A
McNj-17	Prehistoric	Campsite	Stone Circle, Lithic Isolated Find	The site is located on an esker between two lakes.	The site consists of 2 tent rings with 1 chert scraper (collected).	Moderate-high	NUNAVUT 2010-024A
McNj-18	Historic	Campsite	Stone Circle, Stone Rectangle, Historic Material	The site is located on the beach on the eastern shore of Bathurst Lake.	The site consists of 3 stone circles and 1 rectangular stone alignment, likely from a canvas tent. Historic metal debris, including the remains of a stove and table legs, were observed at the site.	Moderate	NUNAVUT 2010-024A

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Borden Number	Antiquity	Site Type	Contents	Terrain	Artifacts	Site Significance	Permit Number
McNj-19	Prehistoric / Historic	Campsite	Stone Circle, Stone Oval, Stone Alignment, Lithic Isolated Find, Other	The site is located on a terrace above the western shore of Bathurst Inlet.	The site consists of 4 stone circles, 1 stone oval, 1 pink quartzite flake, and 1 piece of green beach glass.	Moderate	NUNAVUT 2010-024A
McNj-20	Historic	Campsite	Stone Circle, Stone Alignment, Hearth	The site is located on the western shore of Bathurst Inlet.	The site consists of five features including 2 stone circles, a hearth, 1 rectangular rock alignment, and a woodpile of small sticks. There is a scatter of broken bone near the hearth feature. No artifacts were observed at the site.	Moderate	NUNAVUT 2010-024A
McNj-21	Historic	Campsite	Stone Circle, Stone Alignment, Cache, Historic Material	The site is located on the western shore of Bathurst Inlet.	The site consists of 4 features, including 2 stone circles, a firewood cache, and 1 rectangular stone alignment. Historic debris observed in the area included hand-carved wooden tent pegs, ground soapstone, a broken skidoo ski, a 30-calibre rifle cartridge case, a metal axe head, 2 rusted tin cans, and a small piece of rubber. Several caribou antlers with cut marks and broken animal bones were observed in the site.	Moderate	NUNAVUT 2010-024A
McNj-22	Prehistoric	Campsite	Stone Circle	The site is located on the western shore of Bathurst Inlet.	The site consists of 1 stone circle. No artifacts were observed at the site.	Moderate	NUNAVUT 2010-024A
McNj-23	Prehistoric	Campsite	Stone Circle	The site is located on a bench approximately 50 m west of Bathurst Inlet.	The site consists of 2 concentric stone circles. The smaller one is surrounded by a partially complete larger one.	Moderate	NUNAVUT 2011-022A
McNj-24	Prehistoric	Campsite	Stone Circle	The site is located on a bench approximately 8 m west of Bathurst Inlet.	The site consists of 1 stone circle.	Low	NUNAVUT 2011-022A
McNj-40	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a bedrock outcrop overlooking Bathurst Inlet, located 260 m to the northeast.	The site consists of 100s of chert and quartz flakes and 2 biface fragments, 2 microblade cores, and 1 biface, microblades, 3 scrapers, 1 white chert core fragment, 3 basal fragments of bifaces, and 1 grey siltstone or felsic tuff chisel. Artifacts are indicative of the ASTt.	Moderate	NUNAVUT 2011-022A
McNj-41	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a remnant beach terrace overlooking Bathurst Inlet, located approximately 230 m northeast.	The site consists of a white chert core fragment. No other cultural material was observed.	Low	NUNAVUT 2011-022A
McNj-43	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a bench along the west side of Bathurst Inlet, approximately 230 m northeast.	The site consists of a lithic scatter of white chert and quartz tools and debitage from the surface of the site area.	Moderate	NUNAVUT 2011-022A
McNj-44	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a terrace north of a small creek overlooking Bathurst Inlet, approximately 200 m northeast.	The site consists of a lithic scatter of approximately 15 white chert debitage from the surface of the site area.	Low	NUNAVUT 2011-022A
McNj-45	Prehistoric	Lithic Isolated Find	Lithic Isolated Find	The site is located on a sandy northeast-southwest trending ridge beside a fast flowing creek overlooking Bathurst Inlet, approximately 250 m to the northeast.	The site consists of a white chert core fragment. No other cultural material was observed.	Low	NUNAVUT 2011-022A
McNj-46	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located 200 m west of Bathurst Inlet.	The site consists of a white chert lithic scatter with 1 flake and 4 microblade fragments. Artifacts are indicative of the ASTt.	Moderate-high	NUNAVUT 2012-12A
McNj-47	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located 200 m west of Bathurst Inlet.	The site consists of 8 chert lithic flakes and 4 microblades (3 white chert and 1 light orange chert). Artifacts are indicative of the ASTt.	Moderate-high	NUNAVUT 2012-12A
McNj-48	Prehistoric / Historic	Resource Gathering	Stone Alignment, Lithic Scatter, Historic Material	The site is located south of Bathurst Inlet.	The site consists of a stone alignment and 9 lithic scatters containing 100s of flakes, 1 orange-beige blade/end scraper, 1 white chert sideblade, 1 white chert biface, 1 brown banded chert biface, 1 clear quartz scraper, 10+ white quartz crystals, 2 quartz wedges. Artifacts are indicative of the ASTt. One Western 25-20 cartridge shell was also located.	High	NUNAVUT 2012-12A
McNj-49	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located south of Bathurst Inlet.	The site consists of 1 white chert asymmetric knife, 1 biface fragment and 1 lithic scatter with 8 flakes. Artifacts are indicative of the ASTt.	Moderate-high	NUNAVUT 2012-12A
McNj-50	Prehistoric	Campsite	Stone Circle	The site is located south of Bathurst Inlet.	The site consists of 1 stone circle on a bedrock exposure with a small area of flat pavement of stones inside.	Moderate	NUNAVUT 2012-12A
McNk-1	Undetermined	Marker	Cairn	The site is located at the south end on a point of land at the south end of Bathurst Inlet.	The site consists of a stone cairn.		
McNk-3	Historic	Campsite	Stone Circle, Stone Rectangle, Hunting Blind, Cache, Hearth, Inuksuk, Stone Trap	The site is located at the north end of Bathurst Lake (Tahikaffaaluk), on either side of stream that flows from unnamed lake (located northwest) into Bathurst Lake.	About 75 archaeological features were noted and mapped and about 30 features were examined, identified and named by Kiluhiqturmiut Inuit elders from Cambridge Bay during this project. (Stewart 2004 site form). Nothing collected.	High	NUNAVUT 2004-019A
McNk-4	Prehistoric / Historic	Campsite	Stone Circle, Stone Alignment, Cache, Lithic Scatter, Historic Material	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 2 stone circles, 3 stone alignments, 1 cache and a pink quartzite lithic scatter including 2 cores and debitage. Historic materials located at the site include a plastic tent peg, and a tin can. No diagnostic artifacts found.	High	NUNAVUT 2010-024A
McNk-5	Prehistoric	Campsite	Stone Circle	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 2 stone circles, one of which has a pavement of stone slabs. No artifacts were observed at the site.	Moderate	NUNAVUT 2010-024A

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Borden Number	Antiquity	Site Type	Contents	Terrain	Artifacts	Site Significance	Permit Number
McNk-6	Prehistoric	Resource Gathering	Cache, Faunal Material	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 1 cache measuring 5 m diameter with caribou bones visible in centre. No artifacts visible.	Moderate	NUNAVUT 2010-024A
McNk-7	Historic	Resource Gathering	Cache, Faunal Material, Historic Material	The site is located on the northernmost tip of Bathurst Lake.	The site consists of at least 6 stone caches constructed from larges pink quartzite stone slabs. Caribou bones were visible in two of the caches and a metal wrench and other modern debris were also observed in some of the caches. No prehistoric artifacts were observed.	Moderate	NUNAVUT 2010-024A
McNk-8	Prehistoric	Campsite	Stone Circle, Stone Alignment, Hearth, Cairn	The site is located on the northernmost tip of Bathurst Lake.	The site consists of a stone circle with a hearth feature at the south end and a stone alignment that consists of four discrete piles of stones that incorporate slabs of pink quartzite placed vertically to stand on edge.	High	NUNAVUT 2010-024A
McNk-9	Prehistoric	Campsite	Stone Circle	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 1 stone circle. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
McNk-10	Prehistoric	Campsite	Stone Circle, Stone Oval, Cairn	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 14 stone features including 7 stone circles, 3 stone semi-circles, 1 stone oval, 1 pavement of stone slabs, 1 stone pile, and 1 cairn.	High	NUNAVUT 2010-024A
McNk-11	Prehistoric	Campsite	Stone Oval, Stone Alignment, Cairn	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 5 features including 1 stone oval, 1 stone alignment, and 3 stone markers.	High	NUNAVUT 2010-024A
McNk-12	Historic	Campsite	Stone Circle, Cache, Hearth, Historic Material	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 3 stone circles and 1 cache/hearth feature containing historic debris (batteries, a tin can, and broken bone).	High	NUNAVUT 2010-024A
McNk-13	Prehistoric	Resource Gathering	Cache	The site is located on the northernmost tip of Bathurst Lake.	The site consists of a small cache constructed of flat pink quartzite slabs. No artifacts were observed in the area.	Moderate	NUNAVUT 2010-024A
McNk-15	Historic	Resource Gathering	Historic Material	The site is located on a small knoll between two ridges.	The site consists of 1 surface find containing 2 spent rifle cartridges. The cartridges were dated from the headstamps: WRA Co. 38-55 (Winchester Repeating Arms - produced 1866-1932) and D.C. Co. 38-55 (Dominion Cartridge Co. - produced 1886-1947).	Low	NUNAVUT 2010-024A
McNk-16	Prehistoric	Resource Gathering	Stone Alignment, Inuksuk	The site is located on a bench approximately 25 m west of Bathurst Inlet.	The site consists of a rectangular stone alignment and a collapsed stone cairn.	Low	NUNAVUT 2011-022A
McNk-17	Prehistoric	Campsite	Stone Oval, Cairn, Other	The site is located on a bench approximately 20 m southwest of Bathurst Inlet.	The site consists of 1 stone oval, 1 stone pile with 5 stones, and an abrasive stone with numerous groove marks. These are interpreted as prehistoric. The scatter of wood sticks (possibly firewood) is likely historic.	Low	NUNAVUT 2011-022A
McNk-18	Historic	Historic Artifact Scatter	Historic Material	The site is located on along the beach on the east side of Bathurst Inlet, approximately 35 m from the shoreline.	The site consists of several runner pieces of a wood sled and a wood oar. These are interpreted to be historic (20th century) items.	Low	NUNAVUT 2011-022A
McNk-19	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a high bedrock ridge.	The site consists of approximately 25 white quartzite flakes.	Low	NUNAVUT 2012-12A
McNk-20	Prehistoric	Campsite	Stone Circle	The site is located on a ridge overlooking Bathurst Inlet to the east.	The site consists of 1 stone circle.	Moderate	NUNAVUT 2012-12A
McNk-21	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a terrace above Bathurst Inlet.	The site consists of 2 white chert lithic scatters: LS1 with 21-30 flakes, LS2 with 2 flakes, 1 chert biface, 1 retouched quartzite flake, and 1 chert flake.	Low-moderate	NUNAVUT 2012-12A
McNk-22	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on terrace overlooking Bathurst Inlet.	The site consists of 10 lithic scatters with 100s of flakes, 1 white chert bipoint, white quartzite ovoid knife fragment, and 1 burin spall tool. Material types included white and light green quartzite and white chert. Artifacts are indicative of the ASTt.	High	NUNAVUT 2012-12A
McNk-23	Historic	Resource Gathering	Historic Scatter	The site is located to the north of a small lake west of Bathurst Inlet.	The site consists of 5 rifle cartridges, D.C. co. 30-30, likely manufactured by the Dominion Cartridge Company of Montreal between 1886 and 1947 (Steinhauser nd).	Low-moderate	NUNAVUT 2012-12A
McNk-24	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an esker.	The site consists of 1 white chert microblade and 7 flakes (2 white quartzite, 4 white chert). Artifacts are indicative of the ASTt.	Moderate-high	NUNAVUT 2012-12A
McNk-25	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a raised area west of Bathurst Inlet.	The site consists of 1 lithic scatter with 11-20 white quartzite flakes.	Low	NUNAVUT 2012-12A
MdNk-1	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of 2 artifacts in fully exposed context. One secondary flake of quartz and one flake fragment of white chert.	Low	NUNAVUT 2001-019A
MdNk-2	Prehistoric	Lithic Isolated Find	Lithic Isolated Find	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of 1 sandstone flake (collected).	Low	NUNAVUT 2001-019A
MdNk-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	Consists of a limited artifact scatter in exposed context. A large quartz decortication flake fragment and a quartz cobble spall were found within 5 m of each other.	Low	NUNAVUT 2001-019A
MdNk-4	Prehistoric	Campsite	Hearth, Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of a hearth feature, and a lithic scatter including 1 blade, 3 modified flakes, 6 pieces of quartz shatter, and 53 quartz flakes (collected).	Moderate-high	NUNAVUT 2001-019A
MdNk-5	Undetermined	Marker	Cairn	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of a cairn of large rocks. The rocks are located on top of a large boulder and look like they were piled more recently than other stone features in the area, based on lichen growth and neighboring stone contact points.	Low	NUNAVUT 2002-035A

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Borden Number	Antiquity	Site Type	Contents	Terrain	Artifacts	Site Significance	Permit Number
MdNk-6	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of 9 artifacts including 7 quartz flakes, 1 quartz scraper fragment, and 1 piece of quartz shatter.	Low-moderate	NUNAVUT 2002-035A
MdNk-7	Prehistoric	Resource Gathering	Cache, Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of a small surface scatter, mostly banded chert flakes along with 1 projectile point preform, along with a cache of rocks and a small stone feature.	High	NUNAVUT 2002-035A
MdNk-8	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of an exposed artifact scatter. 107 artifacts were collected including 1 small lanceolate arrow tip.. Artifacts are suggestive of the Taltheilei tradition.	Moderate-high	NUNAVUT 2002-035A
MdNk-9	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of an exposed artifact scatter (13 lithic artifacts collected including 1 quartzite biface).	Moderate	NUNAVUT 2002-035A
MdNk-10	Prehistoric / Historic	Campsite	Stone Circle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	Undisturbed surficial stone features. Tent rings are located above the shoreline on the first terrace overlooking the water at the tip of the peninsula. Two more tent rings are located on the shore west of the site and a number of the tent ring sites are located on the shoreline down the east side of the peninsula. No artifacts were identified. Historic residue in the form of oil drums and faunal remains appear nearby.	Moderate	NUNAVUT 2002-035A
MdNk-11	Undetermined	Campsite	Stone Circle, Historic Material	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of 2 tent rings. No associated artifacts. Oil drums and faunal remains appear nearby.	Moderate	NUNAVUT 2002-035A
MdNk-12	Undetermined	Campsite	Stone Circle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of tent rings. A large number of flowers were observed growing in and around the features possibly indicating a burial or increased organic content from butchering activity.	Moderate	NUNAVUT 2002-035A
MdNk-13	Undetermined	Campsite	Stone Circle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of 2 tent rings. No associated artifacts.	Moderate	NUNAVUT 2002-035A
MdNk-14	Undetermined	Resource Gathering	Cache	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of 2 small stone rings interpreted as caches about 12 m apart. Features are disturbed.	Moderate	NUNAVUT 2002-035A
MdNk-15	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of an exposed artifact scatter. Eighty-five artifacts were collected consisting of 4 tools (including a unifacially flaked semi-lunate biface), 77 quartz flakes and 4 pieces of quartz shatter.	Moderate	NUNAVUT 2002-035A
MdNk-16	Historic	Campsite	Stone Rectangle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of a stone rectangle from a canvas tent.	Low	NUNAVUT 2002-035A
MdNk-17	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of an exposed artifact scatter. Chert material of a high quality. Forty-eight artifacts were collected.	Moderate	NUNAVUT 2002-035A
MdNk-18	Prehistoric	Campsite	Stone Circle, Lithic Scatter	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of a tent ring of 20 -22 stones. This is the only tent ring site located on top of the peninsula as all others are situated on or above the shoreline. Forty-three artifacts were collected (mostly flakes and shatter).	Moderate	NUNAVUT 2002-035A
MdNk-19	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of a small surface lithic scatter of approximately 100 pieces observed.	Low	NUNAVUT 2002-035A
MdNk-20	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of 1 lithic flake of white quartz. No additional materials.	Low	NUNAVUT 2002-035A
MdNk-21	Prehistoric	Campsite	Stone Circle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of a small tent ring approximately 2 m x 1.5 m. No artifacts identified.	Low	NUNAVUT 2002-035A
MdNk-22	Prehistoric	Campsite	Stone Circle, Heart, Cache	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of 2 tent rings, 1 hearth and 1 cache.	High	NUNAVUT 2002-035A
MdNk-23	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	Artifacts were all recovered on the downslope blown out sandy areas. 79 artifacts were collected including projectile points, drills, microblades, microblade cores, end scrapers and side blades. Potentially a multicomponent site. Artifacts are indicative of both the ASTt and the Taltheilei Tradition.	High	NUNAVUT 2002-035A
MdNk-24	Prehistoric	Campsite	Stone Circle	The site is located on a peninsula which juts out from the western shore of Bathurst Inlet.	The site consists of 1 stone circle. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
MdNk-25	Prehistoric	Campsite	Stone Circle, Cairn	The site is located on a peninsula which juts out from the western shore of Bathurst Inlet.	The site consists of 2 stone circles and another small stone feature consisting of four rocks placed together. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
MdNk-26	Prehistoric	Campsite	Stone Circle	The site is located on the western shore of Bathurst Inlet.	The site consists of 1 stone circle.	Low	NUNAVUT 2010-024A
MdNk-27	Historic	Campsite	Stone Circle, Hearth, Historic Material	The site is located on a knoll 1.5 km west of Bathurst Inlet.	The site consists of a wooden axe handle, a small wooden toy sled, a rifle shell, a stove-pipe collar, a carved wooden stake and a tobacco can. All artifacts left in situ.	Low	NUNAVUT 2010-024A
MdNk-28	Prehistoric	Campsite	Stone Circle, Other	The site is located on a gravel bench just above the beach, approximately 50 m southwest of the shore of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet.	The site consists of 1 stone circle with 12 stones and 2 wooden sticks with the ends squared.	Low	NUNAVUT 2011-022A

Appendix V8-1A. Archaeological Sites within the LSA and TCWR Winter Road Connector Assessment Area

Borden Number	Antiquity	Site Type	Contents	Terrain	Artifacts	Site Significance	Permit Number
MdNk-29	Prehistoric / Historic	Campsite	Stone Circle, Hearth, Faunal Material, Historic Material	The site is located on a bench of exposed gravel and sparse vegetation just above the beach, approximately 15 m southwest of the shore of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet.	The site consists of 3 stone circles and 1 hearth, all interpreted as prehistoric. Scatters of broken bone were observed on the ground across the area. A wooden jigger and rifle shell casing are likely from historic use of this area.	Low	NUNAVUT 2011-022A
MdNk-30	Prehistoric / Historic	Campsite	Stone Circle, Historic Material	The site is located on a grassy bench just above the beach, approximately 15 m southwest of the shore of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet.	The site consists of 1 stone circle of 23 stones and 4 m in diameter, which is interpreted as being prehistoric and a wooden handle is interpreted as being from historic use of this area.	Low	NUNAVUT 2011-022A
MdNk-31	Prehistoric	Campsite	Stone Circle, Faunal Tool	The site is located on a bench just above the beach, approximately 15 m southwest of the shore of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet.	The site consists of a stone circle consisting of 25 stones and a bone scraper, both interpreted as being prehistoric. The bone scraper was left in situ.	Low	NUNAVUT 2011-022A
MdNk-32	Prehistoric	Resource Gathering	Stone Alignment, Faunal Material	The site is located on a bench approximately 40 m southwest of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet.	The site consists of 1 stone alignment, 9 stones and 1 stone circle of 7 stones. Scatters of broken bone observed on the ground within one of the stone circles.	Low	NUNAVUT 2011-022A
MdNk-33	Prehistoric	Campsite	Stone Circle, Stone Oval, Inuksuk, Lithic Scatter	Situated on a bench overlooking Bathurst Inlet to the northeast.	The site consists of 2 stone piles, 3 stone circles, 1 stone oval and a scatter of quartzite flakes on the surface including 10 green quartz flakes, 2 pink quartz flakes, and 1 white quartz flake. All artifacts were left in situ.	Moderate	NUNAVUT 2011-022A
MdNk-34	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a bench overlooking Bathurst Inlet to the northeast.	The site consists of 8 white quartz flakes on the surface.	Low	NUNAVUT 2011-022A
MdNk-35	Prehistoric	Isolated Lithic Tool	Lithic Scatter	The site is located on a bench of exposed gravel and sand overlooking Bathurst Inlet to the northeast.	The site consists of 1 pink-rose quartzite cortex spall tool from the surface of the site area. No other cultural material was observed.	Low	NUNAVUT 2011-022A
MdNk-36	Prehistoric / Historic	Campsite	Stone Circle, Stone Oval, Faunal Material, Historic Material	The site is located on a bench just above the beach west of Bathurst Inlet.	The site consists of 2 stone circles and 2 stone ovals. Additionally, several pieces of broken bone and a piece of brown glass were observed.	Low	NUNAVUT 2011-022A
MdNk-37	Prehistoric	Campsite	Stone Circle	The site is located on a raised beach east of Bathurst Inlet.	The site consists of a stone circle.	Low	NUNAVUT 2011-022A
MdNk-38	Prehistoric	Campsite	Stone Circle, Faunal Tool	The site is located on a bench,west of a creek and waterfalls, and east of Bathurst Inlet.	The site consists of a stone circle and ulna bone tool that was left in situ.	Low	NUNAVUT 2011-022A
MdNk-39	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge west of Bathurst Inlet.	The site consists of 8 lithic scatters consisting of 100s of flakes. Lithic material found at the site includes banded brown and white chert, orange chert, and white chert. Additionally one large cobble with a bowl shaped pecked depression was found and left in situ and 1 white chert burin, 1 chert point fragment and 1 white chert side blade were collected. Artifacts are indicative of the ASTt.	High	NUNAVUT 2012-12A
MdNk-40	Prehistoric	Resource Gathering	Cache	The site is located on the edge of a terrace west of Bathurst Inlet.	The site consists of 1 cache.	Moderate	NUNAVUT 2012-12A
MdNk-41	Prehistoric	Resource Gathering	Cache, Hearth	The site is located on a terrace west of Bathurst Inlet.	The site consists of 1 cache and 1 hearth.	Moderate-high	NUNAVUT 2012-12A
MdNk-42	Prehistoric	Campsite	Stone Circle, Cache	The site is located on a terrace south of a small stream.	The site consists of 1 stone circle and 1 cache.	Moderate	NUNAVUT 2012-12A
MdNk-43	Prehistoric	Campsite	Stone Circle, Hearth	The site is located on a knoll southwest of Bathurst Inlet.	The site consists of 1 stone circle and 1 hearth.	Moderate-high	NUNAVUT 2012-12A
MdNk-44	Prehistoric	Campsite	Stone Circle, Kayak Stand	The site is located on the west side of Bathurst Inlet.	The site consists of 2 stone circles and 2 kayak stands.	Moderate	NUNAVUT 2012-12A
MdNk-45	Prehistoric	Campsite	Stone Circle, Cache	The site is located on the west side of Bathurst Inlet.	The site consists of 3 stone circles and 1 stone cache.	Moderate	NUNAVUT 2012-12A
MdNk-46	Prehistoric	Resource Gathering	Cache	The site is located west of Bathurst Inlet.	The site consists of 3 caches.	Moderate	NUNAVUT 2012-12A
MdNk-47	Undetermined	Campsite	Stone Circle	The site is located on the west side of Bathurst Inlet.	The site consists of 1 stone circle.	Moderate	NUNAVUT 2012-12A
MdNk-48	Historic	Campsite	Stone Circle, Stone Alignment, Hearth, Historic Material	The site is located on the south side of the outlet of Amagok Creek into the west side of Bathurst Lake.	The site consists of stone circles, hearths, stone alignments, a wooden platform, old core boxes and 2 x 4s. Likely related to mineral exploration.	Low-moderate	NUNAVUT 2012-12A
MdNl-5	Undetermined	Campsite	Stone Circle	The site is located on the west shore of Bathurst Inlet on a grass and gravel hillside, up to 110 m from shore. First major point south of Young Point.	Tent ring site, sterile, littered with loose stone. The extant tent rings are overgrown and partially buried.	Moderate-high	NWT 78-432
MdNl-6	Prehistoric	Campsite	Stone Oval, Cache, Lithic Scatter	The site is located on a peninsula on the western shore of Bathurst Inlet.	The site consists of 1 cache with a pavement of stones beside it, 2 stone ovals, and a lithic scatter of 40+ white chert, pink and white quartzite flakes, 1 white chert asymmetrical knife fragment. Artifacts are indicative of the ASTt.	High	NUNAVUT 2012-12A
MdNl-7	Prehistoric / Historic	Campsite	Stone Oval, Lithic Scatter, Historic Material	The site is located on a peninsula on the western shore of Bathurst Inlet.	The site consists of 2 stone ovals, one with a pavement of flat stones, 2 lithic scatters with a total of 7 flakes, 1 white chert side blade, 1 clear quartz core, and 2 asymmetric knifes of white chert Artifacts are indicative of the ASTt. A rifle cartridge (223 Remington) was also located.	High	NUNAVUT 2012-12A
MdNl-8	Prehistoric	Campsite	Hearth, Lithic Scatter	The site is located on a peninsula on the western shore of Bathurst Inlet.	The site consists of a pavement of 20 flat stone (possibly a hearth) and 9 lithic scatters consisting of 100s of chert and quartz debitage, 1 beige banded chert asymmetric knife, 2 beige and brown banded points, 1 white chert burin and 1 white chert sideblade. Artifacts are indicative of the ASTt.	High	NUNAVUT 2012-12A

Appendix V8-1A. Archaeological Sites within the LSA and TCWR Winter Road Connector Assessment Area

Borden Number	Antiquity	Site Type	Contents	Terrain	Artifacts	Site Significance	Permit Number
MdNl-9	Prehistoric	Campsite	Stone Circle, Hearth	The site is located above the current shoreline on the western side of Bathurst Inlet.	The site consists of 1 fire pit and 1 stone circle.	Moderate	NUNAVUT 2012-12A
MdNl-10	Prehistoric	Campsite	Stone Rectangle, Isolated Find	The site is located above the current shoreline on the western side of Bathurst Inlet.	The site consists of 1 stone rectangle and 1 quartzite spall tool.	Moderate	NUNAVUT 2012-12A
MdNl-11	Historic	Faunal Tool	Faunal Tool	The site is located above the current shoreline on the western side of Bathurst Inlet.	The site consists of 1 seal skin rope 12 m long and 1 cm wide.	Moderate	NUNAVUT 2012-12A
MdNl-12	Prehistoric	Resource Gathering	Cache, Cairn	The site is located on break in slope, on a peninsula on the western side of Bathurst Inlet.	The site consists of 1 cache and 1 cairn.	Moderate	NUNAVUT 2012-12A
MdNl-13	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a terrace above Bathurst Inlet.	The site consists of 2 white quartzite flakes.	Moderate	NUNAVUT 2012-12A
MdNl-14	Undetermined	Campsite	Stone Circle	The site is located on a rise on the western side of Bathurst Inlet.	The site consists of 2 stone circles.	Moderate	NUNAVUT 2012-12A
MdNl-15	Undetermined	Resource Gathering	Cache	The site is located on the shore of Bathurst Inlet.	The site consists of 5 caches.	High	NUNAVUT 2012-12A
MdNl-16	Historic	Campsite	Stone Circle, Faunal Material, Historic Material	The site is located on a terrace on a peninsula on the western side of Bathurst Inlet.	The site consists of 1 stone circle, rusted tin cans, plastic fragments, broken caribou bone, and a toy Land Rover.	Low	NUNAVUT 2012-12A
MdNl-17	Undetermined	Campsite	Stone Circle, Hearth	The site is located on a bench overlooking the beach on the western shore of Bathurst Inlet.	The site consists of 1 stone circle and 1 hearth.	Moderate	NUNAVUT 2012-12A
MdNl-18	Undetermined	Campsite	Stone Circle, Faunal Material	The site is located on the western shore of Bathurst Inlet.	The site consists of 1 stone circle with scatter of broken caribou bone around it.	Moderate	NUNAVUT 2012-12A
MdNl-19	Historic	Historic Isolated Find	Historic Material	The site is located on the western shore of Bathurst Inlet.	The site consists of one wooden oar with a wrapped metal end.	Low	NUNAVUT 2012-12A
MdNl-20	Historic	Historic Artifact Scatter	Historic Material	The site is located on the western shore of Bathurst Inlet at an elevation of 1 m asl.	The site consists of 1 piece of wooden board with a curved side (perhaps a piece of a lid) and a rusted metal screw or pin.	Low	NUNAVUT 2012-12A
MeNl-15	Undetermined	Resource Gathering	Hunting Blind, Inuksuk	The site is located on top of a ridge over looking Bathurst Inlet to east.	A hunting blind, three inuksuit and a piece antler (potentially worked). The hunting blind has 19 stones and two of the inuksuit consist of a stone slabs held upright by smaller stones. The third inuksuk consists of a slab sitting on top of a boulder.	Moderate	NUNAVUT 2013-20A

Appendix V8-1B

Back River Project: Cumulative Heritage Baseline Report 2013

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BACK RIVER PROJECT
Cumulative Heritage Baseline Report 2013

Rescan an ERM company

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November 2013

BACK RIVER PROJECT
CUMULATIVE HERITAGE BASELINE REPORT 2013

November 2013
Project #0194096-0010

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Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

Rescan Environmental Services Ltd., an ERM company
Vancouver, British Columbia

Executive Summary

Executive Summary

This report presents the results of archaeological investigations undertaken within the Back River Project area. The proposed mining project is located in the West Kitikmeot Region of Nunavut. The assessments carried out for the Project were conducted under Class 2 Nunavut Territory Archaeologist Permits issued by the Government of Nunavut, Department of Culture and Heritage (formerly the Department of Culture, Language, Elders and Youth).

The objectives of the archaeological baseline is to identify and evaluate any archaeological sites located within and adjacent to proposed developments and to identify and assess possible impacts of the proposed developments on any identified archaeological sites. The field investigations focused on potential infrastructure and known mineral deposits at the George Property and the Goose Property Potential Development Areas (PDAs), the Marine Laydown PDA, and proposed winter road alignments. As a result, site densities are greatest near proposed developments where the most intensive studies were conducted.

The archaeological studies undertaken for the Project have contributed greatly to the overall archaeological knowledge for the region. The cumulative findings of the archaeological impact assessments during the 2010, 2011, 2012, and 2013 field seasons and prior studies suggest that the area has been used throughout the prehistoric and historic periods, with archaeological assemblages dating back to 3,500 BP. Of the 380 sites recorded in the 2013 archaeological permit area (Permit area), 261 are prehistoric sites, 42 are historic sites, 29 are sites with both historic and prehistoric components, and 48 are sites of undetermined age.

Cultural affiliations have not been identified at most archaeological sites; however, artifacts indicative of all the expected cultural traditions are present in the Permit area. Of the 380 archaeological sites with the Permit area, 27 sites have artifacts that are diagnostic of particular prehistoric cultures. Of these, 21 sites have artifacts that are suggestive of the Pre-Dorset Arctic Small Tool tradition, three sites have artifacts suggestive of the Dorset culture, and three sites have artifacts that are suggestive of the Taltheilei period.

Of the 380 archaeological sites within the Permit area, 135 were classified as campsites with evidence of habitation features including stone circles, stone ovals, and stone rectangles large enough to be attributed to holding down hide or canvas tents, 43 had features associated with resource gathering that including hunting, fishing, and storage of subsistence resources including hunting blinds, caches, caribou drive lanes, 32 were markers (inuksuit or cairns), one was identified as a lithic quarry, 155 were lithic sites containing lithic artifacts but no features, seven had historic artifacts but no features, three had tools made from faunal material, and four are possible grave sites.

Locational information pertaining to archaeological sites is protected by a Data Licence Agreement issued by the Government of Nunavut. A condition of the data licence stipulates that archaeological sites will not be plotted on a map that could be made available to the public unless the scale of the map is less than or equal to 1:2,000,000 and the positional accuracy has been randomized. As such, there are no maps showing archaeological sites in this report. Positional data for archaeological sites have been provided separately to Sabina Gold & Silver Corp., the Nunavut Department of Culture and Heritage, the Canadian Museum of Civilization, and the Inuit Heritage Trust.

Acknowledgements

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Acknowledgements

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BACK RIVER PROJECT
CUMULATIVE HERITAGE BASELINE REPORT 2013

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Glossary and Abbreviations

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

ASTt	Arctic Small Tool tradition
BIPR	Bathurst Inlet Port and Road
BP	Before present. A term used to refer to the antiquity of archaeological materials or cultures. Generally, BP is recorded in relation to 1950.
Burin	A stone tool with a narrow point, resulting in a chisel-like end. Often made by the removal of one or more flakes to create desired point.
Campsite	An archaeological site that has cultural features that suggest habitation and/or the presence of cultural material that suggest a variety of activities.
Chithos	A large but thin disc-shaped tool made from a coarse-textured stone that was used for hide-working.
Core	A rock that is struck to remove flakes and is used as the source material for the manufacture of stone tools.
Feature	Portions of an archaeological site that are not portable but have been created or modified by humans. In this region, features are often formed of varying arrangements and numbers of rocks: hearths, stone circles (i.e., tent rings), graves, and cultural depressions or caches.
Flake	Pieces of stone removed and discarded during the manufacture of stone tools.
GN-DCH	Government of Nunavut, Department of Culture and Heritage
GPS	Global Positioning System
Historic	Refers to a time period during which there are written records. This period of time is also referred to as post-contact.
Inuksuit	The plural of inuksuk
Inuksuk	An arrangement of stones, such as a cairn or marker. The Kiligiktokmiut spelling for this is *inokhok*.
In situ	Used to indicate that an artifact or feature has been left in the original location it was found.
Isolated find	An archaeological site that consists of only a single artifact, whether it is a formed stone tool or a flake.
KHS	Kitikmeot Heritage Society
KIA	Kitikmeot Inuit Association
Lithic	Made of stone.
Lithic scatter	An archaeological site or portion of a site consisting of a scattering of stone artifacts, including tools and flakes.

Lookout	An archaeological site or location that has an advantageous view of the surrounding terrain that could be used for spotting game or for reasons of safety.
m	metre(s)
masl	Metres above sea level
MLA	Marine Laydown Area
Nadlok	A narrowing in a body of water where caribou swim across during the ice-free season and, because of this, can be important hunting and camping areas.
NTKP	Naonaiyaotit Traditional Knowledge Project
PDA	Potential Development Area
Prehistoric	Refers to a time period during which there were no written records. This period of time is also known as pre-contact.
Retouch	To modify a stone tool by secondary flaking along the cutting edge.
RSL	Relative sea level
Sabina	Sabina Gold & Silver Corp.
Scraper	A type of stone tool made of a flake that is roughly rounded providing a flat working edge and having a wide range of functions (woodworking, boneworking, skinning hides, etc.).
Stone circle	A type of archaeological stone feature commonly found in this region of the Arctic. Most stone circles are suggested to be tent rings, the stones used to hold down the fabric of a circular tent made of hide. Smaller stone circles have been suggested to have been used for drying hides or used for temporary shelter.
Talo	The Kiligiktokmiut word for a hunting blind.
TCWR	Tibbitt to Contwoyto Winter Road
Workshop	An archaeological site that has a significant amount of lithic material to suggest the intensive manufacture of stone tools.

1. Introduction

1. Introduction

The Back River Project (the Project) is a proposed gold project owned by Sabina Gold & Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut (Figure 1-1). This report presents the results from the archaeology studies conducted for the Back River Project. The field investigations were conducted under Class 2 Nunavut Territory Archaeologist Permits issued by the Government of Nunavut, Department of Culture and Heritage (GN-DCH). This report details the Project setting including environmental, cultural, traditional knowledge, and historical factors that influence the archaeological record and our understanding of it (Section 2). Section 4 provides an overview of the types of artifacts and features that have been located during the archaeological assessments conducted for the Back River Project. Archaeological sites are a VSEC and those identified within the potential development areas that may be directly impacted by the Project are discussed in detail in Section 5.

The objectives of the archaeological impact assessments conducted for the Project were to:

- identify and evaluate any archaeological sites located within and adjacent to the proposed developments;
- identify and assess possible impacts of the proposed developments on any identified archaeological sites;
- provide recommendations regarding the need and appropriate scope of further archaeological studies prior to the initiation of any proposed developments; and
- recommend viable alternatives for managing adverse impacts.

Permit reports are submitted yearly and the 2013 permit report will be submitted by March 31, 2014 to the GN-DCH, the Canadian Museum of Civilization, and the Inuit Heritage Trust.

Figure 1-1

Back River Project Location

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2. Project Setting

2. Project Setting

This section defines the Back River Project heritage setting in terms of its legislative, spatial, environmental, cultural, historic, prehistoric, and archaeological framework.

2.1 TERRITORIAL AND FEDERAL LEGISLATION

Archaeological and paleontological sites in Nunavut are protected under territorial or federal legislation. Archaeological and paleontological sites are protected under Section 51 of the *Nunavut Act* (1993; Nunavut Archaeological and Paleontological Sites Regulations [SOR/2001-220]). In addition, archaeological sites and as yet unrecorded archaeological sites found on federal Crown Land are protected by the Territorial Land Use Regulations (CRC, C.152) of the *Territorial Lands Act* (1985) and by the *Canada Oil and Gas Operations Act* (1985; Canada Oil and Gas Geophysical Operations Regulations [SOR/96-117]).

Permits to conduct archaeological and paleontological research throughout Nunavut are applied for and issued under the *Nunavut Act* (1993; Nunavut Archaeological and Paleontological Sites Regulations [SOR/2001-220]). In addition, work conducted on Inuit-owned Lands or within the Nunavut Settlement Area should be conducted in accordance with Articles 21 and 33 of the *Nunavut Land Claims Agreement Act* (1993).

Locational information pertaining to archaeological sites is protected by a Data Licence Agreement issued by the Government of Nunavut. A condition of the data licence stipulates that archaeological sites will not be plotted on a map that could be made available to the public unless the scale of the map is less than or equal to 1:2,000,000 and the positional accuracy has been randomized. As such there are no maps showing archaeological sites in this report. Positional data for archaeological sites have been provided separately to Sabina, GN-DCH, Canadian Museum of Civilization, and Inuit Heritage Trust.

2.2 SPATIAL BOUNDARIES

The spatial boundary of the heritage baseline is defined by the Permit area for Nunavut Archaeologist Permit 2013-20A (Figure 2.2-1). This boundary encompasses the Regional Study Area and the Local Study Area for the Project, previously proposed Project developments, and an area large enough to provide additional archaeological data necessary to place the Project areas within a regional context. Field assessment focused on proposed Project developments.

2.3 ENVIRONMENTAL SETTING

The Project is located within the north-central Arctic region in the Bear-Slave Upland of the Canadian Shield (Rogers and Smith 1984). The climate is classified as Cold Continental (Stager and McSkimming 1984). Until approximately 9,000 BP, this region was covered by the Laurentide continental ice sheet. Glacial movement and recession formed the characteristic features of the current Arctic landscape. The scouring effect of the ice sheets across the landscape and the underlying geology created depressions, bedrock exposures and a low-lying, gently rolling landscape of rocky ridges and bluffs dispersed between the expansive flatlands that characterize the region. Glacial meltwater filled the depressions left by the glacial recession creating the numerous lakes that dot the landscape.

Fluvial action formed esker complexes that are a prominent characteristic of the Central Arctic landscape. The ground surface consists primarily of bedrock and gravels, with large boulder fields a common terrain feature (Stager and McSkimming 1984).

The Southern Arctic Ecozone has long cold winters and short cool summers with a mean January temperature of -30ºC and a mean July temperature of 10ºC. Mean annual precipitation ranges between 200 mm in the north of the ecozone and 400 mm in the south of the ecozone. The vegetation of the Southern Arctic Ecozone includes shrubs such as the dwarf birch, willows, and heath species mixed with herbs and lichens (Parks Canada 2009). The aridity of the soil tends to favour low-growing plants and grasses, accented during a short bloom period in summer by various flowering and berry-producing species (Wilkinson 1970). The physical features of this environment provide a refuge for numerous small animal species such as foxes, hares, weasels, and ground squirrels (Wilkinson 1970). The ecozone is also home to large mammals, including grizzly and polar bears, muskox, and wolves and serves as the major summer and calving grounds of two caribou herds (Parks Canada 2009). Fish species such as lake trout, whitefish, and Arctic grayling can be found in the freshwater rivers and seals and whales can be found in the neighbouring marine environment. Avian species including owls, ravens, geese and ducks are found throughout the area (Parks Canada 2009, Wilkinson 1970).

2.4 TRADITIONAL KITIKMEOT LAND USE

The primary resource consulted for this section is the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project* report (KIA 2012), as this is the most detailed and geographically relevant study pertaining to the region. The study was prepared on behalf of the Kitikmeot Inuit Association's Land and Environment Department for Sabina's Back River Project, and used oral data collected between 1995 and 2000, which was subsequently verified through a series of workshops. This study is also referred to as the Naonaiyaotit Traditional Knowledge Project (NTKP; KIA 2012).

Additional literature consulted includes archaeological studies by Keith and Stewart (2005), Gordon (1996), Morrison (1978, 1979) and Noble (1971); and ethnographic and ethno-historic accounts by Birket-Smith (1959), Boas (1964), Damas (1972, 1984), Franklin (1823), Hearne (1911), Jenness (1921, 1922, 1923a, 1923b, 1923c, 1924a, 1924b, 1928, 1944, 1946), Mathiassen (1927), Pryde (1971), Rasmussen (1932), Roberts and Jenness (1925), Savard (1966), Stefansson (1914, 1919, 1921), Thorpe et al. (2002), and Usher (1971).

2.4.1 Cultural Setting

The Inuit of the Central Arctic (or Kitikmeot) are the known as the Kitikmiut. The Kitikmiut were previously referred to in the ethnographic literature as the "Copper Inuit" because early Europeans noted their use of native copper to fashion tools and other objects (KIA 2012). Their territory includes: portions of Victoria and Banks Islands; the Barren Lands south to Back River; Beechey Lake west to Contwoyto Lake; and extends from Wise Point, west of the Coppermine River and east to Perry River (Damas 1984). Their dialect is considered to be in the Inuit-Inupiaq (Eastern Eskimo) division, one of the major languages of the Eskimo Aleut language family (Woodbury 1984). The NTKP divides the Kitikmiut of western Kitikmeot into three regional groups: the Ocean Inuit, Nunamiut, and Kiligiktokmiut. The Ocean Inuit lived in coastal areas north of the Project area, and their life ways focused on marine resources such as seal. The Nunamiut lived in the tundra west of the Project area and focused on terrestrial resources, primarily caribou. The third group, the Kiligiktokmiut, are the Kitikmiut group most closely associated with the Project area and, consequently, are the focus of the following discussion.

Kiligiktokmiut translates as "people of the small stiches" because of their skill at sewing (KIA 2012). Their traditional land use encompasses all of Bathurst Inlet and many of the surrounding drainages, including the Hood, Burnside, Western, Ellice, and Perry rivers (KIA 2012). A list of place names near the Project area is provided in Table 2.4-1, with both the English and the *Inuinnaktun* names.

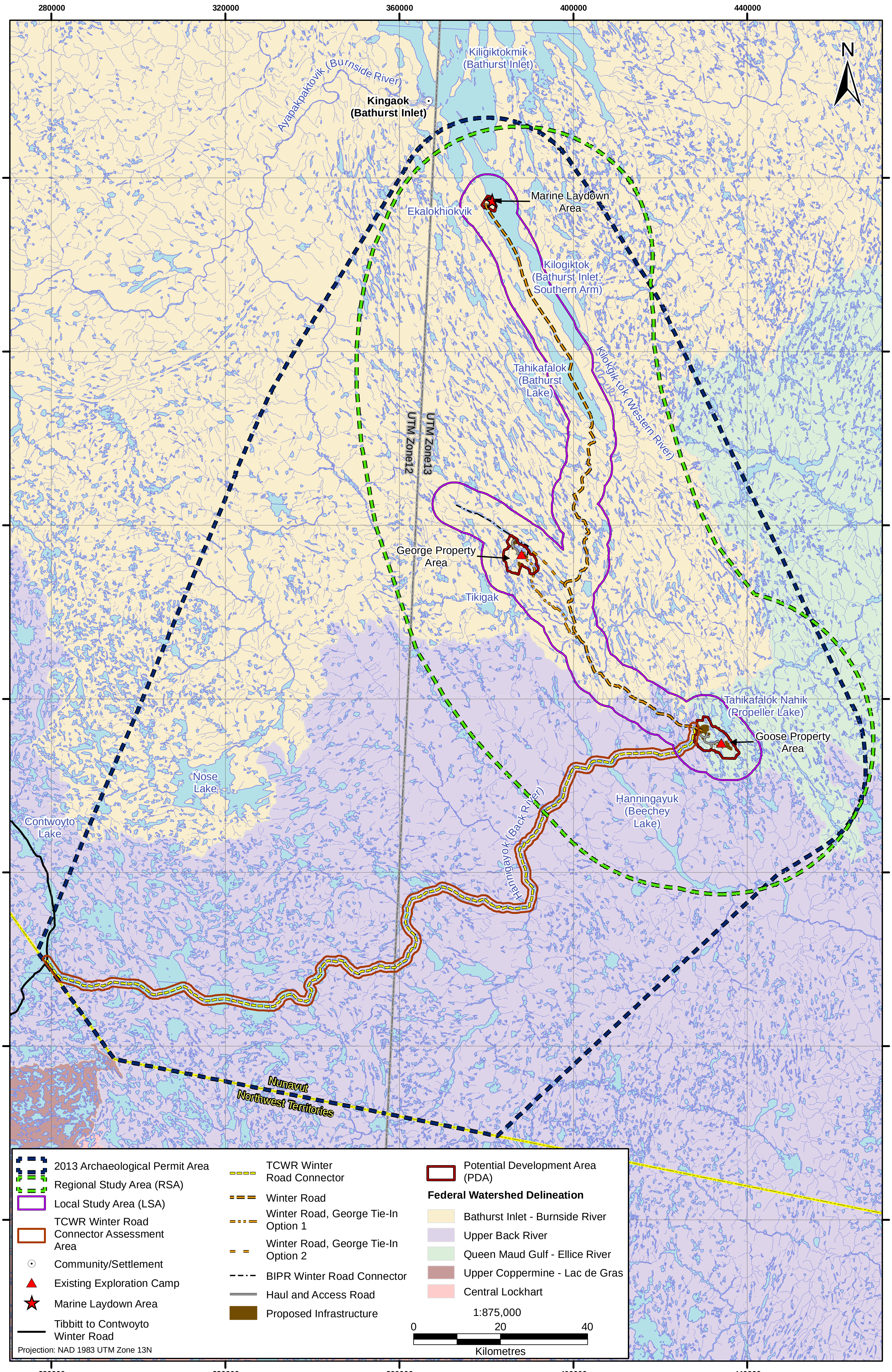

Figure 2.2-1

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Back River Project Study Area

Figure 2.2-1

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Table 2.4-1. Kitikmiut Place Names near the Project Area

Amagok Creek	*Amagok means "wolf" in Inuinnaktun*	**Beechey Lake**	*Hanninggayuk*
Back River	*Hannigayok*	**Propeller Lake (NE of Goose Lake)**	*Tahikafalok Nahik*
Bathurst Inlet	*Kiligiktokmik, Kilogiktok*	**George Lake**[1]	*Tikigak*
Bathurst Lake	*Tahikafalok*	**Western River**	*Kilokgiktok*

Source: KIA (2012).
[1] This reference is not to the George Lake at the exploration camp but to a lake approximately 10 km to the southeast of the existing George camp.

Samuel Hearne's encounter with the Inuit in 1771, when he travelled to the Central Arctic on behalf of the Hudson's Bay Company, is the first reported European contact with people in this area (Hearne 1911). Hearne also encountered a large group of Aboriginal people he called Copper Indians hunting deer (caribou) as they crossed the Coppermine River. This group provided him with information on the mouth of the river.

Many of the late 19th and early 20th century accounts of Inuit life were documented during expeditions to establish Canada's sovereignty in the Arctic. In the early 1900s, Vilhjalmur Stefansson conducted several research projects amongst the Inuit. He documented much of the seasonal round of the Kitikmiut who, as well as hunting seal and whale along the coast also travelled as far south as Great Bear Lake to hunt and collect wood in the summer (Stefansson 1914). Stefansson also documented 125 Inuit camped west of the mouth of the Coppermine River in late May. The majority of this group were heading south to Dismal Lake and Dease River though a few families were going to hunt caribou around the Rae River and another group would spend the summer fishing at Bloody Falls (Stefansson 1921). According to A. P. Low, who voyaged with the Neptune in 1903, the Inuit would move south in September to hunt the barren-ground caribou only returning to the coast when enough snow had fallen to make the return trip on dog sleds (Low 1906). The intensive fur trading activities that would change the seasonal round of the Kitikmiut did not occur in the region until the 1920s when trading posts were established near Bathurst Inlet (Neatby 1984).

2.4.2 Kiligiktokmiut Traditional Knowledge

Because of their geographical position near Bathurst Inlet and Beechey Lake, the Kiligiktokmiut could harvest a range of terrestrial and marine resources, most importantly caribou and ringed seal. This contrasts with the neighbouring Kitikmiut groups: the marine-focused Ocean Inuit and the terrestrial-focused Nunamiut (KIA 2012).

The Kiligiktokmiut had access to the mainland Bathurst caribou herd throughout the most of year; however, during winter months only a portion of the herd wintered in the Kiligiktokmiut area around Beechey Lake, while the remainder of the herd wintered north of the Kiligiktokmiut area. The NTKP describes the movement of caribou as frequently changing and of variable distribution across the landscape; however, the herd's main calving areas are consistently described as being in southern Bathurst Inlet and at Beechey Lake. Other species were also hunted to supplement caribou, including muskox, ground squirrels, hares, and waterfowl. Fishing was common during the spring and fall, with Arctic char being the main species fished. Campsites were often located along lakes and streams to take advantage of fishing opportunities. The Kiligiktokmiut used small shrubs for wood (KIA 2012). No important sources of copper or carving stone were noted within the Kiligiktokmiut area in the NTKP study.

Traditionally, the Kiligiktokmiut were highly mobile, travelling long distances in small groups seeking widely distributed resources. They lived in temporary camps consisting of igloos in the winter and tents made from animal skins during the summer. Maps in the NTKP report show the communities of Bathurst Inlet and *Omingmaktok* (Bay Chimo) as focal points for travel throughout the region, with intensive use of southern Bathurst Inlet, Bathurst Lake, the Western River and Beechey Lake for travel, gathering and camping. One informant described camping for nine nights as they travelled on foot from Beechey Lake to the community of Bathurst Inlet, a distance of approximately 160 km (KIA 2012).

Kiligiktokmiut ways of life changed during the 1900s with their increasing participation in the fur trade. The Kiligiktokmiut began incorporating trips to fur trade post into their annual travels. The fur trade introduced them to new types of European goods including foods, tobacco, tools, firearms, and snow machines, as well as Anglican and Catholic missionaries. However, the first permanent community in Bathurst Inlet, called Bathurst Inlet (or *Kingoak*), did not exist until the establishment of a Hudson's Bay Company fur trade post during the 1920s. Animal species that were previously of marginal importance to the Kiligiktokmiut, such as wolverine (KIA 2012), became more widely trapped and traditionally trapped species, such as fox, became more intensively harvested.

2.4.3 Kiligiktokmiut Land Use within the Project Area

The following sections summarize Kiligiktokmiut traditional knowledge within the Project area, divided into four main geographic areas: 1) Southern Bathurst Inlet, 2) Bathurst Lake, 3) the Western River, and 4) the Goose, George, and Beechey lakes area.

<u>Southern Bathurst Inlet</u>

The NTKP study documents extensive use of the southern portion of Bathurst Inlet by the Kiligiktokmiut as a travel, resource gathering and camping area. Southern Bathurst Inlet is a main calving area for the Bathurst caribou herd, and this in turn attracts a number of other species, in particular grizzlies and wolves. An area where ringed seals were hunted is mapped in Bathurst Inlet east of the proposed Marine Laydown Area, and Bathurst Inlet is described as a well-known area for hunting wolves (KIA 2012).

The NTKP study identifies a major nadlok (a narrowing in a body of water where caribou swim across during the ice-free season) in Bathurst Inlet that includes the proposed Marine Laydown Area (KIA 2012). Nadloks are important hunting and camping areas (KIA 2012). This method of hunting is described in Keith and Stewart (2005):

> *Other hunters would be hiding in the qajaq [kayak] at the water's edge for the caribou to enter and begin crossing the lake. Once they were committed to crossing, the hunters would move behind the animals and spear them using a caribou lance called a kaput* (2005:14).

Keith and Stewart also note that Diamond Jenness believed that Bathurst Inlet had a relatively large number of kayaks due to the prevalence of this hunting method (Jenness 1922; Keith and Stewart 2005).

Two fur trade posts are identified in Southern Bathurst Inlet in the NTKP study. One is mapped on the first point of land on the eastern side of the inlet, several kilometres north of the mouth of the Western River. This post corresponds to historic and prehistoric archaeological site McNj-28 recorded by Rescan during baseline studies for the Project and is likely one of the earliest Hudson's Bay Company posts in the inlet, dating to the 1920s (KIA 2012; Usher 1971). The second post is mapped on a point of land on the western side of the inlet, within the proposed Marine Laydown Area. This post has a place name associated with it (*Tikighik*); however, this name is not defined in the NTKP study (KIA 2012).

A number of "major camps" are described as being on both sides of Bathurst Inlet, but their locations are not defined further. These camps may be associated with some of the archaeological sites that have been recorded along the shores of the inlet, as many of these have a historic component. In particular, Fishing Creek and Fishing Lake, located outside of the proposed Marine Laydown Area to the northwest and west, is identified as an important camp area and grave site (KIA 2012).

Bathurst Lake

Bathurst Lake is described as an important camping area and caribou calving area (KIA 2012). The lake is important for trapping foxes and fishing Arctic char (KIA 2012). Grizzlies are mentioned as being numerous around Bathurst Lake. Specific camps described in the NTKP study include one on an esker south of the lake, and another at the north end of the lake where families wintered (KIA 2012). Additionally, a trading post is described as having been located at the southern end of the lake (KIA 2012). The camp at the north end of the lake may be the Tahikaffaaluk Site (McNk-3 to McNk-13) described in detail in Keith and Stewart (2005). The site has numerous features including dwellings, caches, hunting features, and cooking and food preparation areas. There are discreet domestic and hunting areas, divided by bedrock ridges. Keith and Stewart (2005) estimate that the site predates 1920s or 1930s, as there were no artifacts to indicated reliable access to Western goods.

Western River

The Western River was an important travel corridor to Beechey Lake and important camping areas are located on both sides of the river and at its mouth (KIA 2012). An important nadlok is located at a rapids on the Western River, east of Bathurst Lake, where caribou would sometimes die if the water was too rough to cross (KIA 2012). Caribou could also die if they got stuck in the cliffs that border the Western River Valley (KIA 2012). Arctic char from the Western River were fished by hook and bait and grizzlies are described as numerous within the valley (KIA 2012). It is noted that “trees” (likely willow) are plentiful within the Western River Valley (KIA 2012), and because wood is very scarce within the Kiligiktokmiut area, prehistorically, the valley may have been an important location for gathering this resource. However, to date, there has been very little archaeological study of the Western River Valley. There are currently five sites (McNj-4, McNj-5, McNj-14, McNj-16, and McNj-42) recorded near the mouth of the river, including both historic and prehistoric hunting and camping sites. Two large historic camp sites (LkNh-1 and LkNh-2), recorded by Campbell (1975) 70 km upstream on the Western River, do not correspond to any specific sites identified in the NTKP study.

Goose and George Property Areas and Beechey Lake

While the NTKP study does not contain much traditional knowledge relating specifically to the Goose and George property areas, Beechey Lake, located to the south, was an important area for the Kiligiktokmiut. Beechey Lake is essentially a widening of the Back River, and the area is a major calving ground for the Bathurst caribou herd. Caribou pass through the Beechey Lake area around August but would also spend the winter here because the snow was less deep due to the rocky terrain in the area. Specific named camping areas are identified along Beechey Lake including Tudlak, Hannigayok, Kongok, and Papegak, several of which are identified as sites where families would overwinter. Beechey Lake is also identified as an important fox hunting area and a fishing spot where people would net for grayling, codfish, longnose sucker, lake trout, and whitefish. The Goose and George property areas are described primarily as part of the travel corridor between Beechey Lake and other areas like Bathurst Inlet (KIA 2012). Archaeological sites (LiNj-2, LjNj-2 to LjNj-6, LjNi-3, and LjNi-4) have been identified within the Tudlak and Hanningayok areas, suggesting repeated use dating back to the prehistoric period.

2.4.4 Summary — Naonaiyaotit Traditional Knowledge Project and Cultural Heritage Resources

The NTKP study adds to our understanding of the known archaeological sites in the Project area, and identifies specific land use sites and areas that may have potential for archaeological sites. The most intensive land use occurred along Bathurst Inlet and up the adjacent river systems. The Kiligiktokmiut were highly mobile “multi-taskers” who began residing in permanent settlements only after the establishment of Hudson’s Bay Company posts after the 1920s. Seasonal activities focused on hunting caribou and ringed seals, but the Kiligiktokmiut were by necessity flexible and opportunistic, supplementing their diet with fish, birds, muskox, Arctic hares, and ground squirrels, as needed. Numerous activities would take place simultaneously while travelling the landscape which makes separating Kiligiktokmiut activity areas into “travelling areas,” “gathering areas,” or “camping areas” an inaccurate depiction of their land use (KIA 2012).

The NTKP study also speaks to the archaeological visibility of some land use activities. Kiligiktokmiut fishing methods included the use of stone weirs on many the region’s rivers (KIA 2012), and caribou hunting often involved the construction of *inokhok* (“inuksuk” is another common spelling) and *talo* (hunting blinds; KIA 2012). Such stone features should still be highly visible on the landscape today. During summer months the Kiligiktokmiut lived in skin tents, which would have been weighted down with stones resulting in the tent rings that are commonly found in the archaeological sites in the region. In contrast, at winter camps, where igloos were used, only stone hearths might remain (Ramsden and Murray 1995). The old burial practices described in the NTKP study are surface graves where the deceased is wrapped in caribou skins and positioned facing north (KIA 2012). Such a practice would leave little trace archaeologically. At grave sites near the community of Bathurst Inlet skeletal remains on the ground surface and animal savaging is described (KIA 2012).

2.5 REGIONAL HISTORY

The Back River Project area was part of the Northwest Territories until the creation of the new territory of Nunavut in 1999. The history of this region is marked by several changes in colonial ownership and governance.

During the early exploration and colonization of North America, the northernmost area of British North America was divided into three regions, known as Rupert’s Land, the North-Western Territory, and the British Arctic Territories. In 1670, the Hudson’s Bay Company was created and issued ownership of all Rupert’s Land, defined as lands draining into Hudson Bay, for purposes of developing a fur trading business in this region. Although the North-Western Territory (i.e., lands to the northwest of Rupert’s Land) was not owned by the Hudson’s Bay Company until 1859, they nonetheless maintained a significant presence in this area during the 18th and 19th centuries. The islands of the high Arctic, the British Arctic Territories, were claimed by Britain based on their discovery by 16th century explorer Martin Frobisher.

Upon Canadian confederation in 1867, negotiation began for transfer of these territories to the new Canadian government. Sale and transfer of Rupert’s Land and North-Western Territory by the Hudson’s Bay Company to the new Canadian government occurred in 1870, and the transfer of the British Arctic Territories from the British to Canada in 1880. For a list and description of place names used in this report, see Appendix B.

2.5.1 Early Exploration of the Arctic Coast — 1700s to 1870

This section describes the earliest European incursions into the central Arctic, and in several instances into the Project area itself.

Samuel Hearne

The earliest exploration of the region was by a Hudson’s Bay Company expedition lead by Samuel Hearne between 1770 and 1772. Employing Dene and Cree guides, Hearne led an overland expedition from Fort Prince of Wales on Hudson Bay, proceeding northwesterly, up the Coppermine River, and reaching the Arctic Ocean at Coronation Gulf (Hearne 1911).

John Franklin

Between 1819 and 1822 John Franklin, an officer in the British Royal navy, led an overland expedition to map the Arctic coastline east of the Coppermine River (Figure 2.5-1; Franklin 1823; Houston 1994).

On August 5, 1821, travelling south by canoe, the expedition reached the southern tip of Bathurst Inlet. Franklin named the outlet of the river at the tip of Bathurst Inlet after George Back, a member of the expedition. The expedition was plagued by inclement weather and logistical problems resulting in supply shortages and the loss of half the party to famine (Houston 1994).

George Back

The first survey of Back River was undertaken by its namesake George Back in 1834. In 1833, George Back returned from Europe to launch an expedition in search of Captain John Ross and the crew of the *Victory*, which had gone missing in 1829 while attempting to locate the Northwest Passage. Back believed that, if stranded, Ross would be taking refuge at Fury Beach where stores of supplies were left when the *Fury* was abandoned in 1825. A secondary goal of the expedition was continued mapping of uncharted areas of the Arctic coastline east of Point Turnagain. Back was under orders to begin returning by August to ensure he had returned before winter set in. In October 1833 they received word that Ross and survivors of his crew had returned to England, having been rescued by a whaling ship, and Back's expedition became entirely one of exploration. Back's expedition was launched from Fort Resolution on Great Slave Lake and proceeded northeasterly reaching Back River and descending the river and its treacherous rapids by canoe. At that time the outlet of the river was suspected to be at the southern end of Bathurst Inlet, where in 1821 John Franklin had named a river emptying into the inlet Back River after Back, previously a member of his crew. However, Back discovered that these were not the same rivers; the "Back River" he followed in 1834 empties into Chantry Inlet, east of Bathurst Inlet. The name of the river that empties into Bathurst Inlet was subsequently changed to the Western River (Back 1836; Steele 2003).

Canadian Arctic Expedition

In 1913, the Canadian government, motivated by the desire to establish Canadian sovereignty over the Arctic region, funded the Canadian Arctic Expedition, a multi-disciplinary exploration and research expedition of the Arctic. The expedition lasted from 1913 to 1918 and was directed by Vilhjalmur Stefansson, an explorer and anthropologist who during a previous trip to the Arctic in 1910 had "discovered" the Copper Inuit peoples of the Coronation Gulf, and the Dolphin and Union straits areas. The Canadian Arctic Expedition was divided into two parties; a northern party led by Stefansson and a southern party led by zoologist Dr. Rudolph Anderson. The southern party included young anthropologist Diamond Jenness, who, beginning in August 1914, spent two years conducting ethnographic fieldwork with the Copper Inuit. The ethnographic information collected by Jenness is the earliest from the Back River Project area and, because it was conducted several years prior to the introduction of the fur trade into the region, describes a people whose culture had been minimally affected by European influences (Stefansson 1914; Jenness 1922, 1946).

Northwest Mounted Police Bathurst Inlet Patrol

In 1917, the Northwest Mounted Police (now Royal Canadian Mounted Police) launched a second attempt at conducting a patrol of Bathurst Inlet to investigate the two murders allegedly committed by Inuit men at Bathurst Inlet in 1911. The first attempt in 1914 had been a failure due in part to the officers' lack of experience in the Barren Lands. The second attempt in 1917 was an extensive operation led by officers Francis H. French and Thomas B. Caulkin. The patrol was conducted by dogsled with the party comprising the two officers and four Inuit guides. They departed from the Baker Lake police detachment at Hudson Bay in March 1917 and reached Bathurst Inlet in May 1917. The officers were able to confirm from the Inuit living at Bathurst Inlet and Bernard Harbour that the murders were acts of self-defence. No arrests were made. The return trip took several months on dog sleds, arriving in Baker Lake on January 29, 1918 (Hulgaard and White 2002; Arctic Institute of North America 2012).

Figure 2.5-1

Franklin Expeditions in Relation to the Back River Project

Sabina Gold & Silver Corp.

Rescan an ERM company

2.5.2 Rise of the Fur Trade on the Arctic Coast — 1870 to 20th Century

In 1870, there were no fur trade posts along the central Arctic coast and only nine posts within all of present-day Northwest Territories and Nunavut. The nine posts were all located within the Mackenzie Valley. Though between 1889 and 1907, American whalers were operating along the Arctic coast as far east as Cape Parry, they had not reached as far as Bathurst Inlet. During their whaling trips, some of these whalers began to engage in fur trading with the Inuit as a side business (Usher 1971). In 1906, Roald Amundsen completed the first successful crossing of the Northwest Passage and after 1910 the Arctic fur trade quickly intensified.

The first fur trade post in the region was a Hudson's Bay Company post established in 1912 at Kittigazuit, near Tuktoyaktuk. Permanent fur trade posts began to spring up rapidly during the 1910s and 1920s. Competing posts were established by the Hudson's Bay Company, American firms like the San Francisco-based Canalaska Trading Company, and some Inuit-owned and independent trading operations. Independent traders were often former whalers trading from their schooners ("floating posts") or those setting up temporary encampments. The wreck of a beached whaling schooner observed in Daniel Moore Bay in 1975 by a Geological Survey of Canada crew may have been one of these floating posts (Campbell 1977). After the creation of the Arctic Islands Game Preserve (which included all Arctic islands and the mainland east of Bathurst Inlet) and the peak in fur prices in 1930, the Arctic fur trade economy began a steady decline (Usher 1971).

The closest fur trade post to the Back River Project area was the Hudson's Bay Company's Bathurst Inlet Post (Table 2.5-1; Figure 2.5-2; Usher 1971).The Bathurst Inlet Post was relocated several times. The initial post was built in 1925 on the west side of the outlet of the Western River. In 1926, it was relocated to the east side of the Western River, approximately three miles north of its outlet. In 1927, the Bathurst Inlet Post was moved northwest to the northeast side of Banks Peninsula to counter a rival Canalaska Trading Company post that had been built there (KHS 2012). Between 1930 and 1964, the Bathurst Inlet Post was located near the mouth of the Burnside River, the former location of the Bathurst Inlet settlement. Finally in 1964 the Hudson Bay's Company post was moved to Baychimo Harbour Settlement (Bay Chimo or Omingmaktok), at the northeast end of Bathurst Inlet.

Table 2.5-1. Historic Fur Trade Posts in Bathurst Inlet

Fur Trade Post	Post Ownership	Post Location	Dates in Operation	Post ID No. and Name (from Usher 1971)	
HBC Bathurst Inlet Post	Hudson's Bay Company	West side of mouth of Western River	1925-1926	4B18	Western River
		East side of mouth of Western River	1926-1927	4B18	Western River
		Northeast side of Banks Peninsula	1927-1930	4B14-2	Banks Peninsula
		Mouth of Burnside River (former Bathurst Inlet settlement)	1930-1964	4B17	Burnside River
		Chimo Bay (Omingmaktok), east side of Bathurst Inlet	1964-now closed	4B19	Baychimo Harbour Settlement
Canalaska Trading Company Post at Banks Peninsula	Canalaska Trading Company	Northeast side of Banks Peninsula	1926-1937	4B14-1	Banks Peninsula
Inuit-owned Post at Arctic Sound	Inuit owned	Seven miles south of Wollaston Point	1931-1934	4B15	Arctic Sound
Independent Post at Hood River	Independent	Opposite Wollaston Point, on west side of Arctic Sound	1927-1929	4B13	Kater Point
Independent Post at Hood River	Independent	Near river mouth in Baillie Bay	1936-1941	4B16	Hood River

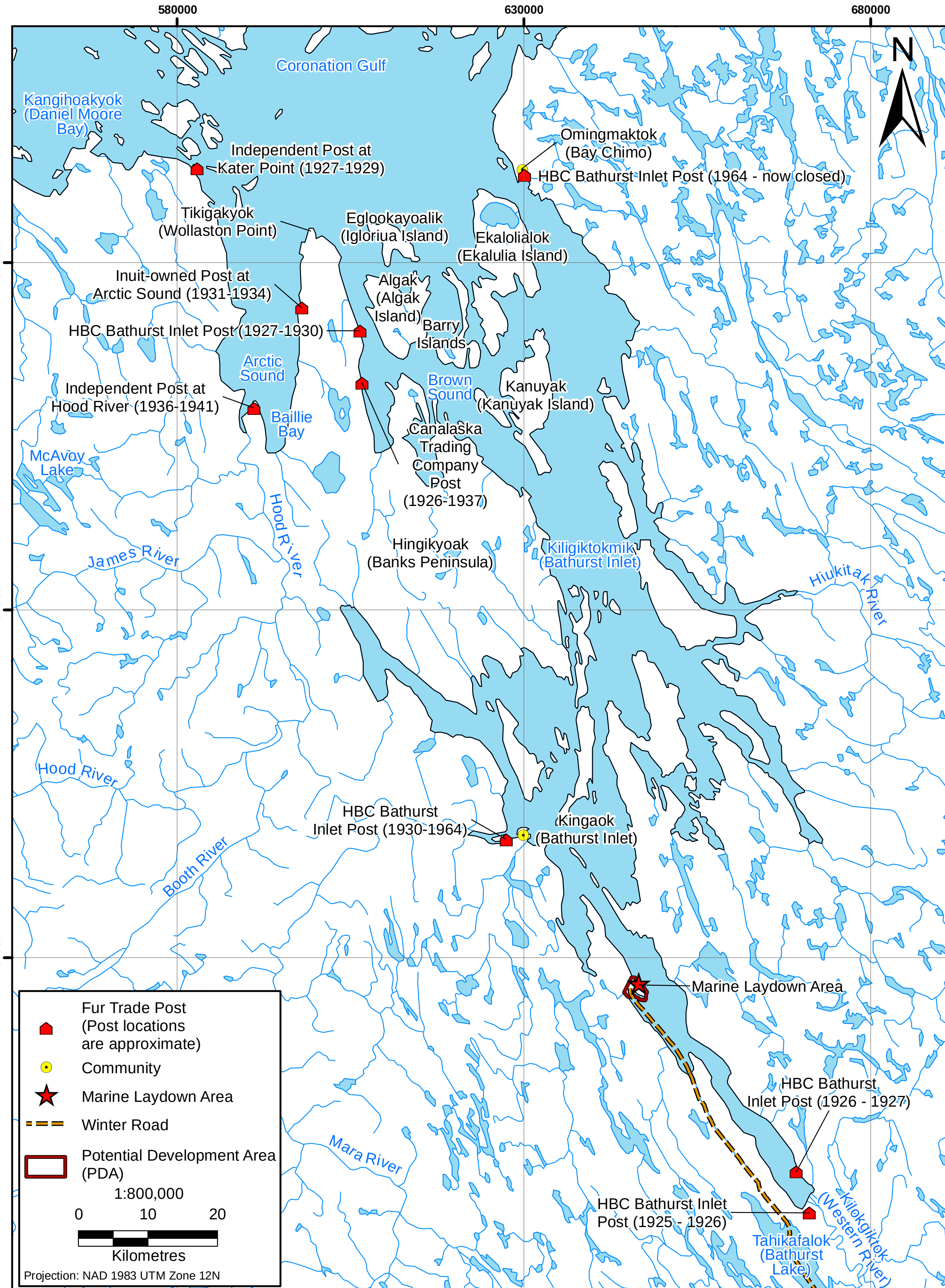

Figure 2.5-2

Historic Fur Trade Posts in Bathurst Inlet

Sabina GOLD & SILVER CORP.

Rescan an ERM company

There were also short-lived fur trade posts in the northern portion of Bathurst Inlet including a Canalaska Trading Company post near Banks Peninsula (operated 1926 to 1937), independent posts at Kater Point (operated 1927 to 1929) and Hood River (operated 1936 to 1941), and an Inuit-owned post at Arctic Sound approximately seven miles south of Wollaston Point (operated 1931 to 1934; Usher 1971). There were no fur trade posts of note to the south of the Project area for several hundred kilometres.

2.6 PREHISTORY OF THE CENTRAL ARCTIC

The cultural traditions identified in the Project area include the Pre-Dorset, Dorset (Early, Middle and Late), Thule, and Taltheilei. The earliest archaeological materials from this region date to approximately 3,500 BP and are associated with the Pre-Dorset culture (McGhee 1996).

Pre-Dorset and Dorset archaeological cultures are called Paleo-Eskimo, as they are not directly ancestral to present-day Inuit peoples. Rather, the Inuit are descended from the Thule culture. The Taltheilei archaeological culture is thought to be ancestral to the Dene (Athapaskan) peoples of the subarctic and northern Plains, including the Chipewyan and Yellowknife. The Arctic Neo-Eskimo, Thule and Inuit likely interacted along the borders of their territories with the Northern Plains First Nations cultures (Rescan 2007).

2.6.1 Pre-Dorset

The Pre-Dorset culture (3,800 to 2,700 BP) had a similar toolkit to the contemporaneous Independence I culture of the high Arctic, as well as the later Dorset culture. Pre-Dorset can be identified by a distinct assemblage of very small, well-made tools known as the Arctic Small Tool tradition (ASTt), and by several characteristic manufacturing techniques, including parallel sided or shallowly notched bifaces with straight bases. Spalled burins are also very prevalent during this period (Stenton and Park 1998). In 1965, William E. Taylor Jr. found tools made from a locally available orange-pink quartzite in association with Pre-Dorset artifacts at several sites in the Ekalluk River region (Taylor 1967). Two types of harpoon heads have been recovered from this period. The first type was thin, with an open socket, two basal spurs, one or two barbs, and a drilled line hole positioned towards the base. The second is thin with an open socket and a lashing bed, a single medial basal spur, and a centred drilled line hole. Both of these antler harpoon heads were self-bladed with no endblade slot (Park and Stenton 1998). Pre-Dorset habitation features are generally represented archaeologically by round to oval stone circles with a central hearth feature (Bielawski 1988).

2.6.2 Dorset

The Dorset cultures (including the Early, Middle, and Late Dorset) employed hunting techniques centred on the procurement of sea mammals, primarily seals, through holes in the sea ice. This reliance on sea mammals may have been due to the onset of a colder period that saw caribou wintering further to the south, beyond the reach of many Dorset peoples (Coltrain et al. 2004). However, recent evidence suggests that in areas where sea mammals were scarce caribou were also utilized (Howse 2008; Milne, Park, and Stenton 2012). Caribou were hunted by driving them into a vulnerable position where they were speared (Maxwell 1984). Dorset material culture is characterized by ground and chipped slate tools, implements for cutting snow, stone oil lamps, and the absence of drilled holes in their tools. The Dorset culture produced holes through cutting or gouging, forming ovoid holes rather than the round holes created by a drill. The presence of burin-like tools at a site is indicative of the Dorset culture (Stenton and Park 1998). One of the characteristic features of Dorset culture is the rectangular stone alignments, which have been identified as the remains of Dorset longhouses (Friesen 2007).

2.6.2.1 Early Dorset

The Early Dorset culture (2,700 to 1,800 BP) is characterized by the prevalence of ground and polished slate knives, microblades, and burin-like tools. Chert and quartz endblades were tip-fluted and usually triangular with straight bases and one or more side notches (Stenton and Park 1998). The Tyara Sliced harpoon head is characteristic of the Early Dorset Period. This ivory harpoon head has a thin, "sliced" closed socket with an elliptical cross-section, a cut oval line hole, and endblade slot perpendicular to the axis of the line hole, and the concave base curves into two weak symmetrical spurs (Park and Stenton 1998).

2.6.2.2 Middle Dorset

In the Middle Dorset culture (1,800 to 1,500 BP), triangular endblades often featured slightly concave bases and side or corner notches. The use of slate and the tip fluting of endblades are less prevalent than in the Early Dorset period (Stenton and Park 1998). Two distinct harpoon head technologies were developed. The Kingait Closed Head is thin with a rectangular closed socket, a centrally located cut, oval, line hole, an endblade slot perpendicular to the line hole, and a notched base that forms two strong symmetrical spurs. The Nanook Wasp Waist is a thin self-bladed harpoon head with a rectangular closed socket, a waisted profile, a centrally located circular line hole, and a notched base that forms two strong symmetrical spurs (Park and Stenton 1998).

2.6.2.3 Late Dorset

By the Late Dorset culture (1,500 to 1,000 BP), endblades had deep concave bases and serrated lateral edges and large chert bifacial knives, ground slate knives, and asymmetrical chert scrapers, which characterized tool assemblages. During this period microblade usage declined and endblades were no longer tip-fluted (Stenton and Park 1998). Though seals still constituted the majority of their diet the Late Dorset period population increased their exploitation of other available resources as evidenced in the faunal remains from Late Dorset sites (Howse 2008). Three main harpoon types typify this period: the Dorset Type G, the Dorset Type Ha, and the Dorset Type J. The Dorset Type G are antler or ivory harpoon heads with paired line holes perpendicular to the endblade slot and a deeply notched base that forms two sharp symmetrical spurs. The Dorset Type F is similar but is self-bladed. The Dorset Type Ha is a thin antler harpoon head with an open socket and lashing grooves, a centred line hole, and was self-bladed. The Dorset Type J is a thin antler self-bladed harpoon head with a centre line hole towards its base (Park and Stenton 1998). At the Late Dorset Cadfael Site on Victoria Island anvil boulders were used for the bi-polar reduction of grey to beige and pink quartzite cobbles (Taylor 1967; Brink 1992).

2.6.3 Thule

The Thule culture is divided into three periods: the Classic Thule (1,100 to 800 BP); Post Classic Thule (800 to 400 BP); and Early Historic (400 to 200 BP). This culture represents an eastward migration of a new group of people from Alaska across the Canadian Arctic and into Greenland around approximately 1,100 BP. It marks a sharp transition in the archaeological record from the preceding Dorset culture. The Thule culture was more whaling-focused, and as it moved out of the western Arctic it either displaced the existing Dorset culture or moved into the vacuum left by the departure of the Dorset. The Thule culture is characterized in the archaeological record by semi-subterranean houses framed with wood or bone, the use of dog sleds, and the use of ground stone rather than flaked stone tool technology. This change in manufacturing necessitated a shift in material from chert and quartz to slate and similar materials (Stenton and Park 1998). The Thule generally appear to have preferred metal over stone when available for the creation of sharp edge tools for working with bone antler and ivory (McGhee 1984). The Thule are considered to be the ancestors of the current Inuit population of the Arctic.

2.6.4 Taltheilei

The Taltheilei archaeological culture is thought to represent proto-Athapaskan peoples in the western subarctic, ancestral to the Chipewyan, Dogrib, and Yellowknife. Their seasonal rounds followed the caribou migration north onto the tundra during the summer months. This likely brought them into contact with the northern inhabitants who also relied on the caribou migration. Noble (1971) defined the Taltheilei tradition and divided it into 10 distinct complexes (Hennessey, Taltheilei, Windy Point, Waldron River, Narrows, Lockhart, Frank Channel, Fairchild Bay, Snare River, and Reliance) spanning approximately 2,000 years (2,200 BP to 150 BP). Gordon (1996) has since simplified this typology into Earliest, Early, Middle, and Late. Large Taltheilei sites have been located along the treeline where they would have aggregated during the spring and fall hunts while sites to the south of the treeline and north out on the Barren Lands are generally smaller and consist primarily of tent rings and lithic scatters (Friesen 2004). Archaeological sites near Black Lake in Northern Saskatchewan include evidence of an extensive Taltheilei occupation, as well as sites with Pre-Dorset culture ASTt artifacts (Minni 1975). Additionally, Morrison (1978) recorded the Nanegoak site (MeNl-13) on the western shore of Bathurst Inlet that he classifies as Taltheilei, based on a lanceolate projectile point suggestive of Hennessey or Windy Point traditions. The Black Lake and Nanegoak sites illustrate the overlapping ranges of the Paleo-Eskimo/Inuit and Taltheilei/Dene cultures. This overlap is confirmed through oral histories of the Inuit at Bathurst Inlet recorded by Keith and Stewart (2005).

2.7 METHODOLOGICAL ISSUES IN ARCTIC ARCHAEOLOGY

Due to the lack of soil deposition at many archaeological sites in the Arctic, other methods have been developed to determine the temporal inter-relationship of artifacts and features recorded within and amongst archaeological sites. Tool typologies have been created that allow artifact collections to be categorized into various complexes based on distinctive features. As the divisions between these complexes are sometimes blurred due to a lack of characteristic artifacts located within the collection, other dating templates have also been used to culturally and temporally place these collections and to test the veracity of the accepted complexes. These techniques include radiocarbon dating, changes in the elevation of coastal sites and examination of the surrounding environment for anthropogenic effects.

In one study of environmental anthropogenic effects, sediment samples from a freshwater pond were able to provide the habitation sequence for a nearby site based on the introduction of nutrients that changed the biochemistry of the pond. Changes in the pond’s biochemistry, revealed in the sediment cores, provided a temporal sequence for the use and reuse of the site (Douglas et al. 2004). In 2007, Kristopher Hadley also looked at similar anthropogenic contamination of Arctic ponds in his 2007 Master’s thesis (Hadley 2007).

Radiocarbon dating is often used to date archaeological sites when organic materials are recovered. Radiocarbon dating uses the half-life of the carbon-14 isotope to determine the date at which organic remains stopped absorbing carbon from the environment. These dates can have wide margins of error and can provide erroneous information if the samples are contaminated by improper handling or if the nature of the material sampled is not adequately understood. Dating of artifacts crafted from driftwood, for example, may provide dates that are too early due to the time elapsed between the death of the tree, its availability on the shoreline, and its use by a human agent. Park (1993) suggested that numerous radiocarbon dates should be taken from a site to minimize these types of erroneous data.

2.7.1 Relative Sea Level History

Sea level changes and isostatic rebounds that have occurred since the last ice age have resulted in a series of raised beaches left behind by the recession of the sea. In areas of regular habitation, sites can be sequenced based on their elevation above sea level.

Rapid deglaciation of Bathurst Inlet occurred between 9,200 and 8,500 BP, progressing from north to south as the Laurentide Ice Sheet retreated inland. Initially, the Arctic Ocean's sea level relative to land was higher, resulting in the sea extending over the continental landmass. The relative sea level (RSL) curve devised by Kerr (1996) estimates that at approximately 8,500 BP, the early post-glacial sea level in southern Bathurst Inlet was 225 m higher than present, with ocean water extending inland by approximately 30 to 40 km from the present shoreline in some areas. There is no sea level data for southern Bathurst Inlet during the middle Holocene (7,600 to 3,600 BP); however, by approximately 3,500 BP the relative sea level had decreased to 33 masl, to 29 masl at approximately 3,100 BP, and to 9 masl at approximately 1,850 BP (Kerr 1996).

In general, this means that Pre-Dorset sites (3,800 to 2,700 BP) should be situated above approximately 20 masl, Dorset sites (2,700 to 1,000 BP) could be situated as low as approximately 5 masl, and Thule sites (after 1,100 BP) could be located anywhere from the present-day shoreline and upwards. These elevation ranges are generally consistent with recent findings from the Kent Peninsula, located northeast of Bathurst Inlet. Dyke and Savelle (2009) conducted a systematic survey of middle and late Holocene beaches on the Kent Peninsula and King William Island and used radiocarbon dating to create a RSL curve for the area that relates elevation to time periods. They found that the majority of Pre-Dorset and Dorset features were located on raised gravel beaches between 7 and 50 masl, with the majority between 29 and 40 masl. This is generally consistent with what would be expected using Kerr's RSL curve for Southern Bathurst Inlet (Dyke and Savelle 2009).

2.8 ARCHAEOLOGICAL RESEARCH IN REGIONAL STUDY AREA

The first archaeological studies in the region were conducted in the 1920s by Mathiassen (1927), as part of the Danish Fifth Thule Expedition in 1921 to 1924. Southern Bathurst Inlet has been the subject of several archaeological studies. During the 1970s, geologist Fred Campbell submitted reports to the Archaeological Survey of Canada describing a number of archaeological sites he observed in Bathurst Inlet while conducting work for the Geological Survey of Canada (Campbell 1975, 1977). In 1978, David Morrison conducted a survey of southern Bathurst Inlet and recorded 61 archaeological sites, although he believed most were attributable to Inuit use and that many of the sites were not prehistoric. Additional archaeological investigations have been conducted in the George Lake area by Bertulli (1991) and in the Goose Lake area by Fedirchuk (1997).

Recent studies in the southern Bathurst Inlet have been conducted in 2001, 2002, and 2010 as part of the proposed Bathurst Inlet Port and Road (BIPR) Project, which would consist of port infrastructure on the west side of Bathurst Inlet and a road southwest to Contwoyto Lake (Fedirchuk 2001; Blower 2003; Tischer 2010). In 2004, Darren Keith and Andrew Stewart conducted an oral history and archaeological study of a caribou hunting camp site (*Tahikaffaaluk*) at the north end of Bathurst Lake (Keith and Stewart 2005). Studies were also conducted for the Hackett River Project in 2007, 2010, and 2012 (Rescan 2008, 2011, 2013a) and in 2011, 2012 and 2013 for the Back River Project (Rescan 2012, 2013b, 2013c).

3. Methodology

3. Methodology

The methodology employed for this baseline is summarized below.

3.1 LITERATURE REVIEW

Background research was conducted, including review and evaluation of archaeological, historical, and ethnographic literature relevant to the proposed Project area and the region (Section 2). When available, traditional knowledge and traditional use information was also used to assess potential.

3.2 DATA ANALYSIS

Archaeological site information is outlined in Sections 4, 5, and 6 of this report. Only general location information is provided in this report as a measure of security for the archaeological sites.

Often varied terminology is used by different researchers to define site types and features. For the purposes of this report an attempt has been made to standardize these descriptions. A brief description of the site type terminology used in this report is outlined below, and a glossary of archaeological terms can be found at the beginning of this report. Based on the known features and artifacts present at a site, an overall functional description has been provided. Due to the nature of the archaeological studies conducted within the Permit area, the functional determination is preliminary and may be subject to change upon further investigation at these sites. The functional descriptors include campsite, resource gathering, lithic reduction, lithic workshop, marker, grave, quarry, faunal tool, isolated lithic tool, and lithic isolated find. The function attributed to a site is in some case hierarchical where the presence of a specific feature or artifact moves it up a level.

The most complex sites were campsites. This site type encompasses all sites with evidence of habitation features including stone circles, stone ovals, and stone rectangles large enough to be attributed to holding down hide or canvas tents. A site containing both a lithic scatter and a stone circle will be described as a campsite as will a site containing a drive lane or cache that without a habitation feature would be describe as a resource gathering site. A resource gathering site encompasses all sites not classified as campsites that include features associated with hunting, fishing, and storage of subsistence resources including hunting blinds, caches, and caribou drive lanes. Quarry sites have both lithic scatters and lithic raw material with evidence of prehistoric use. Site described as markers includes those with cairns or inuksuk not obviously associated with other higher level activities such as drive lanes or campsites. Lithic sites containing no features but with large numbers of flakes ($n > 50$) and/or stone tools are described as lithic workshops. Sites with small amounts of lithic debitage and no formed tools are described as lithic reduction sites. Single artifact sites include isolated lithic tools (if a tool is present), lithic isolated finds (only debitage), and faunal tools of antler or bone.

Professional judgement was used on a site by site basis to determine site significance assessments based on the potential each site has to contribute scientific value and its ability to contribute to the regional cultural history (Appendix C). No assessment of cultural value has been conducted. All determinations of archaeological significance are preliminary and may be revised higher or lower upon further investigation. Archaeological significance ratings reported in this baseline are based on those provided in the permit reports. For newly recorded sites and those for which no significance rating was provided ratings of high archaeological significance were given to sites which are unique, have diagnostic artifacts or features and/or have the ability to contribute new or substantial information to the archaeological knowledge of the region. Moderate-high significance is similar to high but with less chance of subsurface deposits. Ratings of moderate archaeological significance were given to sites that may be common to the region but have the ability to provide some new knowledge. Low-moderate significance has been assigned to otherwise low significance sites if there is a reason for further study beyond documentation and collection. Ratings of low archaeological significance were given to sites that have few artifacts and/or are not diagnostic, and therefore lack the ability to contribute substantial information to the overall archaeological knowledge for the region.

4. Archaeological Overview

4. Archaeological Overview

There are the 380 sites recorded in the Permit area, 68.7% are prehistoric sites (n = 261), 11.1% are historic sites (n = 42), 7.6% are sites with both historic and prehistoric components (n = 29), and 12.6% are sites of undetermined age (n = 48). Cultural affiliations have not been identified at most archaeological sites; however, artifacts indicative of all the expected cultural traditions are present in the Permit area. Of the 380 archaeological sites within the Permit area, 7.1% have artifacts that are diagnostic of particular prehistoric cultures (n = 27). Of the 261 sites with a prehistoric component, 84.7% (n = 221) have a lithic component, while the remainder consist of stone features and/or faunal remains. The historic sites include features associated with historic material or mineral exploration. Undetermined sites largely consisted of cairns, inuksuk, and tent rings with no obvious historic or prehistoric material in their vicinity. Sites tend to be located on bedrock outcrops, knolls, ridges, eskers, and shorelines.

There are 24 archaeological sites with a Paleo-Eskimo component within the Permit area; 21 are identified by the presence of ASTt tools and 3 were identified as Dorset. Of the 24 Paleo-Eskimo sites, 19 are located in the Bathurst Inlet and Bathurst Lake area with the remaining five sites located along waterways. Only three sites within the Permit area have been identified as Taltheilei, two are located near Bathurst Inlet and the other is over 45 km inland. Sites with historic period components are distributed fairly evenly throughout the survey areas. No sites identified as Thule were recorded in the Permit area.

The areas around Bathurst Inlet and Bathurst Lake have the greatest density of sites and the greatest density of campsites sites (101 out of 135) suggesting a fairly consistent use of the area throughout the prehistoric and historic periods. This is consistent with the current scholarship, which suggests that the Paleo- and Neo-Eskimo cultures were primarily focused on the harvesting of marine mammal resources (Section 2.6). The inland campsites on the Barren Lands appear, as expected, to be primarily associated with the harvesting of caribou.

4.1 LITHIC TOOLS

There are 221 archaeological sites within the Permit area with a prehistoric lithic component. Lithic tools are informative as they can reveal the types of activities that took place at a site and may also be indicative of a particular cultural tradition.

4.1.1 Burins

Within the Permit area, the presence of burins and burin spalls are most commonly associated with the Pre-Dorset tradition (Stenton and Park 1998). Burins are created by preparing a core and then striking its distal end to remove a transverse flake or a spall (burination) and create a working edge (Plates 4.1-1 and 4.1-2). Multiple spalls are often sequentially removed from a single tool creating a characteristic stepped or notched edge along the spall scar (Riddle 2010). This repeated burination is likely for re-sharpening the burin, though it is also possible that the creation of burin spalls was a goal in and of itself. Burins would most likely have been hafted onto a handle of wood or bone and used as both a scraper, using the working edge, and as a graver, using the bit.

4.1.2 Burin-like Tools

Burin-like tools are thought to have been used for the same purpose as burins with the main differentiator being the use groundstone edges rather than burination to create the planning or scraping edge (Plate 4.1-3). To create the burin-like tool the chosen blank was roughed out and the base for hafting flaked prior to the grinding of the working edges. These tools are indicative of the Dorset period (Stenton and Park 1998).

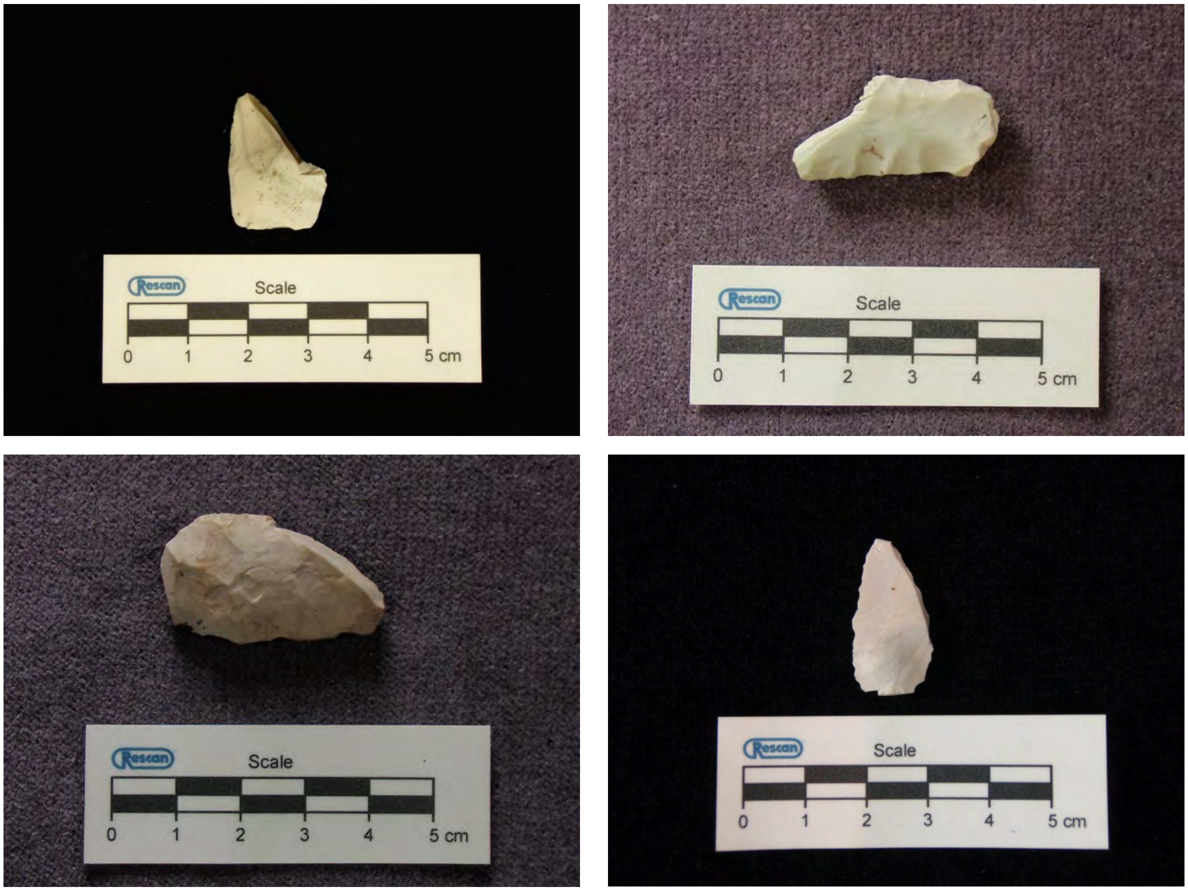

Plate 4.1-1. Burins from MdNl-7 (top left), McNj-32 (top right), McNj-33 (bottom left), and LlNo-2 (bottom right).

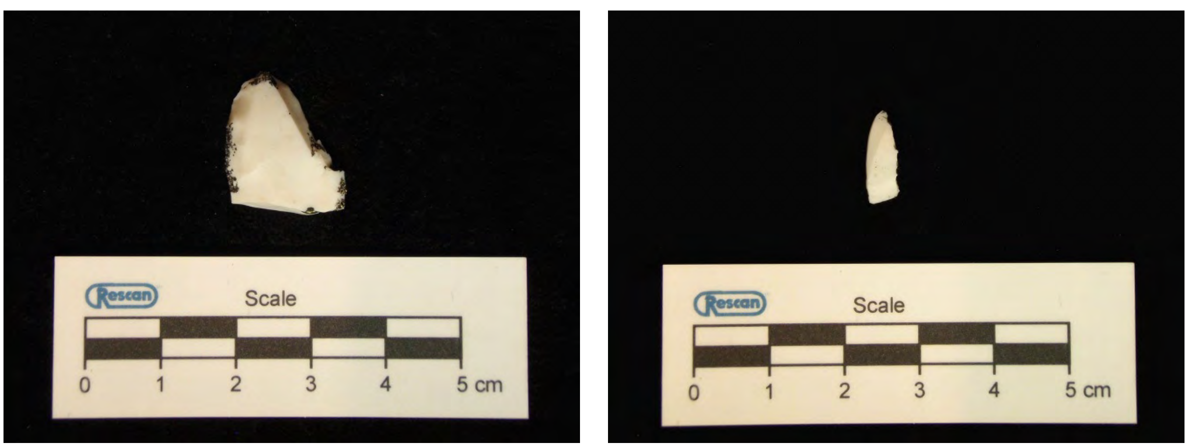

Plate 4.1-2. Burin (left) and burin spall (right) from MdNl-8.

4.1.3 Points

Points are bifaces designed to be hafted onto shafts for use as harpoons, spears, or arrows. Points sized for hafting onto arrow shafts are small, finely crafted, and bifacially flaked. These points are found in a variety of styles including the bi-pointed example from McNk-22 indicative of an early Pre-Dorset occupation, the concave base lanceolate points from MdNl-8 and McNj-49, indicative of the Pre-Dorset and to a lesser extent the Dorset period (Plate 4.1-4). Notched Paleo-Eskimo points are indicative of

Dorset period sites as is tip fluting. The shouldered point base fragment (bottom right) from LlNk-8 is indicative of the Taltheilei period.

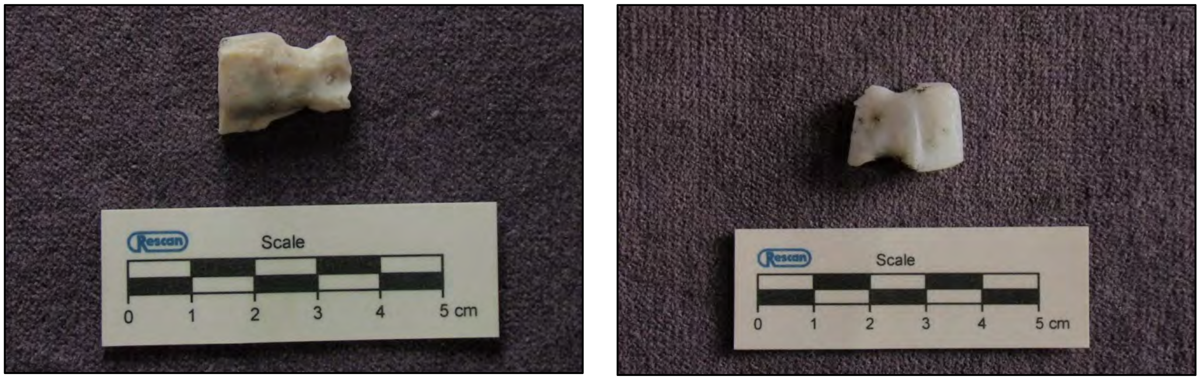

Plate 4.1-3. Burin-like tools from McNj-28 (left) and McNj-19 (right).

Plate 4.1-4. Points from McNk-22 (top left), MdNl-8, (top right), MdNl-8 (bottom left), and LlNk-8 (bottom right).

4.1.4 Knives

Knives are bifaces designed for hafting onto a wood or bone handle to be used for cutting and slicing of soft animal tissue (Plate 4.1-5). Notching on the artifact from LlNo-2 is likely due to retouch of the cutting edges while hafted. The exposed portion would be damaged during use and retouched while the protected area beneath the hafting would retain its original breadth.

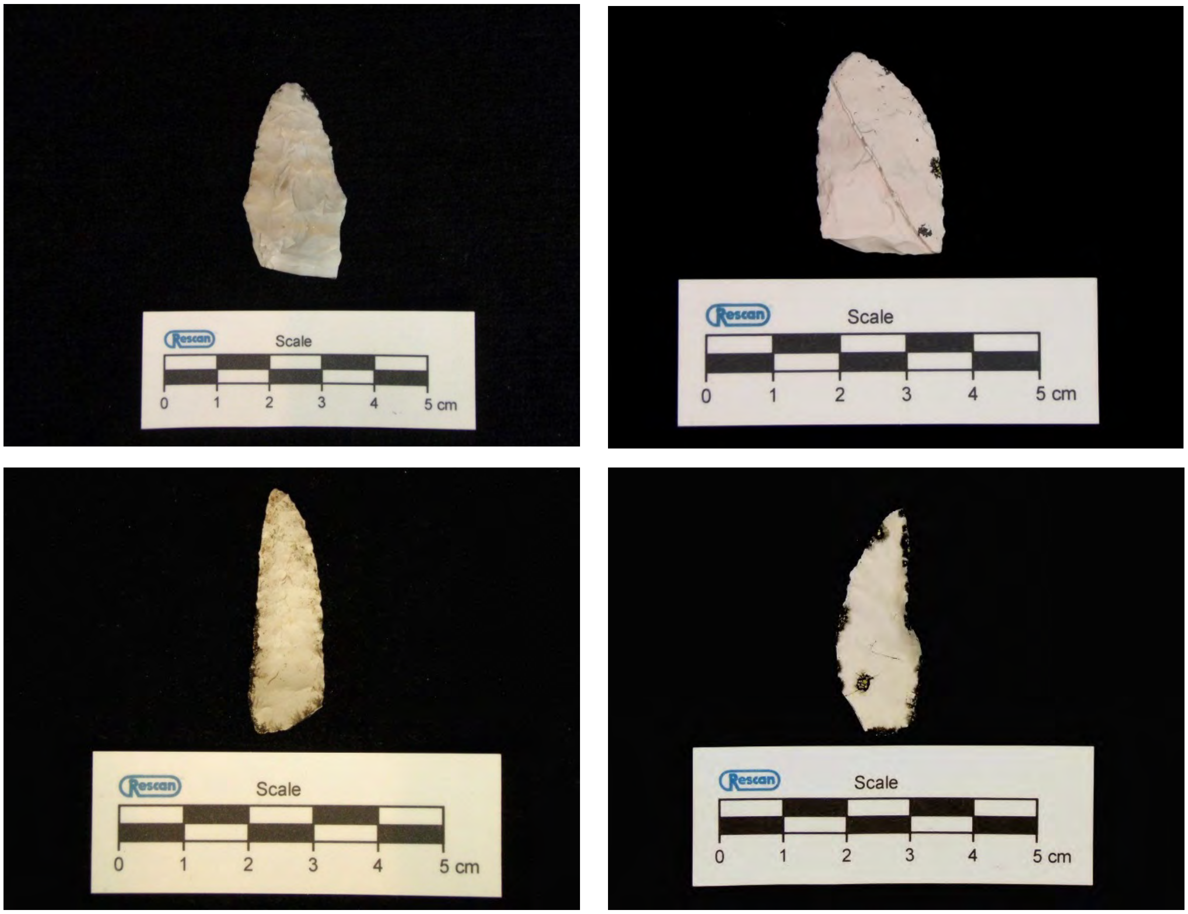

Plate 4.1-5. Knives from LlNo-2, (top left), MdNl-7 (top right), MdNl-8 (bottom left), McNj-48 (bottom right). Notches in knife from LlNo-2 may indicate re-sharpening while hafted.

4.1.5 Microblades

Chert and quartz microblades are common at both Pre-Dorset and Dorset sites (Stenton and Park 1998). Microblades are small thin sharp blades removed from a prepared core (Plate 4.1-6). The resulting tool has roughly parallel lateral edges and often a dorsal ridge that runs the length of the blade. With the exception of occasional lateral retouch at the proximal end for hafting microblades are unmodified following removal from the core.

4.1.6 Scrapers

Scrapers are a common lithic tool that was crafted from many materials (Plate 4.1-7). During the Pre-Dorset period, chert was commonly used for formed tools and quartzite for expedient tools (Riddle 2010). Scrapers can generally be divided into two main categories end-scrapers and side-scrapers. They are formed by removing flakes unifacially or bifacially at a steep angle along the working edge of the tool. The four scrapers below are various forms of end scrapers and the shouldered scraper from MbNj-5 is indicative of the Taltheilei period.

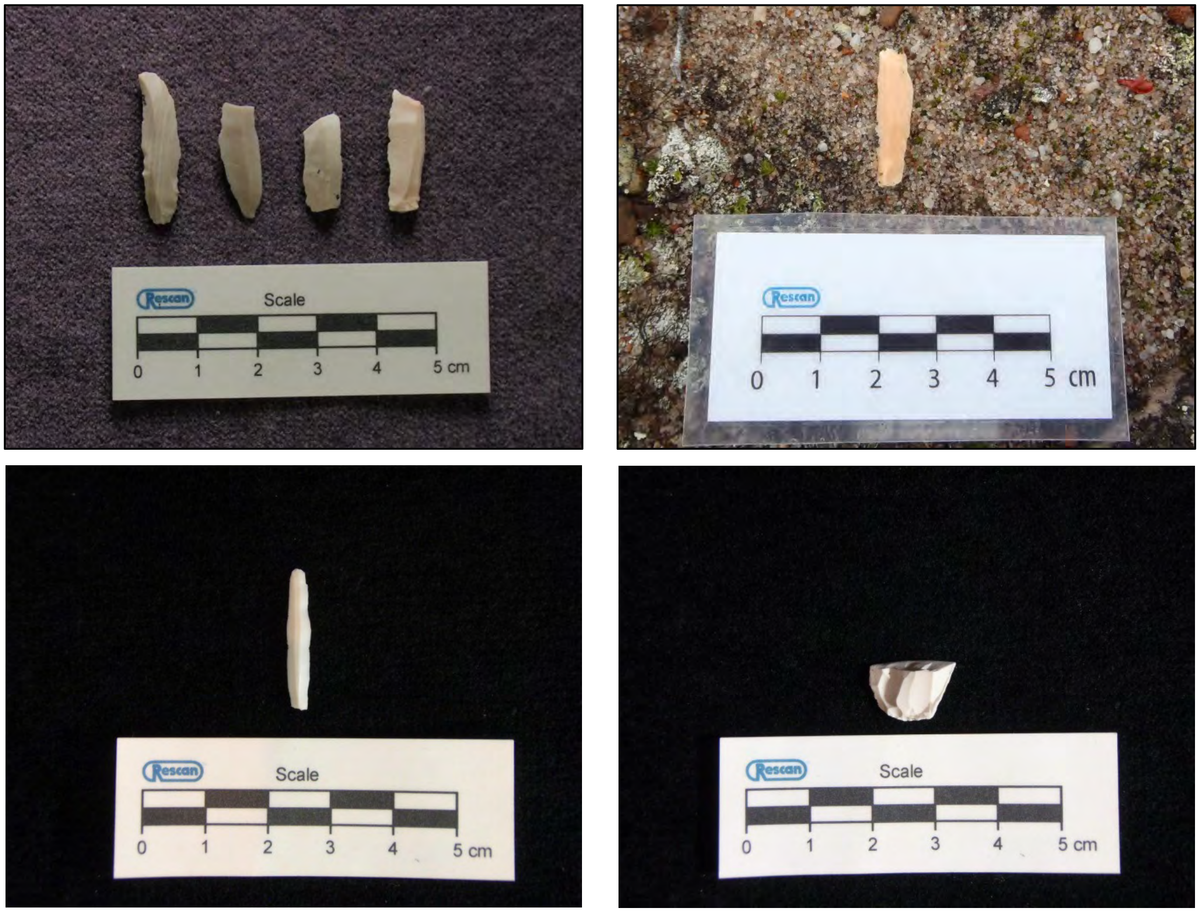

Plate 4.1-6. Microblades from McNj-40 (top left), McNj-47 (top right), LlNo-2 (bottom left) and a microblade core from LlNo-2 (bottom right).

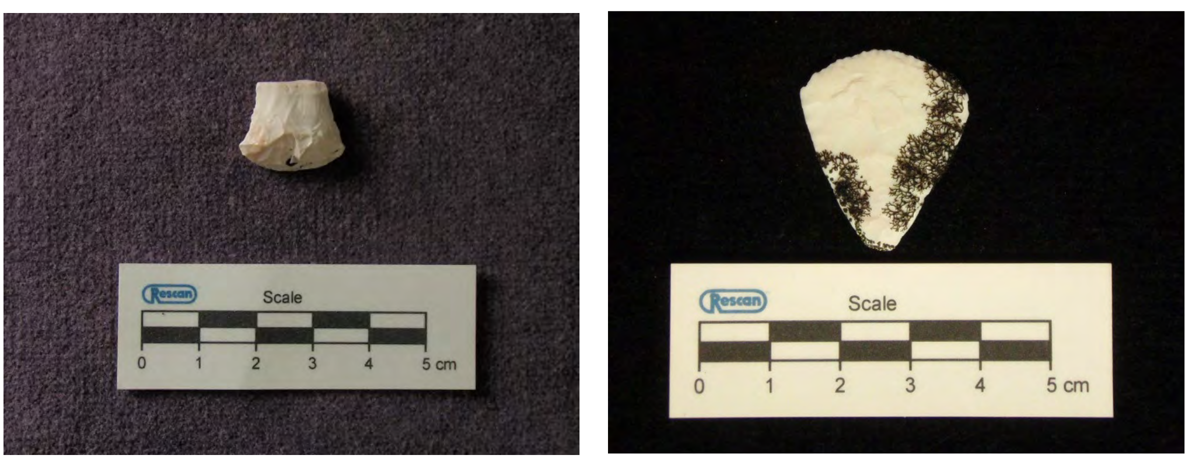

Plate 4.1-7. Scrapers from McNj-40 (top left), MdNl-7 (top right), McNj-48 (bottom left), and MbNj-5 (bottom right).

(continued)

Plate 4.1-7 (completed). Scrapers from McNj-40 (top left), MdNl-7 (top right), McNj-48 (bottom left), and MbNj-5 (bottom right).

4.2 NON-DIAGNOSTIC LITHIC ARTIFACTS

Non-diagnostic artifacts include both formed tools and flakes that are not suggestive of a particular cultural tradition or time period. Debitage makes up the majority of the lithic material recorded at archaeological sites (Plate 4.2-1). Debitage, including flakes and block shatter, is created during the production of stone tools. The production and use of a single tool may produce 100s to 1,000s of pieces of debitage. Tools without obvious diagnostic features are also found at many archaeological sites. Undiagnostic tools include artifacts like biface preforms (material has been removed but the final tool has not been formed) and items used throughout the prehistoric period (Plate 4.2-2).

Plate 4.2-1. A small scatter of lithic debitage from McNk-21.

Plate 4.2-2. White quartzite biface preform (LlNk-10:1) collected from site LlNk-10.

4.3 FEATURES

Prehistoric features recorded in the Permit area include stone circles, caches, cairns/inuksuit, hearths, kayak stands, and hunting blinds. Possible chamber burials were also located at LiNj-3. These features often play an important role in determining the function of a site and suggest more extended use of an area than does a lithic scatter found in isolation. Campsites and resource gathering sites such as drive lanes often incorporate multiple types of features and/or multiple features of the same type.

4.3.1 Burials

Within the Permit area, the dead were often covered in caribou skins and left on the tundra (KIA 2012). Unless human remains were located, this type of burial would leave little evidence that could be identified archaeologically. Archaeological sites LkNh-2, MeNl-0, and MeNl-3 were identified as possible burials based on the presence of scattered remains likely resulting from surface burials. Graves, however, could also be created by piling stones around the deceased in order to deter animals or occasionally a square or rectangular chamber was built from heavy flat stones. These chamber burials are thought to be from the Dorset period (Lynnerup et al. 2003). Possible chamber burials were located at LiNj-3 (Plate 4.3-1).

4.3.2 Habitation Features

Habitations features within the Permit area vary in size and shape. Circles, ovals, and rectangles of stone located within the Permit area over a 2-m diameter are assumed to be habitation features (Plate 4.3-2). If there are no artifacts present to help determine the antiquity of the site, stone circles and ovals are assumed to have held down hide tents and be prehistoric in origin. Heavy stone circles or "qarmaq" were walled with larger more tightly spaced stones than normal and may indicate a cold weather habitation. Stone rectangles are generally assumed to have held down canvas tents and date to the historic period. The exception would be the long narrow rectangular stone features associated with the Dorset longhouse though none of these features were located within the Permit area. Less obvious on the landscape are the locations were igloo or sod houses were used during the winter. Hearth features, shallow depressions, berms, and differential vegetation may provide archaeological clues to indicate the location of these habitation features.

Plate 4.3-1. Possible chamber burial with no remains present at LiNj-3.

Plate 4.3-2. Stone circles from MdNk-33 (top left), MdNk-47 (top right), a stone rectangle from MdNl-10 (bottom left), and strong stone circles from MbNj-14.

4.3.3 Inuksuit/Cairns

Inuksuit and cairns are stone features designed to be visible on the landscape (Plate 4.3-3). The term inuksuk is used if the feature is thought to be Aboriginal in origin and cairn if it is determined to relate to mineral exploration or survey activities. These features were used for a variety of purposes including for navigation, to mark important locations, to herd caribou, and to leave messages for others.

Plate 4.3-3. Inuksuk at LgNm-6 (top left), MaNj-4 (top right), LlNm-26 (bottom left) and a drive lane with three of the four inuksuit at site MbNj-17 (bottom right).

4.3.4 Hunting Blinds

Hunting blinds are low linear to curvilinear stone features of two or more stones that allowed hunters to ambush prey from a protected position and are often located on heights of land with good views of the surrounding terrain (Plate 4.3-4). The large blinds would also have provided protection from the wind while the hunters waited for the game to arrive. These features are often associated with drive lanes.

4.3.5 Caches

Caches were used to protect valuable items so that they were available for future use (Plate 4.3-5). The three types of caches found archaeologically in the area are described by Stewart et al. (2000) in an ethnographic study conducted along the Kazan River. A low cairn of loosely piled stones was often used to protect a carcass over the winter, a cache constructed of stones placed to form a hollow structure was used to hold dried meat or equipment, and a small stone circle could be the remnants of a cache used to secure a protective hid over stored equipment. Caches often made use of naturally occurring cracks or hollows.

Plate 4.3-4. Hunting blinds at MbNj-20 (top left), LlNn-11 (top right), MaNj-7 (bottom left), LlNo-1 (bottom right).

Plate 4.3-5. Caches at LkNh-3 (top left), LlNk-17 (top right), aerial view of caches at MdNl-15 (bottom left) and close up of cache at MdNl-15 (bottom right).

(continued)

Plate 4.3-5 (completed). Caches at LkNh-3 (top left), LlNk-17 (top right), aerial view of caches at MdNl-15 (bottom left) and close up of cache at MdNl-15 (bottom right).

4.3.6 Other Stone Features

Two other stone features constructed of as little as three to four stones are kayak stands and hearths (Plate 4.3-6). The small features though simple in construction are easy to identify and provide important information on the types of activities taking place at the site. Hearths are often constructed of three stones arranged in an open ended rectangle. This configuration would have provided the fire with some protection from the wind and served as a shelf for cooking. Kayak stands consist of at least two a pairs of standing stones that were arranged to raise the kayak off the ground allowing the hide hull to dry.

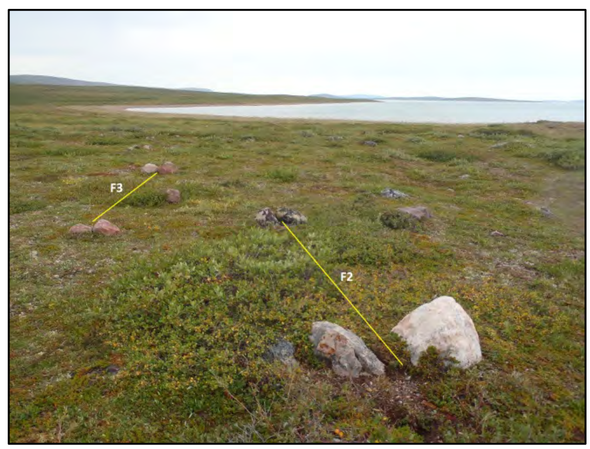

Plate 4.3-6. A hearth at MdNk-43 (left) and two kayak stands at MdNk-44 (right).

5. Archaeological Sites within Potential Development Areas

5. Archaeological Sites within Potential Development Areas

This section presents a description of the terrain within the PDAs, the MLA, and along Project road alignments. Archaeological sites within 50 m of these proposed developments that are anticipated to be directly affected by Project development are discussed in detail. The 2010 to 2013 field investigations focused the George and Goose property PDAs, as well as the proposed MLA. Assessments were also carried out along five proposed road alignments: 1) the BIPR Winter Road Connector, 2) the temporary winter road for construction to the proposed MLA from George and Goose properties, 3) a Winter Road between the Goose and George property PDAs and 4) the Tibbitt to Contwoyto Winter Road (TCWR) Winter Road Connector.

5.1 GEORGE PROPERTY PDA

The terrain within the George Property PDA consists of large bedrock outcrops, boulder fields, low-lying wetlands, knolls, and eskers (Plate 5.1-1). Vegetation in the area is generally sparse with low-lying willow, moss, lichen, and grasses. Pedestrian survey of the George Property focused on proposed site infrastructure and immediately adjacent areas.

Plate 5.1-1. Typical terrain around the George Property, summer 2012.

The George Property has been subject to exploration activity for over 15 years. There are numerous mining stake cairns throughout the area (Plate 5.1-2), as well as evidence of previous exploration programs. Where recent historic evidence of exploration was observed, such as cairns, it were noted; however, the field investigations focused on recording sites that were 50 years or older.

Plate 5.1-2. Mining stake cairn, typical of those found around the George Property, summer 2012.

There are 11 known archaeological sites within the George Property PDA (LlNk-1, LlNk-2, LlNk-5, LlNk-7, LlNk-8, LlNk-9, LlNk-10, LlNk-11, LlNk-12, LlNk-20, and LlNk-21). The site types found in this area include a campsite, lithic scatters, and cache pits.

5.1.1 LlNk-1

Archaeological site LlNk-1 is a small disassembled cache of undetermined antiquity located on a prominent knoll within the George Property PDA. The cache pit feature consists of several flat rocks surrounding a shallow cultural depression with differential vegetation. Based on the features present the site is determined to have moderate archaeological significance. No artifacts were identified in the area (Rescan 2011).

5.1.2 LlNk-2

Archaeological site LlNk-2 is a prehistoric lithic scatter located on an east-west trending esker overlooking a marshy area to the southeast. The site measures 7 m north-south by 12 m east-west and consists of one white quartzite core and one piece of block shatter. As the site is in close proximity to the George Exploration Camp and a proposed ice-road, the artifacts were collected. No diagnostic artifacts were observed, and the site is determined to have low archaeological significance (Rescan 2011).

5.1.3 LlNk-5

Archaeological site LlNk-5 is a prehistoric lithic scatter located on the top of an east-west trending esker. The site measures 11.5 m north-south by 23 m east-west and consists of one white quartzite biface fragment, three white quartzite flakes, and one piece of white quartzite block shatter (all collected). No diagnostic artifacts were identified. Based on the landform and the artifacts present, the site is determined to have moderate archaeological significance (Rescan 2011).

5.1.4 LlNk-7

Archaeological site LlNk-7 is a prehistoric lithic scatter site located on a surface exposure between two bedrock outcrops. Site boundaries measure 15 m in diameter. Vegetation at the site is sparse, but where present it consists of dwarf shrubs, sedges, moss, and lichen. The site consists of a surface lithic scatter of approximately 100 to 200 white quartzite flakes. All artifacts were left *in situ*. The site appears to be in good condition. Based on the number of artifacts present the site is determined to have a moderate-high archaeological significance (Rescan 2013b).

5.1.5 LlNk-8

Archaeological site LlNk-8 is a prehistoric isolated lithic find, located on a gravel exposure. Site boundaries measure 10 m in diameter. Vegetation is very sparse at the site and consists of only small patches of dwarf shrubs, sedges, moss, and lichen. The site consists of a single basal point fragment of a shouldered point of grey siltstone (Plate 5.1-3), suggestive of the Early to Middle Taltheilei tradition. The artifact was collected. The site appears to be in good condition. Based on the artifact present the site is determined to have moderate archaeological significance (Rescan 2013b).

5.1.6 LlNk-9

Archaeological site LlNk-9 is a cache site of undetermined age, located in a surface exposure on a small bench. Site boundaries measure 10 m in diameter. Vegetation at the site is sparse and consists of a few small patches of dwarf shrubs, sedges, moss, and lichen. The site consists of a single cache, which has been taken apart. No artifacts were observed. The site appears to be in good condition, and is assessed to have low archaeological significance (Rescan 2013b).

5.1.7 LlNk-10

Archaeological site LlNk-10 is a prehistoric lithic scatter site, located in a surface exposure on a small bench. Site boundaries measure 65 m north-south by 30 m east-west. Vegetation at the site is sparse and consists of a few small patches of dwarf shrubs, sedges, moss, and lichen. The site consists of three surface lithic scatters with a total of approximately 400 flakes all of white quartzite, as well as several biface fragments. All artifacts were left *in situ*, with the exception of the biface preform collected from lithic scatter 1 (Plate 5.1-4). The site appears to be in good condition and is assessed to have moderate-high archaeological significance (Rescan 2013b).

5.1.8 LlNk-11

Archaeological site LlNk-11 is a prehistoric lithic scatter site, located in a surface exposure on a knoll west of Long Lake. Site boundaries measure 15 m in diameter. Vegetation at the site consists of patches of dwarf shrubs, sedges, moss, and lichen. The site consists of one surface lithic scatter of approximately 30 white quartzite flakes. All artifacts were left *in situ*, with the exception of one quartzite graver, which was collected (Plate 5.1-5). The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

5.1.9 LlNk-12

Archaeological site LlNk-12 is a prehistoric isolated lithic find site, located in a surface exposure on a terrace on the north-western shore of George Lake. Site boundaries measure 10 m in diameter. Vegetation at the site is minimal but where present consists of dwarf shrubs, sedges, moss, and lichen. The site consists of a single grey quartzite scraper which was collected from the surface (Plate 5.1-6). The site appears to be in good condition and is assessed to have low-moderate archaeological significance (Rescan 2013b).

Plate 5.1-3. Early or Middle Taltheilei point fragment (LlNk-8:1) collected from site LlNk-8.

Plate 5.1-4. White quartzite biface preform (LlNk-10:1) collected from site LlNk-10.

Plate 5.1-5. Clear quartzite graver (LlNk-11:1) found at site LlNk-11.

Plate 5.1-6. Grey quartzite scraper (LlNk-12:1) collected from site LlNk-12.

5.1.10 LlNk-20

Archaeological site LlNk-20 is a prehistoric campsite located on an esker in the southeast of the George Property PDA. Site boundaries measure 12 m in diameter. Vegetation at the site is very sparse and consists of only a few patches of grass and lichens. The site consists of one stone circle with some animal bone fragments around the feature. No artifacts were found at the site. The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

5.1.11 LlNk-21

Archaeological site LlNk-21 is a prehistoric lithic scatter site located on an esker within 50 m of the George Property PDA. Site boundaries measure 8 m in diameter. Vegetation at the site consists of small patches of ground-covering bushes and lichens. The site consists of one lithic scatter containing four white quartzite flakes. All artifacts were left *in situ*. The site appears to be in good condition and is assessed to have low archaeological significance (Rescan 2013b).

5.2 GOOSE PROPERTY PDA

The terrain within the Goose Property PDA includes large bedrock outcrops, boulder fields, low-lying wetlands, knolls, and eskers (Plate 5.2-1). Vegetation in the area is generally sparse with low-lying willow, moss, lichen, and grasses. Pedestrian survey of the Goose Property focused on proposed mine site infrastructure, including proposed open pits, waste rock storage areas and a potential tailings storage area. Local access roads generally fall within areas that are low and marshy.

Plate 5.2-1. Typical terrain around the Goose Property, summer 2012.

There are four known archaeological sites within the Goose Property PDA: LjNh-1, LjNj-2, LjNh-4 and LjNj-5. All of the sites within the Goose Property PDA are lithic sites.

5.2.1 LjNh-1

Archaeological site LjNh-1 is a prehistoric lithic workshop located on a bedrock outcrop surrounded by marsh. The site has a good outlook over Llama Lake to the southeast. The site measures 18 m north-south by 8 m east-west and consists of an artifact assemblage of three pink quartzite flakes, 147 white quartzite flakes (including approximately 100 pieces of micro-debitage), and three pieces of white quartzite block shatter. No formed tools or diagnostic artifacts were observed at the site. Due to the close proximity of the site to exploration activities, the surface finds were collected. The site is assessed to have low archaeological significance (Rescan 2011).

5.2.2 LjNh-2

Archaeological site LjNh-2 is a prehistoric isolated find. The site measures 6 m north-south by 3 m east-west and consists of a single pink quartzite retouched flake located on a bedrock outcrop surround by marsh and uneven rocky terrain. The site has a good outlook over Llama Lake to the southeast. Due to the close proximity of the site to exploration activities, the surface find was collected. The site is assessed to have low archaeological significance (Rescan 2011).

5.2.3 LjNh-4

Archaeological site LjNh-4 is a prehistoric lithic reduction site situated at on a bedrock outcrop approximately 20 m east of a small unnamed pond. It measures 5 m north-south by 5 m east-west, and consists of four grey quartz flakes and two unifacially retouched flakes observed on the ground at the site (left *in situ*; Plate 5.2-2). No formed tools or diagnostic artifacts were observed, and the site is assessed to have low archaeological significance (Rescan 2012).

Plate 5.2-2. Quartz flakes from site LjNh-4.

5.2.4 LjNh-5

Archaeological site LjNh-5 is a prehistoric reduction site situated at approximately 320 masl on a knoll overlooking the outlet of an unnamed creek flowing into Goose Lake. The site measures 12 m north-south by 12 m east-west, and consists of a white chert and three white quartz flakes observed in a surface exposure (left *in situ*). No formed tools or diagnostic artifacts were observed, and the site is assessed to have low archaeological significance (Rescan 2012).

5.3 MARINE LAYDOWN AREA

The MLA is located on the western side of Bathurst Inlet approximately 38 km north of the mouth of the Western River. The topography in this area is variable as it takes in the shoreline and several terraces. It ranges from being relatively level to steeply sloped and undulating terrain. The vegetation is sparse with large subsurface exposures and includes low-lying willow, dwarf sedges, moss and lichen (Plate 5.3-1).

Plate 5.3-1. Aerial view of MLA, view north, summer 2012.

Fifteen archaeological sites are located within the MLA: MdNl-5, MdNl-6, MdNl-7, MdNl-8, MdNl-9, MdNl-10, MdNl-11, MdNl-12, MdNl-13, MdNl-14, MdNl-16, MdNl-17, MdNl-18, MdNl-19, and MdNl-20. Sites types within the MLA include campsites, lithic scatters, a historic hunting site, cache sites, and historic artifact find sites.

5.3.1 MdNl-5

Archaeological site MdNl-5 is a campsite of undetermined age located on a bedrock exposure overlooking Bathurst Inlet. The site was originally recorded in 1978 (Morrison 1978) and was revisited during the 2012 field assessments. Vegetation at the site consists of patches of mosses, lichens, and grasses. The site is in good condition. All previously recorded features were relocated and an additional eight features including two stone alignments, two stone circles, one cache, one fire pit, a temporary shelter, and a pavement of flat stones were recorded. Site boundaries have been revised and now measure 175 m north-south by 185 m northwest-southeast. The site is assessed to have moderate-high archaeological significance (Rescan 2013b).

5.3.2 MdNl-6

Archaeological site MdNl-6 is a prehistoric campsite located in a surface exposure overlooking Bathurst Inlet. Site boundaries measure 230 m east-west by 60 m north-south. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one cache with a pavement of stones beside it (Plate 5.3-2), two stone ovals, and one lithic scatter of approximately 40 white chert, and pink and white quartzite flakes was located in a surface exposure. Seven artifacts, which are suggestive of the Arctic Small Tool tradition, were collected from the site (Plate 5.3-3). The site appears to be in good condition and is assessed to have high archaeological significance (Rescan 2013b).

Plate 5.3-2. Cache (F1) at site MdNl-6.

Plate 5.3-3. Artifacts collected from site MdNl-6.

5.3.3 MdNl-7

Archaeological site MdNl-7 is a prehistoric lithic workshop site with historic components located on a slope overlooking Bathurst Inlet within the Marine Laydown PDA. Site boundaries measure 175 m east-west by 140 m north-south. The sparse vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of two stone ovals, one with a pavement of flat stones; lithic scatters located in surface exposures included eighteen lithic tools (Plate 5.3-4), approximately 20 flakes of white chert, white and green quartzite, 4 single chert flakes, and 1 white chert core, as well as one wooden peg, one rifle cartridge (223 Remington, first issued in 1957), and one piece of worked antler (Plate 5.3-5). Several of the lithic artifacts from the site are suggestive of the Arctic Small Tool tradition and were collected along with the rifle cartridge. All other artifacts were left *in situ*. The site appears to be in good condition and is assessed to have high archaeological significance (Rescan 2013b).

Plate 5.3-4. Artifacts collected from site MdNl-7.

Plate 5.3-5. Worked antler from site MdNl-7.

5.3.4 MdNl-8

Archaeological site MdNl-8 is a prehistoric lithic workshop overlooking Bathurst Inlet. Site boundaries measure 100 m in diameter. Vegetation at the site is sparse consisting of patches of mosses, lichens, and grasses. The site includes lithic scatters, located in surface exposures with a total of 200 flakes of light grey quartzite, grey and white chert, clear quartz, grey siltstone, and orange banded chert, as well as ten lithic artifacts, which were collected (Plate 5.3-6). Three of the collected artifacts are suggestive of the Arctic Small Tool tradition. The site appears to be in good condition and is assessed to have high archaeological significance (Rescan 2013b).

Plate 5.3-6. Artifacts collected from MdNl-8.

5.3.5 MdNl-9

Archaeological site MdNl-9 is a prehistoric campsite overlooking Bathurst Inlet. Site boundaries measure 35 m northwest-southeast by 15 m southwest-northeast. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one small stone circle, which may be a hearth or cache and one larger stone circle. No artifacts were found at the site. The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

5.3.6 MdNl-10

Archaeological site MdNl-10 is a prehistoric campsite located on a surface exposure overlooking Bathurst Inlet. Site boundaries measure 15 m diameter. The sparse vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one stone rectangle (Plate 5.3-7) and one quartzite spall tool. The artifact was left *in situ*. The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

5.3.7 MdNl-11

Archaeological site MdNl-11 is an historical faunal tool site overlooking Bathurst Inlet. Site boundaries measure 24 m north-south by 10 m east-west. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one piece of sinew rope. The artifact was left *in situ*. The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

5.3.8 MdNl-12

Archaeological site MdNl-12 is a prehistoric resource gathering site located on a break-in-slope overlooking Bathurst Inlet. Site boundaries measure 10 m north-south by 21 m east-west. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one cache and one cairn. No artifacts were located at the site. The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

Plate 5.3-7. Stone rectangle (F1), with Bathurst Inlet in background, at site MdNl-10.

5.3.9 MdNl-13

Archaeological site MdNl-13 is a prehistoric lithic reduction site located in a surface exposure on a terrace overlooking Bathurst Inlet. Site boundaries measure 10 m in diameter. Vegetation at the site is sparse and consists of patches of mosses, lichens, and grasses. The site consists of one lithic scatter containing two white quartzite flakes. All artifacts were left *in situ*. The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

5.3.10 MdNl-14

Archaeological site MdNl-14 is a campsite of undetermined age located on a rise immediately west of Bathurst Inlet. Site boundaries measure 65 m north-south by 15 m east-west. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of two stone circles. No artifacts were found at the site. The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

5.3.11 MdNl-16

Archaeological site MdNl-16 is a historic campsite located on a terrace. Site boundaries measure 27 m east-west by 18 m north-south. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one stone circle and historic debris, including tin cans, a toy NASA Land Rover truck, which started being produced in 1987, caribou bone fragments, plastic fragments, and wooden tent pegs. No prehistoric artifacts were found at the site and all historic artifacts were left *in situ*. The site appears to be in good condition and is assessed to have low archaeological significance (Rescan 2013b).

5.3.12 MdNl-17

Archaeological site MdNl-17 is a campsite of undetermined age located on a bench overlooking the beach. Site boundaries measure 20 m north-south by 10 m east-west. Vegetation at the site consists of ground-covering bushes, grasses, lichens, and mosses. The site consists of one stone circle and one hearth. No artifacts were found at the site. The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

5.3.13 MdNl-18

Archaeological site MdNl-18 is a campsite of undetermined age located on the shore of Bathurst Inlet. Site boundaries measure 15 m in diameter. Vegetation is sparse to non-existent at the site, but a few small patches of low ground cover are present. The site consists of one stone circle and a scatter of broken animal bone. No artifacts were located at the site. The site appears to be in good condition and is assessed to have moderate archaeological significance (Rescan 2013b).

5.3.14 MdNl-19

Archaeological site MdNl-19 is an historical isolated find site located on the shore of Bathurst Inlet. Site boundaries measure 10 m in diameter. Vegetation at the site consists of grasses, mosses, and lichens. The site consists of one wooden oar with one end wrapped in metal (Plate 5.3-8). No other artifacts were found at the site (Rescan 2013b). The site appears to be in good condition and is assessed to have low archaeological significance.

Plate 5.3-8. Wooden oar with wrapped end found at site MdNl-19.

5.3.15 MdNl-20

Archaeological site MdNl-20 is an historical artifact find site located on the shore of Bathurst Inlet within the Marine Laydown PDA north of the Laydown Pad. Site boundaries measure 10 m in diameter. The site consists of one piece of a wooden lid, with a curved side and a lip, two pieces of wood, and a rusted metal pin. No other artifacts were found at the site. All artifacts were left *in situ*. The site appears to be in good condition and is assessed to have low archaeological significance (Rescan 2013b).

5.4 BIPR WINTER ROAD CONNECTOR

The proposed BIPR Winter Road Connector travels primarily along Upper and Lower Long Lake. The terrain along both sides of the lake is varied, including large bedrock outcrops, boulder fields, low-lying wetlands, knolls, and eskers (Plate 5.4-1). Vegetation in the area is generally sparse with low-lying willow, moss, lichen, and grasses. Pedestrian survey of the proposed winter road alignment focused on lake edges, prominent points, and peninsulas which extend into the lake as well as a proposed infrastructure area near the western end of the proposed alignment. One archaeological site, LlNk-18, was recorded within 50 m of BIPR Winter Road Connector. One archaeological site, McNj-18, was recorded within 50 m of the proposed winter road from the Goose and George properties to the MLA.

Plate 5.4-1. Typical terrain along the shore of Upper Long Lake, summer 2012.

5.4.1 LlNk-18

Archaeological site LlNk-18 is a prehistoric lithic reduction site located on a knoll on the shore of Upper Long Lake at an elevation of 367 masl (Plate 5.4-2). Site boundaries measure 12 m in diameter. Vegetation at the site consists of mosses, lichens, and ground-covering bushes. The site consists of one lithic scatter containing approximately 10 to 20 white quartzite flakes. All artifacts were left *in situ*. The site appears to be in good condition and is assessed to have low archaeological significance (Rescan 2013).

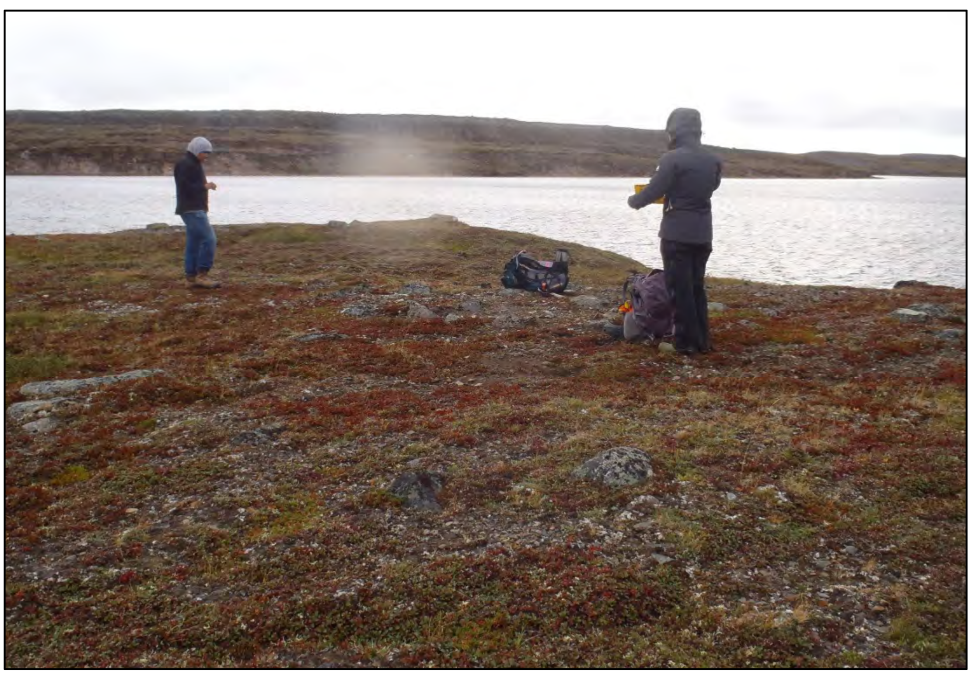

Plate 5.4-2. The terrain at archaeological site LlNk-18.

5.5 PROPOSED WINTER ROAD TO PROPOSED MARINE LAYDOWN AREA FROM GEORGE LAKE AND GOOSE LAKE PROPERTIES

The proposed winter road from the Goose and George properties to the proposed MLA travels through varied terrain including large bedrock outcrops, boulder fields, low-lying wetlands, knolls, and eskers (Plate 5.5-1). Vegetation in the area is generally sparse with low-lying willow, moss, lichen and grasses. Pedestrian survey of the proposed winter road alignment focused on areas assessed to have moderate to high archaeological potential. While proposed quarry locations were not identified at the time of the field investigations, some areas with the potential for use as a quarry were also examined.

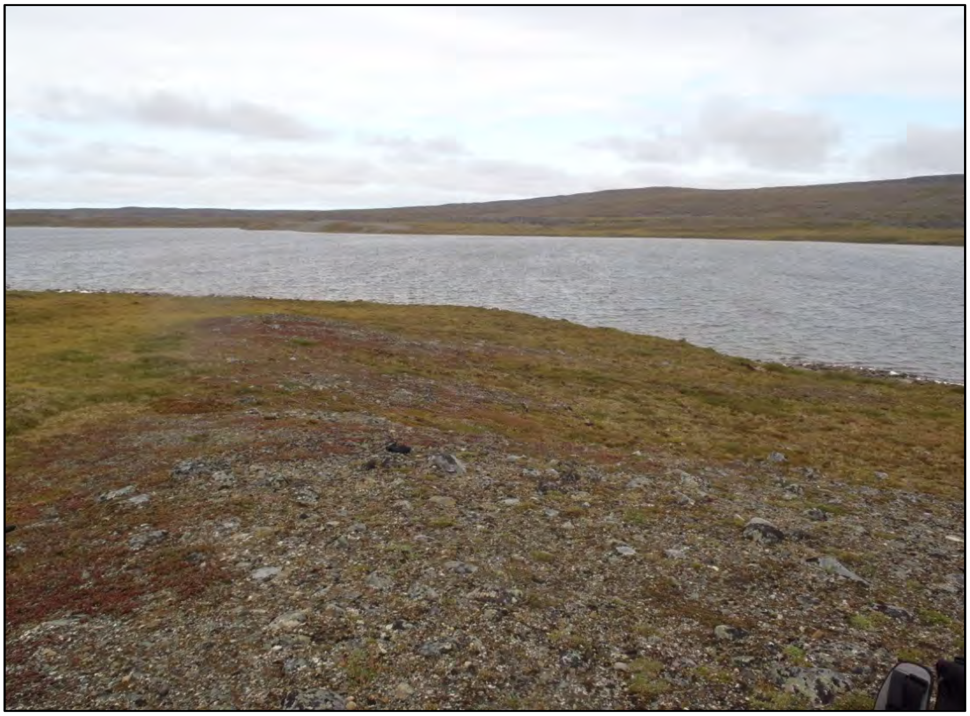

Plate 5.5-1. Typical terrain along Upper Long Lake, view north from western shore, summer 2012.

5.5.1 McNj-18

Archaeological site McNj-18 is a campsite of undetermined antiquity located on the beach along the eastern shore of Bathurst Inlet. The site measures 24 m north-south by 88 m east-west and includes three stone circles and a rectangular stone alignment, likely from a canvas tent. Historic metal debris, including the remains of a stove and table legs, were observed at the site. There is the potential for additional artifacts beneath the vegetation and the site is assessed to have moderate archaeological significance (Rescan 2011).

5.6 PROPOSED WINTER ROAD FROM GEORGE TO GOOSE PROPERTIES

The proposed winter road from the Goose Property to the George Property primarily travels over frozen lakes and streams; however, there are numerous areas of archaeological potential, particularly on geological features including eskers, bedrock exposures and ridges, and around the shorelines of the numerous unnamed lakes that dot the landscape (Plate 5.6-1). No archaeological sites were recorded within 50 m of the proposed winter road between the George and Goose properties.

Plate 5.6-1. A deflated esker feature near the proposed winter road between the Goose and George properties.

5.7 TIBBITT TO CONTWOYTO WINTER ROAD WINTER ROAD CONNECTOR

The TCWR Winter Road Connector Assessment Area is 213 km long running southwest and west from the Goose property connecting to the TWCR at Pellatt Lake. The potential road alignment travels along and over numerous small lakes as well as larger lakes and rivers including Back River, Beechey Lake, Thistle Lake, Migration Lake, Ghurka Lake, and Pellat Lake and across varied terrain including large bedrock outcrops, boulder fields, low-lying wetlands, knolls, and eskers (Plate 5.7-1). Vegetation in the area is generally sparse with low-lying willow, moss, lichen and grasses. There are three known archaeological sites located within 50 m of the TCWR Winter Road Connector: LfNo-3, LfNo-5, and LhNk-4.

5.7.1 LfNo-3

Archaeological site LfNo-3 is a lithic workshop with located on surface exposures to the south of a creek that connects two lakes located to the east and west. The site measures 60 m by 50 m and includes lithic scatters located on the two knolls and a low density scatter between them. Vegetation at the site consists of mosses, lichens, and ground-covering bushes. The site contains a total of approximately 100 grey quartzite flakes. The site appears to be in good condition and all artifacts were left *in situ*. There is the potential for additional artifacts beneath the vegetation. The site is assessed to have low-moderate archaeological significance (Rescan 2013c).

5.7.2 LfNo-5

Archaeological site LfNo-5 is a lithic workshop with located in a surface exposure on a knoll to the south of a creek that connects two lakes located to the east and west. The site measures 15 m by 35 m and includes over 200 white and grey quartzite flakes. Vegetation at the site consists of mosses, lichens, and ground-covering bushes. The site appears to be in good condition and all artifacts were left *in situ*. There is the potential for additional artifacts beneath the vegetation. The site is assessed to have moderate archaeological significance (Rescan 2013c).

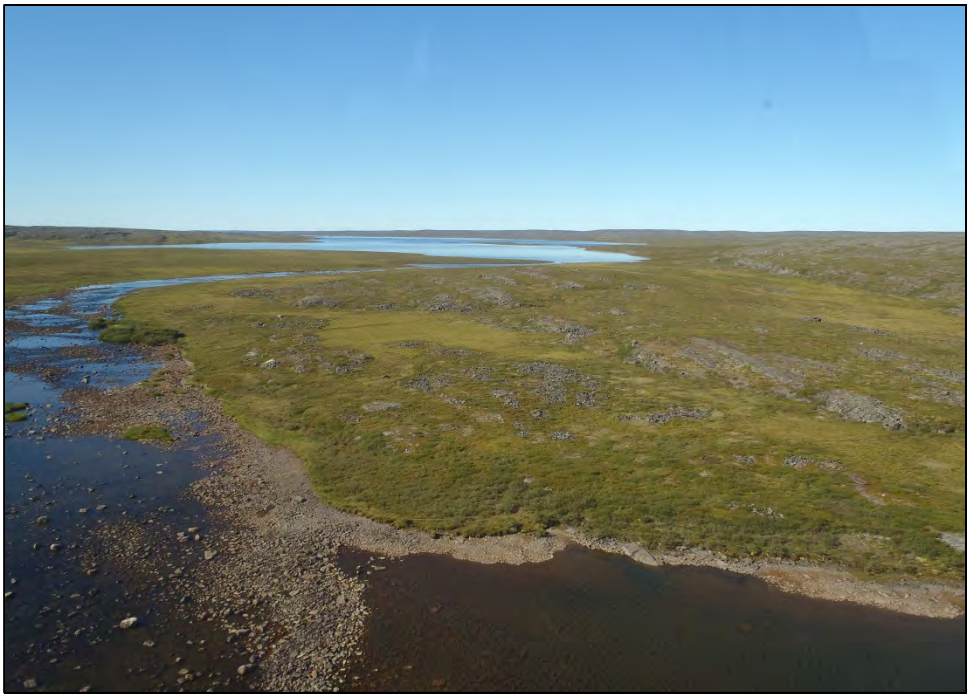

Plate 5.7-1. View north over terrain to the north of Beechey Lake.

5.7.3 LhNk-4

Archaeological site LhNk-4 is a lithic reduction site located on a rocky terrace overlooking Back River to the east. The site measures 10 m diameter and consists of a lithic scatter with 10 flakes and three pieces of micro-debitage of white quartzite. The site appears to be in good condition and all artifacts were left *in situ*. Vegetation at the site consists of mosses, lichens, and ground-covering bushes and there is the potential for additional artifacts beneath the vegetation. The site is assessed to have low archaeological significance (Rescan 2013c).

6. Discussion/Conclusion

6. Discussion/Conclusion

The archaeological assessments conducted for the Back River Project have significantly added to the growing archaeological knowledge for the region. The archaeological survey conducted for the Project was necessarily focused on Project development and was not a regional study; however, initial analysis of the data does suggest that site types and distributions generally conform to the accepted norms for the region.

Cultural affiliations have not been identified at most archaeological sites; however, artifacts indicative of all the expected cultural traditions are present in the Project area. The findings of the cumulative archaeological assessments during the 2010, 2011, 2012, and 2013 field seasons as well as those sites that were recorded during other studies, suggest that the area has had continuous use throughout the prehistoric and historic periods, with archaeological assemblages dating back to 3,500 BP. Of the 380 archaeological sites with the Permit area, 27 sites (7.1 %) have artifacts that are diagnostic of particular prehistoric cultures. Twenty-four sites are Paleo-Eskimo with 21 having artifacts suggestive of the Arctic Small Tool tradition and three with artifacts suggestive of the Dorset culture. Of the 24 Paleo-Eskimo sites within the Permit area, 19 are located in the Bathurst Inlet and Bathurst Lake area with the remaining 5 sites (LfNo-4, LjNg-3, LjNj-3, LjNj-6, and LlNo-2) located further inland and likely associated with caribou hunting. Only three sites within the Permit area have been identified as Taltheilei: MdNk-8 and MdNk-23 are located near Bathurst Inlet and LlNk-8 is over 45 km inland. While no sites were identified as Thule based on the lithic evidence, as Neo-Eskimo period sites with historic period components are distributed fairly evenly throughout the survey areas, it is likely that many of the sites to which no cultural affiliation has been assigned have a Thule component.

The areas around Bathurst Inlet and Bathurst Lake have the greatest density of sites and the greatest density of campsites suggesting a fairly consistent use of the area throughout the prehistoric and historic periods. This is consistent with the current scholarship, which suggests that the Paleo- and Neo Eskimo cultures were primarily focused on the harvesting of marine mammal resources (Section 2.6). The inland campsites on the Barren Lands appear, as expected, to be primarily associated with the harvesting of caribou. The Taltheilei site on the Barren Lands also conforms to expectations as they followed the caribou migration. The Taltheilei site on Bathurst Inlet would however appear to be beyond the established normal range of the Taltheilei culture.

Of the 380 archaeological sites within the Permit area, 135 were classified as campsites with evidence of habitation features including stone circles, stone ovals, and stone rectangles large enough to be attributed to holding down hide or canvas tents, 43 had features associated with resource gathering that including hunting, fishing, and storage of subsistence resources including hunting blinds, caches, caribou drive lanes, 32 were markers (inuksuit or cairns), 1 was identified as a lithic quarry, 155 were lithic sites contained lithic artifacts but no features, 7 had historic artifacts but no features, 3 had tools of faunal made from faunal material, and 4 are possible grave sites.

References

References

Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

1985. *Canada Oil and Gas Operations Act,* RSC. C. O-7.

1985. *Territorial Lands Act*, RSC. C. T-7.

1993. *Nunavut Act,* SC. C. 28

1993. *Nunavut Land Claims Agreement Act,* SC. c29.

Canada Oil and Gas Geophysical Operations Regulations, SOR/96-117.

Nunavut Archaeological and Paleontological Sites Regulations, SOR/2001-220.

Territorial Land Use Regulations, CRC, C.1524.

Arctic Institute of North America. 2012. *The Bathurst Inlet Patrol and the RCMP in the Arctic*. Arctic Institute of North America, University of Calgary. http://www.ucalgary.ca/arcticexpedition/rcmp (accessed January 2012).

Back, G. 1836. *Narrative of the Arctic Land Expedition to the Mouth of the Great Fish River, and along the Shores of the Arctic Ocean, in the Years 1833, 1834 and 1835*. Paris, France: A and W. Calignani. (Reprint edition, Adamant Media Corporation).

Bertulli, M. 1991. *Archaeological inspections at George Lake, District of Mackenzie, Northwest Territories, 3-4 July 1991*. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Blower, D. 2003. *Heritage Resources Studies Mitigation and Assessment 2002 — Bathurst Inlet Port and Road Project, Nunavut Permit 02-035A*. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Bielawski, E. 1988. Paleoeskimo Variability: The Early Arctic Small-Tool Tradition in the Central Canadian Arctic. *American Antiquity* 53 (1): 52-74.

Birket-Smith, K. 1959. *The Eskimos*. London, UK: Methuen and Co.

Boas, F. 1964. *The Central Eskimo*. NE: Lincoln University of Nebraska Press.

Brink, J. 1992. Anvil Boulders and Lithic Reduction on Southern Victoria Island, Northwest Territories. *Arctic*, 45 (2): 138-144.

Campbell, F. H. A. 1975. *Archaeological Report, Bathurst Inlet Area*. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Campbell, F. H. A. 1977. *Observations in the Bathurst Inlet Area, 1977*. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Coltrain J. B., M. G. Hayes, and D. H. O'Rourke. 2004. Sealing, Whaling and Caribou: the Skeletal Isotope Chemistry of Eastern Arctic Foragers. *Journal of Archaeological Science*, 31: 39–57.

Damas, D. 1972. The Copper Eskimo. In *Hunters and Gatherers Today*. Ed. M. G. Bicchiere. 3-50 New York, NY: Holt, Rinehart and Winston.

Damas, D. 1984. Introduction. In: *Handbook of North American Indians: Arctic*. Vol. 5. 1-8. Washington, DC: Smithsonian Institution.

Douglas, M. S. V., J. P. Smol, J. M. Savelle, and J. M. Blais. 2004. Prehistoric Inuit Whalers Affected Arctic Freshwater Ecosystems. In: *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, 101(6): 1613-1617.

Dyke, A. S. and J. M. Savelle. 2009. Paleoeskimo Demography and Sea-level History, Kent Peninsula and King William Island, Central Northwest Passage, Arctic Canada. *Arctic*, 62(4): 371-392.

Fedirchuk, G. J. 1997. *Heritage Resources Impact Assessment: Kit Resources NWT Ltd., Goose Lake Project*. Permit 97-844. Report prepared for Norecol, Dames & Moore by Fedirchuk McCullough & Associates Ltd.

Fedirchuk, G. 2001. *Heritage Resources Studies, Bathurst Inlet Port and Road Project, Nunavut Permit 01-019A*. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Franklin, J. 1823. *Narrative of a Journey to the Shores of the Polar Sea, in the Years 1819, 20, 21 and 22*. London: J. Murray.

Friesen, T. M. 2004. A Tale of Two Settlement Patterns: Environmental and Cultural Determinants of Inuit and Dene Site Distributions. In *Hunter-Gatherers in Theory and Archaeology*. Occasional Paper No. 31. Carbondale: Center for Archaeological Investigations.

Friesen, T. M. 2007. Hearth rows, hierarchies and Arctic hunter-gatherers: the construction of equality in the Late Dorset period. *World Archaeology*, 39 (2): 194-214

Gordon, B. C. 1996. *People of Sunlight, People of Starlight: Barrenland Archaeology in the Northwest Territories of Canada*. Archaeological Survey of Canada Mercury Series Paper 154. Canadian Museum of Civilization: Gatineau, QC.

Hadley, K. R. 2007. *Assessing Thule Inuit Impacts on High Arctic Lakes and Ponds: A Paleolimnological Approach*. M.Sc. thesis, Queen's University.

Hearne, S. 1911. *A Journey from Prince of Wales Fort in Hudson's Bay to the Northern Ocean*. Toronto, ON: The Champlain Society.

Houston, C. S., Ed. 1994. *Arctic Artist: The Journal and Paintings of George Back, Midshipman with Franklin, 1819-1822*. Montreal, QC; Buffalo, NY: McGill-Queen's University Press.

Howse, L. 2008. Late Dorset caribou hunters: Zooarchaeology of the Bell Site, Victoria Island. *Arctic Anthropology*, 45(1): 22-40.

Hulgaard, W. J. and J. W.White. 2002. *Honoured in Places: Remembered Mounties across Canada*. Victoria, BC: Heritage House.

Jenness, D. 1921. The Cultural Transformation of the Copper Eskimos. *Geographical Review*, 11(4): 541-550.

Jenness, D. 1922. *The Life of the Copper Eskimos*. Report of the Canadian Arctic Expedition 1913-1918. Vol. 12(A). Ottawa, ON: King's Printer.

Jenness, D. 1923a. The Copper Eskimos: Physical Characteristics of the Copper Eskimos. *Report of the Canadian Arctic Expedition 1913-18*. Vol. 12(B). Ottawa, ON: King's Printer.

Jenness, D. 1923b. Origin of the Copper Eskimos and Their Copper Culture. *Geographical Review* 13(4): 540-551.

Jenness, D. 1923c. *The Copper Eskimos: Osteology of the Western and Copper Eskimos*. Report of the Canadian Arctic Expedition 1913-1918. Vol. 13(B). Ottawa, ON: King's Printer.

Jenness, D. 1924a. *Eskimo String Figures*. Report of the Canadian Arctic Expedition 1913-18. Vol. 13(B). Ottawa, ON: King's Printer.

Jenness, D. 1924b. *Myths and Traditions from Northern Alaska, the Mackenzie Delta, and Coronation Gulf*. Report of the Canadian Arctic Expeditions 1913-18. Vol. 13(A). Ottawa, ON: King's Printer.

Jenness, D. 1928. *The People of the Twilight*. New York, NY: The Macmillan Co.

Jenness, D. 1944. *Grammatical Notes on Some Western Eskimo Dialects*. Report of the Canadian Arctic Expedition 1913-1918. Vol. 15(B). Ottawa, ON: King's Printer.

Jenness, D. 1946. *Material Culture of the Copper Eskimos*. Report of the Canadian Arctic Expedition 1913-18. Vol. 16. Ottawa, ON: King's Printer.

Kerr, D. E. 1996. Late Quaternary Sea Level History in the Paulatuk to Bathurst Inlet area, Northwest Territories. *Canadian Journal of Earth Science*, 33: 389-403.

Keith, D. and A. M. Stewart. 2005. *Kiluhiqturmiut Nunaa: Inuinnaqtun Immersion, Oral History and Archaeology Project, Tahikaffaaluk Site (McNk-3), Bathurst Lake Nunavut*. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

KHS. 2012. *Kitikmeot Place Name Atlas.* http://www.kitikmeotheritage. ca/atlas.htm (accessed January 2012).

KIA. 2012. Inuit Traditional Knowledge of Sabina Gold and Silver Corporation's Back River (Hannigayok) Project. *Naonaiyaotit Traditional Knowledge Project* (NTKP), Kitimeot Inuit Association, Kugluktuk NU. December 7, 2012.

Low, A. P. 1906. *The cruise of the Neptune 1903-1904; Report on the Dominion Government Expedition to Hudson Bay and the Arctic Islands on board the D.G.S. Neptune*. Ottawa, ON: Government Printing Bureau.

Lynnerup, N., J. Meldgaard, J. Jakobsen, M. Appelt, A. Koch, and B Frøhlich. 2003. Human Dorset Remains from Igloolok, Canada. *Arctic*, V56(4): 349-358.

Mathiassen, T. 1927. *Archaeology of the Central Eskimos*. Report of the Fifth Thule Expedition 1921-24. Vol. 4. Copenhagen: Glydendalske Boghandell, Nordisk Forlag.

Maxwell, M. 1984. Pre-Dorset and Dorset Prehistory of Canada. In H*andbook of North American Indians: Arctic*. Vol. 5. 359-368. Washington, DC: Smithsonian Institute.

McGhee, R. 1984. *The Timing of the Thule Migration*. Polarjorschung 54(1): 1-7.

McGhee, R. 1996. *Ancient People of the Arctic*. Vancouver, BC: UBC Press.

Milne, S., R. Park, and D. Stenton. 2012. Dorset Culture Land Use Strategies and the Case of Inland Southern Baffin Island. *Canadian Journal of Archaeology*, 36: 267-288.

Minni, S. 1975. *The Prehistoric Occupations of Black Lake, Northern Saskatchewan*. Master of Arts thesis, University of Saskatchewan.

Morrison, D. 1978. *Archaeological Survey of Southern Bathurst Inlet, N.W.T.* Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Morrison, D. 1979. *The Archaeology of Bathurst Inlet, N.W.T.: Literature Search*. Report prepared for the National Museum of Canada, National Museum of Man, Archaeological Survey of Canada. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Neatby, L. H. 1984. Exploration and History of the Canadian Arctic. In H*andbook of North American Indians: Arctic*. Vol. 5. 377-390. Washington, DC: Smithsonian Institution.

Noble, W. C. 1971. Archaeological Surveys and Sequences in the Central District of Mackenzie, N.W.T. *Arctic Anthropology*, 3: 102-135.

Park, R. W. 1993. The Dorset-Thule Succession in Arctic North America: Assessing Claims for Culture Contact. *American Antiquity*, 58(2): 203-234.

Park, R. W. and D. R. Stenton. 1998. *Ancient Harpoon Heads of Nunavut: An Illustrated Guide*. Ottawa, ON: Parks Canada.

Parks Canada. 2009. *Terrestrial Ecozones of Canada: Southern Arctic Ecozone*. http://www.pc.gc.ca/apprendre-learn/prof/itm2-crp-trc/htm/ecozone_e.asp#no3 (accessed March 2011).

Pryde, D. 1971. *Nunaga: Ten Years Among the Eskimo*. London, UK: Eland Books.

Ramsden, P. and M. Murray. 1995. Identifying Seasonality in Pre-Dorset Structures in Back Bay, Prince of Wales Island, NWT. *Arctic Anthropology*, 32(2):106-117.

Rasmussen, K. 1932. *Intellectual Culture of the Copper Eskimos*. Report of the Fifth Thule Expedition 1921-24. Copenhagen: Gyldendalske Boghandel, Nordisk Forlag.

Rescan. 2007. *Inuit Heritage and Cultural Use of the Bathurst Inlet Port and Road Project*. Report prepared for BIPR Joint Venture Ltd. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2008. *2007 Archaeology Baseline Report, Hackett River Project – Nunavut Territory Archaeologist Permit No. 2007-022A*. Report prepared for Sabina Silver Corporation by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2011. *Hackett River Project: Final Report for Nunavut Territory Archaeologist Permit 10-024A*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2012. *Back River Project: Final Report for Nunavut Territory Archaeologists Permit 11-022A*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2013a. *Hackett River Project: Final Report for Nunavut Territory Archaeologist Permit 2012-22A*. Prepared for Xstrata Zinc Canada by Rescan Environmental Services Ltd.: Vancouver, BC.

Rescan. 2013b. *Back River Project: Final Report for Class 2 Nunavut Territory Archaeologists Permit 2012-12A*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.

Rescan. 2013c. *Back River Project: Final Report for Class 2 Nunavut Territory Archaeologists Permit 2013-20A*. In preparation for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd. (in progress).

Riddle, A. T. R. 2010. *Camping at the Caribou Crossing: Relating Palaeo-Eskimo Lithic Technological Change and Human Mobility Patterns in Southeastern Victoria Island, Nunavut*. Ph.D. thesis, University of Toronto.

Roberts, H. H. and D. Jenness. 1925. *Eskimo Songs: Songs of the Copper Eskimos*. Report of the Canadian Arctic Expedition 1913-18. Volume 14. Ottawa, ON: King's Printer.

Rogers, E. and J. Smith. 1984. Environment and Culture of the Shield and MacKenzie Borderlands. In *Handbook of North American Indians: Arctic*. Vol. 6. 130-145. Washington, D.C.: Smithsonian Institute.

Savard, R. 1966. *Les Eskimo de Bathurst Inlet (Territoires du Nord-Ouest)*. Preliminary report dated January 1966. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Stager, J. and R. McSkimming. 1984. Physical Environment. In *Handbook of North American Indians: Arctic*. Vol. 6. 27-35. Washington, DC: Smithsonian Institute.

Steele, P. 2003. *The Man Who Mapped the Arctic: The Intrepid Life of George Back, Franklin's Lieutenant*. Vancouver, BC: Raincoast Books.

Stefansson, V. 1914. Prehistoric and present commerce among the Arctic Coast Eskimo. *Canada Department of Mines Geological Survey Museum Bulletin*. Ottawa, ON: Government Printing Bureau.

Stefansson, V. 1919. *Stefansson-Anderson Arctic Expedition 1909-1912*. Anthropological Papers of the American Museum of Natural History. Vol. 14. New York: American Museum of Natural History.

Stefansson, V. 1921. *The Friendly Arctic: The Story of Five Years in Polar Regions*. New York: The MacMillan Company.

Stenton, D. R. and R. W. Park. 1998. *Ancient Stone Tools of Nunavut*. Ottawa, ON: Parks Canada.

Stewart, A., T. M. Friesen, D. Keith, and L. Henderson. 2000. Archaeology and Oral History of Inuit Land Use on the Kazan River, Nunavut: A Feature-based Approach. *Arctic,* 56(3): 260-278.

Taylor, W. E. 1967. Summary of archaeological field work on Banks and Victoria Islands, Arctic Canada, 1965. *Arctic Anthropology*, 4(1): 221-243.

Thorpe, N., N. Hakongak, S. Eyegetok, and the Kitikmeot Elders. 2002. *Thunder on the Tundra, Inuit Qaujimajatuqangit of the Bathurst Caribou*. Vancouver, BC: Generation Printing.

Tischer, J. C. 2010. *Archaeological Impact Assessment 2010: Bathurst Inlet Port and Road Project Nunavut Permit 10-023A*. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Usher, P. J. 1971. *Fur Trade Posts of the Northwest Territories, 1870-1970*. Ottawa: Northern Science Research Group, Department of Indian Affairs and Northern Development.

Wilkinson, D. 1970. *The Illustrated Natural History of Canada: The Arctic Coast*. Toronto: Natural Sciences of Canada Ltd.

Woodbury, A. 1984. Eskimo and Aleut Languages. In *Handbook of North American Indians: Arctic*. Vol.5. 49-63. Washington, D.C.: Smithsonian Institute.

Works Consulted

Department of Culture, Language, Elders and Youth. 2003. *Guidelines for Applicants and Holders of Nunavut Territory Archaeology and Palaeontology Permits*. Government of Nunavut: Iqaluit, NU.

Friesen, T. M. and A. Stewart. 1994. Protohistoric Settlement Patterns in the Interior District of Keewatin: Implications for Caribou Inuit Social Organization. In *Threads of Arctic Prehistory: Papers in Honour of William E. Taylor, Jr*. Archaeological Survey of Canada Mercury Series Paper 149. Eds. D. Morrison and J. Pilon. 341-360. Gatineau, QC: Canadian Museum of Civilization.

Jenness, S. 1995. *Arctic Odyssey: The Diary of Diamond Jenness, 1913-1916*. Gatineau, QC: Canadian Museum of Civilization.

Prager, G. 2001. *Archaeological Investigations Hope Bay Joint Venture Project, Nunavut, 2000 (NWT Archaeologist's Permit 00-013)*. Report on file with the Canadian Museum of Civilization: Gatineau, QC.

Taylor, W. E. 1964. Interim account of an archaeological survey in the Central Arctic, 1963. *Anthropological Papers of the University of Alaska* 12:46-55.

Taylor, W. E. 1972. *An Archaeological Survey Cape Parry and Cambridge Bay, N.W.T., Canada in 1963*. Ottawa, ON: Archaeological Survey of Canada, National Museum of Man, National Museums of Canada.

Appendix A
Place Names in the Back River Project Area

Appendix A. Place Names in the Back River Project Area

English Name	Kitikmeot Name	Meaning	Source
Arctic Sound	Katimannik	"Because of the two rivers that meet together"	Golder 2003
Back River	*Hanningayok*	"Across". The Aboriginal name (likely Dene) used by George Back was Thew-ee-choh (Great Fish River). When Back surveyed this river in 1834 he thought it may be the same river that he and Franklin had discovered in 1821 emptying into Bathurst Inlet. However, Back found that it did not empty into Bathurst Inlet, but rather further east into Chantrey Inlet.	KHS 2012; Steele 2003
Bathurst Inlet (southern region)	*Kiligiktokmik*	Unknown. Regional group from this area is called Kiligiktokmuit. John Franklin named the inlet in 1821 after the Earl Bathurst.	KHS 2012; Thorpe et al. 2001
Bathurst Inlet (settlement)	*Kingaok*	Unknown.	Thorpe et al. 2001
Bathurst Lake	*Tahikafalok*	"Huge lake"	KHS 2012
Beechey Lake	*Hanningayuk*	"River lake"	KHS 2012
Cambridge Bay (village)	*Ikaluktuuttiak*	“A good place with lots of fish”	Nunavut Tourism 2012; Thorpe et al. 2001
Contwoyto Lake	*Tahikyoak*	"Very long large lake"	Rescan 2007
Coppermine (village)	*Kugluktuk*	"Place of moving water". Rapids are located nearby at Kugluk/Bloody Falls.	Nunavut Tourism 2012; Thorpe et al. 2001
Mara River	*Hanimok*	"Big bend in river that changes direction"	Rescan 2007
Nose Lake	*Kingalhoak*	"Nose lake"	Rescan 2007
Pellat Lake	*Nonatoklik*		Rescan 2012
Unnamed peninsula; site of proposed BIPR port	*Tikighik*	"Point"	KHS 2012
Western River	*Kilokgiktok*	"Kiluhiqtuq's river" (KHS 2012). Stewart and MacDonald report that its name means "poor fish river" (1978). When they discovered its outlet into Bathurst Inlet in 1821, John Franklin initally named this river Back River, after a member of his crew George Back. Its name was later changed to Western River, and Back River was the name given to another river that George Back surveyed in 1834.	KHS 2012; Stewart and MacDonald 1978

Appendix B
Archaeological Sites within the Study Area

Appendix B. Archaeological Sites with the Study Area

Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LfNn-1	Prehistoric	Campsite	Stone Oval, Lithic Scatter	The site is located on a small island on the east side of a lake.	The site consists of a 2 m diameter stone oval with 25 stones and a lithic scatter of 10 clear quartz flakes.	Moderate	NUNAVUT 2013-20A
LfNo-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a small knoll on the south side of a stream between to lakes to the east and west.	The site consists of a lithic scatter with approximately 200 white and grey quartzite flakes and 20 black basalt flakes.	Low-Moderate	NUNAVUT 2013-20A
LfNo-2	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a knoll on the south side of a stream between to lakes to the east and west.	The site consists of two lithic scatters one containing over 200 white and grey quartzite flakes and the other with a white quartzite scraper and 9 white quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-3	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on two small knolls and the area between to the south a a creek that runs between lakes to the east and west.	The site consists of two lithic scatters with a low density of flakes between them. One scatter contains 30 grey quartzite flakes and the othe contains between 30 and 40 grey quartzite flakes.	Low-Moderate	NUNAVUT 2013-20A
LfNo-4	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the south side of a stream between to lakes to the east and west.	The site contains three lithic scatters containing a white chert burin indicative of the Arctic Small Tool tradition, a grey quartzite scraper, and over 100 grey chert, and white and grey quartzite flakes.	Moderate-High	NUNAVUT 2013-20A
LfNo-5	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on top of a large knoll on the south side of a stream between to lakes to the east and west.	The site consists of over 200 white and grey quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-6	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an east-west trending esker overlooking a small pond to the northeast and a lake to the south.	The site consists of a quartzite biface fragment, and over 250 grey and white quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-7	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an east-west trending esker overlooking a small pond to the north and a lake to the south.	The site consists of a quartzite point, a quartz blade, and over 50 white and grey quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-8	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on top of a knoll surrounded by a boulder field.	The site consists of a lithic scatter of 10 white quartzite flakes.	Low	NUNAVUT 2013-20A
LfNo-9	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on top of a knoll surrounded by a boulder field.	The site consists of a lithic scatter of 20 white and grey quartzite flakes	Low	NUNAVUT 2013-20A
LfNo-10	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on top of a knoll surrounded by a boulder field.	The site consists of a lithic scatter of one grey chert flake, one grey chert nodule, and over 100 grey quartzite flakes.	Low-Moderate	NUNAVUT 2013-20A
LfNo-11	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on top of a knoll surrounded by a boulder field.	The site consists of a lithic scatter containing 15 grey quartzite flakes.	Low	NUNAVUT 2013-20A
LfNo-12	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a knoll to the overlooking a creek the south that runs between lakes to the east and west.	The site consists of a very dense lithic scatter containing thousands of white quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNo-13	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the west shore of a lake.	The site consists of two lithic scatters one with three white quartzite bifaces, bipolar cores and hundreds of white quartzite and brown siltstone and chert flakes and the other lithic scatter with over 200 white and grey quartzite flakes.	Moderate-High	NUNAVUT 2013-20A
LfNo-14	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll overlooking and lake to the south and and outlet to the east.	The site consists of a lithic scatter of over 40 grey quartzite flakes.	Low-Moderate	NUNAVUT 2013-20A
LfNo-15	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on top of a knoll overlooking a creek to the south that connects lakes to the east and west.	The site contains two lithic scatters with one containing over 50 grey quartzite flakes and the other 20-30 grey quartzite flakes.	Low-Moderate	NUNAVUT 2013-20A
LfNo-16	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on top of a knoll overlooking a creek to the south that connects lakes to the east and west.	The site contains a quartzite bifacial scraper and over 100 grey quartzite flakes.	Moderate	NUNAVUT 2013-20A
LfNp-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located in a sand exposure overlooking a lake to the south.	The site consists of a clear quartzite point fragment and 2 white quartzite flakes.	Low-Moderate	NUNAVUT 2013-20A
LfNp-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker with low-lying land the east and west.	The site consists of two white-clear quartz flakes.	Low	NUNAVUT 2013-20A
LfNp-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker with low-lying land to the east and west.	The site consists of 10-15 white quartzite flakes.	Low	NUNAVUT 2013-20A
LfNp-4	Prehistoric	Lithic Workshop	Stone Circle, Lithic Scatter	The site is located at the end of an esker that extends out into a lake to the north.	The site consists of a stone circle of 22 stones and 2 lithic scatters containing over 50 grey quartzite flakes.	Moderate	NUNAVUT 2013-20A

Appendix B. Archaeological Sites with the Study Area

Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LfNp-5	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a sandy beach on the south shore of a lake.	The site consists of a lithic scatter that includes two white quartz biface fragments and 5 white quartz flakes.	Low-Moderate	NUNAVUT 2013-20A
LfNq-3	Undetermined	Marker	Cairn	The site is located on an island in Pellet Lake.	The site consists of a cairn constructed of 10 stones with an additional four stones on the ground nearby.	Low	NUNAVUT 2013-20A
LgNm-1	Prehistoric	Marker	Inuksuk	The site is located on a bedrock outcrop on top of a prominent landform.	The site consists of an inuksuk/cairn constructed of 6 stones set atop a large boulder.	Low	NUNAVUT 2013-20A
LgNm-2	Prehistoric	Marker	Inuksuk	The site is located in a bedrock exposure on a high knoll.	The site consists of a collapsed inuksuk/cairn of 9 stones.	Low	NUNAVUT 2013-20A
LgNm-3	Prehistoric	Marker	Inuksuk	The site is located on the edge of bluff overlooking a small lake to the north.	The site consists of two cairns/inuksuit of stones set on top of boulders.	Low	NUNAVUT 2013-20A
LgNm-4	Prehistoric	Resource Gathering	Cairn, Cache	The site is located to the west of a lake.	The site consists of two cairns one next to a stone lined pit 0.50 x 0.40 m and 0.10 m deep.	Low-Moderate	NUNAVUT 2013-20A
LgNm-5	Historic / Undetermined	Campsite	Stone Rectangle, Stone Circle, Hearth, Historic Scatter, Faunal Material	The site is located on low benches overlooking a pond.	The site consists of a stone rectangle, a stone circle with a hearth in the centre surrounded by tin cans, oil drums, caribou antlers, and metal debris.	Moderate	NUNAVUT 2013-20A
LgNm-6	Undetermined	Marker	Inuksuk	The site is located on a bedrock exposure overlooking a pond to the north.	The site consists of an inuksuk/cairn constructed from 6 stones	Low	NUNAVUT 2013-20A
LhNk-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located towards the eastern end of a prominent ridge in a large sand exposure.	The site consists of a lithic scatter of over 50 white quartzite flakes.	Low-Moderate	NUNAVUT 2013-20A
LhNk-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a deflated esker along the west bank of Back River.	The site consists of 6 flakes of clear quartz and over 20 of white quartzite.	Low	NUNAVUT 2013-20A
LhNk-3	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a terrace overlooking Back River to the east.	The site consists of a lithic scatter including several bifaces and unifacial scrapers as well as over 200 flakes of white and grey quartzite.	Moderate-High	NUNAVUT 2013-20A
LhNk-4	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a rocky terrace overlooking Back River to the east.	The site consists of a low density lithic scatter containing 10 white quartzite flake and 3 pieces of microdebitage.	Low	NUNAVUT 2013-20A
LhNk-5	Undetermined	Marker	Inuksuk, Cairn	The site is located on a rocky terrace overlooking Back River to the east.	The site consists of an inuksuk/cairn constructed from 4 stones.	Low	NUNAVUT 2013-20A
LhNk-6	Prehistoric / Historic	Campsite	Lithic Scatter, Stone Rectangle, Historic Material	The site is located in a sand exposure on a rocky terrace overlooking Back River to the east.	The site consists of a bifacially flaked core and a small lithic scatter of over 50 white quartzite flakes, four stone rectangle and historic debris including green glass bottle fragment, metal tin can, wooden stakes for mining and a tent peg.	Moderate-High	NUNAVUT 2013-20A
LhNk-7	Historic / Undetermined	Campsite	Stone Circle, Cache, Historic Scatter	The site is located on a low terrace near base of slope from next terrace above Back River and overlooking Back River to the east.	The site consists of a stone circle, 5 small pits filled with tin cans and garbage, a coleman stove and a fuel drum (shot with shotgun).	Moderate	NUNAVUT 2013-20A
LiNh-1	Historic	Campsite	Stone Circle, Historic Scatter, Survey Marker	The site is located on an esker in the middle of a lake, on the eastern shores of Gander Lake.	The site consists of 2 stone circles, historic debris (tin cans, rifle shell, metal strapping and stove parts around stone circles, circa 1960s - 1970s and stash of wooden stakes (mining stake claim style).	Moderate	NUNAVUT 2012-12A
LiNj-1	Historic	Campsite	Stone Oval, Hearth, Other	The site is located on the east side of the second lake south of the west end of Beechey Lake on the Back River. Pike mentions conspicuous flat rocks close to the river and a prominent island in the lake is mentioned on his and Back's map..	This site was found by Warburton Pike in 1890 and consists of seven oval shaped structures surrounded by turf heaps 6 inches high, several blackened fireplaces, stones propped on end that had been used probably for drying meat. A flat stone kettle was picked up with grease still sticking to it and a small piece of copper let into the back. Several pieces of undressed sealskin with the hair on it were reported. A Yellowknife Indian accompanying Pike felt that the inhabitants had come in the autumn, stayed through the winter and left late in the spring, about six weeks before Pike's arrival. He also felt that this was a regular camping spot.	High	
LiNj-2	Prehistoric	Campsite	Stone Circle	The site is located on a terrace overlooking Back River to the south and southwest with an inlet stream to the east.	The site consists of two stone circles. The larger of the two has an extension similar to those found in some Dorset and Thule habitation features.	Moderate	NUNAVUT 2013-20A
LiNj-3	Prehistoric / Historic	Burial	Burial, Hunting Blind, Cache, Lithic Scatter, Faunal Material, Inuksuk, Historic Scatter	The site is located to the north of Back River.	The site consists of stone structures that are possible chamber burials, hunting blinds, caches, inuksuit/cairns lithic material, bone, and historic debris.	High	NUNAVUT 2013-20A

Appendix B. Archaeological Sites with the Study Area

Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LiNj-4	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a terrace overlooking Back River to the west.	The site consists of a biface fragment and white quartzite flakes.	Low-Moderate	NUNAVUT 2013-20A
LiNk-1	Prehistoric	Resource Gathering	Cache	The site is located on a terrace within a boulder field overlooking Back River to the east.	The site consists of two cache pits.	Low-Moderate	NUNAVUT 2013-20A
LiNo-1	Undetermined	Campsite		This site is located on a small island in Nose Lake.	The site was recorded by Fitzpatrick in 1996.		
LiNo-2	Undetermined	Campsite		This site is located on a small island in Nose Lake.	The site was recorded by Fitzpatrick in 1996.		
LiNp-1	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an exposure near Nose Lake.	The site consists of 2 quartz flakes (collected).	Low	NUNAVUT 2001-019A
LiNp-2	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on an exposure on a high bank overlooking an unnamed lake.	The site consists of a quartz flake (collected).	Low	NUNAVUT 2001-019A
LiNp-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker feature near Nose Lake.	The site consists of a quartz core, 5 pieces of quartz shatter, and 5 quartz flakes and flake fragments (collected).	Low-Moderate	NUNAVUT 2001-019A
LiNp-4	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an esker feature near Nose Lake.	The site consists of over 100 quartz lithic artifacts including a uniface, shatter, and flakes (47 collected).	Low-Moderate	NUNAVUT 2001-019A
LiNp-5	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a knoll near Nose Lake.	The site consists of a quartz flake (collected).	Low	NUNAVUT 2001-019A
LiNp-6	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on an esker feature near Nose Lake.	The site consists of a quartz flake (collected).	Low	NUNAVUT 2001-019A
LiNp-7	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an esker feature near Nose Lake.	The site consists of 37 quartz artifacts including a scraper, a core fragment, and a possible burin (collected).	Low-Moderate	NUNAVUT 2001-019A
LiNp-8	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker feature near Nose Lake.	The site consists of a split quartz nodule and two pieces of shatter (collected).	Low	NUNAVUT 2001-019A
LiNp-9	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker feature near Nose Lake.	The site consists of 24 quartz artifacts including a biface blank, a core, 6 pieces of shatter, and 14 flakes and flake fragments (collected).	Low-Moderate	NUNAVUT 2001-019A
LiNq-6	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an esker near Skewer Lake.	The site consists of a large artifact scatter from which 79 artifacts were collected. There is the potential for additional surface and subsurface artifacts.	Moderate	NUNAVUT 2001-019A
LiNq-7	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker near Skewer Lake.	The site consists of 3 quartz flakes and one quartzite flake (collected).	Low	NUNAVUT 2001-019A
LjNg-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a sandy bench on the western shores of Ellice Lake and beside a small stream, approximately 28 km east of the southern shores of Propellor Lake.	The site consists of 2 lithic scatters with 100-150 white quartzite flakes and a single chert flake.	Moderate	NUNAVUT 2012-12A
LjNg-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a sandy terrace beside a small creek on the western shores of Ellice Lake, approximately 28 km east of the southern shores of Propellor Lake.	The site consists of 1 lithic scatter 50 x 50cm with 2 white chert flakes.	Low	NUNAVUT 2012-12A
LjNg-3	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the western shores of Ellice Lake, approximately 28 km east of the southern shores of Propellor Lake.	The site consists of a stone floor with 57 flat stones, 2 lithic scatters with 150-200 flakes, 4 microblades, and a small bifacial tool fragment indicative of ASTt.	High	NUNAVUT 2012-12A
LjNh-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a bedrock outcrop surrounded by marsh and uneven rockey terrain. The site has a good outlook over Llama Lake to the southeast.	The site consists of 3 pink quartzite flakes, 147 white quartzite flakes (includes 100 pieces micro-debitage), and 3 pieces white quartzite block shatter. No diagnostic artifacts were found at the site.	Low	NUNAVUT 2010-024A
LjNh-2	Prehistoric	Lithic Isolated Find	Lithic Isolated Find	The site is located on a bedrock outcrop surrounded by marsh and uneven rockey terrain. The site has a good outlook over Llama Lake to the southeast.	The site consists of 1 isolated pink quartzite retouched flake. No diagnostic artifacts found to determine cultural affiliation.	Low	NUNAVUT 2010-024A
LjNh-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a bedrock outcrop on a ridge. The ridge overlooks Llama Lake to the east, an unnamed lake to the south, and a valley to the west. The ridge continues to the north.	The site consists of 2 quartzite cores (1 grey and 1 pink; collected) and 2 grey quartzite flakes were found (left *in situ*).	Low	NUNAVUT 2010-024A
LjNh-4	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a bedrock outcrop approximately 20 m east of a small unnamed pond.	The site consists of 4 grey quartz flakes and 2 unifacially retouched flakes from the surface of the site area.	Low	NUNAVUT 2011-022A
LjNh-5	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll overlooking the outlet of an unnamed creek flowing into Goose Lake, approximately 320 m north.	The site consists of 1 white chert and 3 white quartz flakes observed on the ground at the site (left *in situ*). No formed tools or diagnostic artifacts were observed.	Low	NUNAVUT 2011-022A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LjNi-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located at the end of a bedrock outcrop overlooking a marsh to the north.	The site consists of 100 + white quartzite flakes and a quartzite outcrop with flake scars. No diagnostic artifacts were found. All artifacts were left *in situ*.	Moderate	NUNAVUT 2010-024A
LjNi-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker approximately 6 km east (and slightly south) of Moby Lake.	The site consists of 1 lithic scatter 2 x 2 m with white quartzite 3 flakes.	Low	NUNAVUT 2012-12A
LjNi-3	Undetermined	Resource Gathering	Drive Lane, Inuksuk	The site is located on a rise in topography overlooking marshy low-lying areas to north and south.	Ths site consists of 34 cairns aligned northwest to southeast for 156 m.	Moderate-High	NUNAVUT 2013-20A
LjNi-4	Historic	Resource Gathering	Cache, Historic Material	The site is located in a boulder field with marshy ground and a lake to the south.	The site consists of a cache pit with a tobacco tin located approximately 20 m to the north.	Moderate	NUNAVUT 2013-20A
LjNj-1	Undetermined	Campsite	Stone Circle, Hunting Blind	The site is located on a bedrock outcrop.	The site consists of 1 hunting blind and 1 stone circle.	Moderate	NUNAVUT 2012-12A
LjNj-2	Historic / Unknown	Campsite	Stone Circle, Hearth, Faunal Material	The site is located on a broad plateau several hundred metres west of a stream that flows into Back River.	The site consists of a stone circle with a large scatter of caribou skulls, and a hearth.	Moderate	NUNAVUT 2013-20A
LjNj-3	Prehistoric / Historic	Campsite	Stone Circle, Hunting Blind, Cache, Historic Scatter, Faunal Material, Lithic Scatter	The site is located on a north-south ridge towards the south end of the landform.	This site consists of stone circles, caches, hunting blinds, a large dense scatter of bone, wood, and historic debris. Four white chert ASTt artifacts were collected including a knife, a drill, a scraper, and a microblade.	High	NUNAVUT 2013-20A
LjNj-4	Undetermined	Campsite	Stone Circle, Faunal Material	The site is located on a bedrock outcrop ridge sloping south towards Beechey Lake.	The site consists of a stone circle and a stone cache with bone inside.	Moderate	NUNAVUT 2013-20A
LjNj-5	Undetermined	Campsite	Stone Circle, Hunting Blind, Inuksuk	The site is located on a west sloping bedrock outcrop above Beechey Lake to the south.	The site consists of a stone circle, 2 hunting blinds, and an inuksuk/cairn.	Moderate-High	NUNAVUT 2013-20A
LjNj-6	Prehistoric / Historic	Campsite	Stone Circle, Stone Rectangle, Hunting Blind, Lithic Scatter, Fauanl Material, Historic Scatter	The site is located on a broad prominent hill with extensive bedrock outcrops.	The site consists of stone circles, stone rectangles, hunting blinds, caches, Arctic Small Tool tradition artifacts, bone, and historic debris. This is a large site with extensive landscape modification through movement of boulders.	High	NUNAVUT 2013-20A
LjNo-1	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on the side of an esker associated with a drainage channel west of the Mara River.	The site consists of 1 red quartzite flake (collected).	Low	NUNAVUT 2001-019A
LjNo-2	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on exposure on a gravel ridge associated with Mara River drainage channel.	The site consists of 1 rhyolite flake (collected).	Low	NUNAVUT 2001-019A
LjNo-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on exposures in a gravel knoll associated with unnamed western tributary of Mara Lakes.	The site consists of 3 quartz flakes (collected).	Low	NUNAVUT 2001-019A
LjNo-4	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an exposed knoll above an unnamed tributary of the Mara River.	The site consists of 1 sandstone and 1 quartz flake (collected).	Low	NUNAVUT 2001-019A
LjNp-1	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a esker near Nose Lake.	The site consists of 1 quartz flake (collected).	Low	NUNAVUT 2001-019A
LjNp-2	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a esker near Nose Lake.	The site consists of 1 quartz flake (collected).	Low	NUNAVUT 2001-019A
LjNp-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a esker near Nose Lake.	The site consists of 21 quartz artifacts including 2 cores, 3 pieces of shatter, and 16 flakes or flake fragments (collected).	Low-Moderate	NUNAVUT 2001-019A
LjNp-4	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a esker near Nose Lake.	The site consists of a lithic scatter including quartz cores, flakes and flake fragments. Potential for subsurface deposits.	Low-Moderate	NUNAVUT 2001-019A
LkNh-1	Historic	Campsite	Stone Circle, Faunal Material, Historic Material	The site is located on a ridge overlooking a small lake and a grassy north-south plain just east of the Western River.	The site consists of tent rings, meat caches, caribou bones, and some historic debris that litters the top of the ridge. Evidence of recent use such as board fragments with saw tooth marks. Occasional 30-30 shell casing. No excavation. Hudson Bay 1/2 lb. tea tin on surface.	Moderate	NWT 75-377
LkNh-2	Historic	Grave	Burial, Faunal Material	The site is located on a ridge between two small lakes, just east of the Western River.	The site consists of tent rings, meat caches, caribou bones and a possible Inuit grave site. The site has probably been in use for a long time perhaps in conjunction with LkNh-1 to the north.	High	NWT 75-377
LkNh-3	Historic	Resource Gathering	Cache, Historic Material	The site is located on a rocky outcrop.	The site consists of 1 cache with cast iron pot w/lid, and 3 square metal gas cans.	Low-Moderate	NUNAVUT 2012-12A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LkNh-4	Prehistoric	Resource Gathering	Cache	The site is located approximately 40 km west of the western shores of Ellice River and 30 km northwest of Propellor Lake.	The site consists of 1 rectangular stone cache. The cache is open and empty.	Low-Moderate	NUNAVUT 2012-12A
LkNh-5	Prehistoric	Lithic Isolated Find	Lithic Isolated Find	The site is located on a bedrock outcrop with soil exposures overlooking a small lake.	The site consists of one orange and white banded chert flake.	Low	NUNAVUT 2013-20A
LkNi-1	Prehistoric	Campsite	Stone circle, Hunting Blind, Cache, Hearth	The site is located on the east bank Western River southeast of Lost Lake on a till exposed terrace at narrows in river with rapids to the south.	The site consists of 25 and 30 stone features along the edge of the terrace and perhaps 50-60 meters inland. Appears to represent a caribou ambush site with numerous blinds. Some antiquity is suggested by in-filled stone circles. No collections.	High	NWT 97-844
LkNi-2	Prehistoric	Campsite	Stone Circle, Cache, Cairn, Lithic Scatter	The site is located on a bedrock outcrop.	The site consists of 1 cache, 1 cairn, 1 stone circle, and a low density lithic scatter of white quartzite flakes across the site. No diagnostic tools were observed.	Moderate-High	NUNAVUT 2012-12A
LkNj-1	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an esker 120 m to the south of a small lake.	The site consists of over 75 white quartzite flakes and block shatter. No formed tools or diagnostic artifacts were observed.	Low	NUNAVUT 2010-024A
LkNj-2	Undetermined	Marker	Cairn	The site is located on a bedrock outcrop.	The site consists of 1 cairn constructed with 2 large stones.	Low	NUNAVUT 2012-12A
LkNk-1	Historic	Campsite	Stone Circle, Faunal Material, Historic Material	The site is located on an esker running southwest of the southern end of George Lake, Barren Grounds, south of Bathurst Inlet and north of the Back River.	The site consists of 2 tent rings on top of an esker near George Lake. The tent rings are not heavily lichenated. Visible artifacts include only a rusted tin lid. An extensive scattering of caribou bones, predominantly split long bones, was associated with the tent rings. The site probably dates to within the last fifty years.	Low-Moderate	NWT 91-707
LkNl-1	Prehistoric / Historic	Campsite	Stone Circle, Stone Alignment, Stone Resctangle, Lithic Scatter, Historic Material	The site is located at the north end of an esker, between a creek and a lake.	This site consists of both prehistoric and historic features and artifacts. There are 24 features located at the site including rock alignments, stone circles, stone rectangles, a hearth, caches, cultural depressions, and bone scatters. It is likely that the two stone circles were used to hold down hide tents and the three rectangular stone features were used to hold down canvas tents. Additionally, at the north end of the site there is a mound-like feature that may represent the remains of a semi-subterranean dwelling; however, additional testing will be required to determine its function. The artifact assemblage located at the site includes a prehistoric lithic scatter consisting of six quartzite flakes and two pieces of block shatter, as well as a historic rifle cartridge and a cooking pot.	High	NUNAVUT 2010-024A
LkNl-2	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the north end of an esker, between an creek and a small lake.	The site consists of 60 white & gray quartzite flakes, 3 chert flakes, 4 quartzite cores, 1 basalt core, 1 basalt scraper, 1 white quartzite notched flake, 1 white quartzite retouched flake & a scatter of bone. No diagnostic artifacts found.	Moderate	NUNAVUT 2010-024A
LkNm-1	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an exposure on the high west bank of Storak River.	The site consists of 1 quartz core fragment and 11 flakes (collected).	Low	NUNAVUT 2001-019A
LkNm-2	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a knoll between two small unnamed lakes to the northwest and east. Site is south of a stream channel that connects the two lakes.	The site consists of a scatter of approximately 20 white quartz flakes and one scraper from the surface of the site area.	Low	NUNAVUT 2011-022A
LkNm-3	Prehistoric	Campsite	Stone Circle	The site is located at the tip of a small peninsula that juts into the north shore of a small unnamed lake.	The site consists of a stone circle (Feature 1). A helicopter landing pad, approximately 30 years old, is located 2 m north of Feature 1.	Low	NUNAVUT 2011-022A
LlNj-1	Prehistoric	Campsite	Stone Circle, Lithic Scatter, Faunal Material, Other	The site is located on the western shore of an unnamed lake.	The site consists of 5 stone features including 4 stone circles and a stone semi-circle. Five pink quartzite flakes, 2 pink quartzite cores and 1 red quartzite core were observed at the site and left *in situ*. No diagnostic tools were observed. Additionally, a muskox skull, scatter of bone, and a piece of soap stone were observed at the site.	High	NUNAVUT 2010-024A
LlNk-1	Prehistoric	Resource Gathering	Cache	The site is located on a prominent knoll overlooking a fast flowing creek to the south.	The site consists of a cache. The cache pit feature consists of several flat rocks surrounding a shallow cultural depression with differential vegetation. No artifacts were identified in the area. Site photographed and mapped.	Moderate	NUNAVUT 2010-024A
LlNk-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker overlooking a marshy area to the southeast.	The site consists of 1 white quartzite core and 1 piece of block shatter collected from the site. No diagnostic artifacts were found.	Low	NUNAVUT 2010-024A
LlNk-3	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a deflated end of a esker 300 m to the south of one lake and 160 m to the northeast of a second lake.	The site consists of 1 white quartzite biface preform, 1 white quartzite core fragment, 2 pink quartzite utilized flakes, and 1 pink, 5 white, and 1 yellow quartzite flakes (collected). Some additional artifacts are still visible on the surface.	Moderate	NUNAVUT 2010-024A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LlNk-4	Prehistoric	Resource Gathering	Stone Alignment, Lithic Scatter	The site is located on a bedrock ridge 300 m northwest of a small lake.	The site consists of 2 stone features. One is a linear feature made of 8 large rocks and the second is an L-shaped feature made of 9 rocks. The linear feature has a large pink quartzite core at the northern end.	Moderate	NUNAVUT 2010-024A
LlNk-5	Prehistoric	Lithic Workshop	Lithic Scatter	This site is located along the top on an esker, 33.5 km at a bearing of 32 degrees from the southernmost point of Bathurst Lake.	The site consists of 1 white quartzite biface fragment, 3 white quartzite flakes and one piece white quartzite block shatter collected from site.	Moderate	NUNAVUT 2010-024A
LlNk-6	Prehistoric / Historic	Campsite	Stone Circle, Cache, Hearth, Faunal Material, Historic Material	The site is located on a small esker 640 m south of a small lake.	Site consists of a hearth, 2 stone circles and a rectangular stone feature (likely an emptied cache). A scatter of broken bones is on the east side of site with a metal can lid in it. No other artifacts were observed. All artifacts left *in situ*.	High	NUNAVUT 2010-024A
LlNk-7	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a surface exposure between two bedrock outcrops.	The site consists of 1 white quartzite lithic scatter, 5 x 5 m diameter with 101-200 flakes. No diagnostic tools observed.	Moderate-High	NUNAVUT 2012-12A
LlNk-8	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on a gravel exposure, 1.1 km northwest of George Lake.	The site consists of 1 shouldered point fragment. The point is suggestive of the early to middle Taltheilei period.	Moderate	NUNAVUT 2012-12A
LlNk-9	Prehistoric	Resource Gathering	Cache	The site is located on a small bench, approximately 1.5 km northwest of George Lake.	The site consists of 1 stone cache.	Low-Moderate	NUNAVUT 2012-12A
LlNk-10	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a small bench, approximately 1.5 km northwest of George Lake.	The site consists of 3 lithic scatterswith 300-400 white quartzite flakes and several white quartzite biface fragments.	Moderate-High	NUNAVUT 2012-12A
LlNk-11	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a knoll 200 m west-southwest of Long Lake.	The site consists of 1 lithic scatter with 30 + white quartzite flakes and 1 white quartzite graver.	Moderate	NUNAVUT 2012-12A
LlNk-12	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on a terrace on the northwestern shore of George Lake.	The site consists of 1 grey quartzite scraper.	Low-Moderate	NUNAVUT 2012-12A
LlNk-13	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll on an island in the middle of Long Lake.	The site consists of 2 lithic scatters 40-50 white quartzite flakes.	Low-Moderate	NUNAVUT 2012-12A
LlNk-14	Prehistoric	Campsite	Stone Circle	The site is located on a knoll 170 m northeast of Long Lake.	The site consists of 1 stone circle.	Moderate	NUNAVUT 2012-12A
LlNk-15	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an gravel exposure on the northern shore of Long Lake.	The site consists of 1 white quartzite lithic scatter with 51-100 flakes.	Low-Moderate	NUNAVUT 2012-12A
LlNk-16	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on an esker 45 m east of Long Lake.	The site consists of 1 purple slate chithos (left *in situ*).	Low-Moderate	NUNAVUT 2012-12A
LlNk-17	Prehistoric	Resource Gathering	Cache, Faunal Material	The site is located on a bedrock knoll on the southern shore of Long Lake.	The site consists of 1 rectangular stone cache with fragments of bone inside.	Moderate	NUNAVUT 2012-12A
LlNk-18	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll on the shore of Long Lake.	The site consists of 1 lithic scatter 2 x 2m with 11-20 white quartzite flakes.	Low	NUNAVUT 2012-12A
LlNk-19	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a northwest trending esker along Long Lake.	The site consists of 2 lithic scatters with 8 white and grey quartzite flakes and 1 white chert flake.	Low-Moderate	NUNAVUT 2012-12A
LlNk-20	Prehistoric	Campsite	Stone Circle, Faunal Material	The site is located on an esker approximately 3 km south of Dragon Lake.	The site consists of 1 small stone circle with broken caribou bone around it.	Moderate	NUNAVUT 2012-12A
LlNk-21	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker approximately 3 km south of Dragon Lake.	The site consists of 1 lithic scatter with 4 white quartzite flakes.	Low	NUNAVUT 2012-12A
LlNk-22	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on an esker approximately 3 km south of Dragon Lake.	The site consists of 1 light pink quartzite scraper observed and left *in situ* at the site.	Low-Moderate	NUNAVUT 2012-12A
LlNl-1	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a sandy exposure northeast of the Storak River.	The site consists of 1 primary decortication flake and 1 primary flake of quartz, and 1 fragment of chert shatter (collected).	Low	NUNAVUT 2001-019A
LlNl-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on top of a knoll.	The site consists of a surface lithic scatter of 2 pink quartzite flakes on top of knoll and one pink quartzite core.	Low	NUNAVUT 2007-022A
LlNl-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll northeast of Chair Lake.	The site consists of a surface lithic scatter of 2 pink quartzite cores and approximately 30 flakes on top of a knoll.	Low	NUNAVUT 2007-022A
LlNl-4	Prehistoric	Marker	Cairn	The site is located on top of a knoll bedrock outcropping north of Chair Lake.	The site consists of a rock cairn consisting of fifteen rocks of differing material constructed on top of a large prominent bedrock outcrop knoll. The structure is partly collapsed and, while it was likely much taller than it is now, its current dimensions measure 1 m wide, 70 cm deep and 1.6 m high. Photographed. Nothing collected.	Moderate	NUNAVUT 2007-022A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LlNl-5	Prehistoric	Campsite	Stone Circle, Faunal Material	The site is located on small knoll overlooking a small lake.	The site consists of a small stone tent ring with broken faunal bone fragments likely the result of marrow extraction. Stone ring visible on surface and broken faunal fragments located approximately 36 m away from stone ring to the northeast.	Moderate	NUNAVUT 2007-022A
LlNl-6	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a low esker overlooking lakes to northeast and southwest.	The site consists of a lithic scatter of over 400 pieces of quartz debitage.	Moderate-High	NUNAVUT 2010-023A
LlNl-7	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker overlooking a lake to the southwest.	The site consists of siltstone, chert, and quartz artifacts eroding out of a subsurface deposit.	High	NUNAVUT 2010-023A
LlNl-8	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker overlooking a lake to the southwest.	The site consists of 1 chert retouched flake, and 4 quartz flakes or flake fragments (collected).	Low	NUNAVUT 2010-023A
LlNl-9	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an esker overlooking a creek to the north and a lake to the west	The site consists of4 lithic scatters with over 600 total artifacts.	Moderate-High	NUNAVUT 2010-023A
LlNl-10	Prehistoric	Lithic Reduction	Lithic Scatter	On a low esker overlooking drainages to the east and west.	The site consists of 1 quartz flake and a quartz flake fragment (collected).	Low	NUNAVUT 2010-023A
LlNl-11	Prehistoric	Lithic Reduction	Lithic Scatter	On an esker overlooking drainages to the east and west.	The site consists of 1 quartz retouched flake, a quartz core, and a quartz flake (collected).	Low	NUNAVUT 2010-023A
LlNl-12	Prehistoric	Lithic Workshop	Lithic Scatter	On an esker overlooking a drainage to the east.	The site consists of 2 lithic scatters totaling 67 quartz artifacts (collected).	Low-Moderate	NUNAVUT 2010-023A
LlNl-13	Historic	Marker	Hearth, Cairn	On the south end of an esker overlooking a drainage to the south.	The site consists of a hearth and a stone marker.	Moderate	NUNAVUT 2010-023A
LlNl-14	Prehistoric	Resource Gathering	Lithic Scatter, Cairn	The site is located on a terrace 500 m southwest of upper Long Lake.	The site consists of 1 cairn and 1 white quartzite lithic scatter with 11-20 flakes.	Moderate	NUNAVUT 2012-12A
LlNl-15	Prehistoric	Campsite	Stone Circle	The site is located on a ridge 650 m south of upper Long Lake.	The site consists of 1 stone circle.	Moderate	NUNAVUT 2012-12A
LlNl-16	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll with a marsh to north and east and hills to south and west.	The site consists of 3 white quartzite flakes and a possible block shatter.	Low	NUNAVUT 2012-22A
LlNl-17	Prehistoric	Quarry	Lithic Quarry, Lithic Scatter	The site is located on a bedrock outcrop with a lower marshy area to east.	The site consists of 4 white quartzite boulder cores. The largest core has over 100 flakes beneath it.	Low-Moderate	NUNAVUT 2012-22A
LlNm-1	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a ridge top immediately above the western side of the Hackett River.	The site consists of a surface lithic scatter of pink quartzite flakes across the ridge top and one large pink quartzite core in a localized area of the ridge.	Moderate	NUNAVUT 2007-022A
LlNm-2	Undetermined	Resource Gathering	Stone Alignment, Lithic Isolated Find	The site is located on top of a knoll overlooking small unnamed lakes to the south.	The site consists of 4 small rocks in a line behind a large pile indicating direction of travel and 1 slate scraper also found near the rock alignment.	High	NUNAVUT 2007-022A
LlNm-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on top of a knoll.	The site consists of 7 quartzite cores and associated block shatter.	Moderate	NUNAVUT 2007-022A
LlNm-4	Prehistoric	Resource Gathering	Rock Shelter, Faunal Material	The site is located on a knoll southeast of the Hackett River with a good vantage overlooking a gradually sloping tundra meadow.	The site consists of broken caribou bone and a small rock shelter with good vantage. Broken faunal remains scattered across top of knoll. A small crevasse in a prominent rock feature may have been used as a temporary shelter.	Low	NUNAVUT 2007-022A
LlNm-5	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a small flat terrace overlooking the Hackett River approximately 500 m to the northeast.	The site consists of 1 pebble pink quartzite stone tool located on good vantage point. Photographed. Nothing collected.	Low	NUNAVUT 2007-022A
LlNm-6	Prehistoric	Campsite	Stone Circle, Cultural Depression, Lithic Scatter	The site is located on a terrace overlooking the Hackett River to the west and an extinct river bed to north.	The site consists of stone tent rings, small cultural depressions, a lithic scatter of rose quartzite, and a slate knife. A large campsite consisting of 5 stone tent rings, 3 small cultural depression, stone tool reduction site of lithic scatter. Lithic material found on surface near old river bed. Cultural depressions have vegetation growing in center as do stone tent rings.	High	NUNAVUT 2007-022A
LlNm-7	Undetermined	Resource Gathering	Cache	The site is located on a terrace overlooking the Hackett River to the west.	The site consists of a cache consisting of a large rock covered with loose fill and topped with large boulders. Loose fill and large boulders on top still intact. This site is associated with site LlNm-6 and is likely prehistoric.	High	NUNAVUT 2007-022A
LlNm-8	Undetermined	Marker	Cairn	The site is located on gradually sloping open tundra plain approximately 350 m east of the Hackett River.	The site consists of 1 rock cairn made of 6 flat blocks of pink quartzite. Appears to be intact with some lichen growth on the stones. As pink quartzite is relatively rare in this landscape and was used for stone tools in prehistoric sites, it is likely that this is a prehistoric feature, possibly a cache of lithic material.	High	NUNAVUT 2007-022A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LlNm-9	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a terrace approximately 250 m west of the Hackett River.	The site consists of 1 unifacial steep edged scraper and 1 flake with some block shatter observed. Lithic scatter appears undisturbed on surface.	Low	NUNAVUT 2007-022A
LlNm-10	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on a terrace overlooking an open tundra plain east of the Hackett River.	The site consists of 1 notched end scraper flake. Lithic material appears to be undisturbed and found on the surface.	Low	NUNAVUT 2007-022A
LlNm-11	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the west side of the Hackett River, approximately 650 m north of Camp Creek.	The site consists of 1 unifacial steep-edged scraper and 1 flake located on a pile of pink quartzite block shatter. Site appears to be undisturbed and in good condition.	Moderate	NUNAVUT 2007-022A
LlNm-12	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located approximately 650 m northwest of Joe Lake.	The site consists of 1 unifacially retouched flake scraper. Site appears to be undisturbed and in relatively good condition.	Low	NUNAVUT 2007-022A
LlNm-13	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a small knoll overlooking a shallow valley to the north, and approximately 750 m west of the Hackett River.	The site consists of 3 flakes and two cores of pink quartzite.	Low	NUNAVUT 2007-022A
LlNm-14	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on two knolls approximately 1 km north of the Hackett River.	The site consists of 5 flakes found on a western knoll and 4 flakes and 1 burin-like tool found on an eastern knoll, all of pink quartzite.	Moderate	NUNAVUT 2007-022A
LlNm-15	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on an esker overlooking shallow valley east of the Hackett River.	The site consists of several pink quartzite flakes.	Low	NUNAVUT 2007-022A
LlNm-16	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a gravel knoll overlooking a constriction of the Hackett River, approximately 1 km south of Camp Creek.	The site consists of 10 pink quartzite flakes. Site appears to be intact and undisturbed despite its exposed position to prevailing winds.	Low	NUNAVUT 2007-022A
LlNm-17	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a gravel esker on the south side of Camp Creek.	The site consists of approximately 20 white quartz flakes on an exposed gravel esker. Site appears to be intact and undisturbed despite its exposed position to prevailing winds.	Moderate	NUNAVUT 2007-022A
LlNm-18	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a gravel esker that runs on the south side of Camp Creek.	The site consists of pink quartzite flakes and 1 burin-like tool on an exposed gravel esker. Site appears to be intact and undisturbed despite its exposed position to prevailing winds.	Moderate	NUNAVUT 2007-022A
LlNm-19	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on the western bank of Hackett River and the northern bank of Camp Creek.	Site consists of 1 pink quartzite hand-sized chopper. Site appears to be intact and undisturbed despite its exposed position to prevailing winds. Photographed. Nothing collected.	Low	NUNAVUT 2007-022A
LlNm-20	Prehistoric	Marker	Cairn	The site is locatd on a terrace 160 m west of the Hackett River and 600 m south of site LlNm-1.	The site consists of one rock cairn on a large boulder. The rock alignment is made of 5 large rocks, two of which are pink quartzite.	Moderate	NUNAVUT 2010-024A
LlNm-21	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a rock ridge 450 m to the west of the Hackett River.	The site consists of 30+ pink and white quartzite flakes, 3 white quartzite cores and 1 pink quartzite core. All artifacts were left *in situ*.	Low	NUNAVUT 2010-024A
LlNm-22	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a deflated gravel esker, 900 m to the west of the Hackett River and 800 m to the north of a small unnamed lake.	The site consists of 50+ pink and white quartzite flakes. No diagnostic artifacts found. Artifacts left *in situ*. Site is 100 m SW of a surveyors cairn which appears to have a pink quartzite core as one of its rocks. The core is possibly from LlNm-22.	Low	NUNAVUT 2010-024A
LlNm-23	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a small gravel exposure 1 km to the west of the Hackett River and 900 m north of a small unnamed lake.	The site consists of 25-50 pink quartzite flakes and one pink quartzite core. No diagnostic artifacts found. No artifacts were collected.	Low	NUNAVUT 2010-024A
LlNm-24	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a knoll with exposed gravels and boulders, 1.5 km to the west of the Hackett River.	The site consists of 2 scrapers, 1 notched flake, 1 burin, 2 retouched flakes and 1 spall tool all of pink quartzite (collected) and 100+ pink and white quartzite flakes left *in situ*. No diagnostic artifacts were found.	Moderate	NUNAVUT 2010-024A
LlNm-25	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a knoll.	The site consists of 5 pink quartzite flakes, 1 quartzite scraper and 2 pink quartzite cores. All were left *in situ*. No diagnostic artifacts were found.	Moderate	NUNAVUT 2010-024A
LlNm-26	Prehistoric	Marker	Inuksuk	The site is located on a bedrock outcrop on the western shore of a small unnnamed lake.	The site consists of an inuksuk. Inuit assistant stated that the inuksuk was a marker for a good fishing spot and called it a "nunkatuk".	Low	NUNAVUT 2010-024A
LlNm-27	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a knoll overlooking the Hackett River to the east. The terrain consists of a series of knolls located on a northeast slope down to the river.	The site consists of a small lithic scatter containing two quartzite flakes.	Low	NUNAVUT 2012-22A
LlNm-28	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a break in slope. The location is not distinct from the terrain in the area but the location does provide a excellent vantage from which to survey the lower terrain to the south.	The site consists of a white quartzite lithic scatter of 20-30 flakes located on a break in slope.	Low	NUNAVUT 2012-22A

Appendix B. Archaeological Sites with the Study Area

Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LlNm-29	Undetermined	Marker	Inuksuk	The site is located on a break in slope. The terrain rises up to the north and down to the southeast with good views of the lower terrain.	The cairn is similar in construction to features associated with caribou drive lanes including an inuksuk at archaeological site MaNl-2 (Fedirchuk 2001) located 24 km to the east-northeast. No additional features suggestive of a drive lane were located in the area, however, further investigation will be required if the area is impacted by development.	Low-Moderate	NUNAVUT 2012-22A
LlNm-30	Prehistoric	Marker	Inuksuk	The site is located on a bedrock outcrop west of several lakes.	The site consists of a cairn with 11 stones. Cairn includes a piece of white quartzite. Partially collapsed.	Low	NUNAVUT 2012-22A
LlNm-31	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a bedrock outcrop overlooking terrain to west that drops down to Hackett River.	The site consists of 1 quartzite core with cortex, block shatter, and 30-40 flakes from primary to finishing.	Low	NUNAVUT 2012-22A
LlNm-32	Prehistoric / Historic	Lithic Workshop	Lithic Scatter, Historic Material	The site is located along a low ridge on top of a hill with views to the west, south, and east.	The site consists of 3 lithic scatters totalling over 100 white quartzite flakes. A small bore drill collar and associated historic materials were also located at the site.	Low	NUNAVUT 2012-22A
LlNm-33	Undetermined	Faunal Tool	Faunal Tool	The site is located on the south slope of an esker overlooking the Hackett River to south.	The site consists of a possible antler tool handle.	Low	NUNAVUT 2012-22A
LlNn-1	Prehistoric	Isolated Lithic Tool	Lithic Isolated Find	The site is located on a hillside overlooking Boot Lake to the east and in area heavily covered with large boulders.	The site consists of a large pink quartzite chopper. Chopper located on frost heave but otherwise undisturbed.	Low	NUNAVUT 2007-022A
LlNn-2	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located northeast of Finger Lake in an area heavily covered with large boulders.	The site consists of 1 pink quartzite core. Evidence of removal of several large flakes. Lichen growing in several flake scars.	Low	NUNAVUT 2007-022A
LlNn-3	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a knoll approximately 1 km east of Banana Lake and 1.5 km northeast of Camp Lake.	The site consists of 1 pink quartzite core, flaked on both sides. The site appears to be undisturbed and in relatively good condition.	Low	NUNAVUT 2007-022A
LlNn-4	Undetermined	Marker	Cairn	The site is located on a hillside overlooking Bat Lake which is approximately 230 m to the north.	The site consists of rock cairn, constructed on a large prominent boulder, constructed of seven rocks. The cairn is approximately 0.7 m high and 1 m wide.	Moderate	NUNAVUT 2007-022A
LlNn-5	Prehistoric	Marker	Cairn	The site is located on a hillside approximately 100 m southeast of Bat Lake.	The site consists of a rock cairn consisting of nine flat blocks of pink quartzite rocks and constructed on top of a large prominent boulder. Rock cairn is collapsed and the integrity of the structure is in poor condition. As pink quartzite is relatively rare in this landscape and is the material used for stone tools in prehistoric sites, it is likely that this is a prehistoric feature.	High	NUNAVUT 2007-022A
LlNn-6	Prehistoric	Marker	Cairn	The site is located on a hillside overlooking Degaulle Lake to the east.	The site consists of a rock cairn consisting of five flat blocks of pink quartzite rocks and constructed on top of a large prominent boulder. Rock cairn is collapsed. The integrity of the structure is in poor condition. As pink quartzite is relatively rare in this landscape and was used for stone tools in prehistoric sites, it is likely that this is a prehistoric feature.	High	NUNAVUT 2007-022A
LlNn-7	Undetermined	Marker	Cairn	The site is located on a gently sloping hillside on a large prominent boulder overlooking Bat Lake to the east.	The site consists of a rock cairn consisting of three rocks of differing material constructed on top of prominent boulder overlooking Bat Lake to the east. Rock cairn appears to be intact and undisturbed.	Low	NUNAVUT 2007-022A
LlNn-8	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a prominent knoll overlooking six lakes to the south and approximately 500 m east of Chuchu Lake.	The site consists of approximately 45 white quartz flakes and 3 pieces of block shatter.	Moderate	NUNAVUT 2007-022A
LlNn-9	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a knoll overlooking a valley to the south and Degaulle and Michelle Lakes to the southeast.	The site consists of 1 pink quartzite flake.	Low	NUNAVUT 2007-022A
LlNn-10	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a rock strewn hilltop.	The site consists of 2 pink quartzite flakes on a rock strewn hilltop.	Low	NUNAVUT 2012-22A
LlNn-11	Prehistoric	Resource Gathering	Hunting Blind, Lithic Scatter	The site is located on a deflated esker feature made of cobbles and boulders overlooking the Mara River.	The site consists of a stone feature thought to be a hunting blind composed of approximately 50 stones and lithic material spread out along the terrace edge. A total of 10 lithic scatters and 5 isolated finds, totaling approximately 100 artifacts, were found at the site consisting mainly of quartzite flakes. A grey sedimentary chitho that was broken into two pieces was collected.	Moderate	NUNAVUT 2012-22A
LlNo-1	Prehistoric	Resource Gathering	Hunting Blind, Lithic Scatter	The site is located on an east-west trending esker overlooking Mara Lake to north and an unnamed lake to south.	The site consists of a semi-circular hunting blind feature placed at the edge of a depression in the esker. Two small chert flakes were located to the west.	Moderate	NUNAVUT 2012-22A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
LlNo-2	Prehistoric / Historic	Campsite	Stone Circles, Lithic Scatter, Faunal Material, Historic Material	The site is located on a flat rise to the south of Mara Lake, to the north of an unnamed lake, and an esker feature rises up to the east and west. The area is likely a caribou crossing.	This site contains evidence of use throughout the prehistoric and historic period with artifacts dating from the Arctic Small Tool tradition (ASTt) to historic rifle shell cartridges and aluminum pots. A caribou crossing is located to the west of the site. The site includes two prehistoric cultural depressions and another feature possibly a portion of a stone circle of unknown age obscured by vegetation. Artifacts collected from the site include: 3 knives, 2 slotters, 2 bifaces, 2 pieces of flake debitage, 1 point, 1 microblade, 1 core, 1 needle sharpener. All artifacts are made of white chert, with the exception of the needle sharpener, made of brown slate. Additional artifacts at the site include lithic debitage, caribou bones, and modern hunting and camping equipment including wood, nails, stove pipe, rifle shells, and a two hole button. Given the continuous use of the site and the vegetation there is good potential for stratified subsurface deposits at the site.	High	NUNAVUT 2012-22A
LlNo-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located at the base of an esker.	The site consists of 2 lithic scatters with a total of 20-30 white chert flakes at the base of an esker.	Low	NUNAVUT 2012-22A
LlNo-4	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on top of an esker feature overlooking Mara Lake to the north and a small lake to the south.	A scatter of 40-50 white quartzite flakes on top of an esker feature overlooking Mara Lake to the north and a small lake to the south.	Low	NUNAVUT 2012-22A
MaNj-1	Prehistoric	Campsite	Stone Circle, Stone Alignment, Cache, Lithic Scatter	The site is located on a hign knoll above the tundra.	The site consists of 8 stone features including 2 caches, 2 stone circles, 2 rock alignments, 1 rock pile and 1 anvil stone and a lithic scatter that includes 1 piece of flaked slate and 2 quartzite flakes. No diagnostic artifacts or formed tools were observed. Broken caribou bones were observed in one of the caches (found disassembled).	High	NUNAVUT 2010-024A
MaNj-2	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a small exposed knoll, 130 m NW of site MaNj-1.	The site consists of between 40 and 50 pink and white quartzite flakes. No diagnostic or formed tools were observed.	Low	NUNAVUT 2010-024A
MaNj-3	Prehistoric	Campsite	Stone Circle, Hearth	The site is located on a low topographic rise surrounded by several small lakes and streams. Located approximately 10 km south of Bathurst Lake.	The site consists of a stone circle, 3 m in diameter with 16 stones (Feature 1), and a hearth (Feature 2).	Low	NUNAVUT 2011-022A
MaNj-4	Undetermined	Marker	Cairn	The site is located on a bedrock hill between two unnamed ponds, approximately 12 km east-southeast of Bathurst Lake.	The site consists of a stone cairn (Feature 1). The site was identified from the air during a helicopter flight and was not in proximity to the Project.	Low-Moderate	NUNAVUT 2011-022A
MaNj-5	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a deflated esker overlooking a lake to the west and a pond to the east.	The site consists of a lithic scatter of 50 - 100 white and pink quartzite flakes. There are more white flakes than pink.	Low-Moderate	NUNAVUT 2013-20A
MaNj-6	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on soil exposures along the slope of a prominent knoll/ridge that extends into a small lake to the north.	The site consists of a lithic scatter of approximately 50 white quartzite flakes.	Low-Moderate	NUNAVUT 2013-20A
MaNj-7	Prehistoric / Historic	Campsite	Stone Circle, Stone Oval, Hunting Blind, Cache, Cairn, Hearth, Inuksuk, Faunal Material, Drive Lane, Historic Scatter	The site is located on a high bedrock knoll overlooking a lake to the southwest.	The site consists of a cache, 2 hunting blinds, a stone oval, a stone circle, a double stone circle, 2 cairns, an inuksuk, a hearth, wood, a D.C. Co. shell cartridge, and a scatter of caribou bone.	Moderate-High	NUNAVUT 2013-20A
MaNl-1	Prehistoric / Historic	Campsite	Hearth, Lithic Scatter, Historic Material	The site is located on an exposure beside an unnamed creek.	The site has a historic component with a fire pit containing a piece of metal with a rivet and some broken bottle glass and and a prehistoric component consisting of materials found about 20 m north of the historic fire pit including 1 flake fragment and 1 piece of shatter, both of white chert.	Low-Moderate	NUNAVUT 2001-019A
MaNl-2	Prehistoric / Historic	Resource Gathering	Inuksuk, Drive Lane, Lithic Scatter	The site is located on an extensive bedrock ridge north of Tikiraq Lake.	The site consists of an alignment of upright elongate boulders set on top of bedrock outcropping. This caribou drive lane, begins at a larger inuksuk and extends south for over 200 m. At approximately 200 m, 4 more markers were observed spaced between 20 and 30 m apart. Lithics were recovered from a single concentration.	High	NUNAVUT 2001-019A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
MaNl-3	Prehistoric	Campsite	Stone Alignment, Lithic Scatter, Other	The site is located on top of an esker ridge on the east side of an unnamed stream.	The site consists of a lithic scatter of quartz artifacts and 3 stone features. Lithics include 1 end scraper, 1 retouched flake, and 1 burin, 1 core fragment, 1 core platform, 2 primary flakes, 4 secondary flakes, and 2 flake fragments (collected). Feature 1 is 8 m north of the artifact concentration and consists of a semicircular arrangement of flat rocks, approximately 0.6 m across. Two more features occur down slope and on a lower bench to the north and east of the scatter. One consists of a large semicircular arrangement (1 m diameter) of rocks similar to a tent ring. The other consists of an elongate arrangement (2 m long) of flat rocks. All rocks appear to have been removed from a large erratic embedded in the esker.	High	NUNAVUT 2001-019A
MaNl-4	Historic	Marker	Cairn, Survey Marker	The site is located at the mouth of an unnamed stream southwest of Bathurst Lake and north of Tikirak Lake.	The site consists of an inuksuk. A CLS survey marker located immediately northeast of the inuksuk suggests that it is of recent age built to identify the position of the survey marker.	Low-Moderate	NUNAVUT 2001-019A
MaNl-5	Prehistoric / Historic	Lithic Workshop	Lithic Scatter, Cairn, Stone Alignment	The site is located on a ridge 100 m west of upper Long Lake.	The site consists of 1 lithic scatter with over 100 white quartzite flakes.	Moderate	NUNAVUT 2012-12A
MaNl-6	Prehistoric	Resource Gathering	Lithic Scatter, Hearth	The site is located on an esker 100 m west of upper Long Lake.	The site consists of 1 stone hearth, 1 lithic scatter with 9 white quartzite flakes.	Moderate	NUNAVUT 2012-12A
MaNl-7	Prehistoric	Resource Gathering	Lithic Scatter, Cache	The site is located on the top of a ridge overlooking upper Long Lake to the north.	The site consists of 1 cache, 1 lithic scatter with 11-20 large biface reduction flakes of banded brown siltstone.	Moderate-High	NUNAVUT 2012-12A
MaNl-8	Prehistoric	Marker	Inuksuk	The site is located on a rocky knoll 366 m south of upper Long Lake.	The site consists of 1 collapsed inuksuk.	Low	NUNAVUT 2012-12A
MaNl-9	Prehistoric / Historic	Campsite	Stone Circle, Hearth, Lithic Scatter. Faunal Material	The site is located on a knoll 100 m north of the northern end of upper Long Lake.	The site consists of 1 stone circle, 1 hearth, 1 lithic scatter with 51-100 white quartzite flakes and scatter of broken caribou bone.	Moderate-High	NUNAVUT 2012-12A
MaNn-1	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a soil exposure associated with a bedrock outcrop overlooking the Hackett River to the east and the Mara River to the west.	The site consists of a small lithic scatter of white quartzite flakes on a soil exposure associated with a bedrock exposure.	Low	NUNAVUT 2012-22A
MaNn-2	Undetermined	Marker	Inuksuk	The site is located on a small bedrock outcrop overlooking the Mara River to the west.	The site consists of a small cairn located on a small bedrock outcrop.	Low	NUNAVUT 2012-22A
MbNj-1	Undetermined	Campsite	Stone Circle, Stone Rectangle, Stone Alignment, Cairn,Lithic Isolated Find, Faunal Material, Other	The site is located on a terrace on the eastern shore of Bathurst Lake.	The site consists of 5 stone features, 2 pieces of bone, 2 pieces of wood (possible plank fragments), and 1 possible quartzite core.	High	NUNAVUT 2010-024A
MbNj-2	Undetermined	Campsite	Stone Circle, Stone Alignment	The site is located on an esker on the northern shore of Bathurst Lake.	The site consists of 2 stone circles and 1 stone alignment.	High	NUNAVUT 2010-024A
MbNj-3	Prehistoric	Campsite	Stone Circle, Stone Alignment, Hunting Blind, Cache	The sites is located along a ridge on the eastern shore of Bathurst Lake. A caribou migration route runs along the ridge.	The site consists of 13 features, including 6 stone circles, 4 caches, 1 oval stone alignment, 1 rectangular stone alignment, and 1 hunting blind. No artifacts were identified.	High	NUNAVUT 2010-024A
MbNj-4	Prehistoric	Campsite	Stone Circle, Cairn, Lithic Scatter	The sites is located along a ridge on the eastern shore of Bathurst Lake. A substantial caribou trail runs along the ridge.	The site consists of 3 white quartzite flakes found near the centre of a stone circle. No artifacts collected from site. No diagnostic artifacts found at site. A small white chert flake & a collapsed cairn were located in revisit.	Moderate	NUNAVUT 2010-024A
MbNj-5	Prehistoric	Lithic Workshop	Lithic Scatter	The sites is located along a ridge on the eastern shore of Bathurst Lake. A substantial caribou trail runs along the ridge	The site consists of 1 Dorset bifacial endscraper and 3 flakes (2 chert, 1 quartzite).	High	NUNAVUT 2010-024A
MbNj-6	Prehistoric	Campsite	Stone Oval	The site is located along a ridge on the eastern shore of Bathurst Lake. A substantial cariibou trail runs along the ridge.	The site consists of 1 oval stone feature. No diagnostic artifacts were found.	Moderate	NUNAVUT 2010-024A
MbNj-7	Prehistoric / Historic	Campsite	Stone Circle, Hearth, Kayak Stand, Cultural Depression, Historic Material	The site is located on western shore of Bathurst Lake, 4 km northwest of the southern tip of the lake.	The site consists of 18 features including 10 stone circles, 1 stone semi-circle, 2 hearths, 3 rock features, 1 cultural depression, and 1 kayak stand. A heavily corroded tin can was observed at the site.	High	NUNAVUT 2010-024A
MbNj-8	Prehistoric	Campsite	Stone Circle, Stone Alignment	The site is located on western shore of Bathurst Lake, 4 km northwest of the southern tip of the lake.	The site consists of 2 stone circles and 2 stone alignments.	Moderate	NUNAVUT 2010-024A
MbNj-9	Prehistoric / Historic	Campsite	Stone Circle, Cache, Cairn, Faunal Material, Claim Marker	The site is located on the western shore of Bathurst Lake 8.5 km northwest of the southernmost point of the lake.	The site consists of a stone circle, a stone cache, and a rock cairn. Caribou bone was located in the vicinity of the cache and a claim marker for claim B3796 was located 2 m west of the cairn.	Moderate	NUNAVUT 2010-024A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
MbNj-10	Prehistoric	Campsite	Stone Circle, Stone Oval	The site is located on a small knoll between a small body of water and Bathurst Lake.	The site consists of 1 small oval stone feature that is open at one end and 1 stone circle. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
MbNj-11	Prehistoric	Resource Gathering	Cache	The site is located on a small knoll between a small body of water and Bathurst Lake.	The site consists of 2 oval stone features.	Moderate	NUNAVUT 2010-024A
MbNj-12	Prehistoric	Campsite	Stone Circle, Cairn	The site is located on a knoll 240 m southwest of the western shore of Bathurst Lake.	The site consists of 4 stone features but no artifacts.	Moderate	NUNAVUT 2010-024A
MbNj-13	Prehistoric	Campsite	Stone Circle	The site is located on a small terrace on the western shore of Bathurst Lake.	The site consists of 1 stone circle. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
MbNj-14	Prehistoric	Campsite	Stone Oval	The site is located on a bedrock ridge on the western shore of Bathurst Lake.	The site consists of 3 stone ovals.	Moderate	NUNAVUT 2010-024A
MbNj-15	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a ridgetop overlooking Bathurst Lake, approximately 300 m west.	The site consists of chert, siltstone and quartz debitage and 1 retouched grey chert flake that were left *in situ*.	Moderate	NUNAVUT 2011-022A
MbNj-16	Prehistoric	Campsite	Stone Rectangle, Lithic Scatter	The site is located on a ridgetop overlooking Bathurst Lake, approximately 300 m west.	The site consists of a square stone alignment and lithic scatter of tools and debitage from the surface of the site area. Material types observed were chert, basalt and quartz.	Moderate-High	NUNAVUT 2011-022A
MbNj-17	Prehistoric	Campsite	Stone Circle, Cairn, Cache, Drive Lane, Inuksuk	The site is located to the north of a small pond, 4.1 km west of the southern end of Bathurst Lake	The site consists of 2 stone circles, 2 cairns, 1 cache pit, 4 inuksuit (possibly a caribou drive lane).	High	NUNAVUT 2012-12A
MbNj-18	Prehistoric	Resource Gathering	Drive Lane, Inuksuk	The site is located 3.8 km west-northwest of the southern end of Bathurst Lake.	The site consists of 3 inuksuit in a line that maybe part of a drive lane.	Moderate-High	NUNAVUT 2012-12A
MbNj-19	Prehistoric	Resource Gathering	Drive Lane, Inuksuk	The site is located 4.3 km west-northwest of the southern end of Bathurst Lake	The site consists of 4 inuksuit which were constructed with upright slabs of stone, maybe part of a drive lane.	Moderate-High	NUNAVUT 2012-12A
MbNj-20	Prehistoric	Campsite	Stone Circle, Stone Alignment, Hunting Blind	The site is located 3.8 km south-southeast of the southern corner of Bathurst Inlet.	The site consists of 5 hunting blinds, 1 stone circle, 1 stone alignment.	Moderate-High	NUNAVUT 2012-12A
MbNj-21	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a gravel exposure overlooking a lake to the west.	The site consists of a low density lithic scatter with one small white chert point base indicative of the Arctic Small Tool tradition and basalt, chert, and quartzite flakes.	Moderate	NUNAVUT 2013-20A
MbNn-1	Undetermined	Campsite	Stone Circle, Faunal Material	The site is located on the Mara River.	The site consists of 1 tent ring, and some broken caribou antlers. However, some of these had saw marks at their bases, and are thus probably of historic age.		
McNj-1	Historic	Resource Gathering	Inuksuk, Cache	The site is located on a ridge along a peninsula that juts out from the east side of Bathurst Inlet	Site consists of 4 stone caches and 1 stone feature.		NWT 78-432
McNj-2	Historic	Campsite	Stone Circle, Inuksuk, Historic Material	The site is located on the east shore of Bathurst Inlet, at base of a point along the point ridge in a gravelly and stoney area of rolling contours.	The sites at the south end of Bathurst Inlet appear to have been in constant and recent use, as there are modern implements at the site, as well as bone implements. There are thousands of inushuks in the area, and it appears to have been a favorite place for hunting caribou for a long time. (Campbell) Tent ring site. Associated debris includes bone, rusted metal and wood. No native made artifacts found on site. (Morrison)		NWT 78-432
McNj-3	Historic	Campsite	Stone Circle, Historic Material	The site is located at the mouth of a small creek draining from Kenyon Lake into the south end of Bathurst Inlet. Situated at foot of small falls on a flat, gravel area framed by high willows.	Site is badly disturbed. Apparently two occupations. One can be dated to 1976 on basis of scraps of Edmonton Journal. Consists of three disturbed tent rings and a buried garbage dump dug up by a bear. This is almost certainly a camp of Dr. Campbell's used during his geological survey of the area. Campbell reported a historic Inuit site here but the remains have almost totally been obliterated. Single artifact collected from surface relating to this earlier occupation.		NWT 78-432
McNj-4	Historic	Campsite	Historic Material	The site is located at the southeast corner of Bathurst Inlet on the south bank of a half dry, marshy creek flowing into Bathurst Inlet in a low lying grassy marshy area.	The site consists of gathered drift wood, rusted tin fragments, a few spruce tent pegs and a single fragment of cloth. No discernable tent rings or other structures. No prehistoric artifacts on site.		NWT 78-432
McNj-5	Undetermined	Marker	Inuksuk	The site is located on at the south end of Bathurst Inlet.	The site consists of an inuksuk.		NWT 78-432
McNj-6	Undetermined	Marker	Inuksuk	The site is located at the south end of Bathurst Inlet.	The site consists of an inuksuk.		NWT 78-432
McNj-7	Undetermined	Marker	Inuksuk	The site is located at the south end of Bathurst Inlet.	The site consists of an inuksuk.		NWT 78-432
McNj-8	Undetermined	Marker	Inuksuk	The site is located at the south end of Bathurst Inlet about 1 1/2 mi. E. of McNj-2 and 3/4 mi. N. of McNj-7.	The site consists of an inuksuk.		NWT 78-432

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
McNj-9	Undetermined	Marker	Inuksuk	The site is located at the south end at the south end of Bathurst Inlet.	The site consists of an inuksuk.		NWT 78-432
McNj-10	Undetermined	Marker	Inuksuk	The site is located at the south end of Bathurst Inlet.	Site consists of an inuksuk.		NWT 78-432
McNj-11	Undetermined	Marker	Inuksuk	The site is located at the south end of Kenyon Lake near the south end of Bathurst Inlet.	Site consists of an inuksuk.		NWT 78-432
McNj-12	Prehistoric / Historic	Campsite	Stone Oval, Lithic Scatter, Historic Material	The site is located at southeast end of Bathurst Inlet along a small rock and gravel ridge.	Site consists of 2 apparent components - first, a historic Inuit composed of a single 4 x 2 m. ovate tent ring in association with a primus stove gas-cap and a bit of cloth (uncollected) and a second, paleo-eskimo component consists of a sparse scatter of chert flakes and tools, inside and in the immediate area of the tent ring.		NWT 78-432
McNj-13	Historic	Campsite	Stone Circle, Cache, Faunal Material, Historic Material	The site is located on southeast end of Bathurst Inlet, on a rocky hill-top, overlooking Bathurst Inlet.	Site consists of tent rings with a single, empty cache. Associated debris includes caribou bone, 303 shells and a few rusted cans. No prehistoric artifacts were found on this site.		NWT 78-432
McNj-14	Undetermined	Resource Gathering	Hunting Blind, Inuksuk	The site is located on a bench on the southwestern tip of Bathurst Inlet.	McNj-14 was originally recorded by D. Morrison in 1978. The site was revisited in 2011 and three of the hunting blinds were relocated. The other two hunting blinds and the six inuksuit recorded on the original site form were not relocated.		NWT 78-432
McNj-15	Historic	Campsite	Stone Rectangle, Historic Material	The site is located at the southwest end of Bathurst Inlet, on point of land on the western shore of Bathurst Inlet, near the far south end.	The site consists of 1 subrectangular tent ring about 70 m from shore. Surface collected. No native-made artifacts were found on this site. Note: This site is almost certainly the McNk-1 reported by Campbell (1976) but incorrectly located by him on the first large peninsula north of its true location. (Morrison 1978).	Moderate	NWT 78-432 NUNAVUT 2011-022A
McNj-16	Prehistoric / Historic	Campsite	Stone Circle, Cache, Historic Material	The site is located on a bench on the southwestern tip of Bathurst Inlet.	A tent ring site situated about 30 m from shore. Two caches were found along with one artifact, a notched and grooved handle.	Moderate-High	NWT 78-432 NUNAVUT 2011-022A
McNj-17	Prehistoric	Campsite	Stone Circle, Lithic Isolated Find	The site is located on an esker between two lakes	The site consists of 2 tent rings with 1 chert scraper (collected).	Moderate-High	NUNAVUT 2010-024A
McNj-18	Historic	Campsite	Stone Circle, Stone Rectangle, Historic Material	The site is located on the beach on the eastern shore of Bathurst Lake.	The site consists of 3 stone circles and 1 rectangular stone alignment, likely from a canvas tent. Historic metal debris, including the remains of a stove and table legs, were observed at the site.	Moderate	NUNAVUT 2010-024A
McNj-19	Prehistoric / Historic	Campsite	Stone Circle, Stone Oval, Stone Alignment, Lithic Tool, Other	The site is located on a terrace above the western shore of Bathurst Inlet.	The site consists of 4 stone circles, 1 stone oval, 1 pink quartzite flake and 1 piece of green beach glass. Three additional artifacts were found during a revisit in 2011 including a burin-like tool (indicative of the Dorset period), a notched point, and a bipoint.	Moderate	NUNAVUT 2010-024A
McNj-20	Historic	Campsite	Stone Circle, Stone Alignment, Hearth	The site is located on the western shore of Bathurst Inlet.	The site consists of five features including 2 stone circles, a hearth, 1 rectangular rock alignment, and a woodpile of small sticks. There is a scatter of broken bone near the hearth feature. No artifacts were observed at the site.	Moderate	NUNAVUT 2010-024A
McNj-21	Historic	Campsite	Stone Circle, Stone Alignment, Cache, Historic Material	The site is located on the western shore of Bathurst Inlet.	The site consists of 4 features, including 2 stone circles, a firewood cache, and 1 rectangular stone alignment. Historic debris observed in the area included hand-carved wooden tent pegs, ground soapstone, a broken skidoo ski, a 30-calibre rifle cartridge case, a metal axe head, 2 rusted tin cans, and a small piece of rubber. Several caribou antlers with cut marks and broken animal bones were observed in the site.	Moderate	NUNAVUT 2010-024A
McNj-22	Prehistoric	Campsite	Stone Circle	The site is located on the western shore of Bathurst Inlet.	The site consists of 1 stone circle. No artifacts were observed at the site.	Moderate	NUNAVUT 2010-024A
McNj-23	Prehistoric	Campsite	Stone Circle	The site is located on a bench west of Bathurst Inlet.	The site consists of 2 concentric stone circles. The smaller one is surrounded by a partially complete larger one.	Moderate	NUNAVUT 2011-022A
McNj-24	Prehistoric	Campsite	Stone Circle	The site is located on a bench west of Bathurst Inlet.	The site consists of 1 stone circle.	Low	NUNAVUT 2011-022A
McNj-25	Prehistoric / Historic	Campsite	Stone Circle, Stone Oval, Stone Alignment, Cairn, Lithic Isolated Find, Historic Material	The site is located on a bench overlooking Bathurst Inlet, approximately 200 m southwest.	The site consists of 1 stone cairn, 2 stone circles, 3 stone ovals, 1 stone alignment, 1 white quartz flake, and 3 rifle shell casings observed on the surface	Moderate	NUNAVUT 2011-022A
McNj-26	Prehistoric	Resource Gathering	Cache	The site is located on a bench west of a small creek and east of Bathurst Inlet.	The site consists of a stone cache (Feature 1).	Low	NUNAVUT 2011-022A
McNj-27	Prehistoric	Faunal Tool	Faunal Tool	The site is located on a bench just above the beach northeast of Bathurst Inlet.	The site consists of a worked bone fragment, 3 cm by 8 cm. It is interpreted as being prehistoric. No other cultural material was observed.	Low	NUNAVUT 2011-022A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
McNj-28	Prehistoric / Historic	Campsite	Stone Circle, Stone Oval, Stone Alignment, Cairn, Lithic Scatter, Lithic Tool	The site is located on an northwest-southeast trending gravel and bedrock outcrop northeast of the shore of Bathurst Inlet.	The site consists of 6 stone circles, 2 stone ovals, 1 stone pile, 1 stone alignment, and a low density lithic scatter of white chert, white quartz and pink quartz debitage and tools including a Burin-like tool (indicative of the Dorset period) and an asymetrical knife. Additional historic materials, including rifle and hand gun shell casings, a tobacco tin, a wood tent peg, a piece of a stove, broken glass, and a wooden fishing float, were also observed at the site. This site may be the remains of the Hudson's Bay Company's Bathurst Inlet Post during the years 1926 and 1927. The location of this post is described in Fur Trade Posts of the Northwest Territories as "moved to east side of Western River in 1926, about three miles from mouth" (Usher 1971:113). This generally matches the site location, and the historic materials at the site suggest a permanent or semi-permanent settlement."	High	NUNAVUT 2011-022A
McNj-29	Prehistoric	Campsite	Stone Circle, Cache	The site is located on a bench northeast of the shore of Bathurst Inlet.	The site consists of 1 stone circle (Feature 1) and 1 stone cache (Feature 2).	Low	NUNAVUT 2011-022A
McNj-30	Prehistoric	Campsite	Stone Circle	The site is located on a bedrock outcrop overlooking Bathurst Inlet to the southwest.	The site consists of a 2 stone circles (Features 1 and 2). Feature 1 has a line of slate stones oriented north-south through its centre, and Feature 2 has an additional smaller stone circle on its west side.	Low	NUNAVUT 2011-022A
McNj-31	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a bedrock bench overlooking Bathurst Inlet to the south.	The site consists of 1 white chert scraper and cluster of 50 + white chert debitage.	Moderate	NUNAVUT 2011-022A
McNj-32	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a bedrock outcrop overlooking Bathurst Inlet to the south.	The site consists of 1 white chert ASTt burin and cluster of approximately 100+ white chert debitage.	Moderate	NUNAVUT 2011-022A
McNj-33	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a bedrock bench overlooking Bathurst Inlet to the southwest.	The site consists of 1 light pink chert biface, 1 cream chert biface, 1 clear quartz biface fragment, 1 microblade core, and a cluster of approximately 100+ white-cream chert and clear quartz flakes, all from the surface of the site area. Several microblades were observed adjacent to the microblade core. The artifacts are indicative of the ASTt.	Moderate	NUNAVUT 2011-022A
McNj-34	Prehistoric	Campsite	Stone Circle	The site is located on a bench immediately north of Bathurst Inlet.	The site consists of 1 stone circle (2 m dia.).	Low	NUNAVUT 2011-022A
McNj-35	Historic	Marker	Stone Alignment	The site is located along a peninsula that juts out from the east side of Bathurst Inlet.	The site consists of a stone alignment (Feature 1) that spells out the letters "J F".The letters "JF" could related to John Franklin who, in August 1821, led an expedition that canoed to the southern tip Bathurst Inlet, at the outlet of the Western River. However, the Bathurst Inlet Lodge occasionally runs John Franklin-themed tours of the inlet and the letters may also related to their activities in the area.	Moderate-High	NUNAVUT 2011-022A
McNj-36	Prehistoric	Campsite	Stone Circle	The site is located on a bench overlooking Bathurst Inlet to the south.	The site consists of a partial stone circle (Feature 1) that is incomplete at its southern end.	Low	NUNAVUT 2011-022A
McNj-37	Prehistoric	Resource Gathering	Hunting Blind, Cache, Inuksuk	The site is located on a peninsula that juts out from the east side of Bathurst Inlet.	The site consists of 1 stone blind/inuksuit with a possible cache in the front and 1 stone cache. Feature 2 is highly visible from shore line. Pile of stones in front of the feature maybe a collapsed portion of this feature or a cache.	Low	NUNAVUT 2011-022A
McNj-38	Prehistoric	Resource Gathering	Cairn, Lithic Scatter	The site is located on a break-in-slope along a peninsula that juts out from the east side of Bathurst Inlet.	The site consists of 1 collapsed stone cairn and a scatter of 1 quartz flake and 3 chert flakes.	Low	NUNAVUT 2011-022A
McNj-39	Prehistoric / Historic	Campsite	Stone Circle, Stone Oval, Stone Alignment, Cache, Cairn, Historic Material	The site is located along the southern shoreline of a peninsula that juts out from the east side of Bathurst Inlet.	The site consists of 3 stone caches , 3 stone circles, 2 stone ovals, 1 collapsed stone cairn, 1 stone oval, and 1 stone wall. A tobacco tin lid was also noted.	Moderate	NUNAVUT 2011-022A
McNj-40	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a bedrock outcrop overlooking Bathurst Inlet to the northeast.	The site consists of over 200 white, pink and grey chert flakes, 2 biface fragments, approximately 10 microblades, 2 microblade cores, 1 biface, 3 scrapers, 1 white chert core fragment, 1 grey chert retouched flake, a grey quartz flake, 3 biface basal fragments, and 1 grey siltstone or felsic tuff chisel. The artifact assemblage is indicative of the ASTt.	Moderate	NUNAVUT 2011-022A
McNj-41	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a remnant beach terrace overlooking Bathurst Inlet to the northeast.	The site consists of a white chert core fragment. No other cultural material was observed.	Low	NUNAVUT 2011-022A
McNj-42	Prehistoric	Campsite	Stone Oval	The site is located on a bench overlooking the outlet of the Western River into Bathurst Inlet to the west.	The site consists of 2 stone ovals.	Low	NUNAVUT 2011-022A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
McNj-43	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a bench along the west side of Bathurst Inlet to the northeast.	The site consists of a lithic scatter of white chert and quartz tools and debitage from the surface of the site area.	Moderate	NUNAVUT 2011-022A
McNj-44	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a terrace north of a small creek overlooking Bathurst Inlet to the northeast.	The site consists of a lithic scatter of approximately 15 white chert debitage from the surface of the site area.	Low	NUNAVUT 2011-022A
McNj-45	Prehistoric	Lithic Isolated Find	Lithic Isolated Find	The site is located on a sandy northeast-southwest trending ridge beside a fast flowing creek overlooking Bathurst Inlet to the northeast.	The site consists of a white chert core fragment. No other cultural material was observed.	Low	NUNAVUT 2011-022A
McNj-46	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located west of Bathurst Inlet.	The site consists of a white chert lithic scatter with 1 flake and 4 microblade fragments. The artifact assemblage is indicative of the ASTt.	Moderate-High	NUNAVUT 2012-12A
McNj-47	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located west of Bathurst Inlet.	The site consists of 2 chert lithic scatters with 7 (white chert) flakes, 1 orange chert flake, 4 microblades (3 white chert and 1 light orange chert). The artifact assemblage is indicative of the ASTt.	Moderate-High	NUNAVUT 2012-12A
McNj-48	Prehistoric / Historic	Resource Gathering	Stone Alignment, Lithic Scatter, Historic Material	The site is located south of Bathurst Inlet.	The site consists of a stone alignment and lithic scatters with over 100 flakes, an orange-beige blade/end scraper, a white chert sideblade, a white chert biface, a brown banded chert biface, a clear quartz scraper,2 quartz wedges, and approximately 10 white quartz crystals. The lithic artifact assemblage is indicative of the ASTt. One Western 25-20 cartridge shell was also found.	High	NUNAVUT 2012-12A
McNj-49	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located south of Bathurst Inlet.	The site consists of 1 white chert asymmetric knife, 1 biface fragment and 1 lithic scatter with 8 flakes. The artifact assemblage is indicative of the ASTt.	Moderate-High	NUNAVUT 2012-12A
McNj-50	Prehistoric	Campsite	Stone Circle	The site is located south of Bathurst Inlet.	The site consists of 1 stone circle on a bedrock exposure with a small area of flat pavement of stones inside.	Moderate	NUNAVUT 2012-12A
McNk-1	Undetermined	Marker	Cairn	The site is located on a point of land at the south end of Bathurst Inlet.	The site consists of a stone cairn.	Low	
McNk-2	Undetermined	Historic Material	Other, Historic Material	The site is located west of Amagok Creek.	The site consists of a part of a short wooden bow (estimated to be about 1/2) whose total length would not have exceeded 3 1/2 ft. In addition, in this same area, a nail-studded kayak paddle was also found lying on the tundra.	Low-Moderate	
McNk-3	Historic	Campsite	Stone Circle, Stone Rectangle, Hunting Blind, Cache, Hearth, Inuksuk, Stone Trap	The site is located at the north end of Bathurst Lake (Tahikaffaaluk), on either side of stream.	About 75 archaeological features were noted and mapped and about 30 features were examined, identified and named by Kiluhiqturmiut Inuit elders from Cambridge Bay during this project. (Stewart 2004 site form). Nothing collected.	High	NUNAVUT 2004-019A
McNk-4	Prehistoric / Historic	Campsite	Stone Circle, Stone Alignment, Cache, Lithic Scatter, Historic Material	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 2 stone circles, 3 stone alignments, 1 cache and a pink quartzite lithic scatter including 2 cores and debitage. Historic materials located at the site includes a plastic tent peg, and a tin can. No diagnostic artifacts found.	High	NUNAVUT 2010-024A
McNk-5	Prehistoric	Campsite	Stone Circle	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 2 stone circles , one of which has a pavement of stone slabs. No artifacts were observed at the site.	Moderate	NUNAVUT 2010-024A
McNk-6	Prehistoric	Resource Gathering	Cache, Faunal Material	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 1 cache measuring 5 m diameter with caribou bones visible in centre. No artifacts visible.	Moderate	NUNAVUT 2010-024A
McNk-7	Historic	Resource Gathering	Cache, Faunal Material, Historic Material	The site is located on the northernmost tip of Bathurst Lake.	The site consists of at least 6 stone caches constructed from larges pink quartzite stone slabs. Caribou bones were visible in two of the caches and a metal wrench and other modern debris were also observed in some of the caches. No prehistoric artifacts were observed.	Moderate	NUNAVUT 2010-024A
McNk-8	Prehistoric	Campsite	Stone Circle, Stone Alignment, Hearth, Cairn	The site is located on the northernmost tip of Bathurst Lake.	The site consists of a stone circle with a hearth feature at the south end and a stone alignment that consists of four discrete piles of stones that incorporate slabs of pink quartzite placed vertically to stand on edge.	High	NUNAVUT 2010-024A
McNk-9	Prehistoric	Campsite	Stone Circle	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 1 stone circle. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
McNk-10	Prehistoric	Campsite	Stone Circle, Stone Oval, Cairn	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 14 stone features including 7 stone circles, 3 stone semi-circles, 1 stone oval, 1 pavement of stone slabs, 1 stone pile, and 1 cairn.	High	NUNAVUT 2010-024A
McNk-11	Prehistoric	Campsite	Stone Oval, Stone Alignment, Cairn	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 5 features including 1 stone oval, 1 stone alignment, and 3 stone markers.	High	NUNAVUT 2010-024A
McNk-12	Historic	Campsite	Stone Circle, Cache, Hearth, Historic Material	The site is located on the northernmost tip of Bathurst Lake.	The site consists of 3 stone circles and 1 cache/hearth feature containing historic debris (batteries, a tin can, and broken bone).	High	NUNAVUT 2010-024A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
McNk-13	Prehistoric	Resource Gathering	Cache	The site is located on the northernmost tip of Bathurst Lake.	The site consists of a small cache constructed of flat pink quartzite slabs. No artifacts were observed in the area.	Moderate	NUNAVUT 2010-024A
McNk-14	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on the top on an esker east of an unnamed river.	The site consists of 1 large pink quartzite core and several flakes. No diagnostic or formed tools were observed.	Low	NUNAVUT 2010-024A
McNk-15	Historic	Resource Gathering	Historic Material	The site is located on a small knoll between two ridges west of Bathurst Inlet.	The site consists of 1 surface find containing 2 spent rifle cartridges. The cartridges were dated from the headstamps: WRA Co. 38-55 (Winchester Repeating Arms - produced 1866-1932) and D.C. Co. 38-55 (Dominion Cartridge Co. - produced 1886-1947).	Low	NUNAVUT 2010-024A
McNk-16	Prehistoric	Resource Gathering	Stone Alignment, Inuksuk	The site is located on a bench west of Bathurst Inlet.	The site consists of a rectangular stone alignment (Feature 1) and a collapsed stone cairn (Feature 2).	Low	NUNAVUT 2011-022A
McNk-17	Prehistoric	Campsite	Stone Oval, Cairn, Other	The site is located on a bench southwest of Bathurst Inlet.	The site consists of 1 stone oval, 1 stone pile with 5 stones, and an abrasive stone with numerous groove marks. These are interpreted as prehistoric. The scatter of wood sticks (possibly firewood) is likely historic.	Low	NUNAVUT 2011-022A
McNk-18	Historic	Historic Artifact Scatter	Historic Material	The site is located on along the beach on the east side of Bathurst Inlet.	The site consists of several runner pieces of a wood sled and a wood oar. These are interpreted to be historic (20th century) items.	Low	NUNAVUT 2011-022A
McNk-19	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a high bedrock ridge west of Bathurst Inlet.	The site consists of 2 white quartzite lithic scatters with approximately 20 flakes.	Low	NUNAVUT 2012-12A
McNk-20	Prehistoric	Campsite	Stone Circle	The site is located on a ridge overlooking Bathurst Inlet to the east.	The site consists of 1 stone circle.	Moderate	NUNAVUT 2012-12A
McNk-21	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a terrace above Bathurst Inlet.	The site consists of 2 white chert lithic scatters with 20-30 flakes, 1 chert biface, and 1 retouched quartzite flake.	Low-Moderate	NUNAVUT 2012-12A
McNk-22	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on terrace overlooking Bathurst Inlet.	The site consists of 10 lithic scatter with over 500 flakes, 1 white chert bipoint, white quartzite ovoid knife fragment, and 1 burin spall tool. Material types included white and light green quartzite and white chert. The artifact assemblage is indicative of the ASTt.	High	NUNAVUT 2012-12A
McNk-23	Historic	Resource Gathering	Historic Scatter	The site is located to the north of a small lake west of Bathurst Inlet.	The site consists of 5 rifle cartridges, D.C. co. 30-30, likely manufactured by the Dominion Cartridge Company of Montreal between 1886 and 1947 (Steinhauser nd).	Low-Moderate	NUNAVUT 2012-12A
McNk-24	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on an esker west of Bathurst Inlet.	The site consists of 1 white chert microblade and 7 flakes (2 white quartzite, 4 white chert). The artifact assemblage is indicative of the ASTt.	Moderate-High	NUNAVUT 2012-12A
McNk-25	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a raised area west of Bathurst Inlet.	The site consists of 1 lithic scatter with 11-20 white quartzite flakes.	Low	NUNAVUT 2012-12A
MdNk-1	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of 2 artifacts in fully exposed context. One secondary flake of quartz and one flake fragment of white chert.	Low	NUNAVUT 2001-019A
MdNk-2	Prehistoric	Lithic Isolated Find	Lithic Isolated Find	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of 1 sandstone flake (collected).	Low	NUNAVUT 2001-019A
MdNk-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	Consists of a limited artifact scatter in exposed context. A large quartz decortication flake fragment and a quartz cobble spall were found within five metres of each other.	Low	NUNAVUT 2001-019A
MdNk-4	Prehistoric	Campsite	Hearth, Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of a hearth feature, and a lithic scatter including 1 blade, 3 modified flakes, 6 pieces of quartz shatter, and 53 quartz flakes (collected).	Moderate-High	NUNAVUT 2001-019A
MdNk-5	Undetermined	Marker	Cairn	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of a cairn of large rocks. The rocks are located on top of a large boulder and look like they were piled more recently than other stone features in the area based on lichen growth and neighbouring stone contact points.	Low	NUNAVUT 2002-035A
MdNk-6	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of 9 artifacts collected from this fully exposed site including 7 quartz flakes, 1 quartz scraper fragment, and 1 piece of quartz shatter.	Low-Moderate	NUNAVUT 2002-035A
MdNk-7	Prehistoric	Resource Gathering	Cache, Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of a small surface scatter, mostly banded chert flakes along with 1 projectile point preform, along with a cache of rocks and a small stone feature.	High	NUNAVUT 2002-035A
MdNk-8	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of an exposed artifact scatter. Over 100 artifacts were collected including 1 small lanceolate arrow tip similar to Taltheilei (but minus the ears).	Moderate-High	NUNAVUT 2002-035A
MdNk-9	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of an exposed artifact scatter (13 lithic artifacts collected including 1 quartzite biface).	Moderate	NUNAVUT 2002-035A

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Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
MdNk-10	Prehistoric / Historic	Campsite	Stone Circle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	Undisturbed surficial stone features. Tent rings are located above the shoreline on the first terrace overlooking the water at the tip of the peninsula. Two more tent rings are located on the shore west of the site and a number of the tent ring sites are located on the shoreline down the east side of the peninsula. No artifacts were identified. Historic residue in the form of oil drums and faunal remains appear nearby.	Moderate	NUNAVUT 2002-035A
MdNk-11	Undetermined	Campsite	Stone Circle, Historic Material	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of 2 tent rings. No associated artifacts. Oil drums and faunal remains appear nearby.	Moderate	NUNAVUT 2002-035A
MdNk-12	Undetermined	Campsite	Stone Circle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of tent rings. A large number of flowers were observed growing in and around the features possibly indicating a burial or increased organic content from butchering activity.	Moderate	NUNAVUT 2002-035A
MdNk-13	Undetermined	Campsite	Stone Circle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of 2 tent rings. No associated artifacts.	Moderate	NUNAVUT 2002-035A
MdNk-14	Undetermined	Resource Gathering	Cache	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of 2 small stone rings interpreted as caches about 12 m. apart. Features are disturbed.	Moderate	NUNAVUT 2002-035A
MdNk-15	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of an exposed artifact scatter. Eighty-five artifacts were collected consisting of 4 tools (including a unifacially flaked semi-lunate biface), 77 quartz flakes and 4 pieces of quartz shatter.	Moderate	NUNAVUT 2002-035A
MdNk-16	Historic	Campsite	Stone Rectangle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of a stone rectangle from a canvas tent.	Low	NUNAVUT 2002-035A
MdNk-17	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of an exposed artifact scatter. Chert material of a high quality. Forty-eight artifacts were collected.	Moderate	NUNAVUT 2002-035A
MdNk-18	Prehistoric	Campsite	Stone Circle, Lithic Scatter	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of a tent ring of 20 -22 stones. This is the only tent ring site located on top of the peninsula as all others are situated on or above the shoreline. Forty-three artifacts were collected (mostly flakes and shatter).	Moderate	NUNAVUT 2002-035A
MdNk-19	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of a small surface lithic scatter of approximately 100 pieces observed.	Low	NUNAVUT 2002-035A
MdNk-20	Prehistoric	Lithic Reduction	Lithic Isolated Find	The site is located on a ridge on a peninsula that extends north into Bathurst Inlet.	The site consists of 1 lithic flake of white quartz. No additional materials.	Low	NUNAVUT 2002-035A
MdNk-21	Prehistoric	Campsite	Stone Circle	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of a small tent ring approximately 2 m x 1.5 m. No artifacts identified.	Low	NUNAVUT 2002-035A
MdNk-22	Prehistoric	Campsite	Stone Circle, Heart, Cache	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	The site consists of 2 tent rings, 1 hearth and 1 cache.	High	NUNAVUT 2002-035A
MdNk-23	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on the eastern shoreline of a peninsula that extends north into Bathurst Inlet.	Artifacts were all recovered on the downslope blown out sandy areas. 79 artifacts were collected including projectile points, drills, microblades, microblade cores, end scrapers and side blades. Potentially a multicomponent site. The artifact assemblage is indicative of the ASTt and the Taltheilei tradition.	High	NUNAVUT 2002-035A
MdNk-24	Prehistoric	Campsite	Stone Circle	The site is located on a peninsula which juts out from the western shore of Bathurst Inlet.	The site consists of 1 stone circle. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
MdNk-25	Prehistoric	Campsite	Stone Circle, Cairn	The site is located on a peninsula which juts out from the western shore of Bathurst Inlet.	The site consists of 2 stone circles and another small stone feature consisting of four rocks placed together. No artifacts were observed.	Moderate	NUNAVUT 2010-024A
MdNk-26	Prehistoric	Campsite	Stone Circle	The site is located on the western shore of Bathurst Inlet.	The site consists of 1 stone circle.	Low	NUNAVUT 2010-024A
MdNk-27	Historic	Campsite	Stone Circle, Hearth, Historic Material	The site is located on a knoll west of Bathurst Inlet.	The site consists of a wooden axe handle, a small wooden toy sled, a rifle shell, a stove-pipe collar, a carved wooden stake and a tobacco can. All artifacts left *in situ*.	Low	NUNAVUT 2010-024A
MdNk-28	Prehistoric	Campsite	Stone Circle, Other	The site is located on a gravel bench just above the beach southwest of the shore of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet.	The consists of 1 stone circle with 12 stones and 2 wooden sticks with the ends squared.	Low	NUNAVUT 2011-022A

Appendix B. Archaeological Sites with the Study Area

Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
MdNk-29	Prehistoric / Historic	Campsite	Stone Circle, Hearth, Faunal Material, Historic Material	The site is located on an bench of exposed gravel and sparse vegetation just above the beach, approximately 15 m southwest of the shore of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet	The site consists of 3 stone circles and 1 hearth, all interpreted as prehistoric. Scatters of broken bone were observed on the ground across the area. A wooden jigger & rifle shell casing are likely from historic use of this area.	Low	NUNAVUT 2011-022A
MdNk-30	Prehistoric / Historic	Campsite	Stone Circle, Historic Material	The site is located on a grassy bench just above the beach southwest of the shore of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet.	The site consists of 1 stone circle, of 23 stones and 4 m in diameter, which is interpreted as being prehistoric and a wooden handle is interpreted as being from historic use of this area.	Low	NUNAVUT 2011-022A
MdNk-31	Prehistoric	Campsite	Stone Circle, Faunal Tool	The site is located on a bench just above the beach southwest of the shore of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet.	The site consists of a stone circle consisting of 25 stones, and a bone scraper, both interpreted as being prehistoric. The bone scraper was left *in situ*.	Low	NUNAVUT 2011-022A
MdNk-32	Prehistoric	Resource Gathering	Stone Alignment, Faunal Material	The site is located on a bench southwest of Bathurst Inlet. The site is on a peninsula that extends north-northwest from the west side of the inlet.	The site consists of 1 stone alignment, 9 stones and 1 stone circle of 7 stones containing a scatters of broken bones.	Low	NUNAVUT 2011-022A
MdNk-33	Prehistoric	Campsite	Stone Circle, Stone Oval, Inuksuk, Lithic Scatter	Situated on a bench overlooking Bathurst Inlett to the northeast.	The site consists of 2 stone piles, 3 stone circles, 1 stone oval, and a scatter of quartzite flakes on the surface including 10 green quartz flakes, 2 pink quartz flakes, and 1 white quartz flake. All artifacts were left *in situ*.	Moderate	NUNAVUT 2011-022A
MdNk-34	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a bench overlooking Bathurst Inlet to the northeast.	The site consists of 8 white quartz flakes on the surface.	Low	NUNAVUT 2011-022A
MdNk-35	Prehistoric	Isolated Lithic Tool	Lithic Scatter	The site is located on a bench of exposed gravel and sand overlooking Bathurst Inlet to the northeast.	The site consists of 1 pink-rose quartzite cortex spall tool from the surface of the site area. No other cultural material was observed.	Low	NUNAVUT 2011-022A
MdNk-36	Prehistoric / Historic	Campsite	Stone Circle, Stone Oval, Faunal Material, Historic Material	The site is located on a bench just above the beach west of Bathurst Inlet.	The site consists of 1 stone circle, one half circle, and 2 stone ovals. Additionally, several pieces of broken bone and a piece of brown glass were observed.	Low	NUNAVUT 2011-022A
MdNk-37	Prehistoric	Campsite	Stone Circle	The site is located on a raised beach east of Bathurst Inlet.	The site consists of a stone circle.	Low	NUNAVUT 2011-022A
MdNk-38	Prehistoric	Campsite	Stone Circle, Faunal Tool	The site is located on a bench east of Bathurst Inlet.	The site consists of a stone circle and ulna bone tool that was left *in situ*.	Low	NUNAVUT 2011-022A
MdNk-39	Prehistoric	Lithic Workshop	Lithic Scatter	The site is located on a ridge west of Bathurst Inlet.	The site consists of 8 lithic scatters with 400-500 total flakes of banded brown and white chert, orange chert, and white chert. Additionally one large cobble with a bowl shaped pecked depression was found and left *in situ* and 1 white chert burin, 1 chert point fragment and 1 white chert side blade were collected. The artifact assemblage is indicative of the ASTt.	High	NUNAVUT 2012-12A
MdNk-40	Prehistoric	Resource Gathering	Cache	The site is located on the edge of a terrace west of Bathurst Inlet.	The site consists of 1 cache.	Moderate	NUNAVUT 2012-12A
MdNk-41	Prehistoric	Resource Gathering	Cache, Hearth	The site is located on a terrace west of Bathurst Inlet.	The site consists of 1 cache and 1 hearth.	Moderate-High	NUNAVUT 2012-12A
MdNk-42	Prehistoric	Campsite	Stone Circle, Cache	The site is located on a terrace south of a small stream.	The site consists of 1 stone circle and 1 cache.	Moderate	NUNAVUT 2012-12A
MdNk-43	Prehistoric	Campsite	Stone Circle, Hearth	The site is located on a knoll southwest of Bathurst Inlet.	The site consists of 1 stone circle and 1 hearth.	Moderate-High	NUNAVUT 2012-12A
MdNk-44	Prehistoric	Campsite	Stone Circle, Kayak Stand	The site is located on the west side of Bathurst Inlet.	The site consists of 2 stone circles and 2 kayak stands.	Moderate	NUNAVUT 2012-12A
MdNk-45	Prehistoric	Campsite	Stone Circle, Cache	The site is located on the west side of Bathurst Inlet.	The site consists of 3 stone circles and 1 stone cache.	Moderate	NUNAVUT 2012-12A
MdNk-46	Prehistoric	Resource Gathering	Cache	The site is located 75 m west of Bathurst Inlet.	The site consists of 3 caches.	Moderate	NUNAVUT 2012-12A
MdNk-47	Undetermined	Campsite	Stone Circle	The site is located on the west side of Bathurst Inlet.	The site consists of 1 stone circle.	Moderate	NUNAVUT 2012-12A
MdNk-48	Historic	Campsite	Stone Circle, Stone Alignment, Hearth, Historic Material	The site is located on the west side of Bathurst Lake.	The site consists of stone circles, hearths, stone alignments, a wooden platform, old core boxes and 2 x 4s. Likely related to mineral exploration.	Low-Moderate	NUNAVUT 2012-12A

Appendix B. Archaeological Sites with the Study Area

Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
MdNl-2	Prehistoric	Campsite	Stone Circle, Hearth, Lithic Scatter	The site is located on a knoll on the west shore of Bathurst Inlet.	Small site, sterile, disturbed tent ring, a hearth windbreak. Scatter of quartzite and chert flakes. Microblade, end scraper and 2 chert artifacts. Test pitting and search of other deflation areas futile. Occupation very small and almost entirely restricted to the already exposed flake scatter. The artifact assemblage is indicative of the ASTt.	Moderate-High	NWT 78-432
MdNl-3	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a small pea-gravel terrace on the south shore of Fishing Creek Lake, west of Bathurst Inlet.	The site consists of a thin scatter of grey quartzite flakes.	Low-Moderate	NWT 78-432
MdNl-4	Prehistoric / Historic	Campsite	Stone Circle, Faunal Material, Lithic Scatter, Historic Material	The site is located on a hill on the southwest of Fishing Creek Lake.	Tent ring site, few rusted metal fragments and a great deal of caribou bone. Also a tiny prehistoric component of three green and white chert flakes, found together on the surface.	Moderate	NWT 78-432
MdNl-5	Undetermined	Campsite	Stone Circle	The site is located on the west shore of Bathurst Inlet on a grass and gravel hillside.	Tent ring site, sterile, littered with loose stone. The extant tent rings are overgrown and partially buried.	Moderate-High	NWT 78-432
MdNl-6	Prehistoric	Campsite	Stone Oval, Cache, Lithic Scatter	The site is located on a peninsula on the western shore of Bathurst Inlet.	The site consists of 1 cache with a pavement of stones beside it, 2 stone ovals, and a lithic scatter of 40 + white chert, pink and white quartzite flakes, 1 white chert asymmetrical knife fragment. The artifact assemblage is indicative of the ASTt.	High	NUNAVUT 2012-12A
MdNl-7	Prehistoric / Historic	Campsite	Stone Oval, Lithic Scatter, Historic Material	The site is located on a peninsula on the western shore of Bathurst Inlet.	The site consists of 2 stone ovals, one with a pavement of flat stones, 7 flakes, 1 white chert side blade, 1 clear quartz core, 2 asymmetric knifes of white chert, and a rifle cartridge (223 Remington). The lithic artifact assemblage is indicative of the ASTt.	High	NUNAVUT 2012-12A
MdNl-8	Prehistoric	Campsite	Hearth, Lithic Scatter	The site is located on a peninsula on the western shore of Bathurst Inlet.	The site consists of a pavement of 20 flat stone possibly a hearth and 9 lithic scatters with over 200 chert and quartz flakes, 1 beige banded chert asymmetric knife, 2 beige and brown banded points, 1 white chert burin, and 1 white chert sideblade. The artifact assemblage is indicative of the ASTt.	High	NUNAVUT 2012-12A
MdNl-9	Prehistoric	Campsite	Stone Circle, Hearth	The site is located above the current shoreline on the western side of Bathurst Inlet.	The site consists of 1 fire pit and 1 stone circle.	Moderate	NUNAVUT 2012-12A
MdNl-10	Prehistoric	Campsite	Stone Rectangle, Isolated Find	The site is located above the current shoreline on the western side of Bathurst Inlet.	The site consists of 1 stone rectangle and 1 quartzite spall tool.	Moderate	NUNAVUT 2012-12A
MdNl-11	Historic	Faunal Tool	Faunal Tool	The site is located above the current shoreline on the western side of Bathurst Inlet.	The site consists of 1 seal skin rope 12 m long and 1 cm wide.	Moderate	NUNAVUT 2012-12A
MdNl-12	Prehistoric	Resource Gathering	Cache, Cairn	The site is located on break in slope, on a peninsula on the western side of Bathurst Inlet.	The site consists of 1 cache and 1 cairn.	Moderate	NUNAVUT 2012-12A
MdNl-13	Prehistoric	Lithic Reduction	Lithic Scatter	The site is located on a terrace above Bathurst Inlet.	The site consists of 2 white quartzite flakes.	Moderate	NUNAVUT 2012-12A
MdNl-14	Undetermined	Campsite	Stone Circle	The site is located on a rise on the western side of Bathurst Inlet.	The site consists of 2 stone circles.	Moderate	NUNAVUT 2012-12A
MdNl-15	Undetermined	Resource Gathering	Cache	The site is located on the shore of Bathurst Inlet.	The site consists of 5 caches.	High	NUNAVUT 2012-12A
MdNl-16	Historic	Campsite	Stone Circle, Faunal Material, Historic Material	The site is located on a terrace on a peninsula on the western side of Bathurst Inlet.	The site consists of 1 stone circle, rusted tin cans, plastic fragments, broken caribou bone, and a toy Land Rover.	Low	NUNAVUT 2012-12A
MdNl-17	Undetermined	Campsite	Stone Circle, Hearth	The site is located on a bench overlooking the beach on the western shore of Bathurst Inlet.	The site consists of 1 stone circle and 1 hearth.	Moderate	NUNAVUT 2012-12A
MdNl-18	Undetermined	Campsite	Stone Circle, Faunal Material	The site is located on the western shore of Bathurst Inlet, approximately 18 km directly east of the western arm of Tahikafalok Lake.	The site consists of 1 stone circle with scatter of broken caribou bone around it.	Moderate	NUNAVUT 2012-12A
MdNl-19	Historic	Historic Isolated Find	Historic Material	The site is located on the western shore of Bathurst Inlet.	The site consists of one wooden oar with a wrapped metal end.	Low	NUNAVUT 2012-12A
MdNl-20	Historic	Historic Artifact Scatter	Historic Material	The site is located on the western shore of Bathurst Inlet, 40.5 km northwest of the southern end of the inlet, at an elevation of 1 m asl.	The site consists of 1 piece of wooden board with a curved side (perhaps a piece of a lid) and a rusted metal screw or pin.	Low	NUNAVUT 2012-12A
MeNl-0	Undetermined	Burial		Young Point. Near Cape Bathurst	A scatter of bone. PA material surface collected during the Stefansson Expedition (Canadian Arctic Expedition 1913-1916). (Per M. Gardiner, GC project 2008-2009).		
MeNl-1	Undetermined	Campsite	Stone Circle, Cache, Inuksuk, Faunal Material, Other	The site is located on a small island in Young Point Cove south of the mouth of the Burnside River and north of the mouth of Fishing Creek on the east side of the bay.	Cache, inuksuk and tent ring site. Caches are unusually large, up to 1 1/2 m.high and 2 m. across at the base. All are open to the sky and empty, except for a few which contain small quantities of willow branches. Save for few scraps of bone, site is sterile. No native made artifacts on site.		NWT 78-432

Appendix B. Archaeological Sites with the Study Area

Borden Number	Antiquity	Site Type - General	Site Type - Specific	Terrain Description	Comments	Site Significance	Permit Number
MeNl-2	Undetermined	Campsite	Stone Circle, Cache	The site is located on the west shore of Bathurst Inlet.	Sterile tent ring and cache site.		NWT 78-432
MeNl-3	Historic	Grave	Burial, Human Remains, Drive Lane, Historic Artifacts, Stone Oval	The site is located along the top of a high stony ridge on the north of Fishing Creek Lake.	A inuksuk and grave site consisting of a 450 m drive lane, a stone oval, a surface burial, and historic grave goods discovered beneath three flat rocks. Skeletal material left *in situ* inlcude a molar, a premolar, a few phalanges, tiny scraps of bone.	High	NWT 78-432
MeNl-4	Historic	Campsite	Stone Circle, Hearth, Hunting Blind, Cache, Inuksuk	The site is located on the east bank of Fishing Creek, west of Bathurst Inlet.	Very large, historic/recent Inuit campsite, spread out over almost 700 m along the east shore of Fishing Creek. It consists of 19 relatively distinct tent rings, caches, inuksuit, shooting blinds and hearths. It is not the remains of single contemporaneous camp as the size alone suggests. Site has clearly been occupied within last few years and for some time before that.	Moderate	NWT 78-432
MeNl-5	Historic	Campsite	Stone Circle, Historic Material	The site is located on a ridge northwest of Fishing Creek Lake.	Tent ring site, 2 tent rings are associated with debris, the others are sterile and overgrown.	Low-Moderate	NWT 78-432
MeNl-6	Historic	Campsite	Stone Circle, Faunal Material, Historic Material	The site is located on the west shore of Bathurst Inlet.	The site consists of five tent rings one the shore, bone, rusted metal, cloth fragments, etc. No native-made artifacts were found on the site.	Moderate-High	NWT 78-432
MeNl-7	Historic	Campsite	Stone Circle	The site is located on the west shore of Bathurst Inlet.	The site is atent ring site that was probably not a single contemporaneous camp. No prehistoric artifacts were found on the site.		NWT 78-432
MeNl-8	Historic	Campsite	Stone Circle, Faunal Material	The site is located on the west shore of Bathurst Inlet.	A tent ring site on the shore. No prehistoric artifacts were found. Note: this is one of the few sites found on which seal bone was observed.		NWT 78-432
MeNl-9	Undetermined	Campsite	Stone Circle	The site is located on the west shore of Bathurst Inlet.	Sterile tent ring site.		NWT 78-432
MeNl-10	Prehistoric	Campsite	Stone Oval	The site is located . in an area of rock and low willows on the west shore of Bathurst Inlet.	The site consists of 2 sterile tent rings, over-grown with willows. This appears to be a fairly old site, possibly prehistoric.		NWT 78-432
MeNl-14	Prehistoric	Campsite	Stone Circle, Hunting Blind, Lithic Scatter, Faunal Material	The site is located on a knoll south of Fishing Creek Lake.	The site consists of a number of discontinuous flake and calcine bone scatters distributed in shallows blowouts along the top of the knoll as well as a small buried component. Also two sterile tent rings and a shooting blind which presumably date much later than the main occupation. Further work recommended. Surface collected by B. Gordon in 1987.	High	NWT 78-432 NWT 87-615
MeNl-15	Undetermined	Resource Gathering	Hunting Blind, Inuksuk	The site is located on top of a ridge over looking Bathurst Inlet to east.	A hunting blind, three inuksuit and a piece antler (potentially worked). The hunting blind has 19 stones and two of the inuksuit consist of a stone slabs held upright by smaller stones. The third inuksuk consists of a slab sitting on top of a boulder.	Moderate	NUNAVUT 2013-20A
MfNm-3	Historic	Campsite	Stone Circle, Faunal Material, Historic Material	The site is located on the west shore of Bathurst Inlet.	Tent ring site including caribou bone, a few cloth and cord fragments and a few pieces of rusted metal. No native-made artifacts were found on the site.		NWT 78-432

Appendix V8-1C
Archaeological Site Type and Artifact Tables

Sabina
GOLD & SILVER CORP.

Table V8-1C-1. Regional Study Area Archaeological Site Types

Antiquity	Site Type	Borden Numbers
Historic	Campsite	LiNh-1, LiNj-1, LkNk-1, McNj-2, McNj-3, McNj-4, McNj-13, McNj-15, McNj-18, McNj-20, McNj-21, McNk-3, McNk-12, MdNk-16, MdNk-27, MdNk-48, MdNl-16, MeNl-4, MeNl-5, MeNl-6, MeNl-7, MeNl-8
	Faunal Tool	MdNl-11
	Grave	MeNl-3, LkNh-2
	Historic Artifact Scatter	McNk-18, MdNl-20
	Historic Isolated Find	MdNl-19
	Marker	LlNl-13, MaNl-4, McNj-35
Prehistoric	Campsite	LiNj-2, LkNi-1, LkNi-2, LlNj-1, LlNk-14, LlNk-20, LlNl-5, LlNl-15, MaNj-1, MaNj-3, MaNl-3, MbNj-3, MbNj-4, MbNj-6, MbNj-8, MbNj-10, MbNj-12, MbNj-13, MbNj-14, MbNj-16, MbNj-17, MbNj-20, McNj-17, McNj-22, McNj-23, McNj-24, McNj-29, McNj-30, McNj-34, McNj-36, McNj-42, McNj-50, McNk-5, McNk-8, McNk-9, McNk-10, McNk-11, McNk-17, McNk-20, MdNk-4, MdNk-18, MdNk-21, MdNk-22, MdNk-24, MdNk-25, MdNk-26, MdNk-28, MdNk-31, MdNk-33, MdNk-37, MdNk-38, MdNk-42, MdNk-43, MdNk-44, MdNk-45, MdNl-2, MdNl-6, MdNl-8, MdNl-9, MdNl-10, MeNl-10, MeNl-14
	Faunal Tool	McNj-27
	Isolated Lithic Tool	LlNk-8, LlNk-12, LlNk-16, LlNk-22, MdNk-35
	Lithic Isolated Find	LjNh-2, LkNh-5, McNj-45, MdNk-2
	Lithic Reduction	LiNj-4, LjNg-2, LjNh-3, LjNh-4, LjNh-5, LjNi-2, LlNk-2, LlNk-13, LlNk-18, LlNk-19, LlNk-21, LlNl-1, LlNl-2, LlNl-3, LlNl-7, LlNl-8, LlNl-10, LlNl-11, LlNl-16, LlNm-3, MaNj-2, MbNj-15, McNj-41, McNj-44, McNk-14, McNk-19, McNk-25, MdNk-1, MdNk-3, MdNk-20, MdNk-34, MdNl-3, MdNl-13
	Lithic Workshop	LjNg-1, LjNg-3, LjNh-1, LjNi-1, LkNj-1, LkNl-2, LlNk-3, LlNk-5, LlNk-7, LlNk-10, LlNk-11, LlNk-15, LlNl-6, LlNl-9, LlNl-12, MaNj-5, MaNj-6, MbNj-5, MbNj-21, McNj-31, McNj-32, McNj-33, McNj-40, McNj-43, McNj-46, McNj-47, McNj-49, McNk-21, McNk-22, McNk-24, MdNk-6, MdNk-8, MdNk-9, MdNk-15, MdNk-17, MdNk-19, MdNk-23, MdNk-39
	Marker	LlNl-4, LlNm-26, MaNl-8
	Quarry	LlNl-17
	Resource Gathering	LkNh-4, LlNk-1, LlNk-4, LlNk-9, LlNk-17, LlNl-14, MaNl-6, MaNl-7, MbNj-11, MbNj-18, MbNj-19, McNj-26, McNj-37, McNj-38, McNk-6, McNk-13, McNk-16, MdNk-7, MdNk-32, MdNk-40, MdNk-41, MdNk-46, MdNl-12
Prehistoric / Historic	Burial	LiNj-3
	Campsite	LjNj-3, LjNj-6, LkNl-1, LlNk-6, MaNj-7, MaNl-1, MaNl-9, MbNj-7, MbNj-9, McNj-12, McNj-16, McNj-19, McNj-25, McNj-28, McNj-39, McNk-4, MdNk-10, MdNk-29, MdNk-30, MdNk-36, MdNl-4, MdNl-7
	Lithic Workshop	MaNl-5
	Resource Gathering	MaNl-2, McNj-48
	Campsite	LkNh-1
Undetermined	Burial	MeNl-0
	Campsite	LjNj-1, LjNj-2, LjNj-4, LjNj-5, MbNj-1, MbNj-2, MdNk-11, MdNk-12, MdNk-13, MdNk-47, MdNl-5, MdNl-14, MdNl-17, MdNl-18, MeNl-1, MeNl-2, MeNl-9
	Historic Material	McNk-2
	Marker	LkNj-2, MaNj-4, McNj-5, McNj-6, McNj-7, McNj-8, McNj-9, McNj-10, McNj-11, McNk-1, MdNk-5
	Resource Gathering	LjNi-3, McNj-14, MdNk-14, MdNl-15, MeNl-15

Table V8-1C-2. Archaeological Site Cultural Affiliations

Row Labels	Arctic Small Tool Tradition	Dorset	Taltheilei	Early Taltheilei	Early or Middle Taltheilei
LfNo-4	1	-	-	-	-
LfNo-7	-	-	-	1	-
LfNp-5	-	-	1	-	-
LjNg-3	1	-	-	-	-
LjNj-3	1	-	-	-	-
LjNj-6	1	-	-	-	-
LlNk-8	-	-	-	-	1
LlNo-2	1	-	-	-	-
MbNj-21	1	-	-	-	-
MbNj-5	-	1	-	-	-
McNj-19	-	1	-	-	-
McNj-28	-	1	-	-	-
McNj-32	1	-	-	-	-
McNj-33	1	-	-	-	-
McNj-40	1	-	-	-	-
McNj-46	1	-	-	-	-
McNj-47	1	-	-	-	-
McNj-48	1	-	-	-	-
McNj-49	1	-	-	-	-
McNk-22	1	-	-	-	-
McNk-24	1	-	-	-	-
MdNk-23	1	-	1	-	-
MdNk-39	1	-	-	-	-
MdNk-8	-	-	1	-	-
MdNl-2	1	-	-	-	-
MdNl-6	1	-	-	-	-
MdNl-7	1	-	-	-	-
MdNl-8	1	-	-	-	-
Grand Total	**21**	**3**	**3**	**1**	**1**

Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LfNn-1	The site consists of a 2 m diameter stone oval with 25 stones and a lithic scatter of 10 clear quartz flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10 (clear quartzite)	–	–
LfNo-1	The site consists of a lithic scatter with approximately 200 white and grey quartzite flakes and 20 black basalt flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	220 (white and grey quartzite)	–	–
LfNo-2	The site consists of two lithic scatters one containing over 200 white and grey quartzite flakes and the other with a white quartzite scraper and 9 white quartzite flakes.	NUNAVUT 2013-20A	–	–	–	1 (white quartzite)	–	–	–	–	–	–	–	–	–	–	–	200+ (white and grey), 9 (white quartzite)	–	–
LfNo-3	The site consists of two lithic scatters with a low density of flakes between them. One scatter contains 30 grey quartzite flakes and the other contains between 30 and 40 grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70 (grey quartzite)	–	–
LfNo-4	The site contains three lithic scatters containing a white chert burin indicative of the Arctic Small Tool tradition, a grey quartzite scraper, and over 100 grey chert, and white and grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	1 (grey quartzite)	1 (white chert, ASTt)	–	–	–	–	–	–	–	–	–	–	100+ (grey chert & white/grey quartzite)	–	–
LfNo-5	The site consists of over 200 white and grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200+ (white & grey quartzite)	–	–
LfNo-6	The site consists of a quartzite biface fragment, and over 250 grey and white quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	1 (quartzite, fragment)	–	–	–	–	250+ (grey & white quartzite)	–	–
LfNo-7	The site consists of a quartzite point, a quartz blade, and over 50 white and grey quartzite flakes.	NUNAVUT 2013-20A	1 (quartzite)	1 (quartz)	–	–	–	–	–	–	–	–	–	–	–	–	–	50+ (white & grey quartzite)	–	–
LfNo-8	The site consists of a lithic scatter of 10 white quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10 (white quartzite)	–	–
LfNo-9	The site consists of a lithic scatter of 20 white and grey quartzite flakes	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20 (white & grey quartzite)	–	–
LfNo-10	The site consists of a lithic scatter of one grey chert flake, one grey chert nodule, and over 100 grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	1 (chert nodule)	–	–	100+ (grey quartzite)	–	–
LfNo-11	The site consists of a lithic scatter containing 15 grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15 (grey quartzite)	–	–
LfNo-12	The site consists of a very dense lithic scatter containing thousands of white quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2000+ (white quartzite)	–	–
LfNo-13	The site consists of two lithic scatters one with three white quartzite bifaces, bipolar cores and hundreds of white quartzite and brown siltstone and chert flakes and the other lithic scatter with over 200 white and grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	3 (white quartzite)	–	2 (bipolar core, white quartzite)	–	–	400+ (white & grey quartzite), 1 (brown siltstone)	–	–
LfNo-14	The site consists of a lithic scatter of over 40 grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40+ (grey quartzite)	–	–
LfNo-15	The site contains two lithic scatters with one containing over 50 grey quartzite flakes and the other 20-30 grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80+ (grey quartzite)	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LfNo-16	The site contains a quartzite bifacial scraper and over 100 grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	1 (bifacial, quartzite)	–	–	–	–	–	–	–	–	–	–	–	100+ (grey quartzite)	–	–
LfNp-1	The site consists of a clear quartzite point fragment and 2 white quartzite flakes.	NUNAVUT 2013-20A	1 (fragment, clear quartzite)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (white quartzite)	–	–
LfNp-2	The site consists of two white-clear quartz flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (white-clear quartzite)	–	–
LfNp-3	The site consists of 10-15 white quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15 (white-clear quartzite)	–	–
LfNp-4	The site consists of a stone circle of 22 stones and 2 lithic scatters containing over 50 grey quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50+ (grey quartzite)	–	–
LfNp-5	The site consists of a lithic scatter that includes two white quartz biface fragments and 5 white quartz flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	2 (fragments, white quartz)	–	–	–	–	5 (white quartzite)	–	–
LfNq-3	The site consists of a cairn constructed of 10 stones with an additional four stones on the ground nearby.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LgNm-1	The site consists of an inuksuk/cairn constructed of 6 stones set atop a large boulder.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LgNm-2	The site consists of a collapsed inuksuk/cairn of 9 stones.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LgNm-3	The site consists of two cairns/inuksuit of stones set on top of boulders.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LgNm-4	The site consists of two cairns one next to a stone lined pit 0.50 x 0.40 m and 0.10 m deep.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LgNm-5	The site consists of a stone rectangle, a stone circle with a hearth in the centre surrounded by tin cans, oil drums, caribou antlers, and metal debris.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–	–	–
LgNm-6	The site consists of an inuksuk/cairn constructed from 6 stones	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LhNk-1	The site consists of a lithic scatter of over 50 white quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50+ (white quartzite)	–	–
LhNk-2	The site consists of 6 flakes of clear quartz and over 20 of white quartzite.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20+ (white quartzite), 6 (clear quartz)	–	–
LhNk-3	The site consists of a lithic scatter including several bifaces and unifacial scrapers as well as over 200 flakes of white and grey quartzite.	NUNAVUT 2013-20A	–	–	–	Several (unifacial)	–	–	–	–	–	–	Several	–	–	–	–	200+ (white & grey quartzite)	–	–
LhNk-4	The site consists of a low density lithic scatter containing 10 white quartzite flake and 3 pieces of microdebitage.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	10	–	–
LhNk-5	The site consists of an inuksuk/cairn constructed from 4 stones.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Artifact types (to the left of "Permit Number") relate mostly to stone tools. More detailed tool descriptions, when available, are noted in brackets after the number. A "+" sign after the number indicates "over" (e.g. 10+ = over 10 artifacts). A "?" indicates rough count estimates. Due to the large variety of historical artifacts, historical remains are not counted but merely noted for their presence or absence. The column "Other Artifacts" contains artifacts/counts that do not fit into any of the other categories as well as notes when a record vaguely mentions artifacts/tools without exact number counts.

Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LhNk-6	The site consists of a bifacially flaked core and a small lithic scatter of over 50 white quartzite flakes, four stone rectangles and historic debris including green glass bottle fragment, metal tin can, wooden stakes for mining and a tent peg.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	1 (bifacially flaked core)	–	–	50+ (white quartzite)	Present	–
LhNk-7	The site consists of a stone circle, 5 small pits filled with tin cans and garbage, a Coleman stove and a fuel drum (shot with shotgun).	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
LiNh-1	The site consists of 2 stone circles, historic debris (tin cans, rifle shell, metal strapping and stove parts around stone circles, circa 1960s - 1970s and stash of wooden stakes (mining stake claim style).	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
LiNj-1	This site was found by Warburton Pike in 1890 and consists of seven oval shaped structures surrounded by turf heaps 6 inches high, several blackened fireplaces, stones propped on end that had been used probably for drying meat. A flat stone kettle was picked up with grease still sticking to it and a small piece of copper let into the back. Several pieces of undressed sealskin with the hair on it were reported. A Yellowknife Indian accompanying Pike felt that the inhabitants had come in the autumn, stayed through the winter and left late in the spring, about six weeks before Pike's arrival. He also felt that this was a regular camping spot.		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
LiNj-2	The site consists of two stone circles. The larger of the two has an extension similar to those found in some Dorset and Thule habitation features.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		–
LiNj-3	The site consists of stone structures that are possible chamber burials, hunting blinds, caches, inuksuit/ cairns lithic material, bone, and historic debris.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200+ (white quartzite)	Present	–
LiNj-4	The site consists of a biface fragment and white quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	1 (white quartzite fragment)	–	–	–	–	4 (white quartzite)	–	–
LiNk-1	The site consists of two cache pits.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LiNo-1	The site was recorded by Fitzpatrick in 1996.		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LiNo-2	The site was recorded by Fitzpatrick in 1996.		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LiNp-1	The site consists of 2 quartz flakes (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (quartz)	–	–
LiNp-2	The site consists of a quartz flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (quartz)	–	–
LiNp-3	The site consists of a quartz core, 5 pieces of quartz shatter, and 5 quartz flakes and flake fragments (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	1 (quartz core)	–	–	10 (quartz)	–	–
LiNp-4	The site consists of over 100 quartz lithic artifacts including a uniface, shatter, and flakes (47 collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	1 (quartz)	–	–	–	100+ (quartz)	–	–
LiNp-5	The site consists of a quartz flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (quartz)	–	–
LiNp-6	The site consists of a quartz flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (quartz)	–	–

Note: Artifact types (to the left of "Permit Number") relate mostly to stone tools. More detailed tool descriptions, when available, are noted in brackets after the number. A "+" sign after the number indicates "over" (e.g. 10+ = over 10 artifacts). A "?" indicates rough count estimates. Due to the large variety of historical artifacts, historical remains are not counted but merely noted for their presence or absence. The column "Other Artifacts" contains artifacts/counts that do not fit into any of the other categories as well as notes when a record vaguely mentions artifacts/tools without exact number counts.

Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LiNp-7	The site consists of 37 quartz artifacts including a scraper, a core fragment, and a possible burin (collected).	NUNAVUT 2001-019A	–	–	–	1 (quartz)	1 (quartz)	–	–	–	–	–	–	–	1 (core, quartz)	–	–	35 (quartz)	–	–
LiNp-8	The site consists of a split quartz nodule and two pieces of shatter (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	2 (split nodule, quartz)	–	–	2 (quartz)	–	–
LiNp-9	The site consists of 24 quartz artifacts including a biface blank, a core, 6 pieces of shatter, and 14 flakes and flake fragments (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	1 (blank, quartz)	–	1 (core, quartz)	–	–	22 (quartz)	–	–
LiNq-6	The site consists of a large artifact scatter from which 79 artifacts were collected. There is the potential for additional surface and subsurface artifacts.	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	79	–	–
LiNq-7	The site consists of 3 quartz flakes and one quartzite flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3 (quartz), 1 (quartzite)	–	–
LjNg-1	The site consists of 2 lithic scatters with 100-150 white quartzite flakes and a single chert flake.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	150 (white quartzite), 1 (chert)	–	–
LjNg-2	The site consists of 1 lithic scatter 50 x 50cm with 2 white chert flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (white chert)	–	–
LjNg-3	The site consists of a stone floor with 57 flat stones, 2 lithic scatters with 150-200 flakes, 4 microblades, and a small bifacial tool fragment indicative of ASTt.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	4 (white chert)	1 (tool, white chert, ASTt)	–	–	–	–	200 (white chert), 30 (white/pink quartzite)	–	–
LjNh-1	The site consists of 3 pink quartzite flakes, 147 white quartzite flakes (includes 100 pieces micro-debitage), and 3 pieces white quartzite block shatter. No diagnostic artifacts were found at the site.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100 (white quartzite)	3 (pink quartzite), 50 (white quartzite)	–	–
LjNh-2	The site consists of 1 isolated pink quartzite retouched flake. No diagnostic artifacts found to determine cultural affiliation.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (retouched, pink quartzite)	–	–	–	–
LjNh-3	The site consists of 2 quartzite cores (1 grey and 1 pink; collected) and 2 grey quartzite flakes were found (left *in situ*).	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, pink quartzite), 1 (core, grey quartzite)	–	–	2 (grey quartzite)	–	–
LjNh-4	The site consists of 4 grey quartz flakes and 2 unifacially retouched flakes from the surface of the site area.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (unifacially retouched, grey quartz)	–	4 (grey quartz)	–	–
LjNh-5	The site consists of 1 white chert and 3 white quartz flakes observed on the ground at the site (left *in situ*). No formed tools or diagnostic artifacts were observed.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (white chert), 3 (white quartz)	–	–
LjNi-1	The site consists of 100 + white quartzite flakes and a quartzite outcrop with flake scars. No diagnostic artifacts were found. All artifacts were left *in situ*.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100+ (white quartz)	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LjNi-2	The site consists of 1 lithic scatter 2 x 2 m with white quartzite 3 flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3 (white quartz)	–	–
LjNi-3	This site consists of 34 cairns aligned northwest to southeast for 156 m.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LjNi-4	The site consists of a cache pit with a tobacco tin located approximately 20 m to the north.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LjNj-1	The site consists of 1 hunting blind and 1 stone circle.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LjNj-2	The site consists of a stone circle with a large scatter of caribou skulls, and a hearth.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LjNj-3	This site consists of stone circles, caches, hunting blinds, a large dense scatter of bone, wood, and historic debris. Four white chert ASTt artifacts were collected including a knife, a drill, a scraper, and a microblade.	NUNAVUT 2013-20A	–	–	1 (white chert, ASTt)	1 (white chert, ASTt)	–	1 (white chert, ASTt)	–	–	–	1 (white chert, ASTt)	–	–	–	–	–	–	Present	–
LjNj-4	The site consists of a stone circle and a stone cache with bone inside.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LjNj-5	The site consists of a stone circle, 2 hunting blinds, and an inuksuk/cairn.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LjNj-6	The site consists of stone circles, stone rectangles, hunting blinds, caches, Arctic Small Tool tradition artifacts, bone, and historic debris. This is a large site with extensive landscape modification through movement of boulders.	NUNAVUT 2013-20A	1 (fragment, grey/white chert, ASTt)	–	2 (fragments, grey banded chert), 1 (fragment, white chert)	–	–	–	–	–	–	–	–	–	–	–	–	100 (white/grey chert)	Present	–
LjNo-1	The site consists of 1 red quartzite flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (red quartzite)	–	–
LjNo-2	The site consists of 1 rhyolite flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (rhyolite)	–	–
LjNo-3	The site consists of 3 quartz flakes (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3 (quartz)	–	–
LjNo-4	The site consists of 1 sandstone and 1 quartz flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (quartz)	–	–
LjNp-1	The site consists of 1 quartz flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (sandstone), 1 (quartz)	–	–
LjNp-2	The site consists of 1 quartz flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (quartz)	–	–
LjNp-3	The site consists of 21 quartz artifacts including 2 cores, 3 pieces of shatter, and 16 flakes or flake fragments (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	2 (core, quartz)	–	–	19 (quartz)	–	–
LjNp-4	The site consists of a lithic scatter including quartz cores, flakes and flake fragments. Potential for subsurface deposits.	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	2 (core, quartz)	–	–	5 (quartz)	–	–
LkNh-1	The site consists of tent rings, meat caches, caribou bones, and some historic debris that litters the top of the ridge. Evidence of recent use such as board fragments with saw tooth marks. Occasional 30-30 shell casing. No excavation. Hudson Bay 1/2 lb. tea tin on surface.	NWT 75-377	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LkNh-2	The site consists of tent rings, meat caches, caribou bones and a possible Inuit grave site. The site has probably been in use for a long time perhaps in conjunction with LkNh-1 to the north.	NWT 75-377	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LkNh-3	The site consists of 1 cache with cast iron pot w/lid, and 3 square metal gas cans.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
LkNh-4	The site consists of 1 rectangular stone cache. The cache is open and empty.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LkNh-5	The site consists of one orange and white banded chert flake.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (white banded chert)	–	–
LkNi-1	The site consists of 25 and 30 stone features along the edge of the terrace and perhaps 50-60 meters inland. Appears to represent a caribou ambush site with numerous blinds. Some antiquity is suggested by in-filled stone circles. No collections.	NWT 97-844	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LkNi-2	The site consists of 1 cache, 1 cairn, 1 stone circle, and a low density lithic scatter of white quartzite flakes across the site. No diagnostic tools were observed.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40 (white quartzite)	–	–
LkNj-1	The site consists of over 75 white quartzite flakes and block shatter. No formed tools or diagnostic artifacts were observed.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	75 (white quartzite)	–	–
LkNj-2	The site consists of 1 cairn constructed with 2 large stones.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LkNk-1	The site consists of 2 tent rings on top of an esker near George Lake. The tent rings are not heavily lichenated. Visible artifacts include only a rusted tin lid. An extensive scattering of caribou bones, predominantly split long bones, was associated with the tent rings. The site probably dates to within the last fifty years.	NWT 91-707	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
LkNl-1	This site consists of both prehistoric and historic features and artifacts. There are 24 features located at the site including rock alignments, stone circles, stone rectangles, a hearth, caches, cultural depressions, and bone scatters. It is likely that the two stone circles were used to hold down hide tents and the three rectangular stone features were used to hold down canvas tents. Additionally, at the north end of the site there is a mound-like feature that may represent the remains of a semi-subterranean dwelling; however, additional testing will be required to determine its function. The artifact assemblage located at the site includes a prehistoric lithic scatter consisting of six quartzite flakes and two pieces of block shatter, as well as a historic rifle cartridge and a cooking pot.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8 (quartzite)	Present	–
LkNl-2	The site consists of 60 white & gray quartzite flakes, 3 chert flakes, 4 quartzite cores, 1 basalt core, 1 basalt scraper, 1 white quartzite notched flake, 1 white quartzite retouched flake & a scatter of bone. No diagnostic artifacts found.	NUNAVUT 2010-024A	–	–	–	1 (basalt)	–	–	–	–	–	–	–	–	4 (cores, quartzite), 1 (core, basalt)	1 (notched, quartzite), 1 (retouched, quartzite)	–	60 (white & grey quartzite), 3 (chert)	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LkNm-1	The site consists of 1 quartz core fragment and 11 flakes (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core fragment, quartz)	–	–	11 (quartz)	–	–
LkNm-2	The site consists of a scatter of approximately 20 white quartz flakes and one scraper from the surface of the site area.	NUNAVUT 2011-022A	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	20 (white quartzite)	–	–
LkNm-3	The site consists of a stone circle (Feature 1). A helicopter landing pad, approximately 30 years old, is located 2 m north of Feature 1.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNj-1	The site consists of 5 stone features including 4 stone circles and a stone semi-circle. Five pink quartzite flakes, 2 pink quartzite cores and 1 red quartzite core were observed at the site and left *in situ*. No diagnostic tools were observed. Additionally, a muskox skull, scatter of bone, and a piece of soap stone were observed at the site.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	2 (cores, pink quartzite), 1 (core, red quartzite)	–	–	5 (pink quartzite)	Present	–
LlNk-1	The site consists of a cache. The cache pit feature consists of several flat rocks surrounding a shallow cultural depression with differential vegetation. No artifacts were identified in the area. Site photographed and mapped.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNk-2	The site consists of 1 white quartzite core and 1 piece of block shatter collected from the site. No diagnostic artifacts were found.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, white quartzite)	–	–	1 (white quartzite)	–	–
LlNk-3	The site consists of 1 white quartzite biface preform, 1 white quartzite core fragment, 2 pink quartzite utilized flakes, and 1 pink, 5 white, and 1 yellow quartzite flakes (collected). Some additional artifacts are still visible on the surface.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	1 (preform, white quartzite)	–	1 (core, white quartzite)	2 (utilized, pink quartzite)	–	1 (pink quartzite), 5 (white quartzite), 1 (yellow quartzite)	–	–
LlNk-4	The site consists of 2 stone features. One is a linear feature made of 8 large rocks and the second is an L-shaped feature made of 9 rocks. The linear feature has a large pink quartzite core at the northern end.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNk-5	The site consists of 1 white quartzite biface fragment, 3 white quartzite flakes and one piece white quartzite block shatter collected from site.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	1 (fragment, white quartzite)	–	–	–	–	4 (white quartzite)	–	–
LlNk-6	Site consists of a hearth, 2 stone circles and a rectangular stone feature (likely an emptied cache). A scatter of broken bones is on the east side of site with a metal can lid in it. No other artifacts were observed. All artifacts left *in situ*.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
LlNk-7	The site consists of 1 white quartzite lithic scatter, 5 x 5 m diameter with 101-200 flakes. No diagnostic tools observed.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200 (white quartzite)	–	–
LlNk-8	The site consists of 1 shouldered point fragment. The point is suggestive of the early to middle Taltheilei period.	NUNAVUT 2012-12A	1 (fragment, gery sedimentary)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNk-9	The site consists of 1 stone cache.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LlNk-10	The site consists of 3 lithic scatters with 300-400 white quartzite flakes and several white quartzite biface fragments.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	5 (fragment, white quartzite)	–	–	–	–	400 (white quartzite)	–	–
LlNk-11	The site consists of 1 lithic scatter with 30 + white quartzite flakes and 1 white quartzite graver.	NUNAVUT 2012-12A	–	–	–	–	–	–	1 (white quartzite)	–	–	–	–	–	–	–	–	30+ (white quartzite)	–	–
LlNk-12	The site consists of 1 grey quartzite scraper.	NUNAVUT 2012-12A	–	–	–	1 (grey quartzite)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNk-13	The site consists of 2 lithic scatters 40-50 white quartzite flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50 (white quartzite)	–	–
LlNk-14	The site consists of 1 stone circle.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNk-15	The site consists of 1 white quartzite lithic scatter with 51-100 flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100 (white quartzite)	–	–
LlNk-16	The site consists of 1 purple slate chithos (left *in situ*).	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	1 (slate)	–	–	–	–	–	–	–	–	–
LlNk-17	The site consists of 1 rectangular stone cache with fragments of bone inside.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNk-18	The site consists of 1 lithic scatter 2 x 2m with 11-20 white quartzite flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20 (white quartzite)	–	–
LlNk-19	The site consists of 2 lithic scatters with 8 white and grey quartzite flakes and 1 white chert flake.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8 (white & grey quartzite), 1 (white chert)	–	–
LlNk-20	The site consists of 1 small stone circle with broken caribou bone around it.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNk-21	The site consists of 1 lithic scatter with 4 white quartzite flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4 (white quartzite)	–	–
LlNk-22	The site consists of 1 light pink quartzite scraper observed and left *in situ* at the site.	NUNAVUT 2012-12A	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNl-1	The site consists of 1 primary decortication flake and 1 primary flake of quartz, and 1 fragment of chert shatter (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3 (quartz)	–	–
LlNl-2	The site consists of a surface lithic scatter of 2 pink quartzite flakes on top of knoll and one pink quartzite core.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, pink quartzite)	–	–	2 (pink quartzite)	–	–
LlNl-3	The site consists of a surface lithic scatter of 2 pink quartzite cores and approximately 30 flakes on top of a knoll.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	2 (cores,pink quartzite)	–	–	30 (pink quartzite)	–	–
LlNl-4	The site consists of a rock cairn consisting of fifteen rocks of differing material constructed on top of a large prominent bedrock outcrop knoll. The structure is partly collapsed and, while it was likely much taller than it is now, its current dimensions measure 1 m wide, 70 cm deep and 1.6 m high. Photographed. Nothing collected.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LlNl-5	The site consists of a small stone tent ring with broken faunal bone fragments likely the result of marrow extraction. Stone ring visible on surface and broken faunal fragments located approximately 36 m away from stone ring to the northeast.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNl-6	The site consists of a lithic scatter of over 400 pieces of quartz debitage.	NUNAVUT 2010-023A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	400 (quartz)	–	–
LlNl-7	The site consists of siltstone, chert, and quartz artifacts eroding out of a subsurface deposit.	NUNAVUT 2010-023A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (siltstone), 1 (chert), 1 (quartz)
LlNl-8	The site consists of 1 chert retouched flake, and 4 quartz flakes or flake fragments (collected).	NUNAVUT 2010-023A	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (retouched, chert)	–	4 (quartz)	–	–
LlNl-9	The site consists of4 lithic scatters with over 600 total artifacts.	NUNAVUT 2010-023A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		600 artifacts
LlNl-10	The site consists of 1 quartz flake and a quartz flake fragment (collected).	NUNAVUT 2010-023A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (quartz)	–	–
LlNl-11	The site consists of 1 quartz retouched flake, a quartz core, and a quartz flake (collected).	NUNAVUT 2010-023A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, quartz)	1 (retouched, quartz)	–	1 (quartz)	–	–
LlNl-12	The site consists of 2 lithic scatters totaling 67 quartz artifacts (collected).	NUNAVUT 2010-023A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	67 artifacts
LlNl-13	The site consists of a hearth and a stone marker.	NUNAVUT 2010-023A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNl-14	The site consists of 1 cairn and 1 white quartzite lithic scatter with 11-20 flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20 (white quartzite)	–	–
LlNl-15	The site consists of 1 stone circle.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNl-16	The site consists of 3 white quartzite flakes and a possible block shatter.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4 (white quartzite)	–	–
LlNl-17	The site consists of 4 white quartzite boulder cores. The largest core has over 100 flakes beneath it.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	4 (cores, white quartzite)	–	–	100+ (white quartzite)	–	–
LlNm-1	The site consists of a surface lithic scatter of pink quartzite flakes across the ridge top and one large pink quartzite core in a localized area of the ridge.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, pink quartzite)	–	–	3 (pink quartzite)	–	–
LlNm-2	The site consists of 4 small rocks in a line behind a large pile indicating direction of travel and 1 slate scraper also found near the rock alignment.	NUNAVUT 2007-022A	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNm-3	The site consists of 7 quartzite cores and associated block shatter.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	7 (cores, quartzite)	–	–	5 (quartzite)	–	–
LlNm-4	The site consists of broken caribou bone and a small rock shelter with good vantage. Broken faunal remains scattered across top of knoll. A small crevasse in a prominent rock feature may have been used as a temporary shelter.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LlNm-5	The site consists of 1 pebble pink quartzite stone tool located on good vantage point. Photographed. Nothing collected.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 pebble stone tool
LlNm-6	The site consists of stone tent rings, small cultural depressions, a lithic scatter of rose quartzite, and a slate knife. A large campsite consisting of 5 stone tent rings, 3 small cultural depression, stone tool reduction site of lithic scatter. Lithic material found on surface near old river bed. Cultural depressions have vegetation growing in center as do stone tent rings.	NUNAVUT 2007-022A	–	–	1 (slate)	–	–	–	–	–	–	–	–	–	–	–	–	5 (rose quartzite)	–	–
LlNm-7	The site consists of a cache consisting of a large rock covered with loose fill and topped with large boulders. Loose fill and large boulders on top still intact. This site is associated with site LlNm-6 and is likely prehistoric.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNm-8	The site consists of 1 rock cairn made of 6 flat blocks of pink quartzite. Appears to be intact with some lichen growth on the stones. As pink quartzite is relatively rare in this landscape and was used for stone tools in prehistoric sites, it is likely that this is a prehistoric feature, possibly a cache of lithic material.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNm-9	The site consists of 1 unifacial steep edged scraper and 1 flake with some block shatter observed. Lithic scatter appears undisturbed on surface.	NUNAVUT 2007-022A	–	–	–	1 (uniface)	–	–	–	–	–	–	–	–	–	–	–	1	–	–
LlNm-10	The site consists of 1 notched end scraper flake. Lithic material appears to be undisturbed and found on the surface.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
LlNm-11	The site consists of 1 unifacial steep-edged scraper and 1 flake located on a pile of pink quartzite block shatter. Site appears to be undisturbed and in good condition.	NUNAVUT 2007-022A	–	–	–	1 (uniface)	–	–	–	–	–	–	–	–	–	–	–	10+ (pink quartzite)	–	–
LlNm-12	The site consists of 1 unifacially retouched flake scraper. Site appears to be undisturbed and in relatively good condition.	NUNAVUT 2007-022A	–	–	–	1 (uniface, white quartzite)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNm-13	The site consists of 3 flakes and two cores of pink quartzite.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	2 (cores, pink quartzite)	–	–	3 (pink quartzite)	–	–
LlNm-14	The site consists of 5 flakes found on a western knoll and 4 flakes and 1 burin-like tool found on an eastern knoll, all of pink quartzite.	NUNAVUT 2007-022A	–	–	–	–	1 (pink quartzite)	–	–	–	–	–	–	–	–	–	–	9 pink quartzite)	–	–
LlNm-15	The site consists of several pink quartzite flakes.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Several (pink quartzite)	–	–
LlNm-16	The site consists of 10 pink quartzite flakes. Site appears to be intact and undisturbed despite its exposed position to prevailing winds.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10 (pink quartzite)	–	–
LlNm-17	The site consists of approximately 20 white quartz flakes on an exposed gravel esker. Site appears to be intact and undisturbed despite its exposed position to prevailing winds.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20 (white quartz)	–	–

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Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LlNm-18	The site consists of pink quartzite flakes and 1 burin-like tool on an exposed gravel esker. Site appears to be intact and undisturbed despite its exposed position to prevailing winds.	NUNAVUT 2007-022A	–	–	–	–	1 (pink quartzite)	–	–	–	–	–	–	–	–	–	–	2 (pink quartzite)	–	–
LlNm-19	Site consists of 1 pink quartzite hand-sized chopper. Site appears to be intact and undisturbed despite its exposed position to prevailing winds. Photographed. Nothing collected.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (chopper, pink quartzite)
LlNm-20	The site consists of one rock cairn on a large boulder. The rock alignment is made of 5 large rocks, two of which are pink quartzite.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNm-21	The site consists of 30+ pink and white quartzite flakes, 3 white quartzite cores and 1 pink quartzite core. All artifacts were left *in situ*.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	3 (cores, white quartzite), 1 (core, pink quartzite)	–	–	30+ (pink & white quartzite)	–	–
LlNm-22	The site consists of 50+ pink and white quartzite flakes. No diagnostic artifacts found. Artifacts left *in situ*. Site is 100 m SW of a surveyors cairn which appears to have a pink quartzite core as one of its rocks. The core is possibly from LlNm-22.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50+ (pink & white quartzite)	–	–
LlNm-23	The site consists of 25-50 pink quartzite flakes and one pink quartzite core. No diagnostic artifacts found. No artifacts were collected.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, pink quartzite)	–	–	50 (pink quartzite)	–	–
LlNm-24	The site consists of 2 scrapers, 1 notched flake, 1 burin, 2 retouched flakes and 1 spall tool all of pink quartzite (collected) and 100+ pink and white quartzite flakes left *in situ*. No diagnostic artifacts were found.	NUNAVUT 2010-024A	–	–	–	2 (pink quartzite)	1 (pink quartzite)	–	–	–	–	–	–	–	–	1 (notched, pink quartzite), 2 (retouched, pink quartzite)	–	100+ (pink quartzite)	–	–
LlNm-25	The site consists of 5 pink quartzite flakes, 1 quartzite scraper and 2 pink quartzite cores. All were left *in situ*. No diagnostic artifacts were found.	NUNAVUT 2010-024A	–	–	–	1 (quartzite)	–	–	–	–	–	–	–	–	2 (cores, pink quartzite)	–	–	5 (pink quartzite)	–	–
LlNm-26	The site consists of an inuksuk. Inuit assistant stated that the inuksuk was a marker for a good fishing spot and called it a "nunkatuk".	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNm-27	The site consists of a small lithic scatter containing two quartzite flakes.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (quartzite)	–	–
LlNm-28	The site consists of a white quartzite lithic scatter of 20-30 flakes located on a break in slope.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30 (white quartzite)	–	–
LlNm-29	The cairn is similar in construction to features associated with caribou drive lanes including an inuksuk at archaeological site MaNl-2 (Fedirchuk 2001) located 24 km to the east-northeast. No additional features suggestive of a drive lane were located in the area, however, further investigation will be required if the area is impacted by development.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Artifact types (to the left of "Permit Number") relate mostly to stone tools. More detailed tool descriptions, when available, are noted in brackets after the number. A "+" sign after the number indicates "over" (e.g. 10+ = over 10 artifacts). A "?" indicates rough count estimates. Due to the large variety of historical artifacts, historical remains are not counted but merely noted for their presence or absence. The column "Other Artifacts" contains artifacts/counts that do not fit into any of the other categories as well as notes when a record vaguely mentions artifacts/tools without exact number counts.

Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LlNm-30	The site consists of a cairn with 11 stones. Cairn includes a piece of white quartzite. Partially collapsed.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNm-31	The site consists of 1 quartzite core with cortex, block shatter, and 30-40 flakes from primary to finishing.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, quartzite)	–	–	40 (quartzite)	–	–
LlNm-32	The site consists of 3 lithic scatters totalling over 100 white quartzite flakes. A small bore drill collar and associated historic materials were also located at the site.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100+ (white quartzite)	Present	–
LlNm-33	The site consists of a possible antler tool handle.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 antler tool handle
LlNn-1	The site consists of a large pink quartzite chopper. Chopper located on frost heave but otherwise undisturbed.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 chopper
LlNn-2	The site consists of 1 pink quartzite core. Evidence of removal of several large flakes. Lichen growing in several flake scars.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, pink quartzite)	–	–	–	–	–
LlNn-3	The site consists of 1 pink quartzite core, flaked on both sides. The site appears to be undisturbed and in relatively good condition.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, pink quartzite)	–	–	–	–	–
LlNn-4	The site consists of rock cairn, constructed on a large prominent boulder, constructed of seven rocks. The cairn is approximately 0.7 m high and 1 m wide.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNn-5	The site consists of a rock cairn consisting of nine flat blocks of pink quartzite rocks and constructed on top of a large prominent boulder. Rock cairn is collapsed and the integrity of the structure is in poor condition. As pink quartzite is relatively rare in this landscape and is the material used for stone tools in prehistoric sites, it is likely that this is a prehistoric feature.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNn-6	The site consists of a rock cairn consisting of five flat blocks of pink quartzite rocks and constructed on top of a large prominent boulder. Rock cairn is collapsed. The integrity of the structure is in poor condition. As pink quartzite is relatively rare in this landscape and was used for stone tools in prehistoric sites, it is likely that this is a prehistoric feature.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNn-7	The site consists of a rock cairn consisting of three rocks of differing material constructed on top of prominent boulder overlooking Bat Lake to the east. Rock cairn appears to be intact and undisturbed.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
LlNn-8	The site consists of approximately 45 white quartz flakes and 3 pieces of block shatter.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	48 (white quartz)	–	–
LlNn-9	The site consists of 1 pink quartzite flake.	NUNAVUT 2007-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (pink quartzite)	–	–
LlNn-10	The site consists of 2 pink quartzite flakes on a rock strewn hilltop.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (pink quartzite)	–	–

Note: Artifact types (to the left of "Permit Number") relate mostly to stone tools. More detailed tool descriptions, when available, are noted in brackets after the number. A "+" sign after the number indicates "over" (e.g. 10+ = over 10 artifacts). A "?" indicates rough count estimates. Due to the large variety of historical artifacts, historical remains are not counted but merely noted for their presence or absence. The column "Other Artifacts" contains artifacts/counts that do not fit into any of the other categories as well as notes when a record vaguely mentions artifacts/tools without exact number counts.

Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
LlNn-11	The site consists of a stone feature thought to be a hunting blind composed of approximately 50 stones and lithic material spread out along the terrace edge. A total of 10 lithic scatters and 5 isolated finds, totaling approximately 100 artifacts, were found at the site consisting mainly of quartzite flakes. A grey sedimentary chitho that was broken into two pieces was collected.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	1 (grey sedimentary)	–	–	–	–	–	–	100 (quartzite)	–	–
LlNo-1	The site consists of a semi-circular hunting blind feature placed at the edge of a depression in the esker. Two small chert flakes were located to the west.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (chert)	–	–
LlNo-2	This site contains evidence of use throughout the prehistoric and historic period with artifacts dating from the Arctic Small Tool tradition (ASTt) to historic rifle shell cartridges and aluminum pots. A caribou crossing is located to the west of the site. The site includes two prehistoric cultural depressions and another feature possibly a portion of a stone circle of unknown age obscured by vegetation. Artifacts collected from the site include: 3 knives, 2 slotters, 2 bifaces, 2 pieces of flake debitage, 1 point, 1 microblade, 1 core, 1 needle sharpener. All artifacts are made of white chert, with the exception of the needle sharpener, made of brown slate. Additional artifacts at the site include lithic debitage, caribou bones, and modern hunting and camping equipment including wood, nails, stove pipe, rifle shells, and a two hole button. Given the continuous use of the site and the vegetation there is good potential for stratified subsurface deposits at the site.	NUNAVUT 2012-22A	1 (white chert)	–	3 (white chert)	–	–	–	–	2 (white chert)	–	1 (white chert)	2 (white chert)	–	1 (core, white chert)	–	–	20+ (white chert)	Present	1 needle sharpener
LlNo-3	The site consists of 2 lithic scatters with a total of 20-30 white chert flakes at the base of an esker.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30 (white chert)	–	
LlNo-4	A scatter of 40-50 white quartzite flakes on top of an esker feature overlooking Mara Lake to the north and a small lake to the south.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50 (white quartzite)	–	
MaNj-1	The site consists of 8 stone features including 2 caches, 2 stone circles, 2 rock alignments, 1 rock pile and 1 anvil stone and a lithic scatter that includes 1 piece of flaked slate and 2 quartzite flakes. No diagnostic artifacts or formed tools were observed. Broken caribou bones were observed in one of the caches (found disassembled).	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (slate), 2 (quartzite)	–	1 anvil stone
MaNj-2	The site consists of between 40 and 50 pink and white quartzite flakes. No diagnostic or formed tools were observed.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50 (pink & white quartzite)	–	–
MaNj-3	The site consists of a stone circle, 3 m in diameter with 16 stones (Feature 1), and a hearth (Feature 2).	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MaNj-4	The site consists of a stone cairn (Feature 1). The site was identified from the air during a helicopter flight and was not in proximity to the Project.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MaNj-5	The site consists of a lithic scatter of 50 - 100 white and pink quartzite flakes. There are more white flakes than pink.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100 (white & pink quartzite)	–	–

Note: Artifact types (to the left of "Permit Number") relate mostly to stone tools. More detailed tool descriptions, when available, are noted in brackets after the number. A "+" sign after the number indicates "over" (e.g. 10+ = over 10 artifacts). A "?" indicates rough count estimates. Due to the large variety of historical artifacts, historical remains are not counted but merely noted for their presence or absence. The column "Other Artifacts" contains artifacts/counts that do not fit into any of the other categories as well as notes when a record vaguely mentions artifacts/tools without exact number counts.

Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
MaNj-6	The site consists of a lithic scatter of approximately 50 white quartzite flakes.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50 (white quartzite)	–	–
MaNj-7	The site consists of a cache, 2 hunting blinds, a stone oval, a stone circle, a double stone circle, 2 cairns, an inuksuk, a hearth, wood, a D.C. Co. shell cartridge, and a scatter of caribou bone.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MaNl-1	The site has a historic component with a fire pit containing a piece of metal with a rivet and some broken bottle glass and a prehistoric component consisting of materials found about 20 m north of the historic fire pit including 1 flake fragment and 1 piece of shatter, both of white chert.	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (white chert)	Present	–
MaNl-2	The site consists of an alignment of upright elongate boulders set on top of bedrock outcropping. This caribou drive lane, begins at a larger inuksuk and extends south for over 200 m. At approximately 200 m, 4 more markers were observed spaced between 20 and 30 m apart. Lithics were recovered from a single concentration.	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–
MaNl-3	The site consists of a lithic scatter of quartz artifacts and 3 stone features. Lithics include 1 end scraper, 1 retouched flake, and 1 burin, 1 core fragment, 1 core platform, 2 primary flakes, 4 secondary flakes, and 2 flake fragments (collected). Feature 1 is 8 m north of the artifact concentration and consists of a semicircular arrangement of flat rocks, approximately 0.6 m across. Two more features occur down slope and on a lower bench to the north and east of the scatter. One consists of a large semicircular arrangement (1 m diameter) of rocks similar to a tent ring. The other consists of an elongate arrangement (2 m long) of flat rocks. All rocks appear to have been removed from a large erratic embedded in the esker.	NUNAVUT 2001-019A	–	–	–	1 (end, quartz)	1 (quartz)	–	–	–	–	–	–	–	1 (core fragment, quartz), 1 (core platform, quartz)	–	–	8 (quartz)	–	–
MaNl-4	The site consists of an inuksuk. A CLS survey marker located immediately northeast of the inuksuk suggests that it is of recent age built to identify the position of the survey marker.	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MaNl-5	The site consists of 1 lithic scatter with over 100 white quartzite flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100+ (white quartzite)	–	–
MaNl-6	The site consists of 1 stone hearth, 1 lithic scatter with 9 white quartzite flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9 (white quartzite)	–	–
MaNl-7	The site consists of 1 cache, 1 lithic scatter with 11-20 large biface reduction flakes of banded brown siltstone.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20 (banded brown siltstone)	–	–
MaNl-8	The site consists of 1 collapsed inuksuk.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MaNl-9	The site consists of 1 stone circle, 1 hearth, 1 lithic scatter with 51-100 white quartzite flakes and scatter of broken caribou bone.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100 (white quartzite)	–	–
MaNn-1	The site consists of a small lithic scatter of white quartzite flakes on a soil exposure associated with a bedrock exposure.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8 (white quartzite)	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
MaNn-2	The site consists of a small cairn located on a small bedrock outcrop.	NUNAVUT 2012-22A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-1	The site consists of 5 stone features, 2 pieces of bone, 2 pieces of wood (possible plank fragments), and 1 possible quartzite core.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, quartzite)	–	–	–	Present	–
MbNj-2	The site consists of 2 stone circles and 1 stone alignment.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-3	The site consists of 13 features, including 6 stone circles, 4 caches, 1 oval stone alignment, 1 rectangular stone alignment, and 1 hunting blind. No artifacts were identified.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-4	The site consists of 3 white quartzite flakes found near the centre of a stone circle. No artifacts collected from site. No diagnostic artifacts found at site. A small white chert flake & a collapsed cairn were located in revisit.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3 (white quartzite)	–	–
MbNj-5	The site consists of 1 Dorset bifacial endscraper and 3 flakes (2 chert, 1 quartzite).	NUNAVUT 2010-024A	–	–	–	1 (bifacial end, chert, Dorset)	–	–	–	–	–	–	–	–	–	–	–	2 (chert), 1 (quartzite)	–	–
MbNj-6	The site consists of 1 oval stone feature. No diagnostic artifacts were found.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-7	The site consists of 18 features including 10 stone circles, 1 stone semi-circle, 2 hearths, 3 rock features, 1 cultural depression, and 1 kayak stand. A heavily corroded tin can was observed at the site.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MbNj-8	The site consists of 2 stone circles and 2 stone alignments.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-9	The site consists of a stone circle, a stone cache, and a rock cairn. Caribou bone was located in the vicinity of the cache and a claim marker for claim B3796 was located 2 m west of the cairn.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-10	The site consists of 1 small oval stone feature that is open at one end and 1 stone circle. No artifacts were observed.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-11	The site consists of 2 oval stone features.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-12	The site consists of 4 stone features but no artifacts.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-13	The site consists of 1 stone circle. No artifacts were observed.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-14	The site consists of 3 stone ovals.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-15	The site consists of chert, siltstone and quartz debitage and 1 retouched grey chert flake that were left *in situ*.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (retouched, grey chert)	–	1 (chert), 1 (siltstone), 1 (quartz)	–	–
MbNj-16	The site consists of a square stone alignment and lithic scatter of tools and debitage from the surface of the site area. Material types observed were chert, basalt and quartz.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (chert), 1 (basalt), 1 (quartz)	–	tools & debitage

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
MbNj-17	The site consists of 2 stone circles, 2 cairns, 1 cache pit, 4 inuksuit (possibly a caribou drive lane).	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-18	The site consists of 3 inuksuit in a line that maybe part of a drive lane.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-19	The site consists of 4 inuksuit which were constructed with upright slabs of stone, maybe part of a drive lane.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-20	The site consists of 5 hunting blinds, 1 stone circle, and 1 stone alignment.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MbNj-21	The site consists of a low density lithic scatter with one small white chert point base indicative of the Arctic Small Tool tradition and basalt, chert, and quartzite flakes.	NUNAVUT 2013-20A	1 (base fragment, white chert, ASTt)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (basalt), 1 (chert), 1 (quartzite)	–	–
MbNn-1	The site consists of 1 tent ring, and some broken caribou antlers. However, some of these had saw marks at their bases, and are thus probably of historic age.		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-1	Site consists of 4 stone caches and 1 stone feature.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-2	The sites at the south end of Bathurst Inlet appear to have been in constant and recent use, as there are modern implements at the site, as well as bone implements. There are thousands of inuksuks in the area, and it appears to have been a favorite place for hunting caribou for a long time. (Campbell) Tent ring site. Associated debris includes bone, rusted metal and wood. No native made artifacts found on site. (Morrison)	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-3	Site is badly disturbed. Apparently two occupations. One can be dated to 1976 on basis of scraps of Edmonton Journal. Consists of three disturbed tent rings and a buried garbage dump dug up by a bear. This is almost certainly a camp of Dr. Campbell's used during his geological survey of the area. Campbell reported a historic Inuit site here but the remains have almost totally been obliterated. Single artifact collected from surface relating to this earlier occupation.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-4	The site consists of gathered drift wood, rusted tin fragments, a few spruce tent pegs and a single fragment of cloth. No discernable tent rings or other structures. No prehistoric artifacts on site.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-5	The site consists of an inuksuk.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-6	The site consists of an inuksuk.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-7	The site consists of an inuksuk.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-8	The site consists of an inuksuk.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-9	The site consists of an inuksuk.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-10	Site consists of an inuksuk.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-11	Site consists of an inuksuk.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Artifact types (to the left of "Permit Number") relate mostly to stone tools. More detailed tool descriptions, when available, are noted in brackets after the number. A "+" sign after the number indicates "over" (e.g. 10+ = over 10 artifacts). A "?" indicates rough count estimates. Due to the large variety of historical artifacts, historical remains are not counted but merely noted for their presence or absence. The column "Other Artifacts" contains artifacts/counts that do not fit into any of the other categories as well as notes when a record vaguely mentions artifacts/tools without exact number counts.

Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
McNj-12	Site consists of 2 apparent components - first, a historic Inuit composed of a single 4 x 2 m. ovate tent ring in association with a primus stove gas-cap and a bit of cloth (uncollected) and a second, paleo-eskimo component consists of a sparse scatter of chert flakes and tools, inside and in the immediate area of the tent ring.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Some (chert)	Present	flakes & tools
McNj-13	Site consists of tent rings with a single, empty cache. Associated debris includes caribou bone, 303 shells and a few rusted cans. No prehistoric artifacts were found on this site.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-14	McNj-14 was originally recorded by D. Morrison in 1978. The site was revisited in 2011 and three of the hunting blinds were relocated. The other two hunting blinds and the six inuksuit recorded on the original site form were not relocated.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-15	The site consists of 1 subrectangular tent ring about 70 m from shore. Surface collected. No native-made artifacts were found on this site. Note: This site is almost certainly the McNk-1 reported by Campbell (1976) but incorrectly located by him on the first large peninsula north of its true location. (Morrison 1978).	NWT 78-432 NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-16	A tent ring site situated about 30 m from shore. Two caches were found along with one artifact, a notched and grooved handle.	NWT 78-432 NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Notched and grooved handle
McNj-17	The site consists of 2 tent rings with 1 chert scraper (collected).	NUNAVUT 2010-024A	–	–	–	1 (chert)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-18	The site consists of 3 stone circles and 1 rectangular stone alignment, likely from a canvas tent. Historic metal debris, including the remains of a stove and table legs, were observed at the site.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-19	The site consists of 4 stone circles, 1 stone oval, 1 pink quartzite flake and 1 piece of green beach glass. Three additional artifacts were found during a revisit in 2011 including a burin-like tool (indicative of the Dorset period), a notched point, and a bipoint.	NUNAVUT 2010-024A	1, 1 (bipoint)	–	–	–	1 (Dorset)	–	–	–	–	–	–	–	–	–	–	1 (pink quartzite)	Present	1 piece of green beach glass
McNj-20	The site consists of five features including 2 stone circles, a hearth, 1 rectangular rock alignment, and a woodpile of small sticks. There is a scatter of broken bone near the hearth feature. No artifacts were observed at the site.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-21	The site consists of 4 features, including 2 stone circles, a firewood cache, and 1 rectangular stone alignment. Historic debris observed in the area included hand-carved wooden tent pegs, ground soapstone, a broken skidoo ski, a 30-calibre rifle cartridge case, a metal axe head, 2 rusted tin cans, and a small piece of rubber. Several caribou antlers with cut marks and broken animal bones were observed in the site.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-22	The site consists of 1 stone circle. No artifacts were observed at the site.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
McNj-23	The site consists of 2 concentric stone circles. The smaller one is surrounded by a partially complete larger one.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-24	The site consists of 1 stone circle.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-25	The site consists of 1 stone cairn, 2 stone circles, 3 stone ovals, 1 stone alignment, 1 white quartz flake, and 3 rifle shell casings observed on the surface	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (white quartz)	Present	–
McNj-26	The site consists of a stone cache (Feature 1).	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-27	The site consists of a worked bone fragment, 3 cm by 8 cm. It is interpreted as being prehistoric. No other cultural material was observed.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-28	The site consists of 6 stone circles, 2 stone ovals, 1 stone pile, 1 stone alignment, and a low density lithic scatter of white chert, white quartz and pink quartz debitage and tools including a Burin-like tool (indicative of the Dorset period) and an asymmetrical knife. Additional historic materials, including rifle and hand gun shell casings, a tobacco tin, a wood tent peg, a piece of a stove, broken glass, and a wooden fishing float, were also observed at the site. This site may be the remains of the Hudson's Bay Company's Bathurst Inlet Post during the years 1926 and 1927. The location of this post is described in Fur Trade Posts of the Northwest Territories as "moved to east side of Western River in 1926, about three miles from mouth" (Usher 1971:113). This generally matches the site location, and the historic materials at the site suggest a permanent or semi-permanent settlement."	NUNAVUT 2011-022A	–	–	1 (asymmetrical)		1 (Dorset)	–	–	–	–	–	–	–	–	–	–	1 (white chert) 1 (white quartz), 1 (pink quartz)	Present	–
McNj-29	The site consists of 1 stone circle (Feature 1) and 1 stone cache (Feature 2).	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-30	The site consists of a 2 stone circles (Features 1 and 2). Feature 1 has a line of slate stones oriented north-south through its centre, and Feature 2 has an additional smaller stone circle on its west side.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-31	The site consists of 1 white chert scraper and cluster of 50 + white chert debitage.	NUNAVUT 2011-022A	–	–	–	1 (white chert)	–	–	–	–	–	–	–	–	–	–	–	50+ (white chert)	–	–
McNj-32	The site consists of 1 white chert ASTt burin and cluster of approximately 100+ white chert debitage.	NUNAVUT 2011-022A	–	–	–	–	1 (white chert, ASTt)	–	–	–	–	–	–	–	–	–	–	100+ (white chert)	–	–
McNj-33	The site consists of 1 light pink chert biface, 1 cream chert biface, 1 clear quartz biface fragment, 1 microblade core, and a cluster of approximately 100+ white-cream chert and clear quartz flakes, all from the surface of the site area. Several microblades were observed adjacent to the microblade core. The artifacts are indicative of the ASTt.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	1 (light pink chert), 1 (cream chert), 1 (fragment, clear quartz)	–	1 (microblade core)	–	–	100+ (white/ cream chert & clear quartz)	–	ASTt tools (listed)
McNj-34	The site consists of 1 stone circle (2 m dia.).	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
McNj-35	The site consists of a stone alignment (Feature 1) that spells out the letters "J F".The letters "JF" could related to John Franklin who, in August 1821, led an expedition that canoed to the southern tip Bathurst Inlet, at the outlet of the Western River. However, the Bathurst Inlet Lodge occasionally runs John Franklin-themed tours of the inlet and the letters may also related to their activities in the area.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-36	The site consists of a partial stone circle (Feature 1) that is incomplete at its southern end.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-37	The site consists of 1 stone blind/inuksuit with a possible cache in the front and 1 stone cache. Feature 2 is highly visible from shore line. Pile of stones in front of the feature maybe a collapsed portion of this feature or a cache.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-38	The site consists of 1 collapsed stone cairn and a scatter of 1 quartz flake and 3 chert flakes.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (quartz), 3 (chert)	–	–
McNj-39	The site consists of 3 stone caches, 3 stone circles, 2 stone ovals, 1 collapsed stone cairn, 1 stone oval, and 1 stone wall. A tobacco tin lid was also noted.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNj-40	The site consists of over 200 white, pink and grey chert flakes, 2 biface fragments, approximately 10 microblades, 2 microblade cores, 1 biface, 3 scrapers, 1 white chert core fragment, 1 grey chert retouched flake, a grey quartz flake, 3 biface basal fragments, and 1 grey siltstone or felsic tuff chisel. The artifact assemblage is indicative of the ASTt.	NUNAVUT 2011-022A	–	–	–	3	–	–	–	–	–	10	1 (white chert), 2 (fragments), 3 (basal fragments)	–	1 (core fragment, white chert), 2 (microblade cores)	–	1 (retouched, grey chert)	200+ (white, pink & grey chert)	–	1 chisel, grey siltstone
McNj-41	The site consists of a white chert core fragment. No other cultural material was observed.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, white chert)	–	–	–	–	–
McNj-42	The site consists of 2 stone ovals.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNj-43	The site consists of a lithic scatter of white chert and quartz tools and debitage from the surface of the site area.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	tools + debitage (number unknown)
McNj-44	The site consists of a lithic scatter of approximately 15 white chert debitage from the surface of the site area.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15 (white chert)	–	–
McNj-45	The site consists of a white chert core fragment. No other cultural material was observed.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	1 (core, white chert)	–	–	–	–	–
McNj-46	The site consists of a white chert lithic scatter with 1 flake and 4 microblade fragments. The artifact assemblage is indicative of the ASTt.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	4 (white chert)	–	–	–	–	–	1 (white chert)	–	–
McNj-47	The site consists of 2 chert lithic scatters with 7 (white chert) flakes, 1 orange chert flake, 4 microblades (3 white chert and 1 light orange chert). The artifact assemblage is indicative of the ASTt.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	3 (white chert), 1 (light orange chert)	–	–	–	–	–	7 (white chert), 1 (orange chert)	–	ASTt tools (listed)

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
McNj-48	The site consists of a stone alignment and lithic scatters with over 100 flakes, an orange-beige blade/ end scraper, a white chert sideblade, a white chert biface, a brown banded chert biface, a clear quartz scraper, 2 quartz wedges, and approximately 10 white quartz crystals. The lithic artifact assemblage is indicative of the ASTt. One Western 25-20 cartridge shell was also found.	NUNAVUT 2012-12A	–	1 (sideblade, white chert)	–	1 (end scraper, orange/ beige chert), 1 (clear quartz)	–	–	–	–	–	–	1 (white chert), 1 (brown banded chert)	–	–	–	–	100+ (white chert)	Present	2 quartz wedges
McNj-49	The site consists of 1 white chert asymmetric knife, 1 biface fragment and 1 lithic scatter with 8 flakes. The artifact assemblage is indicative of the ASTt.	NUNAVUT 2012-12A	–	–	1 (asymmetric, white chert)	–	–	–	–	–	–	–	1 (fragment, white chert)	–	–	–	–	8 (white chert)	–	ASTt tools (listed)
McNj-50	The site consists of 1 stone circle on a bedrock exposure with a small area of flat pavement of stones inside.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-1	The site consists of a stone cairn.		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-2	The site consists of a part of a short wooden bow (estimated to be about 1/2) whose total length would not have exceeded 3 1/2 ft. In addition, in this same area, a nail-studded kayak paddle was also found lying on the tundra.		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNk-3	About 75 archaeological features were noted and mapped and about 30 features were examined, identified and named by Kiluhiqturmiut Inuit elders from Cambridge Bay during this project. (Stewart 2004 site form). Nothing collected.	NUNAVUT 2004-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-4	The site consists of 2 stone circles, 3 stone alignments, 1 cache and a pink quartzite lithic scatter including 2 cores and debitage. Historic materials located at the site include a plastic tent peg, and a tin can. No diagnostic artifacts found.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	2 (cores, pink quartzite)	–	–	3 (pink quartzite)	Present	–
McNk-5	The site consists of 2 stone circles, one of which has a pavement of stone slabs. No artifacts were observed at the site.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-6	The site consists of 1 cache measuring 5 m diameter with caribou bones visible in centre. No artifacts visible.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-7	The site consists of at least 6 stone caches constructed from larges pink quartzite stone slabs. Caribou bones were visible in two of the caches and a metal wrench and other modern debris were also observed in some of the caches. No prehistoric artifacts were observed.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNk-8	The site consists of a stone circle with a hearth feature at the south end and a stone alignment that consists of four discrete piles of stones that incorporate slabs of pink quartzite placed vertically to stand on edge.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-9	The site consists of 1 stone circle. No artifacts were observed.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-10	The site consists of 14 stone features including 7 stone circles, 3 stone semi-circles, 1 stone oval, 1 pavement of stone slabs, 1 stone pile, and 1 cairn.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
McNk-11	The site consists of 5 features including 1 stone oval, 1 stone alignment, and 3 stone markers.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-12	The site consists of 3 stone circles and 1 cache/hearth feature containing historic debris (batteries, a tin can, and broken bone).	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNk-13	The site consists of a small cache constructed of flat pink quartzite slabs. No artifacts were observed in the area.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-14	The site consists of 1 large pink quartzite core and several flakes. No diagnostic or formed tools were observed.	NUNAVUT 2010-024A													1 (core, pink quartzite)			3 (pink quartzite)	–	–
McNk-15	The site consists of 1 surface find containing 2 spent rifle cartridges. The cartridges were dated from the headstamps: WRA Co. 38-55 (Winchester Repeating Arms - produced 1866-1932) and D.C. Co. 38-55 (Dominion Cartridge Co. - produced 1886-1947).	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNk-16	The site consists of a rectangular stone alignment (Feature 1) and a collapsed stone cairn (Feature 2).	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-17	The site consists of 1 stone oval, 1 stone pile with 5 stones, and an abrasive stone with numerous groove marks. These are interpreted as prehistoric. The scatter of wood sticks (possibly firewood) is likely historic.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNk-18	The site consists of several runner pieces of a wood sled and a wood oar. These are interpreted to be historic (20th century) items.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNk-19	The site consists of 2 white quartzite lithic scatters with approximately 20 flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20 (white quartzite)	–	–
McNk-20	The site consists of 1 stone circle.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McNk-21	The site consists of 2 white chert lithic scatters with 20-30 flakes, 1 chert biface, and 1 retouched quartzite flake.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	1 (chert)	–	–	1 (retouched, quartzite)	–	30 (quartzite)	–	–
McNk-22	The site consists of 10 lithic scatter with over 500 flakes, 1 white chert bipoint, white quartzite ovoid knife fragment, and 1 burin spall tool. Material types included white and light green quartzite and white chert. The artifact assemblage is indicative of the ASTt.	NUNAVUT 2012-12A	1 (bipoint, white chert)	–	1 (fragment, quartzite)	–	1 (spall tool)	–	–	–	–	–	–	–	–	–	–	500+ (white & light green quartzite, white chert)	–	ASTt tools (listed)
McNk-23	The site consists of 5 rifle cartridges, D.C. co. 30-30, likely manufactured by the Dominion Cartridge Company of Montreal between 1886 and 1947 (Steinhauser nd).	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
McNk-24	The site consists of 1 white chert microblade and 6 flakes (2 white quartzite, 4 white chert). The artifact assemblage is indicative of the ASTt.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	1 (white chert)	–	–	–	–	–	2 (white quartzite), 4 (white chert)	–	ASTt tools (listed)
McNk-25	The site consists of 1 lithic scatter with 11-20 white quartzite flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20 (white quartzite)	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
MdNk-1	The site consists of 2 artifacts in fully exposed context. One secondary flake of quartz and one flake fragment of white chert.	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (quartz), 1 (white chert)	–	–
MdNk-2	The site consists of 1 sandstone flake (collected).	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (sandstone)	–	–
MdNk-3	Consists of a limited artifact scatter in exposed context. A large quartz decortication flake fragment and a quartz cobble spall were found within five metres of each other.	NUNAVUT 2001-019A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (quartz)	–	–
MdNk-4	The site consists of a hearth feature, and a lithic scatter including 1 blade, 3 modified flakes, 6 pieces of quartz shatter, and 53 quartz flakes (collected).	NUNAVUT 2001-019A	–	1 (quartz)	–	–	–	–	–	–	–	–	–	–	–	3 (modified, quartz)	–	59 (quartz)	–	–
MdNk-5	The site consists of a cairn of large rocks. The rocks are located on top of a large boulder and look like they were piled more recently than other stone features in the area based on lichen growth and neighbouring stone contact points.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-6	The site consists of 9 artifacts collected from this fully exposed site including 7 quartz flakes, 1 quartz scraper fragment, and 1 piece of quartz shatter.	NUNAVUT 2002-035A	–	–	–	1 (fragment, quartz)	–	–	–	–	–	–	–	–	–	–	–	8 (quartz)	–	–
MdNk-7	The site consists of a small surface scatter, mostly banded chert flakes along with 1 projectile point preform, along with a cache of rocks and a small stone feature.	NUNAVUT 2002-035A	1 (preform, banded chert)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3 (banded chert)	–	–
MdNk-8	The site consists of an exposed artifact scatter. Over 100 artifacts were collected including 1 small lanceolate arrow tip similar to Taltheilei (but minus the ears).	NUNAVUT 2002-035A	1 (tip fragment)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100+	–	–
MdNk-9	The site consists of an exposed artifact scatter (13 lithic artifacts collected including 1 quartzite biface).	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	1 (quartzite)	–	–	–	–	12 (quartzite)	–	–
MdNk-10	Undisturbed surficial stone features. Tent rings are located above the shoreline on the first terrace overlooking the water at the tip of the peninsula. Two more tent rings are located on the shore west of the site and a number of the tent ring sites are located on the shoreline down the east side of the peninsula. No artifacts were identified. Historic residue in the form of oil drums and faunal remains appear nearby.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MdNk-11	The site consists of 2 tent rings. No associated artifacts. Oil drums and faunal remains appear nearby.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-12	The site consists of tent rings. A large number of flowers were observed growing in and around the features possibly indicating a burial or increased organic content from butchering activity.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-13	The site consists of 2 tent rings. No associated artifacts.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-14	The site consists of 2 small stone rings interpreted as caches about 12 m apart. Features are disturbed.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
MdNk-15	The site consists of an exposed artifact scatter. Eighty-five artifacts were collected consisting of 4 tools (including a unifacially flaked semi-lunate biface), 77 quartz flakes and 4 pieces of quartz shatter.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	1 (semi-lunate, quartz)	–	–	–	–	81 (quartz)	–	–
MdNk-16	The site consists of a stone rectangle from a canvas tent.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MdNk-17	The site consists of an exposed artifact scatter. Chert material of a high quality. Forty-eight artifacts were collected.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	48 (chert)	–	–
MdNk-18	The site consists of a tent ring of 20 -22 stones. This is the only tent ring site located on top of the peninsula as all others are situated on or above the shoreline. Forty-three artifacts were collected (mostly flakes and shatter).	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43	–	–
MdNk-19	The site consists of a small surface lithic scatter of approximately 100 pieces observed.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–
MdNk-20	The site consists of 1 lithic flake of white quartz. No additional materials.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 (white quartz)	–	–
MdNk-21	The site consists of a small tent ring approximately 2 m x 1.5 m. No artifacts identified.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-22	The site consists of 2 tent rings, 1 hearth and 1 cache.	NUNAVUT 2002-035A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-23	Artifacts were all recovered on the downslope blown out sandy areas. 79 artifacts were collected including projectile points, drills, microblades, microblade cores, end scrapers and side blades. Potentially a multicomponent site. The artifact assemblage is indicative of the ASTt and the Taltheilei tradition.	NUNAVUT 2002-035A	2	2 (sideblades)	–	2	–	2	–	–	–	2	–	–	2 (microblade cores)	–	–	60+	–	ASTt and Taltheilei tools (listed)
MdNk-24	The site consists of 1 stone circle. No artifacts were observed.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-25	The site consists of 2 stone circles and another small stone feature consisting of four rocks placed together. No artifacts were observed.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-26	The site consists of 1 stone circle.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-27	The site consists of a wooden axe handle, a small wooden toy sled, a rifle shell, a stove-pipe collar, a carved wooden stake and a tobacco can. All artifacts left *in situ*.	NUNAVUT 2010-024A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MdNk-28	The site consists of 1 stone circle with 12 stones and 2 wooden sticks with the ends squared.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-29	The site consists of 3 stone circles and 1 hearth, all interpreted as prehistoric. Scatters of broken bone were observed on the ground across the area. A wooden jigger & rifle shell casing are likely from historic use of this area.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–

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Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
MdNk-30	The site consists of 1 stone circle, of 23 stones and 4 m in diameter, which is interpreted as being prehistoric and a wooden handle is interpreted as being from historic use of this area.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MdNk-31	The site consists of a stone circle consisting of 25 stones, and a bone scraper, both interpreted as being prehistoric. The bone scraper was left *in situ*.	NUNAVUT 2011-022A	–	–	–	1 (bone scraper)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-32	The site consists of 1 stone alignment, 9 stones and 1 stone circle of 7 stones containing a scatters of broken bones.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-33	The site consists of 2 stone piles, 3 stone circles, 1 stone oval, and a scatter of quartzite flakes on the surface including 10 green quartz flakes, 2 pink quartz flakes, and 1 white quartz flake. All artifacts were left *in situ*.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10 (green quartz), 2 (pink quartz, 1 (white quartz)	–	–
MdNk-34	The site consists of 8 white quartz flakes on the surface.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8 (white quartz)	–	–
MdNk-35	The site consists of 1 pink-rose quartzite cortex spall tool from the surface of the site area. No other cultural material was observed.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 pink-rose quartzite spall tool
MdNk-36	The site consists of 1 stone circle, one half circle, and 2 stone ovals. Additionally, several pieces of broken bone and a piece of brown glass were observed.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MdNk-37	The site consists of a stone circle.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-38	The site consists of a stone circle and ulna bone tool that was left *in situ*.	NUNAVUT 2011-022A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-39	The site consists of 8 lithic scatters with 400-500 total flakes of banded brown and white chert, orange chert, and white chert. Additionally one large cobble with a bowl shaped pecked depression was found and left *in situ* and 1 white chert burin, 1 chert point fragment and 1 white chert side blade were collected. The artifact assemblage is indicative of the ASTt.	NUNAVUT 2012-12A	1 (fragment, white chert)	1 (sideblade, white chert)	–	–	1 (white chert, ASTt)	–	–	–	–	–	–	–	–	–	–	500 (banded brown & white chert, orange chert, and white chert)	–	–
MdNk-40	The site consists of 1 cache.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-41	The site consists of 1 cache and 1 hearth.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-42	The site consists of 1 stone circle and 1 cache.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-43	The site consists of 1 stone circle and 1 hearth.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-44	The site consists of 2 stone circles and 2 kayak stands.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-45	The site consists of 3 stone circles and 1 stone cache.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-46	The site consists of 3 caches.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-47	The site consists of 1 stone circle.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNk-48	The site consists of stone circles, hearths, stone alignments, a wooden platform, old core boxes and 2 x 4s. Likely related to mineral exploration.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–

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MdNl-2	Small site, sterile, disturbed tent ring, a hearth windbreak. Scatter of quartzite and chert flakes. Microblade, end scraper and 2 chert artifacts. Test pitting and search of other deflation areas futile. Occupation very small and almost entirely restricted to the already exposed flake scatter. The artifact assemblage is indicative of the ASTt.	NWT 78-432	–	–	–	1 (chert)	–	–	–	–	–	1 (chert)	–	–	–	–	–	7 (quartzite and chert)	–	–
MdNl-3	The site consists of a thin scatter of grey quartzite flakes.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3 (grey quartzite)	–	–
MdNl-4	Tent ring site, few rusted metal fragments and a great deal of caribou bone. Also a tiny prehistoric component of three green and white chert flakes, found together on the surface.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3 (green & white chert)	Present	–
MdNl-5	Tent ring site, sterile, littered with loose stone. The extant tent rings are overgrown and partially buried.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNl-6	The site consists of 1 cache with a pavement of stones beside it, 2 stone ovals, and a lithic scatter of 40 + white chert, pink and white quartzite flakes, 1 white chert asymmetrical knife fragment. The artifact assemblage is indicative of the ASTt.	NUNAVUT 2012-12A	–	–	1 (asymmetrical fragment, white chert, ASTt)	–	–	–	–	–	–	–	–	–	–	–	–	40+ (white chert, pink and white quartzite)	–	–
MdNl-7	The site consists of 2 stone ovals, one with a pavement of flat stones, 7 flakes, 1 white chert side blade, 1 clear quartz core, 2 asymmetric knives of white chert, and a rifle cartridge (223 Remington). The lithic artifact assemblage is indicative of the ASTt.	NUNAVUT 2012-12A	–	1 (side, white chert)	2 (asymmetrical, white chert, ASTt)	–	–	–	–	–	–	–	–	–	1 (core, clear quartz)	–	–	7 (chert)	Present	ASTt tools (listed)
MdNl-8	The site consists of a pavement of 20 flat stone possibly a hearth and 9 lithic scatters with over 200 chert and quartz flakes, 1 beige banded chert asymmetric knife, 2 beige and brown banded points, 1 white chert burin, and 1 white chert sideblade. The artifact assemblage is indicative of the ASTt.	NUNAVUT 2012-12A	2 (beige and brown banded chert)	–	1 (asymmetrical, beige banded chert)	–	1 (white chert, ASTt)	–	–	–	–	–	1 (sideblade, white chert)	–	–	–	–	200+ (chert & quartz)	–	ASTt tools (listed)
MdNl-9	The site consists of 1 fire pit and 1 stone circle.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNl-10	The site consists of 1 stone rectangle and 1 quartzite spall tool.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1 quartzite spall tool
MdNl-11	The site consists of 1 seal skin rope 12 m long and 1 cm wide.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MdNl-12	The site consists of 1 cache and 1 cairn.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNl-13	The site consists of 2 white quartzite flakes.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2 (white quartzite)	–	–
MdNl-14	The site consists of 2 stone circles.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNl-15	The site consists of 5 caches.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNl-16	The site consists of 1 stone circle, rusted tin cans, plastic fragments, broken caribou bone, and a toy Land Rover.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MdNl-17	The site consists of 1 stone circle and 1 hearth.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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MdNl-18	The site consists of 1 stone circle with scatter of broken caribou bone around it.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MdNl-19	The site consists of one wooden oar with a wrapped metal end.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MdNl-20	The site consists of 1 piece of wooden board with a curved side (perhaps a piece of a lid) and a rusted metal screw or pin.	NUNAVUT 2012-12A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MeNl-0	A scatter of bone. PA material surface collected during the Stefansson Expedition (Canadian Arctic Expedition 1913-1916). (Per M. Gardiner, GC project 2008-2009).		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MeNl-1	Cache, inuksuk and tent ring site. Caches are unusually large, up to 1 1/2 m high and 2 m across at the base. All are open to the sky and empty, except for a few which contain small quantities of willow branches. Save for few scraps of bone, site is sterile. No native made artifacts on site.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MeNl-2	Sterile tent ring and cache site.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MeNl-3	An inuksuk and grave site consisting of a 450 m drive lane, a stone oval, a surface burial, and historic grave goods discovered beneath three flat rocks. Skeletal material left *in situ* includes a molar, a premolar, a few phalanges, tiny scraps of bone.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MeNl-4	Very large, historic/recent Inuit campsite, spread out over almost 700 m along the east shore of Fishing Creek. It consists of 19 relatively distinct tent rings, caches, inuksuit, shooting blinds and hearths. It is not the remains of single contemporaneous camp as the size alone suggests. Site has clearly been occupied within last few years and for some time before that.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MeNl-5	Tent ring site, 2 tent rings are associated with debris, the others are sterile and overgrown.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MeNl-6	The site consists of five tent rings one the shore, bone, rusted metal, cloth fragments, etc. No native-made artifacts were found on the site.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–
MeNl-7	The site is a tent ring site that was probably not a single contemporaneous camp. No prehistoric artifacts were found on the site.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MeNl-8	A tent ring site on the shore. No prehistoric artifacts were found. Note: this is one of the few sites found on which seal bone was observed.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MeNl-9	Sterile tent ring site.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MeNl-10	The site consists of 2 sterile tent rings, over-grown with willows. This appears to be a fairly old site, possibly prehistoric.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: Artifact types (to the left of "Permit Number") relate mostly to stone tools. More detailed tool descriptions, when available, are noted in brackets after the number. A "+" sign after the number indicates "over" (e.g. 10+ = over 10 artifacts). A "?" indicates rough count estimates. Due to the large variety of historical artifacts, historical remains are not counted but merely noted for their presence or absence. The column "Other Artifacts" contains artifacts/counts that do not fit into any of the other categories as well as notes when a record vaguely mentions artifacts/tools without exact number counts.

Table V8-1C-3. Archaeological Artifacts by Site

Borden Number	Comments	Permit Number	Projectile Points	Blades	Knives	Scrapers	Burins	Drills	Gravers	Slotters	Chithos	Microblades	Bifaces	Unifaces	Nodules/ Cores/ Raw Materials	Utilized/ Modified Flakes	Micro-debitage	Debitage	Historic Materials	Other artifacts
MeNl-14	The site consists of a number of discontinuous flake and calcine bone scatters distributed in shallows blowouts along the top of the knoll as well as a small buried component. Also two sterile tent rings and a shooting blind which presumably date much later than the main occupation. Further work recommended. Surface collected by B. Gordon in 1987.	NWT 78-432 NWT 87-615	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–
MeNl-15	A hunting blind, three inuksuit and a piece antler (potentially worked). The hunting blind has 19 stones and two of the inuksuit consist of stone slabs held upright by smaller stones. The third inuksuk consists of a slab sitting on top of a boulder.	NUNAVUT 2013-20A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
MfNm-3	Tent ring site including caribou bone, a few cloth and cord fragments and a few pieces of rusted metal. No native-made artifacts were found on the site.	NWT 78-432	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Present	–

Note: Artifact types (to the left of "Permit Number") relate mostly to stone tools. More detailed tool descriptions, when available, are noted in brackets after the number. A "+" sign after the number indicates "over" (e.g. 10+ = over 10 artifacts). A "?" indicates rough count estimates. Due to the large variety of historical artifacts, historical remains are not counted but merely noted for their presence or absence. The column "Other Artifacts" contains artifacts/counts that do not fit into any of the other categories as well as notes when a record vaguely mentions artifacts/tools without exact number counts.

Appendix V8-3A

Back River Project: 2012 Socio-economic and Land Use Baseline Report

Sabina
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Sabina Gold and Silver Corp.

BACK RIVER PROJECT
2012 Socio-economic and Land Use Baseline Report

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August 2013

BACK RIVER PROJECT
2012 SOCIO-ECONOMIC AND LAND USE BASELINE REPORT

August 2013
Project #0833-002-21

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Prepared for:

Sabina Gold and Silver Corp.

Prepared by:

Rescan™ Environmental Services Ltd.
Vancouver, British Columbia

Executive Summary

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Executive Summary

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corporation located in the west Kitikmeot Region of Nunavut. This report presents the results from the socio-economic and land use portion of the 2012 baseline research program. The objective of this baseline study is to provide current socio-economic and land use information on the Kitikmeot Region to support the subsequent completion of an Environmental Impact Statement (EIS) for the Project and to inform the further development and design of the Project. Socio-economic and land use fieldwork was completed in 2012 and consisted of community visits and 60 key knowledge holder interviews with Kitikmeot Region service providers and three hunter-trapper focus groups with local land users.

The geographic scope for the socio-economic study was defined by a regional study area (RSA) and a local study area (LSA). The socio-economic and land use RSAs were selected to provide broad-scale information on regional characteristics and conditions. The socio-economic RSA is inclusive of the Kitikmeot Region communities: Kugluktuk, Cambridge Bay, Bathurst Inlet, Omingmaktok, Gjoa Haven, Taloyoak, and Kugaaruk. The socio-economic LSA is represented by community-level information for Bathurst Inlet, Omingmaktok, Kugluktuk, and Cambridge Bay.

The geographic scope for the land use study is similarly defined by an RSA and LSA. The land use RSA was selected to provide broad-scale information on land use characteristics and patterns and includes the communities of Bathurst Inlet, Omingmaktok, Kugluktuk, and Cambridge Bay. The land use LSA is defined as the area of land and water that encompasses the Project and is consistent with the largest boundary of the wildlife, regional marine, and terrestrial study areas as defined by those disciplines.

The Kitikmeot Region is the most western of the three administrative regions within Nunavut. The regional population was estimated to be 6,012 in 2011, an increase of approximately 12.1% since 2006 (Statistics Canada 2007b). The Kitikmeot communities range in size from approximately 771 residents in Kugaaruk to 1,608 residents in Cambridge Bay. All Kitikmeot communities have experienced substantial population growth over the past two decades and have a notable portion of the population who are 15 years of age and under (from a low of 28.7% of the population in Cambridge Bay to 41.6% in Kugaaruk).

Education levels are low; approximately 61% of Kitikmeot residents are without a high school diploma, as compared to 57% of Nunavut residents, and 24% of Canadian residents. Formal education levels are low in all the Kitikmeot communities when compared to Canadian averages. The proportion of the population with formal education is slightly higher in Cambridge Bay, but is still well below the Canadian average. Graduation rates in the Kitikmeot have been variable over the past decade; from a low of 10.1%, or 11 individuals, in 2004 to a high of 28.5%, or 25 individuals, in 2008. More recently, the graduation rate in the Kitikmeot Region was 22.0%, or 24 individuals, in 2011 (GN Department of Economic Development and Transportation 2012). Among the Kitikmeot communities, Cambridge Bay had a relatively high proportion of the population with a university certificate/diploma (16%) or a college degree or diploma (24%) compared with the other communities.

The life expectancy of Nunavummiut at birth is lower than other Canadians (by approximately 10 years) and has decreased in recent years, whereas the life expectancy of Canadians generally continues to increase each year. Other notable issues linked to community health in Nunavut are food security, well-being, housing, crime, health behaviours (e.g., smoking and substance abuse), as well as mental health and suicide. These issues interact with each other and collectively contribute to the overall health and well-being of communities in Nunavut.

The service sector is the base of the Kitikmeot economy, providing employment to around 80% of the employed labour force. Services in the region are related to business, education, retail trade, health, and social services. In contrast, primary and secondary industries, including resource-based industries and construction, account for about 20% of local employment. All Kitikmeot communities exhibit high participation in the education, business, retail, and other service sectors. The unemployment rate in all communities was relatively high compared to the national average of 6.6% and the Nunavut average of 15.6%, except for Cambridge Bay, which reported an unemployment rate of 9.7%. Median earnings in the Kitikmeot Region ($20,041) were lower as compared to the Nunavut median ($26,848); similarly, the percentage of income from government transfers is higher in the Kitikmeot (14.1%) as compared to Nunavut as a whole (11.2%).

Nunavut accounts for approximately 0.1% of the Canadian population and their economy is responsible for approximately 0.1% of Canada's real Gross Domestic Product (GDP). Nunavut's real GDP experienced an overall increase of approximately 26.6%, from $1.3 billion to $1.7 billion between 2007 and 2011. Despite a small decrease between 2008 and 2009, Nunavut's real GDP has increased each year over the specified time period (Statistics Canada 2012b). The four largest contributors to real GDP in Nunavut were consistent between 2007 and 2011 and included construction, education services, health and social assistance, and public administration. Large increases in the contribution from the mining, quarrying, and oil and gas exploration sector places the industry among the four top contributors in 2010 and 2011.

Community well-being (CWB) has become a main focus for Aboriginal communities in Canada, particularly in the north. For Inuit, who lived on the land in extended family groups prior to resettlement into communities in the 1950s, the integration of modern and traditional lifestyles has presented numerous challenges. CWB is linked to health, health behaviors, housing, food security, crime, mental health and suicide, among a variety of other factors. CWB is informed by, and in turn shapes, many other aspects of daily life in Inuit communities.

In Nunavut, there are two main types of land title and tenure: Inuit-owned Land (IOL) and Crown land. The NTI is responsible for IOL, and Aboriginal Affairs and Northern Development Canada is responsible for most Crown land. The proposed Project would be located on both IOL and Crown land. The recently released Draft Nunavut Land Use Plan (NPC 2012) provides guidance for resource use and development in the region.

The Kitikmeot Region has a mixed economy based on traditional and modern economic activities. Local commercial activities include commercial and sports hunts, and eco-lodge businesses. Tourism and recreation activities in the land use study areas include hiking, hunting, fishing, boating, canoeing, kayaking, dog sledding, cross-country skiing, and snowmobile riding. The traditional economy is largely focused on subsistence land use. Land use activities and the subsistence economy are important to Kitikmeot residents and include non-commercial hunting, fishing, trapping, and gathering. Harvesting for personal use and the consumption of country food is common and is linked to personal and community well-being.

There are both cultural and commercial land uses in the vicinity of the Project. Cultural land use typically consists of hunting, trapping, fishing, camping, and travelling, and is guided by a longstanding relationship of reciprocity and respect between Inuit people and their environments. Commercial land use consists primarily of sport hunting, tourism, mineral exploration, and transportation and shipping. Muskox, caribou, wolf, and wolverine are among the species people in the Kitikmeot Region rely upon, with caribou being the most harvested terrestrial mammal. Participation in the subsistence economy remains high and includes the majority of Kitikmeot residents.

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BACK RIVER PROJECT

2012 SOCIO-ECONOMIC AND LAND USE BASELINE REPORT

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Glossary and Abbreviations

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AANDC	Aboriginal Affairs and Northern Development Canada (formerly INAC)
ABE	Adult Basic Education
ATV	All-terrain vehicle
CanNor	Canadian Northern Economic Development Agency
CHARS	Canadian High Arctic Research Station
CHR	Community Health Representative
Co-op	Co-operative
CWB	Community Well-being
EDO	Economic Development Officer
EIS	Environmental Impact Statement
GN	Government of Nunavut
HTO	Hunter and Trapper Organization
INAC	Indian and Northern Affairs Canada (currently known as AANDC)
Inuit	Aboriginal peoples of northern Canada and Greenland. In the context of Nunavut, those with beneficiary status under the Nunavut Land Claims Agreement (NLCA).
IOL	Inuit Owned Land. With respect to the NLCA, it is land that vests in a Designated Inuit Organization as Inuit Owned Land.
Inuit Qaujimajatuqangit	"The traditional, current, and evolving body of Inuit values, beliefs, experience, perceptions, and knowledge regarding the environment, including land, water, wildlife and people, to the extent that people are part of the environment" (Qikiqtani Inuit Association 2009).
Inuit Qaujimaningit	"Inuit Traditional Knowledge and variations of Inuit Traditional Knowledge. Inuit epistemology relating to: Inuit societal values (including the legal obligations set out in the Nunavut Land Claims Agreement regarding Inuit participation, Inuit employment and training, etc.) and Inuit knowledge (both contemporary and traditional)" (Qikiqtani Inuit Association 2009).
KIA	Kitikmeot Inuit Association
LSA	Local Study Area
ML/ARD	Metal Leaching/Acid Rock Drainage
MOU	Memorandum of Understanding
NAC	Nunavut Arctic College
NBCC	Nunavut Business Credit Corporation

NDEDT	Nunavut Department of Economic Development and Transportation
NEDS	Nunavut Economic Development Strategy
NGO	Non-governmental Organization
NHC	Nunavut Housing Corporation
NIRB	Nunavut Impact Review Board
NLCA	Nunavut Land Claims Agreement
NLUP	Nunavut Land Use Plan
NPC	Nunavut Planning Commission
NSRT	Nunavut Surface Rights Tribunal
NSSI	Nunavut Sealift and Supply Inc.
NTCL	Northern Transportation Company Limited
NTEP	Nunavut Teacher Education Program
NTI	Nunavut Tunngavik Incorporated
Nunavummiut	Residents of Nunavut
NWB	Nunavut Water Board
NWMB	Nunavut Wildlife Management Board
NWT	Northwest Territories
Primary industries	Industries which extract or harvest raw materials from nature, including mining, oil/gas, hunting, fishing, forestry, and agriculture.
Project, the	The Back River Project
Rescan	Rescan Environmental Services Ltd.
RIA	Regional Inuit Association
RCMP	Royal Canadian Mounted Police
RNFB	Revised Northern Food Basket
RSA	Regional Study Area
Sabina	Sabina Gold and Silver Corporation
SAO	Senior Administrative Officer
Secondary industries	Manufacturing and construction industries, which create finished products from the materials produced by primary industries.
Service sector	The provision of various services, including government, education, health, social, and trade, among others. Also called the tertiary industry in relation to primary (i.e., natural resources) and secondary (i.e., manufacturing) industries.
Subsistence economy	Non-commercial hunting, fishing, trapping and gathering that provides food and other goods for individuals, households and communities.
Wage economy	Component of livelihood provided through engagement in the labour force and receipt of monetary compensation.

1. Introduction

1. Introduction

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corporation (Sabina) located in the west Kitikmeot Region of Nunavut. Exploration programs were run out of both the Goose and George camps in 2012 (Figure 1-1).

For 2012, Sabina contracted Rescan Environmental Services Ltd. (Rescan) to conduct a comprehensive baseline program that covered the geographical area of the Goose Property, the George Property, and a Marine Laydown Area, located on the southern part of Bathurst Inlet. The following components were included in the 2012 baseline program:

- meteorology;
- air quality and dust;
- noise;
- hydrology and bathymetry;
- freshwater water quality, sediment quality, and aquatic biology;
- freshwater fish and fish habitat;
- marine water quality, sediment quality, and aquatic biology;
- marine fish and fish habitat;
- wildlife (terrestrial and marine);
- wildlife DNA study (grizzly bear and wolverine);
- ecosystem mapping;
- vegetation and wetlands (including rare plants);
- soils and terrain;
- country foods;
- archaeology;
- socio-economics;
- land use; and
- metal leaching (ML) and acid rock drainage (ARD).

The 2012 baseline program was designed around potential infrastructure and known deposits at the Goose Property, George Property, and Marine Laydown Area. It was assumed that access to, from, and between the properties and laydown area would be by winter road. This report presents the results from the socio-economic and land use portion of the 2012 baseline program. The objective of this baseline study is to provide current socio-economic and land use information on the Kitikmeot Region of Nunavut in order to inform the further development and design of the Project. This information will also serve as the baseline for the preparation of the Draft Environmental Impact Statement (EIS) for the Project. Moreover, this baseline report will assist in the identification of potential risks, challenges, and opportunities for Sabina and the Project. A profile of important socio-economic characteristics of Kitikmeot communities and a description of land use was developed by accessing current available statistical and report information and by conducting interviews and focus groups in the Kitikmeot Region. The socio-economic profiles describe current characteristics of the Kitikmeot Region and its communities, including relevant economic, social, education, community, health, and well-being components. The land use section characterizes current land use and harvesting activities taking place in the vicinity of the Project.

Chapter 2 of this report presents the methods, and Chapters 3 through 10 provide the results for the range of socio-economic and land use components examined. Chapter 11 provides a summary of the results.

Figure 1-1

Back River Project Location

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2. Method

2. Methods

The collection of baseline information focused on the need to generate a profile of key socio-economic and land use characteristics for the Kitikmeot Region. Socio-economic study communities included Bathurst Inlet, Omingmaktok, Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, and Kugaaruk, while land use study communities included Kugluktuk, Cambridge Bay, Bathurst Inlet, and Omingmaktok. Information from Statistics Canada, the Government of Nunavut (GN), and other sources was compiled and analyzed, and a literature review of relevant published material was conducted.

Desk-based research consisted of reviewing documents and databases to identify and compile available information. Initially, an internet and bibliographic search was completed to identify potential information sources. The identified sources were then reviewed and applicable information extracted. Sources that were accessed included publically available statistics from government agencies, government reports, private sector and non-governmental organization (NGO) reports, academic literature, and internet publications.

Socio-economic fieldwork was completed in September and October of 2012 and included 60 key knowledge holder interviews with Kitikmeot Region service providers from government administration, health services, wellness and social services, safety and protection services, business and economic development, and education and training.

Land use fieldwork consisted of three hunter and trapper focus groups held in November of 2012, including hunters and trappers from Kugluktuk, Cambridge Bay, Omingmaktok, and Bathurst Inlet. The focus groups included resource mapping and had an average of eight to ten participants. Interviews were also conducted with Hunter and Trapper Organization (HTO) managers or board chairpersons in each community.

2.1 SOCIO-ECONOMIC STUDY AREAS

For the purposes of this baseline report, information is provided at the regional and community levels (Figure 2.1-1). Regional-level information is presented for the Kitikmeot Region of Nunavut, while community-level information is presented for individual Kitikmeot communities: Bathurst Inlet (also known as Kingaok), Omingmaktok (also known as Bay Chimo), Cambridge Bay (also known as Iqaluktuuttiaq), Kugluktuk (previously known as Coppermine), Gjoa Haven (also known as Uqsuqtuuq), Taloyoak (previously known as Spence Bay), and Kugaaruk (previously known as Pelly Bay).

Topics covered at the community and regional levels include demographics, education and experience, health status and community well-being, labour force and economy, land and resource use, and regional transportation. For some socio-economic components, depending on information availability, Nunavut-wide information is presented. Additional community-level information is also presented for Yellowknife, Northwest Territories (NWT) due to the likely socio-economic linkages between the Project and this community. The focus of the report, however, is on communities within the Kitikmeot Region.

The communities of Omingmaktok and Bathurst Inlet are no longer occupied year round and do not offer typical municipal services such as health and education services. As such, this baseline report focuses on the five Kitikmeot communities populated year round.

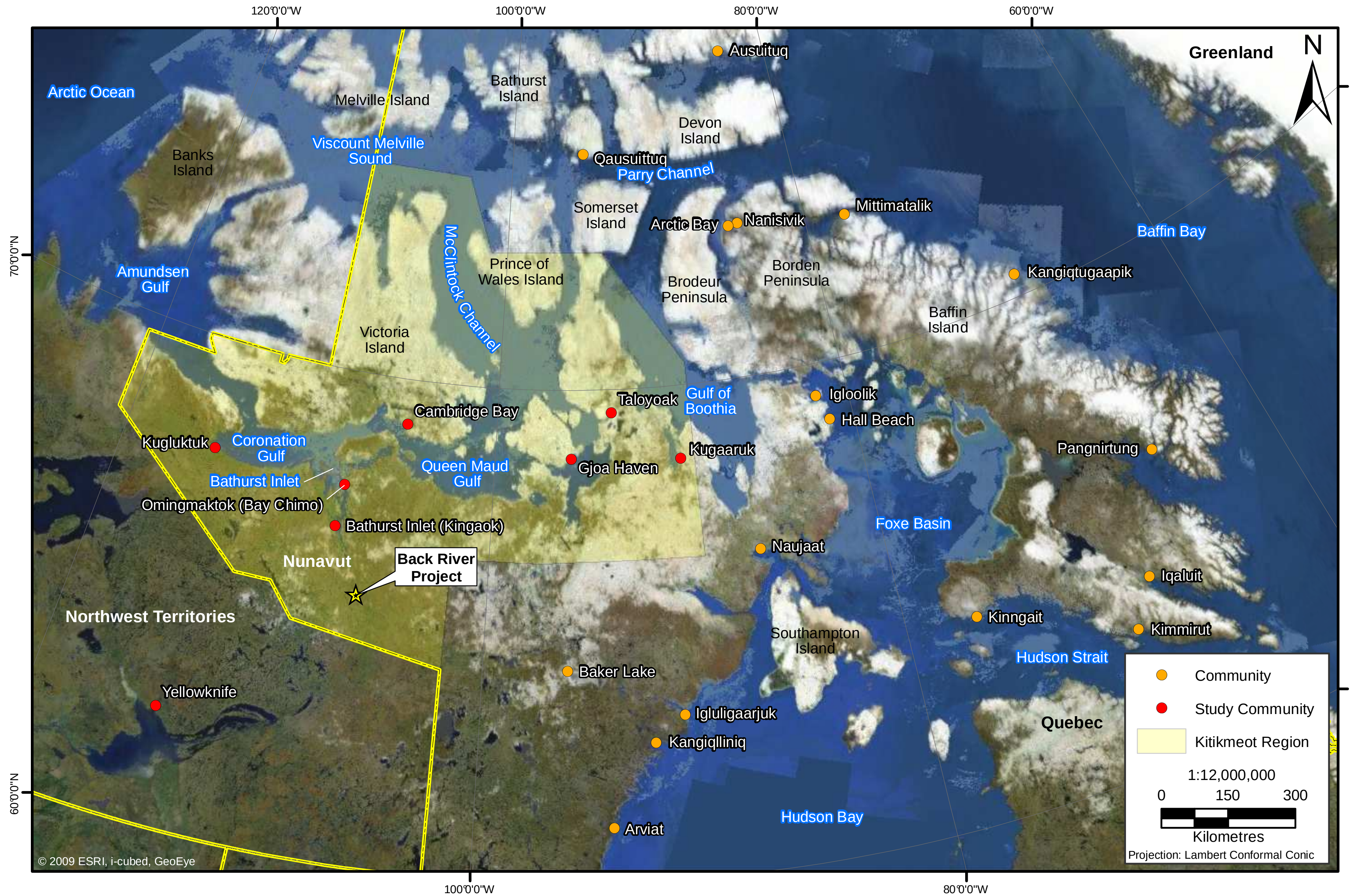

Figure 2.1-1

Socio-economic Study Area

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Lastly, there are two distinct sub-regional areas of interest—the west and east Kitikmeot regions—although aggregated information for these levels is not readily available. The west Kitikmeot Region defines the socio-economic local study area (LSA) and is represented by community-level information for Bathurst Inlet, Omingmaktok, Kugluktuk, and Cambridge Bay. In addition to the west Kitikmeot Region, the regional study area (RSA) is also expanded to include the east Kitikmeot Region, thus including community-level information from Gjoa Haven, Taloyoak, and Kugaaruk. The city of Yellowknife, NWT is also included within the RSA.

2.2 LAND USE STUDY AREAS

The geographic scope for the land use study is similarly defined by an RSA and LSA. The land use RSA was selected to provide broad-scale information on land use characteristics and patterns and includes the communities of Bathurst Inlet, Omingmaktok, Kugluktuk, and Cambridge Bay (as shown in Figure 2.1-1). The land use LSA is defined as the area of land and water that encompasses the Project and is consistent with the largest boundary of the wildlife, regional marine, and terrestrial study areas as defined by the baseline studies of those disciplines (Figure 2.2-1). This boundary is chosen because of the strong link between these environmental components and traditional land use activities.

2.3 REPORT OVERVIEW

A general profile and overview of the Kitikmeot Region and the RSA communities is provided in Chapter 3. This report then provides a more detailed profile of the LSA and RSA for the following socio-economic components: demographics (Chapter 4); education and experience (Chapter 5); labour force and economy (Chapter 6); health status and community well-being (Chapter 7); land and resource use (Chapter 8); subsistence economy, harvesting, and land use activities (Chapter 9); and regional transportation (Chapter 10). A summary of the socio-economic and land use baseline study results is presented in Chapter 11.

Figure 2.2-1

Land Use Local Study Area

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3. Regional Overview

3. Regional Overview

This section provides an overview of the characteristics that describe the Kitikmeot Region communities, including relative location, population, economy, services, and cultural activities. An overview of Yellowknife, Northwest Territories (NWT) is also provided.

3.1 THE KITIKMEOT REGION

The Project is located in the Kitikmeot Region of Nunavut (Figure 2.1-1). The Kitikmeot Region is the most western of the three administrative regions within Nunavut. The region contains the southern and eastern parts of Victoria Island and the adjacent part of the mainland up to the Boothia Peninsula, along with King William Island and the southern portion of Prince of Wales Island (Figure 2.1-1).

The economy of the Kitikmeot Region is mixed; it is based on both traditional and modern economic activities. The traditional economy is largely focused on subsistence land use. Inuit people in the region often supplement their traditional livelihoods by participating in the wage economy, seasonally and at different stages in life, often depending on factors such as seasonal harvesting activities and the availability of wage employment. In 2006, the labour force (i.e., residents aged 15 year and older) consisted of approximately 3,495 individuals, 3,125 of whom reported income in 2005. The median after tax income for these individuals was reported to be approximately $17,856, with 83.8% derived from earnings and 14.1% from government transfer payments. Unemployment rates in 2006 were approximately 22.4% for males and 17.6% for females (Statistics Canada 2007a, 2007b).

3.2 COMMUNITIES

The closest settlements to the Project (Figure 2.1-1) include the small communities of Bathurst Inlet (approximately 160 km from the Project)[1] and Omingmaktok (approximately 250 km away). The communities of Kugluktuk (approximately 460 km away) and Cambridge Bay (approximately 400 km away) are the closest major regional settlements. Other communities within the Kitikmeot Region are Gjoa Haven (approximately 575 km away), Kugaaruk (approximately 795 km away), and Taloyoak (approximately 705 km away). Yellowknife, NWT (approximately 485 km away) is also an important community, as it will likely serve as a hub for transportation and goods and services supply.

3.2.1 Bathurst Inlet

The Inuinnaqtun name for Bathurst Inlet is Kingaok, meaning “nose mountain” (KIA 2011). The community of Bathurst Inlet is one of the smallest in the Kitikmeot Region, with a permanent resident population of zero[2] in 2006 and 2011, down from approximately five in 2001 (Statistics Canada 2007b). It is located, as its name suggests, close to Bathurst Inlet, a deep inlet on the northern coast of Canada’s mainland into which the Burnside and Western rivers drain. Bathurst Inlet is most readily accessed by air from Yellowknife and Cambridge Bay. Access by marine vessel and barge occurs in the summer, and access by snowmobile occurs in the winter and spring.

Most Bathurst Inlet residents currently overwinter in Cambridge Bay and return to spend the spring and summer in their home community. Its population at any given time is driven in part by the tourist season for the Bathurst Inlet Lodge, a joint ecotourism venture between Bathurst Arctic Services and the Bathurst Inlet Inuit.

[1] All distances in parentheses are the approximate straight line, “as the crow flies,” distances from Goose Camp.
[2] Population counts are adjusted by Statistics Canada to the nearest multiple of five to ensure privacy and confidentiality.

With the exception of the operation of the Bathurst Inlet Lodge, there is no retail, education, medical, police, or other services within the community. The closest services are in Cambridge Bay. Communication services are available by satellite phone. Electricity is sourced from personal generators, and water comes from nearby rivers.

The majority of economic activity in the community is generated by tourism, hunting, fishing, and trapping, with a few residents also obtaining employment in the mining sector. The Nunavut Planning Commission notes that the people of Bathurst Inlet follow a traditional and independent way of life, only having recently joined the wage economy to support their traditional lifestyles (NPC 2004). The population remains actively involved in hunting and fishing.

3.2.2 Omingmaktok

Omingmaktok means “like a muskox” in Inuinnaqtun (KIA 2011). Omingmaktok is located on Bay Chimo Harbour and was established around an abandoned Hudson's Bay Company post. Like Bathurst Inlet, most Omingmaktok residents overwinter in Cambridge Bay and return to spend the spring and summer hunting and fishing. The community is accessible by chartered flights from Yellowknife and Cambridge Bay and by marine vessels and a barge service during the ice-free period. Access by snowmobile occurs during the winter and spring.

Similar to Bathurst Inlet, occupation in Omingmaktok is seasonal. Up to recently, a small group of five to ten residents typically remained year round. Census numbers suggest that the population has significantly declined in recent years, from a stable population of approximately 50 people during the 1990s to approximately five people in 2001 (Statistics Canada 2007b). There are no employment data for the community; however, the majority of economic activity comes from tourism, hunting, fishing, trapping, and mineral exploration. The closest services for the community, including retail, education, policing, and medical, are in Cambridge Bay. Communication services are available by satellite phone, and electricity is sourced from portable generators; fresh water is sourced from nearby rivers.

3.2.3 Cambridge Bay

The Inuinnaqtun name for Cambridge Bay is Ikaluktutiak, meaning “good fishing place” (KIA 2011). Cambridge Bay, the largest community in the Kitikmeot Region with a population of approximately 1,608 in 2011 (Statistics Canada 2012b), is situated on the southeast coast of Victoria Island in western Nunavut. The community acts as a regional hub for business, transportation, and government, and is a traditional site for hunting and fishing. Residents undertake harvesting activities for local staple foods, including caribou and Arctic char, although recent statistics suggest a growing reliance on the market economy (Statistics Canada 2008a). There are a number of businesses operating in the community that offer a range of goods and services, including two stores (the Northern and the Co-op), a Royal Canadian Mounted Police (RCMP) station, elementary, and high schools, a branch of the Nunavut Arctic College, a library, churches, a health centre, a wellness centre, a recreation centre, a sports arena and pool, a visitors’ centre, and government regional offices. Government is prominent in the community, and tourism and transportation are other important industries (Back River Project Research Program 2012).

In 2010, Canada announced funding for a world-class Arctic research facility that would garner expertise on Arctic issues related to environmental science and resource development. The $18 million initiative is called the Canadian High Arctic Research Station (CHARS) and will be located in Cambridge Bay. The aim is to create jobs, strengthen Arctic sovereignty, promote economic and social development, and contribute to quality of life in the north. CHARS is predicted to employ between 35 and 50 seasonal, part-time, and full-time staff beginning in 2017 (Prime Mininster of Canada 2012).

3.2.4 Kugluktuk

Kugluktuk means “place of moving waters” in Inuinnaqtun (KIA 2011). Kugluktuk, the second largest community in the Kitikmeot Region with a population of approximately 1,450 in 2011 (Statistics Canada 2012b), is located on the Arctic Coast of the Coronation Gulf near the mouth of the Coppermine River. It is approximately 600 km north of Yellowknife and 450 km southwest of Cambridge Bay. Kugluktuk has experienced consistent population growth over recent years, mainly associated with an increase in employment opportunities in the community related to the mining and government sectors. Employment with the Diavik and Ekati mines has been important to Kugluktuk. Residents also undertake a variety of traditional activities, including trapping, hunting, fishing, and arts and crafts. There are a number of goods and services businesses operating in the community, including contracting and construction businesses, retail, tourism, accommodation, and food services. Other services in the community include two stores (the Northern and the Co-op), an RCMP station, elementary and high schools, a branch of Nunavut Arctic College, churches, a health centre, women’s shelter, library, and recreation centre (Back River Project Research Program 2012).

3.2.5 Gjoa Haven

The Inuktitut name for Gjoa Haven is Uqsuqtuuq, meaning “place of plenty blubber” (KIA 2011). Gjoa Haven is located on the southeastern shore of King William Island. The population of Gjoa Haven has grown strongly over recent decades, rising to approximately 1,279 in 2011 (Statistics Canada 2012b). Hunting and fishing are important traditional economic activities in the community, with land use focused on subsistence land harvesting. There are a number of businesses operating in the community that offers a range of goods and services, such as construction and contracting, retail, technical and communication services, accommodation, and food services. Tourism and cultural economies are also evident, and the community is home to the Northwest Passage Interpretive Centre and Historical Park (Statistics Canada 2008a). Other services in the community include two stores (the Northern and the Co-op), an RCMP station, primary and secondary schools, a branch of Nunavut Arctic College, churches, a health centre, a continuing care facility, a community hall, and an arena (Back River Project Research Program 2012).

3.2.6 Taloyoak

Taloyoak means “caribou blind” in Inuktitut (KIA 2011). Taloyoak, the most northerly mainland community, is located on a narrow inlet on the western side of the Boothia Peninsula, and was known as Spence Bay prior to 1992. The population of Taloyoak has increased steadily in recent years, by approximately 12.4% since 2001, to a population of over 800 people in 2006 (Statistics Canada 2007b), and again by 11%, to 899, in 2011 (Statistics Canada 2012b). Although wage employment has become more prominent in recent years, the pursuit of traditional land use activities is commonly practised by residents of the community (Statistics Canada 2008a). Local businesses offer a range of goods and services, including construction and contracting, retail, technical and communication services, and accommodation and food services. Focus has been placed on the development of the Taloyoak economy as a tourism and arts and crafts centre. Retail and other services in the community include the Northern and Co-op stores, an RCMP detachment, a hotel, a school, a branch of the Nunavut Arctic College, a health centre, an indoor swimming pool, and an arena/community hall.

3.2.7 Kugaaruk

Kugaaruk means “little stream” in Inuktitut (KIA 2011). Kugaaruk, known as Pelly Bay prior to 1999, is located on the northeastern Arctic coast on Pelly Bay, south of the Gulf of Boothia. Kugaaruk is one of the smallest, youngest, fastest growing, and most traditional communities in the Kitikmeot Region. The population of Kugaaruk has increased rapidly from approximately 400 people in 2001 to 690 people in 2006 (an increase of 72.5%; Statistics Canada 2007b), and to 771 in 2011, an additional 11.7%

(Statistics Canada 2012b). There is a high level of participation in traditional activities in the community, including hunting, trapping, and fishing (Statistics Canada 2008a), and businesses offer a range of goods and services in the construction and contracting, technical and communication services, tourism and culture, accommodation and food services, and transportation and shipping sectors. Other businesses and services available in the community include an RCMP detachment, a health centre, a branch of the Arctic College, a school, an arena, a coffee shop, a Co-op store, a hotel, and a women's shelter. As is typical for small and isolated Arctic communities, the public sector has a large influence on the economy, and unemployment levels remain high (Statistics Canada 2007b).

3.2.8 Yellowknife

Yellowknife is in the North Slave Region of the NWT, located on the western shore of Yellowknife Bay and the northern arm of Great Slave Lake. The population of Yellowknife has grown rapidly over the last century, largely due to expansion in the resource sector (City of Yellowknife 2011). From 1996 to 2010, the community experienced moderate growth, with an average annual population growth rate of 0.6% (Nunavut Bureau of Statistics 2011b). But in recent years the population grew from approximately 18,700 in 2006 to 19,234 in 2011, an increase of 2.9%. The population of Yellowknife accounted for about 46.4% of the population of the NWT in 2011 (Statistics Canada 2012b).

Yellowknife was named after the Yellowknives Dene (T'atsaot'ine), whose name derives from the colour of the copper tools they used. The Yellowknives Dene moved into the area, which was previously Tłı̨chǫ (Dogrib) Nation traditional territory, in the early 1800s. The Tłı̨chǫ reoccupied the area in the 1820s following the out-migration of the Yellowknives (City of Yellowknife 2011).

Approximately 18% of Yellowknife residents spoke an Aboriginal language in 2009, which has significantly declined from approximately 51.5% in 1984 (Nunavut Bureau of Statistics 2011b). Aboriginal languages within the community and the territory include Inuktitut, Inuvialuktun, Inuinnaqtun, Dogrib, Cree, Chipewyan, North Slavey, South Slavey, and Gwich'n (City of Yellowknife 2011; Nunavut Bureau of Statistics 2011b).

Yellowknife has a fairly high participation in traditional activities; approximately 34.5% of individuals hunt and fish, and 10.7% of households reported consuming country foods in 2008. In terms of labour force, in 2009 the community had a participation rate of approximately 84.5% and an unemployment rate of 5.6%, making employment conditions moderately better than in the rest of the NWT. Average personal income for community members in 2008 was approximately $62,727, higher than the NWT average of $52,943. There were approximately 225 residents (on average, per month) who requested and received social assistance in 2008 (NWT Bureau of Statistics 2011).

Education levels are increasing within the community. The percentage of the population in 2009 with at least a high school diploma was approximately 83.8%, which has increased since 1986 when only 66.7% of the population had a high school diploma (NWT Bureau of Statistics 2011).

Only approximately 4.3% of households had six or more occupants in 2009. Of the estimated 6,853 dwellings in Yellowknife, 52.8% were owner-occupied. In 2009, approximately 9.6% of dwellings were classified as "in core need," meaning the household lacked suitability, adequacy, and/or affordability, and total household income is below the threshold for owning and operating a home or renting without government assistance. This figure is significantly below the territorial average, which had approximately 19% of homes in core need in 2009 (NWT Bureau of Statistics 2011).

3.3 GOVERNANCE AND GOVERNMENT REVENUES

3.3.1 Implementation of the Nunavut Lands Claim Agreement

The Territory of Nunavut was established on April 1, 1999. As part of the creation of Nunavut, the Government of Canada negotiated the largest lands claim settlement in Canadian history, the Nunavut Lands Claim Agreement (NLCA; Government of Canada, Tungavik Federation of Nunavut, and Government of the Northwest Territories 1993), which covers approximately one-fifth of Canada's land mass. The Tunngavik Federation of Nunavut, now superseded by Nunavut Tunngavik Incorporated (NTI), represented the Inuit for the purposes of negotiating the NLCA. The NTI is responsible for ensuring the implementation of the NLCA and coordinates and manages Inuit responsibilities as described in the NLCA (NTI 2011b).

Nunavut is divided into three administrative regions: the Kitikmeot Region, the Kivalliq Region, and the Qikiqtani Region. Within each region, Regional Inuit Associations (RIAs) are responsible for advancing the rights and benefits of Inuit as guided by the NLCA. The RIAs advocate for Inuit interests and hold legal title to all Inuit-owned surface lands. Along with the NTI, the RIAs are responsible for the management of all Inuit Owned Lands (IOL) in Nunavut. Within the Kitikmeot Region, the RIA is the Kitikmeot Inuit Association (KIA), which has its head offices in Cambridge Bay.

The NTI provides representation for Inuit under the NLCA and implements associated Inuit obligations. Broadly speaking, the NTI is mandated with the pursuit of the economic, cultural, and social well-being of beneficiaries. The NTI is governed by an elected board of directors. There are a number of organizations that have responsibilities to the beneficiaries of the NLCA as coordinated through NTI, which include the following (NTI 2011b).

- Inuit regional development corporations – the regional development corporations focus on realizing business and career development opportunities for Inuit. They aim to encourage entrepreneurship and Inuit employment through joint ventures, training, and mentoring, in addition to investing in promising businesses and joint ventures in the regions they represent (Kitikmeot Corporation 2011).
- Inuit community economic development corporations – the economic development corporations foster economic development with a focus on small business, the support of entrepreneurs, the development of job skills, and social programs aimed at children, youth, the disabled, and other vulnerable groups (Elias et al. 2009).
- Inuit investment corporations – The Atuqtuarvik Corporation, based in Rankin Inlet, provides debt financing and equity investment for business start-ups, expansions, and acquisitions. The NCC Investment Group Inc., based in Iqaluit, operates as the principle owner of GN buildings and infrastructure.
- Inuit wildlife organizations – within each community across Nunavut, HTOs are responsible for the management of harvesting. All Inuit in each community are members of the HTO. The Kitikmeot HTO typically coordinates the management of wildlife harvests for the region, with representation from each HTO operating in Kitikmeot communities. The Nunavut Inuit Wildlife Secretariat provides logistical, technical, financial, and administrative support to the HTOs.
- Joint institutions of public governance – there are a number of other organizations through which both the Inuit and government have joint management functions. This includes the Nunavut Impact Review Board (NIRB), the Nunavut Planning Commission (NPC), the Nunavut Surface Rights Tribunal (NSRT), the Nunavut Water Board (NWB), and the Nunavut Wildlife Management Board (NWMB), the functions of which are described in more detail below.

The NIRB administers and participates in the environmental and social impact assessment process. The board makes recommendations to the federal or territorial ministers about licences to be issued in the Nunavut Settlement Area. The NIRB is based in Cambridge Bay (NIRB 2011).

The NPC is responsible for land use planning in Nunavut to guide and direct resource use and development (NPC 2011). Plans establish guidelines and rules by which land, fresh water, marine waters, and renewable and non-renewable resources may be used and developed. Plans also specify what types of development can take place and, if applicable, what conditions must be applied in order for the development to occur. The NPC works with the Nunavut and federal governments to develop land use plans through consultation and research with communities, government, Inuit organizations, industry, and NGOs (NPC 2011). Released in 2012, the draft Nunavut Land Use Plan outlines land use designations for Nunavut's three regions including goals, objectives, and policies for land use planning. The following land use designations are included in the 2012 plan: protecting and sustaining the environment, encouraging conservation planning, building healthier communities, encouraging sustainable economic development, and mixed use. The NPC will be hosting workshops in each Nunavut municipality, as well as with the Inuit of Nunavik, and the Athabasca and Manitoba Denesuline to obtain feedback on the draft plan (NPC 2012).

The NSRT, created under the NLCA, regulates access to lands. This includes determining the rights of title-holders and any compensation that is to be paid for land use or purchase. The NSRT is also responsible for determining the amount of compensation that is paid as a result of wildlife claims in the Nunavut Settlement Area.

The NWB is responsible for the use, management, and regulation of inland waters in Nunavut (NWB 2011). Projects with expected effects on inland water supplies may require licences from the NWB under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (2002).

The NWMB oversees wildlife management and regulates access to wildlife in Nunavut. The mandate of the NWMB is to ensure the protection and wise use of wildlife and wildlife habitat for the benefit of Inuit and the public. It coordinates its operations with three regional wildlife organizations, as well as the territory's HTOs, to ensure sustainable wildlife populations for the Inuit, the public of Nunavut, and Canada. It also funds wildlife research by government agencies and NGOs; advises the impact review process; promotes wildlife education, training, and awareness; and approves changes to the boundaries of conservation areas (NWMB 2011).

3.3.2 Government of Nunavut Structure and Functions

In 1999, the Government of Nunavut (GN) committed to a decentralized governance model in order to create benefit for all Nunavummiut, through the sharing of government employment and training opportunities among communities. Additionally, a decentralized model was thought to improve access to programs and services by bringing government closer to Nunavummiut and support the government's objective of building healthy communities and increasing self-reliance (GN 2002). The GN functions include the following departments:

- Community and Government Services – supports municipal operation, infrastructure development, and land development, as well as fire safety, electrical and mechanical inspections, emergency management, consumer affairs, and acquisition and distribution of petroleum products. In the Kitikmeot Region, the department maintains an office in Cambridge Bay (GN Department of Community and Government Services 2013).

- Culture and Heritage – implements policies, programs, and services aimed at strengthening the culture, language, heritage, and physical activity of Nunavummiut. In the Kitikmeot Region, the department maintains an office in Kugluktuk (GN Department of Culture and Heritage 2013).
- Economic Development and Transportation – responsible for economic policy, travel (airports and roads), and tourism. The department regulates mining and energy though the Minerals and Petroleum Resources Division. Two Crown corporations, the Nunavut Development Corporation and the Nunavut Business Credit Corporation, report to the Department of Economic Development and Transportation. New programs and services include the Country Food Distribution Program and the Nunavut Anti-Poverty Secretariat and Plan. In the Kitikmeot Region, the department maintains an office in Kugluktuk and Gjoa Haven (GN Department of Economic Development and Transportation 2013).
- Education – responsible for all education levels, including school services (kindergarten to grade 12), adult education, career training and development, and early childhood education. The department also provides an Income Support Program for individuals and families who are unable to meet basic food and housing needs (GN Department of Education 2013). The department has a regional office in Kugluktuk.
- Environment – responsible for four program areas: wildlife management, parks and special places, environmental protection, and fisheries and sealing. Wildlife management includes wildlife research and operations, as well as the Wildlife Deterrence Program. Parks and special places include program development, operations and planning, geospatial information and land tenure, and heritage appreciation. Environmental protection programs include pollution control, environmental assessment and land-use planning, and climate change. Fisheries and sealing programs include commercial fisheries freight subsidy, fisheries development and diversification program, fur pricing program, Nunavut fisheries training consortium, dressed ring seal skins for Nunavummiut, and the Fur Institute. The department's main office is located in Iqaluit; however, there are 23 conservation offices, including 3 in the Kitikmeot Region located in Cambridge Bay, Gjoa Haven, and Kugluktuk (GN Department of Environment 2013).
- Executive and Intergovernmental Affairs – provides leadership and management support to departments in their delivery of programs and services. The department also has a Social Advocacy Office and Energy Policy Division (GN Department of Executive and Intergovernmental Affairs 2013).The department oversees:
  - devolution (of the transfer of federal jurisdiction over Nunavut's land, resources, and inland waters to the GN);
  - intergovernmental affairs;
  - policy, planning, and communications;
  - the Nunavut Bureau of Statistics; and
  - the Government Liaison Office.
- Finance – primary advisor to the GN on financial and budgetary matters, including government revenue and spending, taxation, financial advice, and financial policy direction (GN Department of Finance 2013).
- Health and Social Services – responsible for promoting health and social well-being in Nunavut through the provision or coordination of medical care, health insurance and medical travel, child and family services, mental health and addictions, vital statistics, family violence prevention and protection services, foster care, guardianship, and residential care (GN Department of Health and Social Services 2013). The Kitikmeot Regional office is located in Cambridge Bay.

- Human Resources – provides recruitment; relocation; job evaluation; training and development; employee relations support to Nunavut's public service, including Crown corporations that report to the GN; the hospital system; and the education system. The department is also responsible for promoting the employment of Inuit within the public service sector (GN Department of Human Resources 2005).
- Justice – responsible for legal services, correction program, and community justice. The department also administers the boards and tribunals on legal issues such as human rights and labour standards (GN Department of Justice 2013). A regional office is located in Cambridge Bay.

3.3.3 Hamlet Governance Structure and Functions

Community governance in Nunavut is organized by hamlets. Each hamlet is headed by a mayor, deputy mayor, and council. Substantive government policy and operational decisions go to council, while more routine decisions are made by municipal staff. Committees are established to facilitate municipal policies and address specific portfolios (e.g., justice, finance, recreation, and health and wellness). Typically, a member of the council is appointed as chair of each committee and other members of the committees are selected from the population at large, as determined through a public election.

The hamlet bureaucracy is headed by a Senior Administrative Officer (SAO) who has overall responsibility for operations and reports directly to council. The SAO is supported by staff who conduct hamlet business. A key senior member of the staff is the Economic Development Officer (EDO), who is responsible for economic development programming.

Hamlets have a number of departments that are responsible for the delivery of the different programs and services. The specific organization of departments can vary by community, but typically covers public works, operations and maintenance, water, sewer, waste management, fire protection, wellness, justice, lands, and economic development.

A summary of the hamlet government structure for each Kitikmeot community is provided in Table 3.3-1.

Table 3.3-1. Hamlet Government in the Kitikmeot Region

Hamlet	Mayor	Senior Administration Officer	Committee Portfolios
Cambridge Bay	Jeannie Ehaloak	Stephen King	Wellness, Municipal Works, Recreation, Finance, Planning and Lands, and Economic Development
Gjoa Haven	Allen Aglukkaq	Enuk Pauloosie	Health and Social Services, Justice, Economic Development, Planning and Lands, Recreation, By-laws, Labour and Hiring, Finance, and Wellness
Kugaaruk	Stephen Inaksajak	Gord Holitzki	Health and Social Services, Finance, Lands and Planning, Elders, Youth, Economic Development, Justice, and Public Works
Kugluktuk	Ernie Bernhardt	Don Leblanc	Recreation, Wellness, Economic Development, Finance, Elders, Justice, Planning and Lands, BHP Billiton Funded Projects, and Tourist Centre Construction
Taloyoak	Tommy Aiyout	Chris Dickson	Health, Recreation, Search and Rescue, Community Economic Development, Infrastructure, Finance, and Elders and Youth

Source: Back River Project Research Program (2012).

3.3.3.1 Community Planning

Each Kitikmeot community has adopted a community plan that defines the policies for managing development in a manner that reflects the needs and desires of the community. Goals are specified to guide the implementation of the community plan and the on-going management of development and provision of hamlet services. Although the community plan for each community differs, goals commonly reflect the following (Hamlet of Kugluktuk 2007; Hamlet of Gjoa Haven 2008; Hamlet of Kugaaruk 2009; Hamlet of Taloyoak 2009):

- creation of a safe, healthy, functional, and attractive community that reflects community values and culture;
- availability of land for a mix of all types of uses to support the growth and change of the community;
- building upon community values of participation and unity, support for community projects and local economic development; and
- protection of the natural beauty of the land, protection of viewpoints to the water, and retention of waterfront and lakeshore areas for public uses and traditional activities.

For the Municipality of Cambridge Bay, the goals of the community plan are more diverse and include statements concerning: protection and enhancement of the natural environment; sustainable development in keeping with the physical, cultural, and economic values of the community; support for a variety of housing options and densities; concentration of public and commercial facilities in a core area; support for the provision of a full range of commercial facilities and services in neighbourhoods; diversification of the local economy; provision of land for a wide range of community uses; provision of a diverse range of recreational and cultural opportunities; development of a safe and efficient transportation system; to preserve lands reflecting traditional knowledge and use; and creation of opportunities for public input (Municipality of Cambridge Bay 2007). Cambridge Bay recognizes that community growth will be challenged by limits to the amount of land available for development. The community is currently “hemmed in” by marine waters to the south and southeast, the sewage lagoon and waste dump to the northeast, the federal weather station lands and water supply reserve to the north, Distant Early Warning Line reserve lands to the west, and the airport to the southwest; this presents challenges for community expansion (S. King, pers. comm.).

3.3.3.2 Challenges for Hamlets

Hamlet governments in the Kitikmeot Region face a number of challenges. As is evident from the interview results with hamlet staff, one of the primary challenges is staff hiring and retention. Funded positions can go unstaffed for months and turnover is high in many positions. This is typical of many isolated Arctic communities in Nunavut. In Taloyoak, an under-funded contribution agreement resulted in the loss of employment positions within the Hamlet, for example, the income support position (C. Dickson, pers. comm.).

Locating space for programs and activities can be a challenge as many buildings are older and require repair. Lack of suitable infrastructure in the Kitikmeot communities is an ongoing issue related to staff housing, community services, and recreation. GN buildings face similar challenges. However, these issues are being addressed; for example, new hamlet office buildings and new arenas/recreation facilities have been constructed in both Kugluktuk and Taloyoak (Back River Project Research Program 2012).

3.3.4 Nunavut Government Revenues and Expenditures

The GN saw revenues of $1.305 billion in 2009, $108 million (10.4%) of which originated from within the territory. The remaining $1.177 billion (89.6%) came in the form of transfer payments from the Government of Canada. Of the Nunavut-generated government revenue, approximately 34% ($37 million) was income tax and 38% ($41 million) was from sales of goods and services (Statistics Canada 2011b).

Information on royalties and other tax revenues specifically from the mining sector in Nunavut is not readily available from Statistics Canada, Aboriginal Affairs and Northern Development Canada (AANDC), or the Nunavut Department of Finance.

GN expenditures in 2009 totalled $1.300 billion. Health ($285 million or 21.9%) and education ($241 million or 18.5%) were the largest expenditure items. Housing ($180 million or 13.8%), general government services ($151 million or 11.6%), and social services ($105 million or 8.1%) were the next largest expenditure items (Statistics Canada 2011b).

4. Demographics

4. Demographics

The following section describes the population, age, and gender of the Kitikmeot Region communities.

4.1 POPULATION

The Kitikmeot Region's population has steadily increased from 2001 to 2006, from approximately 4,816 to 5,361 individuals, an increase of 11.3% (Statistics Canada 2007b). Between 2006 and 2011, the population increased from approximately 5,361 to 6,012 individuals, an additional increase of about 12.1%.

The Kitikmeot communities range in size, from Cambridge Bay, the largest, with approximately 1,608 individuals in 2011, to Kugaaruk, the smallest, with approximately 771 individuals in 2011.[3] Kugluktuk and Gjoa Haven had populations of 1,450 and 1,279, respectively, in 2011. Taloyoak, the second smallest community, had a population of 899 in 2011. For Nunavut as a whole, a strong natural increase and net in-migration from other areas of Canada are the main factors that contributed to population growth (Statistics Canada 2012b).

Table 4.1-1 shows how the populations of the Kitikmeot communities have changed over the past 30 years. Over the past decade, the populations of Omingmaktok and Bathurst Inlet have decreased, as families have chosen to no longer remain permanent residents of those communities. However, these families return each spring and stay throughout the summer, participating in traditional activities such as hunting and fishing, and may also work in one of the two nearby lodges (the Bathurst Inlet Lodge and the Elu Inlet Lodge). Table 4.1-1 shows almost complete population decline for these two locations. The five main Kitikmeot communities (Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, and Kugaaruk) have experienced immense population growth over this time period (1981 to 2011), having at least doubled in size (with the exception of Kugluktuk, which has experienced a comparatively smaller population increase of approximately 79%). The populations of Nunavut and the Kitikmeot Region have also experienced a doubling over this time period, with increases of 104.9 and 104.1%, respectively. The largest population increases in the Kitikmeot Region took place in Kugaaruk (200.0%) and Gjoa Haven (144.6%).

Table 4.1-1. Population Trends and Percentage Change (1981 to 2011)

	1981	1986	1991	1996	2001	2006	2011	% Change (1981 to 2011)
Cambridge Bay	815	1,002	1,116	1,351	1,309	1,477	1,608	97.3%
Kugluktuk	809	888	1,059	1,201	1,212	1,302	1,450	79.2%
Gjoa Haven	523	650	783	879	960	1,064	1,279	144.6%
Taloyoak	431	488	580	648	720	809	899	108.6%
Kugaaruk	257	297	409	496	605	688	771	200.0%
Bathurst Inlet	20	16	18	18	5	0	0	-100.0%
Omingmaktok	60	61	53	51	5	0	5	-91.7%
Kitikmeot Unorganized[1]	30	45	7	0	0	21	0	-100.0%
Kitikmeot Region	2,945	3,447	4,025	4,644	4,816	5,361	6,012	104.1%
Nunavut	15,572	18,408	21,244	24,730	26,745	29,474	31,906	104.9%

Source: Nunavut Bureau of Statistics (2012b).
[1] *Includes outposts.*

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[3] Bathurst Inlet and Omingmaktok are the smallest Kitikmeot communities, and because of their small size, do not have secondary statistical information available. See Section 2 for community profile.

A high proportion of the population in the communities is Aboriginal, primarily Inuit. The Aboriginal population in the Kitikmeot Region was approximately 4,800 (90% of the total population) in 2006, of which 4,725 were Inuit. For Cambridge Bay, approximately 83% of residents self-identified as Aboriginal (Table 4.1-2). This proportion was higher in all the other Kitikmeot communities, with 92% or more identifying as Aboriginal. This rate is higher than the Nunavut average of 85% (Table 4.1-2).

Table 4.1-2. Kitikmeot Aboriginal Identity Population (1996 to 2006)

	Aboriginal Population (%)		
Community	**1996**	**2001**	**2006**
Cambridge Bay	76%	79%	83%
Kugluktuk	89%	93%	92%
Gjoa Haven	93%	96%	93%
Taloyoak	95%	94%	92%
Kugaaruk	95%	96%	92%
Kitikmeot Region	-	90%	90%
Nunavut	84%	85%	85%

Sources: Statistics Canada (2007b).

4.2 AGE

The communities in the Kitikmeot Region have young populations. In 2011, the median age ranged from 27.4 years in Cambridge Bay to 18.4 years in Kugaaruk (Table 4.2-1; Figure 4.2-1). The Kitikmeot Region has a median age of 23.0 years, which is slightly lower than Nunavut's median age of 24.1 years and much younger than the Canadian median age of 40.6 years (Statistics Canada 2012b).

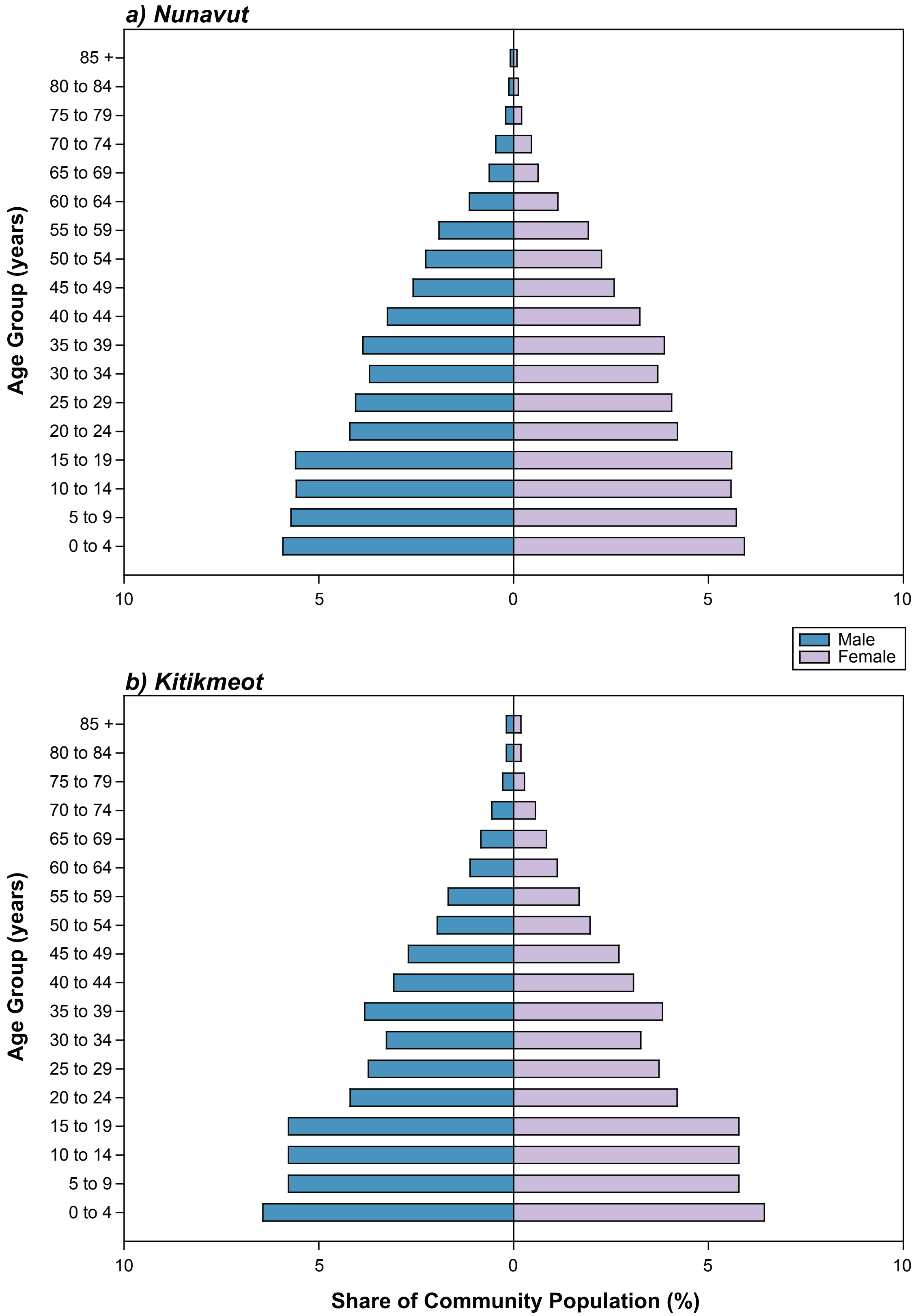
Table 4.2-1. Age Distribution and Median Age by Community

	2011 Census			
Indicator	**Under 15**	**15 to 64**	**65+**	**Median Age (Years)**
Cambridge Bay	460 (28.7%)	1,105 (68.8%)	65 (4.0%)	27.4
Kugluktuk	455 (31.4%)	920 (63.4%)	70 (4.8%)	24.3
Gjoa Haven	470 (36.7%)	755 (59.0%)	60 (4.7%)	21.2
Taloyoak	335 (37.2%)	530 (58.9%)	35 (3.9%)	20.9
Kugaaruk	320 (41.6)	430 (55.8%)	20 (2.6%)	18.4
Kitikmeot Region	2,050 (34.1%)	3,740 (62.2%)	230 (3.8%)	23.0
Nunavut	10,430 (32.7%)	20,425 (64.0%)	1,060 (3.3%)	24.1

Sources: Statistics Canada (2012b).

In 2011, the proportion of the population under the age of 15 in the Kitikmeot communities ranged from a low of 28.7% in Cambridge Bay to a high of 41.6% in Kugaaruk (Table 4.2-1; Figures 4.2-1 and 4.2-2). In Gjoa Haven and Taloyoak, the portion of the population under the age of 15 was higher (36.7 and 37.2%, respectively) compared to the territory (32.7%) and was more than double the Canadian average (16.7%; Nunavut Bureau of Statistics 2011c).

The GN's population projections predict the population will age moderately by 2036, although it will remain a substantially younger population as compared to Canada (Nunavut Bureau of Statistics 2010a).



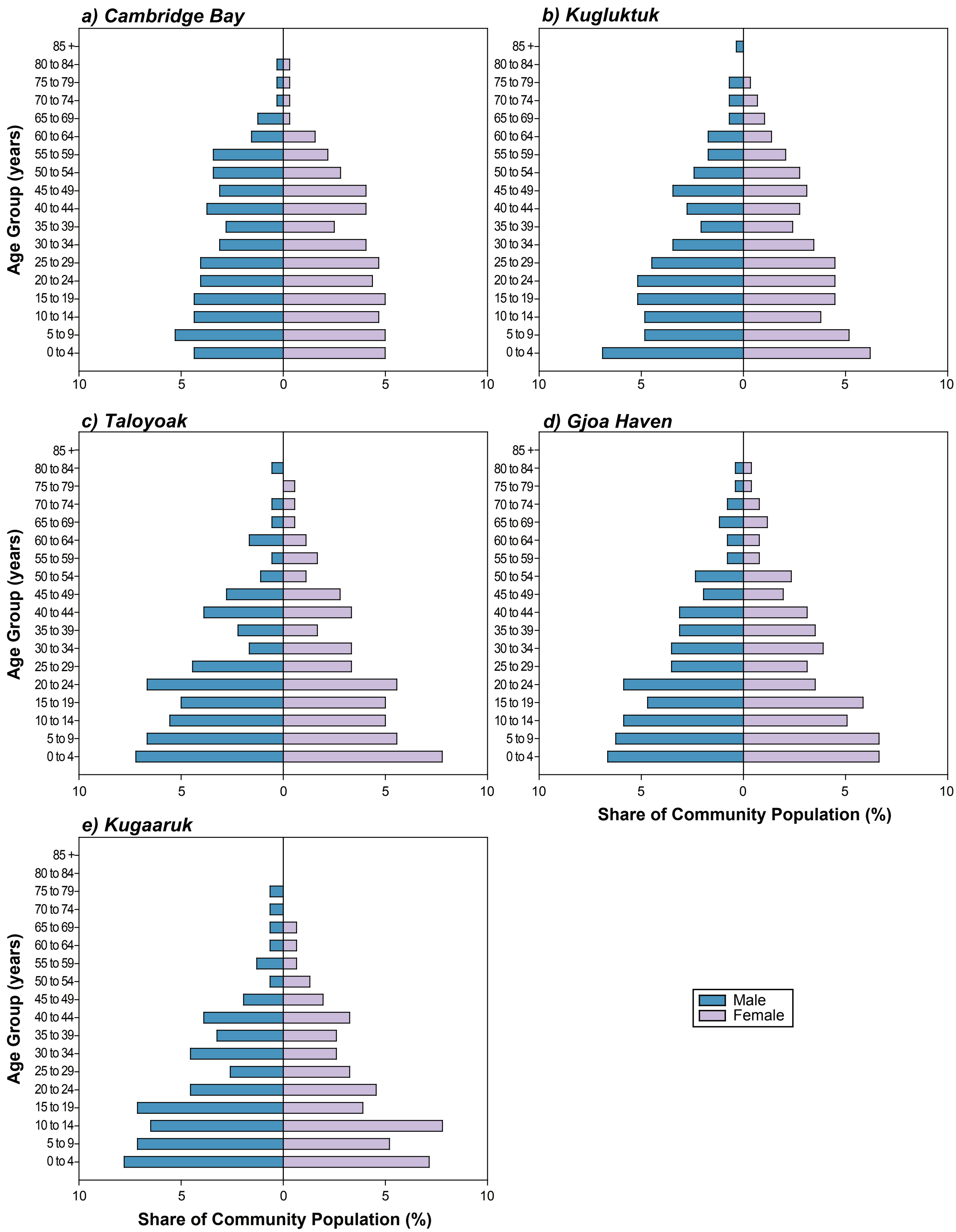
Source: Statistics Canada 2007

Figure 4.2-1

Age Distribution for the Kitikmeot Region and Nunavut

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists



Source: Statistics Canada 2007

Figure 4.2-2

Age Distribution of the Kitikmeot Communities, 2011

4.3 GENDER

The Kitikmeot communities tend to have a slightly higher proportion of males, with the most notable differences in Gjoa Haven and Kugaaruk (Table 4.3-1; Statistics Canada 2007b). This finding may be linked to the composition of the labour force. In 2006, a notable portion of the labour force, over 96% male, was engaged in trades, transport, and equipment operation and related occupations (see Section 7.2; Statistics Canada 2007b). In northern Canada, employers are often required to recruit employees from the south, consequently adding to the male population.

Table 4.3-1. Kitikmeot Community Male to Female Ratios (2006 and 2011)

	Census of Canada 2006				Census of Canada 2011			
Community	Total Population	Male	Female	Male: Female Ratio	Total Population	Male	Female	Male: Female Ratio
Cambridge Bay	1,477	750	725	1.03	1,608	810	800	1.01
Kugluktuk	1,302	655	645	1.01	1,450	745	710	1.05
Gjoa Haven	1,064	550	515	1.07	1,279	665	615	1.08
Taloyoak	809	415	400	1.04	899	455	445	1.02
Kugaaruk	688	360	330	1.09	771	420	350	1.2
Kitikmeot Region	5,361	2,740	2,620	1.05	6,012	3,090	2,925	1.06
Nunavut	29,474	15,105	14,365	1.05	31,906	16,395	15,510	1.06

Sources: Statistics Canada (2007b, 2012b).

4.4 FAMILY STRUCTURE

Family structure in Nunavut differs from that of the general Canadian population. In Inuit culture, family groups are the most important social unit and, prior to the 1950s, Inuit lived in small, family based groups that traveled seasonally in pursuit of food and depended on each other for survival. The transition to permanent communities caused disruption to traditional Inuit culture and values including changes to the roles of men and women within families. Traditional gender roles were based on the ability to perform the tasks required to obtain food and to survive on the land (Pauktuutit Inuit Women of Canada 2006).

Traditionally, marriage took place when a girl was approximately 14 years of age and when a man entered early adulthood. In terms of gender roles within the family, men had primary authority outside the home and were the primary provider, while women had primary authority within the home and were responsible for childrearing and other domestic duties. Modern marriages typically take place in late adolescence or early adulthood. Young couples often continue to live with relatives as there is a shortage of housing in most Inuit communities. “There is no stigma attached to children who are born out of wedlock. In cases where the mother is very young or cannot look after the child, grandparents often assume responsibility for looking after the child” (Pauktuutit Inuit Women of Canada 2006).

The family characteristics of the Kitikmeot communities, the three Nunavut regions, Nunavut, and Canada are summarized in Appendix 1a. Within the Kitikmeot communities and Nunavut regions, families typically consist of approximately 70 to 75% family couples (married or common-law) and 25 to 30% lone-parent families, whereas in Canada approximately 84% are family couples and 16% are lone-parent families. The most notable difference in family structure is seen in the proportion of married couples, which is comparatively lower in the Kitikmeot Region (48.3%) than in Canada (80.1%) (Appendix 1A; Statistics Canada 2012b).

The ratio of married couples to common law couples varies widely within communities, regionally, and between Nunavut and Canada. Regionally, married couples comprise less than half (48.3%) of family couples in the Kitikmeot, just over half (50.8%) in the Baffin Region, and comprise a notably higher proportion of family couples (65.5%) in the Kivalliq Region. In comparison, married couples account for approximately 80% of family couples in Canada (Appendix 1A; Statistics Canada 2012b).

Approximately one-third of married couples in the Kitikmeot Region have three or more children (34.7%), as compared to almost half of all married couples in the Kivalliq (48.8%), and less than one-third in the Baffin Region (28.9%). Comparatively, only 10% of married couples in Canada have three or more children. Of the three Nunavut regions, the Kitikmeot has the highest proportion of female led lone-parent families; however, this varies widely within each of the Kitikmeot communities (from approximately 44.4% in Kugaaruk to 83.3% in Cambridge Bay). In comparison, Nunavut has fewer female-led lone-parent families (71.1%) as compared to the general Canadian population (78.6%) and more male-led lone-parent families (28.9% and 21.4%, respectively; Statistics Canada 2012b).

4.5 LANGUAGE

Table 4.5-1 provides a summary of dominant languages spoken in the Kitikmeot communities, the Kitikmeot Region, and Nunavut. Statistics Canada defines the term “mother tongue” as the first language learned at home in childhood and still understood by the person. If the person no longer understands the first language learned, the mother tongue is the second language learned. Sixty-one percent of people in Nunavut reported an Inuit language as their mother tongue. Similarly, the majority of residents in Taloyoak and Kugaaruk indicated Inuktitut was their mother tongue; however, in Gjoa Haven, Taloyoak, and Kugaaruk, the majority indicated English was their mother tongue. Figure 4.5-1 provides a visual summary of mother tongue in the Kitikmeot communities (Nunavut Bureau of Statistics 2012d).

Table 4.5-1. Language Spoken Most Often at Home (2011)

	Total Population	Inuktitut Only	Inuinnaqtun Only	English Only	French Only	Other Language Only	English and Non-official Language	Other Multiple Responses
Cambridge Bay	1,600	90 (5.6%)	10 (0.6%)	1,475 (92.2%)	0 (0.0%)	10 (0.6%)	5 (0.3%)	0 (0.0%)
Kugluktuk	1,440	25 (1.7%)	90 (6.3%)	1,285 (89.2%)	10 (0.7%)	20 (1.4%)	15 (1.0%)	5 (0.3%)
Gjoa Haven	1,280	175 (13.7%)	0 (0.0%)	1,080 (84.4%)	0 (0.0%)	0 (0.0%)	20 (1.6%)	0 (0.0%)
Taloyoak	900	145 (16.1%)	0 (0.0%)	740 (82.2%)	0 (0.0%)	0 (0.0%)	10 (1.1%)	0 (0.0%)
Kugaaruk	770	150 (19.5%)	0 (0.0%)	605 (78.6%)	0 (0.0%)	5 (0.6%)	15 (1.9%)	0 (0.0%)
Kitikmeot Region	5,990	585 (9.8%)	100 (1.7%)	5,185 (86.6%)	10 (0.2%)	35 (0.6%)	65 (1.1%)	5 (0.1%)
Nunavut	31,770	16,490 (51.9%)	100 (0.3%)	14,440 (45.5%)	250 (0.8%)	235 (0.7%)	250 (0.8%)	na

Source: Nunavut Bureau of Statistics (2012d).

Most residents in the western Kitikmeot reported English as their mother tongue (Cambridge Bay and Kugluktuk, 76.9% and 75.3% respectively), while the eastern communities have higher percentages of Inuktitut speakers (Kugaaruk, 66.2%; Taloyoak, 62.2%; and Gjoa Haven, 43.0%). Inuinnaqtun speakers are mainly located in Kugluktuk (15.6%), although a small portion resides in Cambridge Bay (3.1%). Mother tongue in the eastern Kitikmeot communities was similar to that of Nunavut as a whole, with more Inuktitut than English speakers. However, the opposite is seen in the western Kitikmeot communities, where English is more prevalent (Nunavut Bureau of Statistics 2012d).

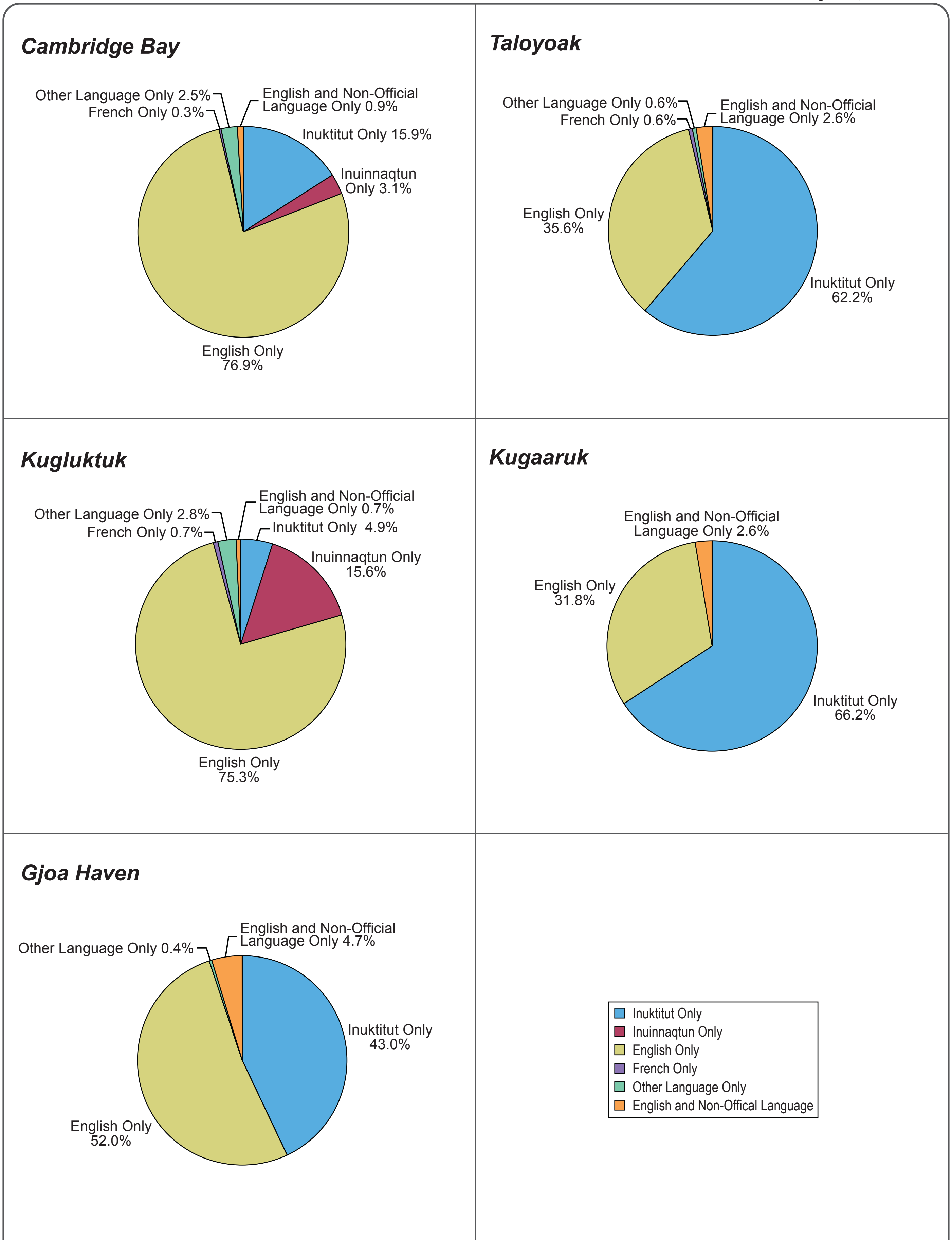


Figure 4.5-1

Mother Tongue in the Kitikmeot Communities, 2011

Sabina GOLD & SILVER CORP.

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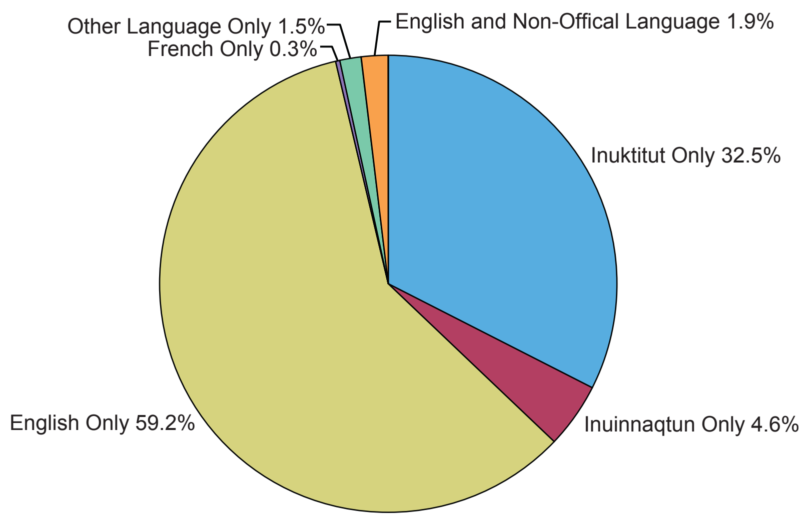
Higher percentages of Kitikmeot residents report that English is the language spoken most often at home (86.6%; Table 4.5-1). Notably, those in the eastern Kitikmeot where the majority of residents reported Inuktitut as their mother tongue mainly speak English at home. The highest portions of residents speaking mostly English at home were found in Cambridge Bay and Kugluktuk (92.2 and 89.2%, respectively), followed closely by Gjoa Haven (84.4%), Taloyoak (82.2%), and Kugaaruk (78.6%). Figure 4.5-2 provides a visual summary of mother tongue and language spoken most often at home in the Kitikmeot Region (see also Appendix 1b).

Inuinnaqtun is not spoken elsewhere is Nunavut and is only spoken in one other community in Canada—Ulukhatok, Northwest Territories. Preservation of the Inuinnaqtun language is a high priority of residents and organizations in the region. The *Inuit Language Protection Act* (2008) is federal legislation that aims to protect and revitalize a first peoples' language. The Act seeks to increase the number of Nunavummiut able to speak and read their language fluently and includes established timelines and targets to obtain these goals. Targets include the development of a language authority to establish language standards by 2009, implementation of the right of all Inuit to work for the GN in their own language by 2011, the provision of municipal services in an Inuit language by 2012, and implementation of the right to an Inuit language education in all school grades by 2019.

4.6 RELIGIOUS CHARACTERISTICS

Traditionally, Inuit spirituality was centred on animism, or a belief that all living and non-living things had a spirit and the belief that humans were made of three parts—a body, a name, and a soul. The religious characteristics of the Kitikmeot communities today stem from their involvement with missionaries which occurred mainly during the late 19th and early to mid-20th centuries. The 2001 Census of Canada indicated the two most commonly identified religions in the Kitikmeot communities were Catholic and Protestant, which together represented approximately 95% of individuals. Other religious affiliations included Christian and Christian Orthodox, while between 2 and 10% of individuals in the Kitikmeot communities reported no religious affiliation. Religious characteristic data was not collected during the 2006 Census of Canada. Data from the 2011 National Household Survey (which has replaced parts of the Census of Canada) indicated similar trends, as a large majority of Kitikmeot residents reported they were Christian, either Anglican (Protestant), or Catholic. Notably, 26% of individuals residing in Cambridge Bay reported no religious affiliation in 2011 (Statistics Canada 2012d), which may be reflective of the increase of non-Inuit in the community.

Mother Tongue



Language Spoken Most Often at Home

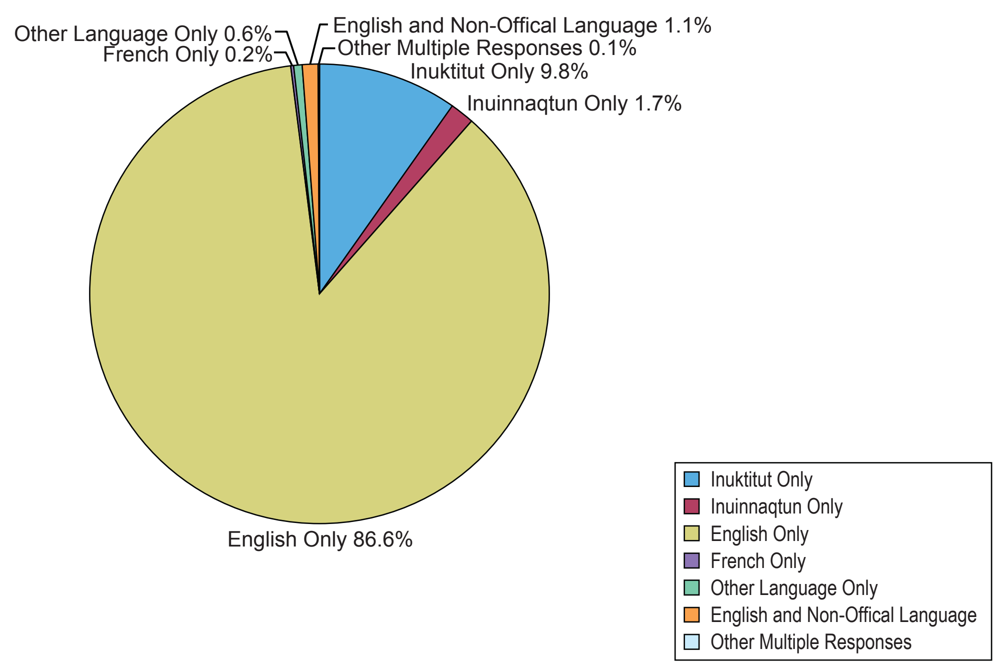


Figure 4.5-2

Mother Tongue and Language Spoken Most Often at Home, Kitikmeot Region, 2011

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5. Education and Experience

5. Education and Experience

The following section describes levels of education, education programs, and education facilities in the Kitikmeot Region communities. Current trends and future directions are highlighted.

5.1 EDUCATIONAL ATTAINMENT AND FIELDS OF STUDY

Approximately 32% of the potential labour force in the Kitikmeot Region (i.e., those aged 15 years and older) had some form of post-secondary education. This proportion increases to approximately 44% among those aged 25 years and older (Statistics Canada 2007b).

In general, high school completion rates remain low in all communities. Gjoa Haven residents exhibited the lowest level of educational attainment in the region, with over 59% of the population aged 25 to 64 lacking high school or other certificates/diplomas (Table 5.1-1). In contrast, Cambridge Bay residents had the highest level of educational attainment among the communities, with only 36% of residents aged 25 to 64 with no high school or other certificates/diplomas. However, for all Kitikmeot communities, the proportion of the population without high school or other certificates/diplomas is well above the Canadian average of 15.4% (Statistics Canada 2007b). Wanting to work (18%), boredom (18%), or having to work (14%) were the most common reasons for not finishing school reported by young Inuit men, while young Inuit women cited pregnancy and child-rearing as the main reasons for not finishing school (Statistics Canada 2008a).

Graduation rates in the Kitikmeot have been variable over the past decade; from a low of 10.1%, or 11 individuals, in 2004 to a high of 28.5%, or 25 individuals, in 2008. More recently, the graduation rate in the Kitikmeot Region was 22.0%, or 24 individuals, in 2011 (GN Department of Economic Development and Transportation 2012). Among the Kitikmeot communities, Cambridge Bay had a relatively high proportion of the population with a university certificate/diploma (16%) or a college degree or diploma (24%) compared with the other communities (Table 5.1-1).

Contextually, western education has historically been controversial for the Inuit as a result of residential schools, social issues around the settlement of communities in the 1960s, and intercultural differences related to culturally appropriate and accessible education. Some of the issues related to these events continue to be relevant today, and for many Inuit who have lived through these changes, obtaining a western education is not seen as relevant or highly valued (Pauktuutit Inuit Women of Canada 2006; Inuit Tapiriit Kanatami 2007; Back River Project Research Program 2012).

Attainment levels for apprenticeship and trade certifications ranged from almost one-quarter of the population in Kugaaruk (22%) to just over one-tenth (12%) of the population in Cambridge Bay. The two most common levels of education in the Kitikmeot Region were trades certificates and college or non-university diplomas. In the western communities, the percentage of individuals who obtained college or other non-university diplomas was higher than trades certificates, while in Gjoa Haven, the proportions were equal, and in the remaining two Kitikmeot communities (Taloyoak and Kugaaruk), trades certificates were more common as compared to college and other non-university diplomas (Table 5.1-1). Notably, over two-thirds of those who obtain apprenticeship or trades certificates are male while slightly more females than males obtain university certificates.

As shown in Table 5.1-2, architecture, engineering, and related technologies were the most common fields of study reported by the communities, with the exception of Cambridge Bay, where the most common field of study reported was management and public administration (Statistics Canada 2007b).

Table 5.1-1. Educational Attainment, 2006

	Total Population Aged 25 to 64									
	Cambridge Bay		Kugluktuk		Gjoa Haven		Taloyoak		Kugaaruk	
Level of Education	**Number**	**Proportion**	**Number**	**Proportion**	**Number**	**Proportion**	**Number**	**Proportion**	**Number**	**Proportion**
No certificate, diploma, or degree	260	36%	275	48%	245	59%	160	54%	130	52%
High school certificate or equivalent	80	11%	40	7%	25	6%	15	5%	0	0%
Apprenticeship or trades certificate or diploma	85	12%	95	17%	60	14%	45	15%	55	22%
College, CEGEP, or other non-university certificate or diploma	175	24%	100	18%	60	14%	40	14%	35	14%
University certificate or diploma below the bachelor level	10	1%	10	2%	10	2%	10	3%	0	0%
University certificate, diploma, or degree	115	16%	55	10%	30	7%	10	3%	20	8%

Source: Statistics Canada (2007b).

Table 5.1-2. Major Field of Study, 2006

	Cambridge Bay		Kugluktuk		Gjoa Haven		Taloyoak		Kugaaruk	
	Number	**Proportion**	**Number**	**Proportion**	**Number**	**Proportion**	**Number**	**Proportion**	**Number**	**Proportion**
Total population 15 years and older	1,025	100.0%	895	100%	660	100%	495	100%	400	100%
No postsecondary certificate, diploma, or degree	620	60.5%	620	69.3%	510	77.3%	365	73.7%	285	71.3%
Education	35	3.4%	30	3.4%	25	3.8%	15	3.0%	15	3.8%
Visual and performing arts, and communications technologies	10	1.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Humanities	15	1.5%	10	1.1%	0	0.0%	10	2.0%	10	2.5%
Social and behavioural sciences and law	25	2.4%	15	1.7%	10	1.5%	20	4.0%	10	2.5%
Business, management, and public administration	125	12.2%	65	7.3%	35	5.3%	20	4.0%	0	0.0%
Physical and life sciences and technologies	15	1.5%	10	1.1%	0	0.0%	0	0.0%	10	2.5%
Mathematics, computer, and information sciences	10	1.0%	0	0.0%	10	0.0%	10	0.0%	0	0.0%
Architecture, engineering, and related technologies	85	8.3%	75	8.4%	45	6.8%	35	7.1%	45	11.3%
Agriculture, natural resources, and conservation	10	1.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Health, parks, recreation, and fitness	40	3.9%	15	1.7%	15	2.3%	10	2.0%	15	3.8%
Personal, protective, and transportation services	45	4.4%	40	4.5%	15	2.3%	15	3.0%	15	3.8%
Other	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

Source: Statistics Canada (2007b).

5.2 PRIMARY AND SECONDARY EDUCATION

Each of the study communities, with the exception of Bathurst Inlet and Omingmaktok, is provided with kindergarten, elementary, and secondary schooling (Table 5.2-1). There are separate secondary and elementary schools in the larger communities (i.e., Cambridge Bay, Kugluktuk, and Gjoa Haven), while in the smaller communities (i.e., Taloyoak and Kugaaruk) there is a single school for all grade levels. Students are provided with the opportunity to obtain their high school certificate (or equivalent) within their home community. The operation of public schools in the region is overseen by the GN through the Kitikmeot School Operations' office based in Kugluktuk.

Table 5.2-1. Schools in Kitikmeot Communities

Name of School	Community	Grades Available
Kullik Ilihakvik	Cambridge Bay	Kindergarten to grade 6
Kiilinik High School	Cambridge Bay	Grades 7 to12
Jimmy Hikok Ilihakvik	Kugluktuk	Kindergarten to grade 6
Kugluktuk High School	Kugluktuk	Grades 7 to12
Quqshuun Ilihakvik Centre	Gjoa Haven	Kindergarten to grade 6
Qiqirtaq Ilihakvik	Gjoa Haven	Grades 7 to12
Netsilik School	Taloyoak	Kindergarten to grade 12
Kugaardjuq School	Kugaaruk	Kindergarten to grade 12

Source: Kitikmeot School Operations (2011).

5.2.1 Multiple Options Program

As of September 2013, the Nunavut school system will adopt a new curriculum that offers high school students a choice of six majors that focus on practical skills. The new curriculum aims to keep students in school and increase graduation rates. The current curriculum is based on curricula used in Alberta and NWT, whereas the new curriculum is thought to better reflect Nunavut's unique culture. The six options are in addition to regular courses, such as math and science; the new courses are: 1) introduction to trades and technology; 2) history, heritage, and culture; 3) community care-giving and family studies; 4) entrepreneurship and small-business studies; 5) fine arts and crafts; and 6) information technology. Educators in each of the Kitikmeot communities will review the options and select those that best fit their students and community expertise (CBC News 2012b; GN Department of Education 2012).

5.2.2 Schools in the Kitikmeot Region

Schools in the Kitikmeot Region typically provide English, math, science, art, physical education, health, and language classes (either Inuinnaqtun and Inuktitut), as well as career and program planning. Support staff typically includes guidance councillor(s), school community support worker(s), student support teacher(s), and student support assistant(s). In the following discussion, attendance rates are based on the student body that attend school at some point in the school year; there is also a group of students called "non-attenders," who are enrolled in school, but have never attended.

5.2.2.1 Cambridge Bay

In Cambridge Bay, high school registration for the 2012/2013 school year was approximately 195, while the number of students attending was approximately 170. Graduation rates vary; 6 students are expected to graduate in 2013, 12 students graduated in 2012, and 17 students graduated in 2011. The school has 16 full-time teachers, 2.5 student support assistants, a language specialist, and a language instructor. The high school was rebuilt in 2002; in addition to classroom and office space, it has a woodworking shop, kitchen, gym, library, language room, computer room, science lab, and cultural centre (A. Daniel, pers. comm.).

5.2.2.2 Kugluktuk

In Kugluktuk, high school registration for the 2012/2013 school year was 140. Graduation rates vary; there were eight graduates in 2011/2012, and eight students are expected to graduate in 2012/2013. The attendance rate is approximately 70%; however, this does not include non-attenders. The Kugluktuk high school has 8.5 full-time staff including the principal. The teaching staff was reduced by 1.5 positions for the 2012/2013 school year due to low attendance (G. Kennedy, pers. comm.).

The high school in Kugluktuk was the pilot location for the pre-trades and engineering program, which has been ongoing for the past eight years. The pilot program has shown that students enrolled in pre-trades are much more likely to graduate, become employed, or continue with post-secondary education as compared to students not enrolled in the program. Male students have been more likely to become employed in trades, whereas females have been more likely to attend post-secondary education. The pre-trades program is premised on four goals: 1) increase attendance, 2) increase graduation rates, 3) provide the skills and education necessary for students to eventually pass a traders certification test, and 4) establish a link in the minds of local people between education and future employment (G. Kennedy, pers. comm.).

The school has nine classrooms, a gym, shop, kitchen, library (community public library), and computer lab/music room. The high school in Kugluktuk is developing the history, heritage, and culture program as one of the multiple options to be delivered in the fall of 2013. This program will include a culture camp led by Elders teaching students to hunt, fish, and prepare food during day trips to established camps. The school currently has one Elder who provides support to the Inuinnaqtun and sewing programs (G. Kennedy, pers. comm.).

5.2.2.3 Gjoa Haven

In Gjoa Haven, high school registration for the 2012/2013 school year was approximately 300; however, the number of attendees is approximately 180. The school has had an attendance rate of approximately 50% for the past 10 years. There were six graduates last year, one of whom was graduating on time. There are 16 potential graduates for the 2012/2013 school year. In October 2012, there were 10.5 full-time teachers (P. Cipriano, pers. comm.).

The high school in Gjoa Haven has eight classrooms; however, two classes are held in the school's library due to lack of space. The school's gym is currently inaccessible due to ongoing renovations (as of fall 2012). The school will be adopting the new Multiple Options Program next year (see Section 5.2.1) and is currently working to select programs that will be most appropriate for and popular with students. The community also has an extended care facility that links to the community care-giving and family studies option, as well as some tourism, which may link to the entrepreneurship and small-business studies option or the fine arts and crafts option (P. Cipriano, pers. comm.).

5.2.2.4 Taloyoak

In Taloyoak, the kindergarten to grade 12 school had an enrolment of 309 students for the 2012/2013 school year. There are approximately 20 students per class, with the exception of the kindergarten, which had 30 students enrolled that year. The number of students graduating varies each year. For example, there was only one graduate for the 2011/2012 school year, while there were six graduates in 2010/2011. The school has 16 full-time teachers, the principal, one program support teacher, three instructors in the preschool, one preschool contractor, one physical education teacher, one bus driver, and one local community member who deals with children who have behavioural challenges. All kindergarten to grade 6 teachers are local people who are graduates of the Nunavut Teacher Education Program (NTEP; G. Pizzo, pers. comm.).

The school in Taloyoak has one classroom per grade (13 in total), a library, gym, industrial arts and home economics lab, weight room, and dental therapist's room. In addition to the standard kindergarten to grade 12 curriculum, the school also offers: career and technology studies, entrepreneurship, heritage studies, a construction program, photography, fine arts, music, and an audio-visual program. These strands will be morphed into the Multiple Options for the 2013/2014 school year (G. Pizzo, pers. comm.).

5.2.2.5 Kugaaruk

The school in Kugaaruk is a kindergarten to grade 12 school, which had 314 students enrolled for the 2011/2012 school year and approximately the same number of students for the 2012/2013 school year. The attendance rate in Kugaaruk was approximately 73% in 2011/2012, which constituted the second highest attendance rate in the Kitikmeot Region. However, this rate includes both the high school and elementary students. Overall, there are higher truancy rates among high school students, and lower truancy rates among elementary school students. There was one graduate in 2011/2012 and seven graduates in 2010/2011. The school has 1 teacher per grade, or 13 teachers in total, including kindergarten. The school also has three language specialists, one student support teacher, three student support assistants, one mentor, one school community counsellor, and one secretary. All teachers from kindergarten to grade 6 are local people who have completed the NTEP (Back River Project Research Program 2012).

The school in Kugaaruk has eight classrooms for the high school (grades 7 to 12) and six classrooms for the elementary school (kindergarten to grade 6). Additionally, the school has a gym, computer lab, kitchen, shop, library, and culture room. The school will offer two of the Multiple Option strands in 2013/2014 (likely history, heritage, culture, and/or entrepreneurship and small business studies'; Back River Project Research Program 2012).

5.2.3 Kitikmeot School Attendance, Enrolment, and Graduates by Community

Truancy rates have varied in the Kitikmeot communities over the 10-year period between 2001/2002 and 2010/2011. While each community has experienced an overall increase in truancy rates, the largest increases were experienced in Cambridge Bay and Kugluktuk, with approximate 5 and 10% increases, respectively (Table 5.2-2).

Table 5.2-2. Kitikmeot Public School Truancy Rate (%) by Community (2001 to 2011)

	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
Kitikmeot Region	21.2	22.3	21.8	24.6	22.3	22.9	19.5	21.0	23.3	25.3
Cambridge Bay	10.6	13.2	13.6	15.9	14.0	15.7	10.7	12.3	16.1	15.0
Kugluktuk	22.4	23.8	23.7	30.4	26.0	27.7	20.6	18.2	18.3	32.5
Gjoa Haven	32.1	31.8	30.3	33.1	33.9	30.5	25.6	34.1	34.6	34.2
Taloyoak	21.3	23.8	21.7	24.4	20.2	20.1	20.6	20.7	26.0	25.9
Kugaaruk	21.9	20.9	23.2	17.9	16.1	17.9	22.5	21.5	23.3	23.7

Source: Nunavut Bureau of Statistics (2012b).
Notes: Public Schools include all elementary and secondary schools, and all students enrolled in kindergarten through grade 12. The truancy rate is the percentage of total school days for which students have unexcused absences from school. The rate is calculated by dividing the total number of truant days by the total number of scheduled school days.

Table 5.2-3 shows a notable increase in truancy rates in the Kitikmeot communities between students in grade 6 and grade 7, with larger increase among males. Grades 10, 11, and 12 students experienced increases in truancy between 2001/2002 and 2010/2011, with approximately 10, 14, and 12% increases for each grade, respectively. The highest truancy rate was exhibited by grade 10 girls in 2010/2011 (46.8%). Community-based research links increased truancy rates for females in grades 9 and up to an increased birth rate for females in that age range (Back River Project Research Program 2012).

Table 5.2-3. Kitikmeot Public School Truancy Rate (%) by Grade and School Year

	2001/2002 (%)			2005/2006 (%)			2010/2011 (%)		
	Both Sexes	Males	Females	Both Sexes	Males	Females	Both Sexes	Males	Females
Total Rate	**21.2**	**21.6**	**20.7**	**22.3**	**23.3**	**21.2**	**25.3**	**24.5**	**26.1**
Kindergarten	19.0	15.1	23.2	13.2	13.7	12.9	11.8	12.5	11.0
Grade 1	19.4	20.8	17.8	22.4	25.5	17.5	19.7	22.7	16.4
Grade 2	16.9	18.9	14.5	16.5	16.4	16.6	13.7	11.2	16.2
Grade 3	12.2	13.3	11.3	16.9	14.1	19.2	15.6	15.4	15.7
Grade 4	15.0	16.0	13.6	14.0	14.6	13.5	12.4	12.0	12.9
Grade 5	11.3	10.6	11.9	11.0	12.8	9.0	13.2	16.7	10.5
Grade 6	16.3	18.1	14.2	16.9	21.6	11.7	19.1	19.4	18.6
Grade 7	29.2	30.5	27.6	21.6	22.9	20.0	25.2	27.1	23.6
Grade 8	32.4	30.8	34.0	32.4	35.3	29.6	33.9	30.6	36.7
Grade 9	31.0	26.3	36.0	32.8	30.7	34.6	34.5	33.5	35.5
Grade 10	32.8	32.8	32.8	28.7	30.0	27.3	42.1	37.8	46.8
Grade 11	22.5	24.0	19.6	36.5	35.9	37.2	36.0	35.3	36.8
Grade 12	14.5	13.0	15.9	23.0	23.2	22.8	26.1	25.8	26.4

Source: Nunavut Bureau of Statistics (2012b).
Notes: Public schools include all elementary and secondary schools and all students enrolled in kindergarten through grade 12. The truancy rate is the percentage of total school days for which students have unexcused absences from school. The rate is calculated by dividing the total number of truant days by the total number of scheduled school days.

Table 5.2-4 shows public school enrolment in the Kitikmeot communities between 2003 and 2011. Overall, the Kitikmeot Region experienced a moderate decline in public school enrolment between 2003 and 2011, with the exception of Taloyoak, which experienced an increase over this time period. Enrolment in Cambridge Bay over this time period varied but was relatively consistent (see Table 5.2-4).

Table 5.2-4. Kitikmeot Public School Enrolment as of September 30 (2003 to 2011)

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Kitikmeot Region	1,651	1,680	1,678	1,612	1,640	1,613	1,582	1,527	1,546
Cambridge Bay	426	433	420	396	397	414	389	399	420
Kugluktuk	372	345	354	329	371	353	325	292	326
Gjoa Haven	356	379	390	368	360	356	335	331	316
Taloyoak	241	264	248	268	259	252	252	255	248
Kugaaruk	372	345	354	329	371	353	325	292	326

Source: Nunavut Bureau of Statistics (2012b).
Notes: Public schools include all elementary and secondary schools. Students who register as full-time students as of September 30 of the school year but accumulate unexcused absences for at least 60% of school days in September are included in enrolment data. That is, the number of students actually present in classrooms may be lower than indicated here as a result of non-attenders.

Table 5.2-5 shows the number of high school graduates by community in the Kitikmeot Region between 2001 and 2011. Overall, the number of high school graduates differs by community size. For example, the eastern Kitikmeot communities have consistently lower numbers of graduates as compared to the two larger, more populous, western Kitikmeot communities. With the exception of Kugaaruk, all communities had a higher number of graduates in 2008. The number of graduates from Taloyoak is consistently lower as compared to the other Kitikmeot communities. There were fewer graduates in Cambridge Bay and Kugluktuk in 2011 in comparison to the number of graduates in those communities in earlier years.

Table 5.2-5. Kitikmeot Secondary School Graduates by Community (2001 to 2011)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Kitikmeot Region	11	12	12	11	17	21	16	35	23	30	24
Cambridge Bay	9	3	3	4	2	4	4	7	4	9	5
Kugluktuk	2	7	3	4	4	1	5	12	9	9	3
Gjoa Haven	0	1	1	2	7	10	6	11	4	5	7
Taloyoak	0	1	1	1	1	2	0	4	0	1	2
Kugaaruk	0	0	4	0	3	4	1	1	6	6	7

Source: Nunavut Bureau of Statistics (2012b).
Notes: Graduates includes students who completed secondary school, but excludes those who completed equivalency or upgrading programs. The number of graduates is totalled at the end of each calendar year.

5.2.4 Education Challenges

Notable challenges to the provision of education include attendance, hiring and retaining qualified staff, and space, as classrooms are reportedly small and the student population is steadily increasing (A. Daniel pers. com.). Overall, there are three common areas in which education providers in the Kitikmeot Region reported challenges:

- infrastructure, resources, and school materials;
- attendance, family issues, and cultural issues; and
- finding and retaining qualified teachers (Back River Project Research Program 2012).

Infrastructure, resources, and school materials can be a challenge for schools in the Kitikmeot Region. Two of the five schools are at or over capacity and require new, larger structures to accommodate the local student population. Facilities such as woodworking shops, science labs, and home economic labs require maintenance, which can, at times, be costly and/or the required services unavailable. Resources such as specialized teachers (e.g., computer science, woodworking, or other trades) can be difficult to attract and retain. In some communities, it can be difficult to obtain teachers due to the lack of available staff housing (Back River Project Research Program 2012).

Lower attendance rates are linked to a number of issues in the Kitikmeot communities. Some cite parental employment as an indication of whether or not children will attend school regularly. That is, parents who are employed and go to work every day are more likely to send their children to school. Others attribute absenteeism to lack of routine resulting from one or a combination of the following: parent's social problems (such as substance abuse), seasonal changes (24 hours of sunlight/darkness), lack of adequate housing, and/or lack of food. Others link higher truancy rates to a disconnect between Inuit and western culture, in that there is a perceived lack of understanding of the value of a western education. Multiple educators expressed the difficulty of explaining the need for a high school diploma to students residing in communities with limited opportunities for employment. Additionally, as the cost of food is high in the Kitikmeot Region many families either supplement or rely wholly upon country food, which further highlights the value of a more traditional Inuit education as opposed to a western education (Back River Project Research Program 2012).

Finding and retaining qualified teachers is also a challenge in the Kitikmeot Region. Although the NTEP program has been very successful, there continues to be a need for additional teachers, and the recruitment of southern teachers is ongoing, particularly high school teachers and specialized teachers (e.g., computer science, woodworking, or other trades). As a standard provision of employment, teachers are provided with staff housing. The lack of available housing has created a situation in which schools are unable to fill funded positions. Teachers for whom housing is available often face a number of challenges in their first year of teaching, such as isolation and cultural differences between themselves and their students and the community (Back River Project Research Program 2012).

5.3 POST-SECONDARY EDUCATION

Post-secondary education is offered through the Nunavut Arctic College (NAC). The college serves Kitikmeot communities through its central campus in Cambridge Bay, which is responsible for all college programming in the region. In addition, education programs are accessible in all Kitikmeot communities through the NAC's network of community learning centres. Each learning centre coordinates the delivery of college programs locally and coordinates partnerships with local organizations (NAC 2008).

Overall, enrolment at the NAC has increased over the past five years, from approximately 1,242 in 2007 to 1,335 in 2011. New program offerings and availability have been cited as the main reasons for the increase. For example, over the past four years, the NTEP has expanded from 4 to 11 communities in Nunavut (Opportunities North 2012). In 2010, the NAC student population comprised more female students (65%) than male students (35%; Association of Canadian Community Colleges 2010).

There are a variety of courses and course levels available, from short, non-credit courses to two-year, full-time programs. Courses range from Adult Basic Education (ABE), which provides course work at the grade 12 level, to NTEP which, in partnership with the University of Regina, results in a Bachelor of Education Degree (NAC 2011). The NAC also provides training programs to support employment in the mining sector through trades and pre-trades programs as well as through the camp cook program. The Pre-Trades Program prepares high school students for the entrance exam to the Nunavut Trades Training Centre in Rankin Inlet. The Pre-Trades program can be described as a combination of high school and college education, allowing part of the coursework to count toward high school credits to help students meet graduation requirements. The camp cook program provides students with the basic knowledge and skills required to obtain employment in the food industry, mainly at mining camps and other institutional camp settings (Back River Project Research Program 2012; NAC 2013). A brief summary of the variety of programs offered by NAC is provided in Table 5.3-1.

Arctic College program offerings are based on demand. Cambridge Bay is home to the region's central campus, which currently consists of four separate facilities and residences equipped to accommodate up to 20 students. There were a total of 42 students enrolled in various programs in Cambridge Bay for the 2012/2013 school year, including: the Trades Access Program, Camp Cook, Hairdressing, Social Service Worker year 1 and year 2, Midwifery (year 1), College Foundations, and ABE. The two most popular programs were Social Services Worker (years 1 and 2), which had a total of eleven students, and ABE, which had nine students (Back River Project Research Program 2012).

Table 5.3-1. Summary of Programs Offered by Nunavut Arctic College

Program Type	Description
Trade Programs	Designed to teach trade skills at different levels, from basic trade skills to the apprenticeship level. There are three types of trade programs available: • introductory trades programs; • pre-trades preparation and trades access programs, which prepare students to write the apprenticeship trades entry exam; and • pre-employment programs, which provide training for apprentices at the first year apprenticeship level.
Certificate and Diploma Programs	These are credit programs offered in a variety of subjects, such as Information Technology, Jewellery, Metal Working, Community Health Representative, and the NTEP. Certificate programs normally include a sequence of 10 courses delivered over a period of one year. Diploma programs are generally delivered over a period of two years and include a sequence of 20 courses.
Career Development Programs	These are short-term skills programs delivered to satisfy training requirements of a particular employment sector, such as the Inshore and Offshore Fisheries Program or the Customer Service Training Program.
Academic Studies Programs	These are basic courses designed to improve skills to meet employment, personal, or educational needs. Some examples of these courses are: life skills; traditional knowledge; or math, English, and science in the ABE Program.
Continuing Education	Other credit and non-credit customized training, personal development, and general interest courses and workshops are offered on a part-time basis through NAC's Continuing Education Department.

Source: NAC (2011).

In the other four Kitikmeot communities, the Arctic College typically consists of one building and offers one or two programs per year. For the 2012/2013 school year there were: eight students attending the Pre-employment Program at the Arctic College in Kugluktuk; eight students attending the NTEP in Gjoa Haven; fifteen students attending the College Foundations Program in Taloyoak; and six students attending the Pre-employment Program in Kugaaruk (Back River Project Research Program 2012).

Completion rates at the Arctic Colleges in the Kitikmeot Region are higher for certificate and diploma programs (approximately 75% completion rate) as compared to literacy level programs. For example, ABE and pre-employment have approximately a 50% completion rate. Presently, there are more female students attending the NAC than male students, although the pre-trades and camp cook programs are expected to draw additional male students (Back River Project Research Program 2012).

6. Labour Force and Economy

6. Labour Force and Economy

The following section describes the labour force and economy in the Kitikmeot Region, Nunavut, and Canada. Specifically, labour force participation and experience, income, and business are explored, as well as challenges to local businesses and current business trends.

6.1 LABOUR FORCE

The potential labour force (i.e., 15 years of age and older) within the Kitikmeot communities (excluding Bathurst Inlet and Omingmaktok) was approximately 3,475 in 2006. The active labour force among these same communities was approximately 2,185 individuals, indicating an average participation rate (i.e., percentage of the potential labour force that is active) of 63.0%. This level of participation is lower than the Nunavut average of 65.3% and the Canadian average of 66.8%. Comparatively, this participation rate falls between that of the Kivalliq Region (61.7%) and Baffin Region (67.9%). Notably, the participation rate in the Kitikmeot Region is higher as compared to the Kivalliq Region, despite a smaller potential labour force (Statistics Canada 2007b).

Participation rates among the communities ranged from approximately 70.6% in Cambridge Bay to 57.6% in Taloyoak, with Gjoa Haven, Kugluktuk, and Kugaaruk having participation rates of 61.4%, 60.3%, and 58.0%, respectively (Table 6.1-1). Employment rates varied by more than 23%; from 40.4% in Taloyoak to 63.7% in Cambridge Bay. The unemployment rate in all communities was relatively high compared to the national average of 6.6% and the Nunavut average of 15.6%, except for Cambridge Bay, which reported an unemployment rate of 9.7% (Tables 6.1-1 and 6.1-2). With the exception of Kugaaruk, there is a notable difference in the participation rates of males and females in the Kitikmeot communities; specifically, participation rates among males are approximately 10% higher as compared to females. In Kugaaruk, the participation rate of males is just 2% higher as compared to females (Statistics Canada 2007b).

Table 6.1-1. Participation and Unemployment Rates, 2006

Community/Region	Potential Labour Force	Active Labour Force	Participation Rate	Employment Rate	Unemployment Rate
Cambridge Bay	1,020	720	70.6%	63.7%	9.7%
Kugluktuk	895	540	60.3%	47.5%	22.2%
Gjoa Haven	660	405	61.4%	43.9%	29.6%
Taloyoak	495	285	57.6%	40.4%	28.1%
Kugaaruk	405	235	58.0%	44.4%	21.3%
Kitikmeot Region	3,490	2,200	63.0%	50.3%	20.2%
Kivalliq Region[1]	5,255	3,240	61.7%	52.0%	15.7%
Baffin Region	10,595	7,195	67.9%	58.4%	14.0%
Nunavut	19,340	12,635	65.3%	55.2%	15.6%
Canada	25,664,220	17,146,135	66.8%	62.4%	6.6%

Source: Statistics Canada (2007b).

Notes: Statistics Canada defines the "Potential Labour Force" as the total population 15 years and over; the "Active Labour Force" as persons who were either employed or unemployed during the week (Sunday to Saturday) prior to Census Day (May 16, 2006); the "participation rate" as the labour force in the week (Sunday to Saturday) prior to Census Day (May 16, 2006), expressed as a percentage of the population 15 years and over excluding institutional residents; the "employment rate" as the number of persons employed in the week (Sunday to Saturday) prior to Census Day (May 16, 2006), expressed as a percentage of the total population 15 years and over excluding institutional residents; and the "unemployment rate" as the unemployed expressed as a percentage of the labour force in the week (Sunday to Saturday) prior to Census Day (May 16, 2006).

[1] Statistics Canada refers to the Kivalliq Region as the "Keewatin" Region.

Table 6.1-2. Labour Force Activity Characteristics of the Aboriginal Identity Population (2006)

	Cambridge Bay	Kugluktuk	Gjoa Haven	Taloyoak	Kugaaruk	Kitikmeot Region	Kivalliq Region[2]	Baffin Region	Nunavut	Canada
Aboriginal identity population 15 years and over[1]	800	800	605	455	365	3,040	4,570	7,900	15,510	823,890
In the labour force	515 (64.4%)	460 (57.5%)	360 (59.5%)	255 (56.0%)	210 (57.5%)	1,810 (59.3%)	2,630 (57.5%)	4,730 (59.9%)	9,170 (59.1%)	519,250 (63.0%)
Employed	445 (55.6%)	340 (42.5%)	245 (40.5%)	175 (38.5%)	165 (45.2%)	1,385 (45.6%)	2,135 (46.7%)	3,800 (48.1%)	7,325 (47.2%)	442,395 (53.7%)
Unemployed	70 (8.8%)	120 (15.0%)	115 (19.0%)	80 (17.6%)	45 (12.3%)	425 (14.0%)	495 (10.8%)	930 (11.8%)	1,845 (11.9%)	76,860 (9.3%)
Not in the labour force	285 (35.6%)	340 (42.5%)	245 (40.5%)	200 (44.0%)	155 (42.5%)	1,230 (40.5%)	1,940 (42.5%)	3,165 (40.1%)	6,340 (40.9%)	304,635 (36.9%)
Participation rate	64.4%	57.5%	59.5%	56.0%	57.5%	59.5%	57.5%	59.9%	59.1%	63.0%
Employment rate	55.6%	42.5%	40.5%	38.5%	45.2%	45.6%	46.7%	48.1%	47.2%	53.7%
Unemployment rate	13.6%	26.1%	31.9%	31.4%	21.4%	23.5%	18.8%	19.7%	20.1%	14.8%

Source: Statistics Canada (2007a).

[1] *Aboriginal identity population 15 years and over refers to the total number of people who identify as Aboriginal and indicate they were in the labour force or not in the labour force the week prior to the Census Day (May 16, 2006).*

[2] *Statistics Canada refers to the Kivalliq Region as the "Keewatin" Region.*

Approximately one-fifth of the Kitikmeot population are unemployed, resulting in the highest unemployment rate regionally (20.2%), notably higher as compared to the Baffin (14.0%) and Kivalliq (15.7%) regions, which more closely reflect the territorial rate (15.6%).

A portion of the non-Inuit population residing in the Kitikmeot Region have relocated from southern communities for the purpose of employment. However, the majority of the population in the Kitikmeot communities are Inuit and this segment of the population is experiencing rapid growth (Section 4.1), meaning that Inuit comprise the large majority of the labour force. Table 6.1-2 summarizes the labour force activities of the Aboriginal identity population in the Kitikmeot communities, the Kitikmeot Region, Nunavut, and Canada.

The percentage of the Aboriginal identity population in the labour force in the Kitikmeot Region (59.3%) is slightly lower as compared to the Aboriginal identity population in the labour force in Canada (63.0%); however, the percentage employed in the Kitikmeot Region (45.6%) is approximately 8% lower as compared to Canada (53.7%; Table 6.1-2).

Participation rates among the Aboriginal identity population in the Kitikmeot communities vary from a high of 64.4% in Cambridge Bay to a low of 56.0% in Taloyoak, resulting in an overall rate for the region (59.5%) that is similar to the rate for Nunavut (59.1%) and moderately lower than the rate for the Aboriginal population of Canada (63.0%). Employment rates in the region vary by community, from a low of 38.5% in Taloyoak to a high of 55.6% in Cambridge Bay. Notably, the employment rate in Cambridge Bay is higher than the rates for both Nunavut and Canada. Unemployment rates were considerably higher in Gjoa Haven and Taloyoak (31.9% and 31.4%, respectively) as compared to the rate for the Canadian Aboriginal population (14.8%; Table 6.1-2).

This focused account of Aboriginal labour force characteristics shows greater balance in participation rates between the Kitikmeot, Kivalliq, and Baffin Regions (59.3, 57.5, and 59.9%, respectively). In terms of unemployment among the Aboriginal identity population, the Kitikmeot Region remains highest of the three (23.5%), but more closely reflects the territorial average (20.1%) as compared to the difference shown in Table 6.1-2. This may be reflective of the number of workers who have relocated to northern Canada for the purpose of employment who currently reside in the Baffin Region. Notably, 87% of the potential labour force of both the Kitikmeot and Kivalliq Regions consists of Aboriginal individuals as compared to only 74.6% of individuals in the Baffin Region (Table 6.1-2).

At the time of the last Canadian census for which data is available (2006), Nunavut's participation rate was 59.1%, approximately 4% lower as compared to the Canadian participation rate; Nunavut's employment and unemployment rates were 47.2% and 20.1%, respectively, meaning employment was approximately 6% lower and unemployment was approximately 5% higher in comparison to the rates for Canada. As of March 2013, the disparity between Nunavut's and Canada's participation rate had decreased to only 2.5%. Further, Nunavut's employment rate has increased by almost 10% and unemployment has decreased by almost 9%. Notably, Canada's unemployment rate in March of 2013 (7.2%) has decreased substantially since the time of the 2006 Census (15.6%; Table 6.1-3).

Table 6.1-3. Labour Force Characteristics in Nunavut and Canada, March 2013

	Participation Rate	Employment Rate	Unemployment Rate
Nunavut	64.1%	56.8%	11.4%
Canada	66.6%	61.8%	7.2%

Source: Nunavut Bureau of Statistics (2013a); Statistics Canada (2013c).

6.2 LABOUR FORCE EXPERIENCE

The majority of Kitikmeot residents in the workforce were employed in service-based activities. The largest proportion of the labour force worked in sales and service occupations, ranging from 23% (Cambridge Bay) to 36% (Kugaaruk). In the majority of the communities, the second largest portion of the labour force was employed in trade, transport, and equipment operations occupations; Cambridge Bay was the exception where business, finance, and administration was the second largest portion of the labour force, which can be expected given Cambridge Bay's role as a service centre in the Kitikmeot Region. Social science, education, government, and religion was the third most common occupational category, engaging around 15% of the labour force in all communities (Table 6.2-1). Management was of particular importance in Cambridge Bay, accounting for more than 14% of the labour force. Occupations unique to primary industries, including mining, accounted for less than 5% of the local workforce within each community, ranging from less than 2% in Cambridge Bay (approximately 10 people) to 5% in Gjoa Haven and Kugaaruk (approximately 10 people; Table 6.2-1). Of special note, those engaged in occupations related to trades, transport, and equipment operation were almost exclusively male; a trend that likely contributes to the higher participation rate among males in the region.

Examining the profile of employment by industry, Kitikmeot residents are most commonly engaged in industries classified as "other services" (Table 6.2-2), which includes industries such as equipment and machinery repair, personal care services, and death care services, among others. Equipment and machinery repair includes automotive repair and maintenance, commercial and industrial machinery and equipment repair and maintenance, as well as personal and household goods repair and maintenance (Statistics Canada 2007d). This category does not include the portion of the labour force employed by businesses engaged in retailing new equipment who also perform repairs and general maintenance (which would fall under the category retail trade); rather, it likely refers to those individuals who may operate, or have employment with, small businesses that perform equipment and machinery repair (Back River Project Research Program 2012). Other industries in which Kitikmeot Region residents are employed include education and business services. Those engaged in education services were more likely to be female, while those engaged business services were more likely to be male (Statistics Canada 2007b). Further, as shown in Table 6.2-2, Kitikmeot community and Nunavut residents are more likely to be employed in education services and less likely to be employed in business services in comparison to Yellowknife residents.

The labour force experience of Cambridge Bay residents more closely resembled Nunavut as a whole, while trends in the eastern Kitikmeot communities differed slightly. For example, greater proportions of the eastern communities were engaged in sales and services occupations. In comparison to Yellowknife, labour force experience in the Kitikmeot and Nunavut was greater in social sciences, education, government, and religion and less concentrated in natural and applied sciences. Experience in business, finance and administration was also slightly higher in Yellowknife (Table 6.2-1).

The service sector is the foundation of local economies in the Kitikmeot Region, accounting for about 80% of employment. All Kitikmeot communities exhibit high participation in the education, business, retail, and other service sectors (Table 6.2-2). Retail trade is particularly important in Kugaaruk and Gjoa Haven (16 and 15% of the labour force, respectively). These labour trends are typical for small, relatively isolated northern communities (Statistics Canada 2007b). The GN is also a notable employer in the Kitikmeot Region, as it is committed to a decentralized model of government. The decentralized model was adopted in 1999, when Nunavut become a territory, in order to provide community opportunities for capacity building while strengthening and diversifying local economies (GN 2002). Table 6.2-3 shows the number of individuals employed by the GN in June of 2012 and the percentage of Inuit employed in each community.

Table 6.2-1. Experienced Labour Force by Occupation, 2006

Occupation	Cambridge Bay		Kugluktuk		Gjoa Haven		Taloyoak		Kugaaruk		Yellowknife		Nunavut	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Total experienced labour force (15 years and older)	715	100%	515	100%	375	100%	250	100%	220	100%	12,095	100%	12,080	100%
Management	100	14%	40	8%	25	7%	15	6%	10	5%	1,530	13%	1,275	11%
Business, finance, and administration	125	17%	50	10%	40	11%	25	10%	25	11%	2,460	20%	1,880	16%
Natural and applied sciences	35	5%	30	6%	10	3%	10	4%	0	0%	1,140	9%	415	3%
Health occupations	15	2%	10	2%	10	3%	0	0%	10	5%	595	5%	310	3%
Social science, education, government, and religion	105	15%	90	17%	65	17%	40	16%	30	14%	1,130	9%	1,985	16%
Art, culture, recreation, and sport	20	3%	20	4%	10	3%	10	4%	0	0%	450	4%	640	5%
Sales and service	165	23%	150	29%	130	35%	75	30%	80	36%	2,695	22%	3,175	26%
Trades, transport, and equipment operators	110	15%	105	20%	85	23%	60	24%	55	25%	1,875	16%	2,045	17%
Primary industry	10	1%	15	3%	20	5%	10	4%	10	5%	170	1%	215	2%
Processing, manufacturing, and utilities	20	3%	10	2%	0	0%	0	0%	10	5%	60	1%	140	1%

Source: Statistics Canada (2007b).

Table 6.2-2. Experienced Labour Force by Industry, 2006

	Cambridge Bay		Kugluktuk		Gjoa Haven		Taloyoak		Kugaaruk		Yellowknife		Nunavut	
Industry	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
Total experienced labour force (15 years and older)	715	100%	515	100%	370	100%	250	100%	220	100%	12,100	100%	12,080	100%
Agriculture and other resource-based industries[1]	55	8%	80	16%	40	11%	30	12%	15	7%	990	8%	585	5%
Construction	40	6%	25	5%	40	11%	20	8%	30	14%	560	5%	730	6%
Manufacturing	20	3%	10	2%	0	0%	0	0%	0	0%	240	2%	155	1%
Wholesale trade	0	0%	0	0%	0	0%	0	0%	0	0%	195	2%	95	1%
Retail trade	65	9%	60	12%	55	15%	35	14%	35	16%	1,170	10%	1,405	12%
Finance and real estate	30	4%	20	4%	10	3%	10	4%	0	0%	460	4%	465	4%
Health care and social services	55	8%	50	10%	20	5%	20	8%	15	7%	1,030	9%	1,095	9%
Educational services	70	10%	60	12%	60	16%	30	12%	35	16%	640	5%	1,535	13%
Business services	100	14%	40	8%	30	8%	30	12%	20	9%	2,700	22%	1,500	12%
Other services	280	39%	170	33%	115	31%	70	28%	60	27%	4,110	34%	4,510	37%

Source: Statistics Canada (2007b).
[1] *This category includes mining.*

Table 6.2-3. Employment Summary of Government of Nunavut Public Service by Community (June 2012)

Community	Total Positions				Beneficiaries	
	Total Positions	Vacancies	Filled	% Capacity	Hired	% IEP
Cambridge Bay	274	86	188	69%	92	49%
Kugluktuk	138	23	115	83%	65	57%
Gjoa Haven	109	29	80	73%	53	66%
Taloyoak	44	11	33	75%	22	67%
Kugaaruk	42	4	38	90%	23	61%
Kitikmeot Region Total	607	153	454	75%	255	56%

Source: GN Department of Human Resources (2012).
[1] *IEP - Inuit Employment Program.*

The GNs Inuit Employment Program stems from Article 23 of the NLCA and aims to increase Inuit participation in government employment to a level that is representative of the population (NTI n.d.). Individuals employed by the GN work in one of the following departments or GN-funded corporations: Community and Government Services; Culture, Language, Elders, and Youth; Economic Development and Transportation; Education; Environment; Executive and Intergovernmental Affairs; Finance; Health and Social Services; Human Resources; Justice; Nunavut Arctic College, Nunavut Housing Corporation, and Qulliq Energy Corporation (GN Department of Human Resources 2012).

Approximately three-quarters of funded government positions in the Kitikmeot Region are staffed. Staffing positions with well-qualified individuals is a continuous challenge. Overall, the Health and Social Services Department has the lowest operating capacity in Cambridge Bay and Gjoa Haven; there were recently 51 and 19 vacant positions, respectively (GN Department of Human Resources 2012). As indicated in Section 6.5, government departments in the Kitikmeot communities have been unable to staff funded positions partly due to the shortage of available staff housing (Back River Project Research Program 2012).

6.3 INCOME

6.3.1 Individual and Household Income

Cambridge Bay had a substantially higher median individual income ($26,061) than the territorial average ($20,042) in 2005 (Table 6.3-1). Other Kitikmeot communities reported median individual incomes below the Nunavut average, ranging from approximately $18,336 in Kugluktuk to only $15,744 in Taloyoak. Cambridge Bay also reported the highest median household income among the Kitikmeot communities ($71,936), which is approximately 22% more than the community with the second highest household income (Kugaaruk at $58,624) and almost 20% more than the Nunavut average (Statistics Canada 2007b). All the other communities have median household incomes that are lower than the Nunavut average. Regionally, median household income in the Kitikmeot falls between that of the Kivalliq and Baffin Regions ($49,835 and $66,517, respectively).

More recent data on incomes for each community reported by tax filers in 2009 shows similarities between Kugluktuk, Gjoa Haven, and Taloyoak. Cambridge Bay had the highest median income in the region while Kugaaruk had the lowest (Table 6.3-1). The Kitikmeot Region reported the lowest median income for tax filers in 2009 ($21,830), just slightly less than Kivalliq Region ($23,760), approximately 30% less than the Baffin Region ($30,990), and approximately 28.5% lower compared to the territory as a whole ($26,830). Similarly, census data indicates that both the median individual income and median household income of Kitikmeot residents ($18,944 and $56,735, respectively) is slightly higher than that of the Kivalliq Region and lower than that of the Baffin Region. Overall, the median incomes of Kitikmeot individuals and households remain below the territorial median incomes of $20,042 for individuals and $60,221 for households (Table 6.3-1). The largest gender based income disparity was in Cambridge Bay, where the median income for females was over $13,000 lower than the median income of males in the community. Interestingly, the smallest income discrepancy was in Kugaaruk, which also accounted for the smallest discrepancy between the proportion of males and females participating in the labour force (see Section 6.1).

Table 6.3-1. Median Individual and Household Income, 2005 and 2008

Community or Region	Census				Tax File	
	2005 Median Individual Income (Population Aged 15+)			Median Household Income 2005	Median Tax Filer Income 2009	Proportion of Tax Filers (Population Aged 15+) 2009
	Total	Male	Female			
Cambridge Bay	$26,061	$33,920	$19,979	$71,936	$27,210	88%
Kugluktuk	$18,336	$20,506	$15,088	$54,976	$20,910	78%
Gjoa Haven	$16,602	$18,768	$15,040	$57,984	$20,480	88%
Taloyoak	$15,744	$14,848	$17,109	$45,952	$20,460	78%
Kugaaruk	$18,304	$18,880	$17,216	$58,624	$18,360	87%
Kitikmeot Region	$18,944	$20,971	$16,928	$56,735	$21,830	84%
Kivallliq Region[1]	$17,440	$16,832	$17,760	$49,835	$23,760	85%
Baffin Region	$24,518	$26,176	$22,816	$66,517	$30,990	82%
Nunavut	$20,042	$22,552	$20,047	$60,221	$26,830	83%

Source: Statistics Canada (2007b), Nunavut Bureau of Statistics (2008, 2010c).
Notes:
[1] Statistics Canada refers to the Kivalliq Region as the "Keewatin" Region.

6.3.2 Sources of Income

Household income is derived from a variety of sources, such as employment, government transfers (e.g., income assistance), and other sources (Table 6.3-2). Approximately 91.4% of household income in Cambridge Bay was from employment, while in Taloyoak employment only accounted for 71.7% of household income. Proportions of household income from employment for Kugluktuk, Kugaaruk, and Gjoa Haven fall between the values for Cambridge Bay and Taloyoak and are close to the Nunavut average of 86.5%. With the exceptions of Cambridge Bay and Kugluktuk, all communities sourced a relatively large amount of household income from government transfers, compared to the average for Nunavut as a whole (11.2%). Taloyoak stands out as having a particularly high proportion of income from government transfers (26.4%) in 2005 (Statistics Canada 2007c).

Kitikmeot and Kivalliq residents derive similar portions of income from employment, government transfers, and other sources of incomes. In comparison, Baffin residents derive a higher portions of income from employment and other sources, and lower portions from government transfers (Table 6.3-2). Again, this may be reflective of the higher portion of individuals who have relocated for employment and are now resident in the Baffin Region.

6.3.2.1 Sources of Income by Family Structure

Within the Kitikmeot communities, families typically consist of approximately 70 to 75% family couples (married or common-law) and 25 to 30% lone-parent families (see Section 4.4). Cambridge Bay families derive the highest portion of their income from employment as compared to government transfer payments and other income sources. Female lone-parent families in all regions derive higher portions of their income from government transfer payments as compared to employment income and other income sources. All family types in the Kitikmeot Region derive higher portions of their income from government transfer payments in comparison to Nunavut averages (Table 6.3-3).

Table 6.3-2. Sources of Income, 2005

Community or Region	Source of Total Household Income		
	Employment Income	Government Transfers	Other Income Sources
Cambridge Bay	91.4%	6.9%	1.5%
Kugluktuk	85.1%	12.6%	2.2%
Gjoa Haven	75.1%	21.9%	2.9%
Taloyoak	71.7%	26.4%	2.5%
Kugaaruk	78.0%	20.6%	1.8%
Kitikmeot Region	83.8%	14.1%	2.0%
Kivalliq Region[1]	84.1%	14.2%	1.8%
Baffin Region	88.2%	9.3%	2.5%
Nunavut	86.5%	11.2%	2.3%

Source: Statistics Canada (2007b).

Notes:

[1] Statistics Canada refers to the Kivalliq Region as the "Keewatin" Region.

Table 6.3-3. Family Structure and Sources of Income (2005)

Community or Region	Couple Families			Male Lone-parent Families			Female Lone-parent Families		
	Employment Income	Government Transfer Payments	Other Income Sources	Employment Income	Government Transfer Payments	Other Income Sources	Employment Income	Government Transfer Payments	Other Income Sources
Cambridge Bay	93.4%	5.0%	1.6%	88.8%	7.9%	3.3%	74.1%	24.1%	1.8%
Kugluktuk	88.1%	10.3%	1.6%	76.3%	20.8%	2.9%	69.4%	28.4%	2.2%
Gjoa Haven	75.9%	20.9%	3.1%	64.1%	34.5%	1.4%	51.7%	46.7%	1.6%
Taloyoak	72.8%	24.6%	2.6%	55.7%	43.5%	0.0%	46.6%	50.1%	3.3%
Kugaaruk	81.5%	17.5%	1.0%	38.9%	60.4%	0.7%	45.1%	53.0%	1.9%
Kitikmeot Region	86.0%	12.1%	1.9%	71.9%	25.8%	2.3%	63.5%	34.5%	2.1%
Kivalliq Region[1]	84.9%	13.7%	1.5%	77.4%	19.3%	3.3%	70.1%	27.7%	2.1%
Baffin Region	89.1%	8.6%	2.4%	79.9%	19.4%	0.9%	71.8%	25.9%	2.3%
Nunavut	87.5%	10.4%	2.1%	77.9%	20.4%	1.7%	69.9%	27.9%	2.2%

Source: Statistics Canada (2007b).

Notes:

[1] Statistics Canada refers to the Kivalliq Region as the "Keewatin" Region.

Regionally, couple families in the Kitikmeot Region derive a higher proportion of their income from employment (86.0%) as compared to couple families in the Kivalliq (84.9%), but less than couple families in the Baffin Region (89.1%). However, for both male and female lone-parent families in the Kitikmeot, lower proportions of their income are derived from employment as compared to that of the Kivalliq and Baffin Regions. Lone-parent families in the Kitikmeot derive more of their income from government transfer payments as compared to the Kivalliq and Baffin Regions, which more closely reflect Nunavut averages (Table 6.3-3).

6.3.3 Earnings

Statistics for earnings, which exclude government transfers, show a difference between communities (Table 6.3-4), which is primarily explained by differences in salaries and the proportion of part- and full-time workers. In Cambridge Bay, average individual earnings were estimated to be $33,408, which is more than double the estimated individual earnings of $12,096 for Gjoa Haven. Full- and part-time individual earnings in Gjoa Haven were 40% lower than those in Cambridge Bay, which largely explains the difference in total individual earning between these communities. In general, all communities reported high proportions of part-time or seasonal work, ranging from approximately 58% in Cambridge Bay to 87% in Gjoa Haven. In Kugluktuk, 72% of work was reported to be part-time or seasonal, and 74% of work in Taloyoak and Kugaaruk was reported to be part-time or seasonal (Statistics Canada 2007b). This has the overall effect of greatly lowering total annual earnings compared to what would be achieved with more full-time employment.

Median full-time individual earnings for Cambridge Bay ($65,856) and Kugluktuk ($60,055) were higher than the Nunavut average ($58,088) in 2005. Full-time earnings for Gjoa Haven, Kugaaruk, and Taloyoak were notably lower than the Nunavut average, having been estimated at $47,360, $38,016, and $30,784, respectively. On the whole, the Kitikmeot Region has the lowest earnings in comparison to the other two regions of Nunavut and is 25% lower in comparison to Nunavut (Statistics Canada 2007b). In addition, in the Kitikmeot communities, women earn significantly less than men (Table 6.3-4). The largest gender disparities in terms of full-time earnings were observed in Taloyoak, where male earnings were more than double female earnings. In general, the Kitikmeot communities have the highest salary disparity between genders than any other region in Nunavut (Nunavut Bureau of Statistics 2008).

In 2012, the annual average earnings in Nunavut was $50,030.76 (Nunavut Bureau of Statistics 2013b).[4] This is the highest annual average of weekly earnings in Nunavut to date, and represents an increase of 6.8% since 2011. In January 2013, average weekly earnings in Nunavut were $952.29, an increase of 6.5% from $893.99, reported in January 2012. In January 2013, Nunavut’s average weekly earnings were lower compared to the Northwest Territories ($1,281.32), lower than Yukon ($981.36), but higher as compared to the Canadian average of $909.00 (Nunavut Bureau of Statistics 2013a; Statistics Canada 2013b).

6.3.3.1 Kitikmeot Region Social Assistance Recipients

The proportion of the population receiving social assistance varies within the Kitikmeot communities from a low of 28.3% in Cambridge Bay, to a high of 70.4% in Taloyoak. Table 6.3-5 shows higher number of social assistance recipients in the eastern Kitikmeot communities (Gjoa Haven, Taloyoak, and Kugaaruk) as compared to the western Kitikmeot communities (Cambridge Bay and Kugluktuk). With the exception of Cambridge Bay, all communities in the Kitikmeot Region exceed the average rate of 41.4% for Nunavut as a whole (Table 6.3-5; Statistics Canada 2007b; Nunavut Bureau of Statistics 2012c).

[4] Based on the average annual weekly income of $962.13 in 2012, multiplied by 52 weeks per year; Nunavut Bureau of Statistics 2013b.

Table 6.3-4. Median Individual Earnings, 2005

Community	Median Earnings (Population 15 and Older with Employment Income)								
	Total			Male			Female		
	Total	Full-time	Part-time	Total	Full-time	Part-time	Total	Full-time	Part-time
Cambridge Bay	$33,408	$65,856	$9,696	$40,032	$71,765	$10,880	$24,986	$63,104	$8,016
Kugluktuk	$23,980	$60,055	$9,632	$27,520	$61,312	$11,984	$21,013	$58,965	$7,104
Gjoa Haven	$12,096	$47,360	$6,792	$13,728	$54,400	$6,992	$10,016	$35,712	$5,392
Taloyoak	$12,928	$30,784	$6,608	$15,520	$49,946	$6,608	$11,296	$24,032	$6,640
Kugaaruk	$15,024	$38,016	$7,136	$17,472	$47,957	$7,136	$11,989	$28,608	$7,280
Kitikmeot Region	$20,041	$56,864	$8,022	$23,984	$60,000	$9,600	$16,969	$50,816	$6,984
Kivalliq Region	$23,232	$50,104	$8,405	$24,040	$50,159	$8,437	$21,909	$50,033	$8,272
Baffin Region	$30,079	$60,060	$11,232	$32,090	$60,111	$12,008	$30,010	$60,006	$10,047
Nunavut	$26,848	$58,088	$10,007	$29,235	$59,915	$10,040	$24,973	$56,005	$9,627

Source: Nunavut Bureau of Statistics (2008).

Table 6.3-5. Kitikmeot Region Social Assistance Recipients (2011)

	2011 Population	2011 Social Assistance Recipients	
		Number	Share of Population (%)
Cambridge Bay	1,608	455	28.3%
Kugluktuk	1,450	680	46.9%
Gjoa Haven	1,279	835	65.3%
Taloyoak	899	633	70.4%
Kugaaruk	771	479	62.1%
Kitikmeot Region	6,012	3,082	51.3%
Kivalliq Region	8,955	3,244	36.2%
Baffin Region	16,939	6,871	40.6%
Nunavut	31,906	13,197	41.4%

Source: Statistics Canada (2007b); Nunavut Bureau of Statistics (2012c).

Regionally, the Kitikmeot has a larger proportion of residents receiving social assistance (51.3%) as compared to the Kivalliq (36.2%) and Baffin (40.6%) regions. All three regions experienced a decrease in individuals receiving social assistance between 2010 and 2011. Despite this decrease, this rate continues to be higher than in the past (Nunavut Bureau of Statistics 2012c). Further, the average rate for the Kitikmeot Region (51.3%) also exceeds the Nunavut average.

Notably, Cambridge Bay was the only Kitikmeot community which experienced a decrease in the number of individuals receiving social assistance between 2005 and 2011 (Table 6.3-6). This may be linked to the decentralization of GN departments and related community employment opportunities in Cambridge Bay (see Section 7.2 for a summary of the number of GN employees per community in the Kitikmeot Region), as well as the greater private sector activity in the community (Section 7.4). Kugluktuk has experienced the largest increase in recipients between 2005 and 2011; specifically, an increase of 47.5%. Recipients in both Taloyoak and Kugaaruk have not experienced meaningful increases over this time period, despite population increases of approximately 100 in each community (see Section 4.1).

Table 6.3-6. Social Assistance Recipients in the Kitikmeot Region and Nunavut (2005 to 2011)

Community or Region	2005	2006	2007	2008	2009	2010	2011	% Change (2005 to 2011)
Cambridge Bay	569	566	450	475	452	481	455	-20.0%
Kugluktuk	461	592	649	688	667	702	680	47.5%
Gjoa Haven	721	720	828	900	875	822	835	15.8%
Taloyoak	626	456	663	682	600	651	633	1.1%
Kugaaruk	490	488	457	496	450	477	479	2.2%
Kitikmeot Region	2,867	2,822	3,047	3,241	3,044	3,133	3,082	7.5%
Kivalliq Region	3,200	3,493	4,062	4,305	3,693	3,522	3,244	1.4%
Baffin Region	6,325	7,255	7,711	7,977	7,300	7,061	6,871	8.6%
Nunavut	12,392	13,570	14,820	15,523	14,037	13,716	13,197	6.5%

Source: Nunavut Bureau of Statistics (2012c).
Notes: Social assistance or income support is a program of last resort for Nunavummiut who, because of inability to obtain employment, loss of the principal family provider, illness, disability, age or any other cause cannot provide adequately for themselves and their dependents. Social assistance is provided by the GN in the form of monthly financial payment to help individuals meet a minimum standard of living. All residents of Nunavut between the ages of 18 and 59 can apply for income support. Recipients are individuals who receive social assistance payments. There may be multiple receipts within a household. Recipients may receive a single payment or multiple payments within a given year.

There were consistent increases in the number of social assistance recipients in the three regions between 2005 and 2008. This was followed by a notable decrease in all regions that began in 2009, and continued through to 2011 in the Kivalliq and Baffin Regions, while the Kitikmeot region experienced both increases and decreases (Table 6.3-6).

6.3.3.2 Personal Disposal Income

Personal disposable income is the sum of all incomes received and includes returns for labour and investments, and transfers from the government and other sectors (including old age security payment and employment insurance). Transfers from the government can also include unemployment compensation and social assistance payments. Personal disposable income is the amount left over after payment of personal direct taxes, including income tax, contributions to social insurance plans (such as Canada Pension Plan contributions and Employment Insurance premiums) and other fees. It is a measure of the funds available for personal expenditure on goods and services and personal or private savings (Statistics Canada 2007e).

Despite a small decline in 2009, average personal disposable income has grown in the North (Nunavut, Northwest Territories, and Yukon) over the past six years, from approximately $34,062 in 2006 to $40,654 in 2011. As shown in Table 6.3-7, Nunavut has consistently had the lowest average personal disposal income in comparison to the other two territories, while the Northwest Territories has been consistently the highest.

Table 6.3-7. Average Personal Disposable Income in the Territories (2006 to 2011)

	Average Personal Disposable Income in the Territories (Current $)					
	2006	2007	2008	2009	2010	2011
Nunavut	$29,929	$26,861	$31,935	$31,124	$32,059	$33,428
NWT	$38,775	$43,610	$45,191	$42,188	$44,626	$46,410
Yukon	$34,482	$38,209	$37,668	$39,611	$41,798	$42,123

Source: Canada Northern Economic Development Agency (2013).

To highlight the importance of personal disposable income as a reflection of the economic reality and cost of living in the Kitikmeot Region, linkages are drawn to the Revised Northern Food Basket (RNFB) and Family Structure, described in further detail in Sections 4.4 and 7.1.5, respectively. In 2009, the most recent year of data availability for the RNFB, average annual personal disposable income in Nunavut was $31,124, or approximately $2,594 per month (Table 6.3-7). According to RNFB data, the cost of food and household items (e.g., such as toiletries) for a family of four ranged between $429 to $471 per week or $1,716 to $1,884 per month, well over half the average annual personal disposable income.

Appendix 1A indicates that approximately 46.7% of Kitikmeot families consist of either four people (19.3%) or five or more people (27.4%), and that approximately 29% of Kitikmeot Region families are led by single parents, which likely corresponds to a single income. Further, over one-third of married and common law couples have more than three children, indicating larger family sizes (Section 4.4; Appendix 1A). Based on the 2009 RNFB, the cost of food and household items for a family of five residing in the Kitikmeot Region would range from $536 to $589 per week, or $2,144 to $2,356 per month,[5] just slightly less than the monthly average for personal disposable income ($2,594) in the Kitikmeot. It is likely that many families have just one income per household as approximately

[5] Based on the RNFB cost range between $429 to $471 per week for four people equating to a range of $107 to $118 per person, and adding that amount to the weekly total to allow for a family of five (e.g., $429+$107=$536 and $471+118=$589).

one-third are lone parent families (Appendix 1A) and unemployment rates range from 14 to 32% (Table 6.1-2). Even with two incomes per household, little is left over for shelter, clothing, health care, or personal savings. Further data describing personal savings and access to credit in the Kitikmeot communities is unavailable. Understanding northern realities and the cost of living in relation to average personal disposal income provides greater perspective on issues such of food security, poverty, and the importance of continued subsistence living (see Section 9.3 for further detail on subsistence living, food security, and well-being).

Although there have been improvements in recent years, access to credit that might help families through difficult financial times or fund improvements to personal property is relatively inaccessible. There are three communities in Nunavut that have bank branches: Iqaluit, Rankin Inlet, and Cambridge Bay. Most other communities have access to an ATM at the Northern Store or Co-op; however, without a bank branch, bank customers do not have the ability to open new accounts, apply for loans, or access other bank products. Bank customers in communities without a bank branch typically do their banking by phone or over the internet. As a result, many Nunavummiut are unable to develop a credit history or safeguard surplus cash and have likely not had access to many bank products related to financial planning and management or family budgeting. Further, lack of access to bank services also means that income may not be well documented and is, therefore, largely unrecognized within Canada's tax system for CPP and GST credits.

The introduction of a wage economy caused many Nunavummiut in communities without a bank branch to become highly dependent on the local retail store (i.e., the Northern Store or the Co-op) for bank services, such as cheque cashing, payment handling, and money transfers. These services were provided for a fee (typically much higher compared to bank fees outside the territory) and essentially limited an individual's control over their money. For example, retailers providing service to individuals cashing a cheque would not provide cash but rather would credit that persons store account, enabling them to purchase groceries, hunting equipment, and clothing (Cousins et al. 2006).

With developing employment prospects and the potential of substantially larger incomes, access to financial management programs has become a widely discussed topic in Kitikmeot communities. It is likely that access to this type of programming would enable resident's greater control over their finances and would provide opportunities for participation in family budgeting and financial planning, including contribution to personal savings, and may also provide information to assist individuals to overcome barriers associated with accessing credit.

6.4 REGIONAL ECONOMY

The Kitikmeot Region has a mixed economy, focusing on public sector services, private sector market economies, and traditional activities. Formal economic sectors of particular importance include: government administration, health care and social services, education, retail, construction, transportation, tourism services, arts and crafts, and mineral exploration and development (Statistics Canada 2007b). The traditional economy is largely focused on subsistence land use that does not involve the exchange of money (as discussed further in Chapter 9). Inuit people in the region often participate in the market economy to supplement their traditional livelihoods. The seasonality of subsistence harvesting and the availability of wage employment influence the timing and consistency of Inuit participation in the market economy.

> *A balance between traditional and wage economies has yet to be achieved in many Inuit communities, as individuals and communities struggle to adapt to the demands of industrial employment in a boom-and-bust economy, while retaining their connection to the land and their traditional way of life* (Thompson 2005).

The service sector is the base of the Kitikmeot economy, providing employment to around 80% of the employed labour force. Services in the region are related to business, education, retail trade, health, and social services. In contrast, primary and secondary industries-including resource-based industries and construction-account for about 20% of local employment (Statistics Canada 2007b). Renewable and non-renewable resource sectors are also important to the regional economy, while tourism is an emerging industry. Opportunities to develop mineral-based deposits are expected over the next 25 years, leading to continued economic growth in the region and its communities. Nunavummiut are expected to significantly benefit from this growth.

6.4.1 Real Gross Domestic Product and Economic Sectors in Nunavut

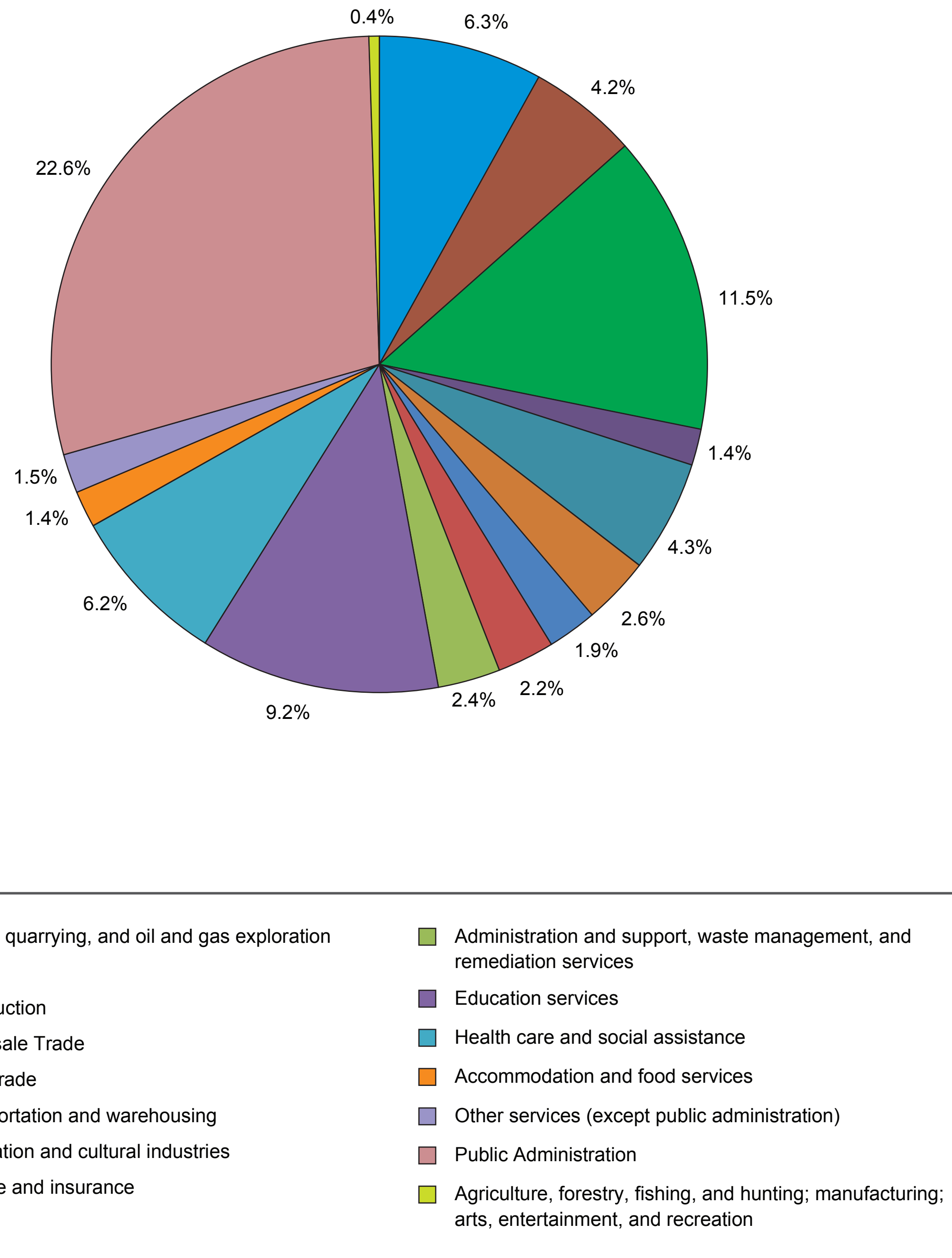
The dominant economic sectors in Nunavut do not reflect the Canadian norm, as the public sector is responsible for a notable portion of economic activity (see Sections 6.2 and 6.3), the number of private businesses are limited (Section 6.5), and the retail industry is hindered by a lack of intra-regional transportation networks, or other forms of cost-effective shipping (Back River Project Research Program 2012). Figure 6.4-1 below summarizes Nunavut's real Gross Domestic Product (GDP) by industry in 2011, indicating the heavy economic reliance on government funded sectors.

The four largest contributors to real GDP in Nunavut were consistent between 2007 and 2011 and included the following industry sectors: construction; education services; health and social assistance; and public administration. However, large increases in the contribution from the mining, quarrying, and oil and gas exploration sector places the industry among the four top contributors in 2010 and 2011. Figure 6.4-2 displays the contribution to real GDP made by the largest contributors and the mining, quarrying, and oil and gas exploration sector.

Nunavut accounts for approximately 0.1% of the Canadian population and their economy is also responsible for approximately 0.1% of Canada's real GDP, with the public administration sector and the construction sector each representing 22.6 and 11.5% of the territorial real GDP, respectively. The public administration sector experienced slow, steady growth between 2007 and 2011 and has increased its contribution to GDP by $17.6 million overall, whereas the construction sector has varied over the time period, but has increased its overall contribution by $63.5 million overall (Figure 6.4-1; Nunavut Bureau of Statistics 2012a).

As shown in Table 6.4-1, Nunavut's real GDP experienced an overall increase of approximately 26.6%, from $1.316 billion to $1.666 billion between 2007 and 2011. Despite a small decrease between 2008 and 2009, Nunavut's real GDP has increased each year over the specified time period (Statistics Canada 2012b). As shown in Figure 6.4-1, the public administration (22.6%), construction (11.5%), and education services (9.2%) sectors were the three largest contributors to real GDP in Nunavut in 2011. These are followed closely by the mining, quarrying, and oil and gas exploration sector (6.3%), and the health care and social assistance sector (6.2%). Few industries reported a decrease in contribution to real GDP (see also Table 6.4-1; Nunavut Bureau of Statistics 2012a).

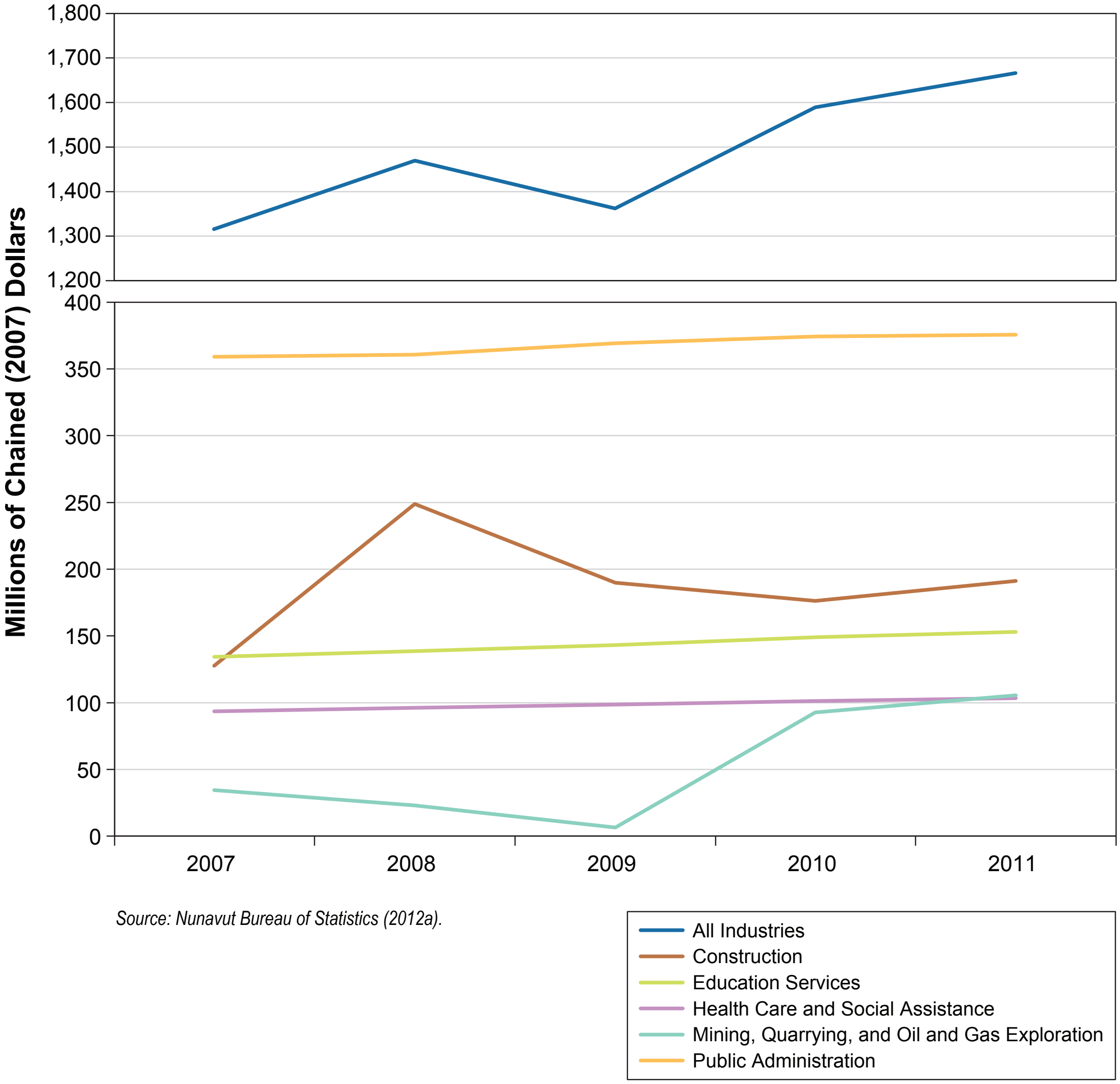
Although mining is relatively new to the region, the mining, quarrying, and oil and gas exploration sector reported the largest increase in contribution to real GDP in Nunavut (206.4%) between 2007 and 2011. The third largest increase occurred in the construction sector, which may be related to the increase in mining activity regionally. As such, the construction industry was one of the largest contributors overall ($191.1 million), an increase of $63.5 million since 2007, second only to the public administration sector. Other notably large changes in contribution to real GDP include a 60.9% increase for the agriculture, forestry, fishing, and hunting sector, although this increase represents a relatively small contribution ($1.4 million) comparatively (Nunavut Bureau of Statistics 2012a).



Source: Nunavut Bureau of Statistics (2012)

Figure 6.4-1

Nunavut Real Gross Domestic Product by Industry (2011)



Source: Nunavut Bureau of Statistics (2012a).

Figure 6.4-2

Nunavut Real Gross Domestic Product, Largest Contributors, 2007 to 2011

Table 6.4-1. Real Gross Domestic Product and Economic Sectors in Nunavut (2008 to 2011)

	2007	2008	2009	2010	2011	% Change
	Millions of Dollars (Chained 2007)					
All industries	**$1,315.9**	**$1,469.4**	**$1,362.4**	**$1,589.2**	**$1,666.1**	**26.6%**
Agriculture, forestry, fishing, and hunting	$2.3	$2.4	$3.4	$3.3	$3.7	60.9%
Mining, quarrying, and oil and gas exploration	$34.4	$23.1	$6.6	$92.6	$105.4	206.4%
Utilities	$68.2	$70.8	$60.6	$65.9	$69.6	2.1%
Construction	$127.6	$248.9	$189.9	$176.3	$191.1	49.8%
Manufacturing	$1.4	$1.3	$1.1	$1.1	$0.5	-64.3%
Wholesale trade	$22.4	$33.2	$24.9	$31.2	$23.1	-3.1%
Retail trade	$57.9	$66.5	$66.0	$68.6	$70.9	22.5%
Transportation and warehousing	$33.9	$37.5	$34.3	$37.3	$43.1	27.1%
Information and cultural industries	$26.1	$29.1	$29.9	$30.5	$31.2	19.5%
Finance and insurance	$33.3	$32.4	$33.3	$33.5	$35.9	7.8%
Administration and support, waste management, and remediation services	$41.2	$41.5	$41.0	$41.0	$40.0	-2.9%
Education services	$134.2	$138.7	$143.0	$149.0	$152.9	13.9%
Health care and social assistance	$93.6	$96.2	$98.5	$101.2	$103.3	9.7%
Arts, entertainment, and recreation	$2.5	$2.3	$2.3	$2.2	$2.2	-12.0%
Accommodation and food services	$20.6	$21.1	$21.0	$22.4	$23.4	13.6
Other services (except public administration)	$23.6	$24.0	$24.4	$24.6	$25.0	5.9%
Public administration	$359.1	$360.7	$369.2	$374.2	$376.7	4.9%

Source: Nunavut Bureau of Statistics (2012a).

Annual growth in real GDP varied between 2007 and 2011 in Nunavut. Table 6.4-2 shows a decrease in real GDP between 2008 and 2009, likely associated with the global economic slowdown of 2008/09. Real GDP more than recovered in 2010, increasing by 16.6%, and then continued to increase in 2011, by 4.8%.

Table 6.4-2. Annual Growth in Real Gross Domestic Product in Nunavut (2007 to 2011)

	2007	2008	2009	2010	2011
	Millions of Dollars (Chained 2007)				
Real GDP – All Industries	$1,315.9	$1,469.4	$1,362.4	$1,589.2	$1,666.1
% Annual Growth	na	11.7%	-7.3%	16.6%	4.8%

Source: Nunavut Bureau of Statistics (2012a).

The Centre for the North's Territorial Outlook report predicted a reduction in Nunavut's growth prospects for 2012 due to the closure of the Hope Bay Mine site, lower than expected gold production at the Meadowbank Mine, and cutbacks to exploration and development budgets. The report also predicts that construction on the Mary River and Meliadine mines will cause real GDP in Nunavut to surge by 17% in 2013 and 14.2% in 2014. Further, the construction industry is expected to continue to grow between 2012 and 2016 (Centre for the North 2012).

6.4.1.1 Gross Domestic Product Expenditure Account and Household Consumption

Comparatively, Nunavut and Canada are polar opposites in terms of private and public spending. In Nunavut, approximately one-third of consumption contributing to GDP is private while two-thirds is public. In Canada, approximately two-thirds of total consumption is private while just over one-quarter is public (see Table 6.4-3).

Table 6.4-3. Nunavut Gross Domestic Product, Expenditure Account (2007 to 2011)

		2007	2008	2009	2010	2011	% Change
		Millions of Dollars (Current)					
Nunavut	Final consumption expenditure[1]	$1,687	$1,881	$1,896	$2,032	$2,107	25.0%
	Household final consumption expenditure[2]	$542 (32.1%)	$588 (31.3%)	$604 (31.9%)	$634 (31.2%)	$675 (32.0%)	24.5%
	Goods	$257 (47.4%)	$278 (47.3%)	$285 (47.2%)	$298 (47.0%)	$316 (46.8%)	23.0%
	Services	$285 (52.6%)	$310 (52.7%)	$319 (52.8%)	$336 (53.0%)	$359 (53.2%)	26.0%
	Non-profit institution serving households' final consumption expenditure (NPISHS)[3]	$40 (7.4%)	$45 (7.7%)	$47 (7.8%)	$46 (7.3%)	$52 (7.7%)	30.0%
	General governments final consumption expenditure[4]	$1,105 (65.5%)	$1,248 (66.3%)	$1,245 (65.7%)	$1,352 (66.5%)	$1,380 (65.5%)	24.9%
Canada	Final consumption expenditure	$1,158,351	$1,197,521	$1,210,338	$1,250,414	$1,275,906	6.5%
	Household final consumption expenditure	$830,572 (71.7%)	$854,387 (71.3%)	$855,099 (70.6%)	$884,895 (70.8%)	$906,941 (71.1%)	9.2%
	Goods	$388,235 (33.5%)	$400,308 (33.4%)	$397,230 (31.3%)	$410,088 (32.8%)	$417,202 (32.7%)	7.5%
	Services	$442,337 (38.2%)	$454,091 (37.9%)	$475,763 (39.3%)	$474,653 (38.0%)	$488,465 (38.3%)	10.4%
	Non-profit institutions serving households final consumption expenditures (NPISHS)	$21,134 (1.8%)	$22,198 (1.9%)	$23,111 (1.9%)	$23,438 (1.9%)	$24,496 (1.9%)	15.9%
	General governments final consumption expenditure	$306,111 (26.4%)	$320,861 (26.8%)	$331,858 (27.4%)	$341,855 (27.3%)	$345,390 (27.1%)	12.8%

Source: OECD (2001); Nunavut Bureau of Statistics (2012a); Statistics Canada (2012a); The World Bank (2013b).
Notes:
[1] Final consumption expenditure (formerly total consumption) is the sum of household final consumption expenditure (private consumption) and general governmental final consumption expenditure (general government consumption; The World Bank 2013b).
[2] Household final consumption expenditure (formerly private consumption) is the market value of all goods and services, including durable products (such as cars, washing machines, and home computers), purchased by households. It excludes purchases of dwellings but includes imputed rent for owner-occupied dwellings. It also includes payments and fees to governments to obtain permits and licences (OECD 2001; The World Bank 2013b).
[3] NPISHS consists of non-profit institutions which are not predominantly financed and controlled by government and which goods or services to households free or at prices that are not economically significant (OECD 2001; The World Bank 2013b).
[4] General Government final consumption expenditure consists of expenditure, including imputed expenditure incurred by general government on both individual consumption goods and services and collective consumption services (OECD 2001; The World Bank 2013b).

Table 6.4-3 summarizes the contribution to GDP made by consumption expenditure in Nunavut and Canada from 2007 to 2011. Final consumption expenditure, also known as total consumption, is the sum of private consumption and general government consumption, which consists of government expenditure on goods and services used for both individual and collective consumption (OECD 2001). Household final consumption expenditure, formerly private consumption, is the market value of all goods and services, including durable products such as cars, washing machines, and home computers that are purchased by households. Home purchases are not included in the category, but imputed rent from owner-occupied homes is. Also included are payments and fees to governments to obtain licences and permits (OECD 2001). In Nunavut, final consumption expenditure, or the total of public and private consumption, increased by approximately 25% between 2007 and 2011. Government consumption in Nunavut accounted for approximately 66% throughout this time period, while household consumption routinely accounting for approximately 32%. Comparatively, general government consumption expenditure in Canada routinely accounted for between 26 to 27% of GDP between 2007 and 2011 (The World Bank 2013a).

In comparison, Nunavut consumes less durable goods, slightly less semi-durable goods, and more non-durable goods, as compared to the general Canadian population. The largest disparity between the territory and the nation is the rate of household consumption of durable goods, or those things that do not quickly wear out might include refrigerators, cars, or mobile phones. Consumption of these goods may be lower in Nunavut because these types of goods tend to be more expensive, as shipping costs are typically added to the consumer price. Semi-durable goods in Nunavut are consumed at slightly higher rate in Nunavut (5% higher) and refer to items such as clothing, shoes, and furniture. Nunavut residents consume approximately 15% more non-durable goods as compared to Canadians, which includes food and other household items not intended for use over an extended period of time (Table 6.4-4; OECD 2001; Nunavut Bureau of Statistics 2012a; The World Bank 2013b).

Table 6.4-4. Household Consumption of Goods by Type (2007 to 2011)

		2007	2008	2009	2010	2011	% Change
		Millions of Dollars (Current)					
Nunavut	Household final consumption expenditure - goods	$257	$278	$285	$298	$316	23.0%
	Durable goods[1]	$30 (11.7%)	$32 (11.5%)	$33 (11.6%)	$34 (11.4%)	$35 (11.1%)	16.7%
	Semi-durable goods[2]	$58 (22.6%)	$62 (22.3%)	$63 (22.1%)	$66 (22.1%)	$68 (21.5%)	17.2%
	Non-durable goods[3]	$169 (65.8%)	$184 (66.2%)	$189 (66.3%)	$198 (66.4%)	$213 (67.4%)	36.7%
Canada	Household final consumption expenditure - goods	$388,235	$400,308	$397,230	$410,088	$417,202	7.5%
	Durable goods[1]	$114,547 (29.5%)	$120,773 (30.2%)	$116,932 (29.4%)	$122,645 (29.9%)	$124,819 (29.9%)	9.0%
	Semi-durable goods[2]	$65,816 (17.0%)	$68,769 (17.2%)	$68,156 (17.2%)	$71,994 (17.6%)	$73,999 (17.7%)	12.4%
	Non-durable goods[3]	$207,872 (53.5%)	$210,834 (52.7%)	$211,927 (53.4%)	$215,546 (52.6%)	$218,593 (52.4%)	5.2%

Source: OECD (2001); Nunavut Bureau of Statistics (2012a); The World Bank (2013b).
Notes
[1] Durable goods are those acquired by households for final consumption (i.e., not used as stores of value), but may be consumed repeatedly or continuously (OECD 2001; The World Bank 2013b).
[2] Semi-durable goods can be used repeatedly or continuously over a period longer than a year and differ from a durable good in that the price is less and expected life significantly shorter (OECD 2001; The World Bank 2013b).
[3] Non-durable goods are those that are used up entirely in less than a year, assuming a normal or average rate of physical usage (OECD 2001; The World Bank 2013b).

Household final consumption expenditure has experienced a notable increase in Nunavut between 2007 and 2011 at 23.0%, only increasing 7.5% nationally. In Nunavut, the most notable increase was in non-durable consumer goods (36.7%), while in Canada the household consumption of non-durable goods experienced an a decrease proportionately (from 53.5% in 2007 to 52.4% in 2011).

6.4.2 Nunavut Imports and Exports

Nunavut imports almost three times as much as it exports, with virtually all exports and imports coming from or ending in other Canadian provinces. Overall, between 2007 and 2011, Nunavut's exports increased by 271.6% and imports increased by 41.1%. In terms of exports, there was a notable decrease of exports to other countries (59.1%) coupled with a dramatic increase in exports to other provinces (425.4%). In terms of imports, both imports from other countries and imports to other provinces increased (14.7 and 47.7%, respectively). The largest increase occurred for import of services from other provinces, which may be linked to the 2010 commencement of the Meadowbank Mine (Table 6.4-5; Nunavut Bureau of Statistics 2012a).

Table 6.4-5. Nunavut Imports and Exports (2007 to 2011)

	2007	2008	2009	2010	2011	% Change
	Millions of Dollars (Current)					
Exports of goods and services	$208	$193	$245	$625	$773	271.6%
Exports to other countries	$66 (31.7%)	$45 (23.3%)	$24 (9.8%)	$26 (4.2%)	$27 (3.5%)	-59.1%
Exports of goods to other countries	$41 (62.1%)	$20 (44.5%)	$9 (37.5%)	$11 (42.3%)	$11 (40.7%)	-73.2%
Exports of services to other countries	$25 (37.9%)	$25 (55.6%)	$15 (62.5%)	$15 (57.7%)	$16 (59.3%)	-36.0%
Exports to other provinces	$142 (68.3%)	$148 (76.7%)	$221 (90.2%)	$599 (95.8%)	$746 (96.5%)	425.4%
Exports of goods to other provinces	$6 (4.2%)	$6 (4.1%)	$2 (0.9%)	$359 (59.9%)	$484 (64.9%)	7,966.7%
Exports of services to other provinces	$136 (95.8%)	$142 (95.9%)	$219 (99.1%)	$240 (40.1%)	$262 (35.1%)	92.6%
Imports of goods and services	$1,381	$1,797	$1,415	$1,646	$1,948	41.1%
Imports from other countries	$279 (20.2%)	$362 (20.1%)	$258 (18.2%)	$285 (17.3%)	$320 (16.4%)	14.7%
Imports of goods from other countries	$237 (84.9%)	$303 (83.7%)	$211 (81.8%)	$235 (82.5%)	$261 (81.6%)	10.1%
Imports of services from other countries	$42 (15.1%)	$59 (16.3%)	$47 (18.2%)	$50 (17.5%)	$59 (18.4%)	40.5%
Imports from other provinces	$1,102 (79.8%)	$1,435 (79.9%)	$1,157 (81.8%)	$1,361 (82.7%)	$1,628 (83.6%)	47.7%
Imports of goods from other provinces	$471 (42.7%)	$691 (48.2%)	$366 (31.6%)	$438 (32.2%)	$490 (30.1%)	4.0%
Imports of services from other provinces	$631 (57.3%)	$744 (51.8%)	$791 (68.4%)	$923 (67.8%)	$1,138 (69.9%)	80.3%

Source: Nunavut Bureau of Statistics (2012a).

The majority of exports of goods and services are to other provinces within Canada (68.3%) and the majority of imports to Nunavut are from other Canadian provinces. Imports from other countries decreased by approximately 4% between 2007 and 2011, while imports from other provinces increased by approximately 3%. The majority of imports from other provinces are services, which have increased by 13%, whereas the percentages of goods imported from other provinces decreased by approximately 12%. Exports jumped dramatically between 2009 and 2010, while the largest increase in imports occurred just prior, between 2007 and 2008. This was followed by a notable drop in imports for 2009, but recovered in 2010 and 2011. Again, both events can be linked to the Meadowbank Mine in the Kivalliq Region. The extreme increase in the export of goods to other provinces (7,966.7%) is likely related to the expenditures of the Meadowbank Mine (Table 6.4-5; Nunavut Bureau of Statistics 2012a).

6.4.3 Trade Balance

Trade balance is the difference in value over a period of time between a country or regions imports or exports of goods or merchandise. When imports are higher than exports there is a trade deficit, which in some cases can be seen as an indicator of economic expansion, as during periods of development increased amounts of goods and services are often required to feed the growing economy. As shown in Table 6.4-6, Nunavut consistently has the highest trade deficit of the three northern territories, reflecting it's least developed status with accessibility challenges (Canada Northern Economic Development Agency 2013); however, this may also indicate the territory is in a development phase linked to spending associated with mineral exploration and development.

Table 6.4-6. Trade Balance in the Territories (2006 to 2010)

	Trade Balance of Goods in the Territories (in Millions of 2002 Dollars)				
	2006	2007	2008	2009	2010
Nunavut	-$789	-$1,082	-$1,409	-$995	-$878
NWT	-$419	-$168	-$270	-$246	-$581
Yukon	-$748	-$776	-$640	-$599	-$814

Source: Canada Northern Economic Development Agency (2013).

6.4.4 Own Source Tax Revenues

Own source tax revenues of territorial governments are a portion of the total territorial tax revenues and can be thought of as indicators of the fiscal health and self-sufficiency of territorial governments in providing services to its population. Own source tax revenues includes personal income taxes, corporate and sales taxes, tobacco and gasoline taxes, payroll taxes, royalties, and others. Own source tax revenues are a fraction of total territorial tax revenues, as territorial economies do not yet generate enough tax revenues to be self-sufficient (Canadian Northern Economic Development Agency 2012).

Despite economic development efforts and successes in Nunavut, the percentage of own source tax revenue remains low (Table 6.4-7). The negative change in 2011 to 2012 may be attributed to a growing population, which increases federal transfers at a faster rate than own source revenues. Yukon is the only territory experiencing general increases in own tax revenues in relation to total revenues (Canadian Northern Economic Development Agency 2012).

Table 6.4-7. Average Own Source Tax Revenues in the Territories (2006/2007 to 2011/2012)

	Average Own Source Tax Revenue in the Territories (%)					
	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012
Nunavut	6.1%	11.4%	11.5%	10.8%	10.2%	8.5%
NWT	27.0%	26.5%	26.8%	23.7%	22.6%	19.7%
Yukon	20.7%	16.5%	28.3%	29.8%	34.0%	32.6%

Source: Canada Northern Economic Development Agency (2013).

6.5 BUSINESS

Industries are growing steadily in Nunavut and there are many business opportunities and advantages to operating a business in Nunavut. For example, there is no territorial sales tax and the corporate tax rate is the second lowest in Canada. Government incentives foster economic development and encourage investment by providing generous financing, loans, and wage subsidy programs for certain investors who partner with Inuit or Nunavut businesses (Government of Canada 2012).

There are approximately 600 new housing units constructed in Nunavut each year across the territory. This generates work and business for manufacturers outside of the territory and also locally for construction companies (Government of Canada 2012). Local businesses found in almost every Nunavut community include a hotel, typically an Inns North, a Co-op and/or Northern store, and at least one local contractor/construction company.

6.5.1 Local Businesses

The co-operative (Co-op) business model is active in Nunavut. Co-ops operate the Inns North hotel chain and also hold a number of other service provision contracts in communities. A Co-op retail store that sells food, clothing, and a broad range of household items can be found in each Kitikmeot community. These communities, with the exception of Kugaaruk, also have a Northern Store (formerly Hudson's Bay Company-owned stores in the North), which is in competition with the Co-ops.

There is no comprehensive listing of local businesses in the Kitikmeot Region. However, NTI maintains a registry of registered Inuit-owned businesses, but excludes other businesses. Inuit-owned businesses registered in Cambridge Bay do not necessarily represent the presence of a physical business in the community. The type of services available through Inuit-owned businesses in the Kitikmeot community are summarized in Table 6.5-1 (NTI 2011a).

Table 6.5-1. Registered Inuit Firms in the Kitikmeot Region

Community	Type of Business	Number of Firms
Cambridge Bay	• Construction, contracting, and property management	7
(32 businesses)	• Accommodation and housing	2
	• Retail	2
	• Air transportation	3
	• Medical, safety, and paramedical	3
	• Logistical services, expediting, and remote site management	3
	• Multiple services to mining sector	1
	• Mine development and training	1
	• Trade and services	3
	• Explosives	1
	• Catering, camp management, and janitorial services	2
	• Taxi	1
	• Translation and language services	1
	• Finance and accounting	1
	• Lodge and guide outfitting	1
Kugluktuk	• Construction, contracting, and property management	2
(3 businesses)	• Accommodation	1
	• Retail	2
	• Taxi	1

(continued)

Table 6.5-1. Registered Inuit Firms in the Kitikmeot Region (continued)

Community	Type of Business	Number of Firms
Gjoa Haven (2 businesses)	• Construction, contracting, and property management • Accommodation • Retail • Consulting • Lodge and guide outfitting	3 1 1 1 1
Taloyoak (3 businesses)	• Construction, contracting, and property management • Accommodation • Retail • Trade and service • Translation and language services	2 1 1 1 1
Kugaaruk (1 business)	• Construction, contracting, and property management • Accommodation • Retail • Fish sales	1 1 1 1

Source: NTI (2011a).

6.5.2 Private Sector Development

The GN dominates the service sector and is the major economic driver of the Kitikmeot communities. Government employment and income support provides the main source of income for residents and this, in turn, supports the presence of the private sector in each community. Dependence on the public sector results from multiple conditions, such as the harsh climate, geographic remoteness, small population, and underdeveloped infrastructure systems, as these conditions have seriously constrained private sector economic development.

As described in Section 7.4.1, private sector businesses prominently include accommodation and retail, as well as a range of smaller-scale goods and service providers in each community. Cambridge Bay, and to a lesser extent Kugluktuk, stands out as a community where the private sector has a more important role in the economy.

Each Kitikmeot community also has at least one prominent construction and contracting firm, due in large part to the opportunities afforded by government spending on housing and infrastructure. Expertise within the firms ranges from housing and building construction, heavy equipment operation and excavation, road construction and maintenance, to crushing to provide aggregate. These firms provide significant employment opportunities, particularly during the summer construction season. In smaller communities, these firms typically provide the majority of employment opportunities outside of the public sector. Construction firms include Inukshuk Enterprises (Cambridge Bay), Kikiak Contracting (Kugluktuk), CAP Enterprises (Gjoa Haven), Lyall Construction Ltd. (Taloyoak), and Koomiut Co-operative Association (Kugaaruk), among others (Back River Project Research Program 2012). Statistics related to contracting and business opportunities in the region are unavailable. A profile of these companies is presented below. It should be emphasized that these profiles are not inclusive; Cambridge Bay, in particular, is the base for a number of firms active in the construction and contracting sector.

Cambridge Bay – Inukshuk Enterprises

The scope of work within each construction and contracting firm varies. Inukshuk Enterprises Ltd. provides property management, general contracting (including home construction), and automotive and building maintenance. Associated business ventures include the Green Row Inn and Suites and the local arcade. These services are organized from Cambridge Bay and available throughout the Kitikmeot Region when the demand arises. Work in other communities is performed in partnership with local construction companies who may not have the volume of skilled labourers to complete concurrent community projects. In such cases, Inukshuk Enterprises may provide labourers from Cambridge Bay to complete work in other communities but will rent equipment locally (Back River Project Research Program 2012).

Inukshuk Enterprises provides on-the-job training and employs approximately 15 Cambridge Bay residents. In recent years, it has become more difficult to hire skilled local people as many of those individuals obtained employment with the Hope Bay Project or other exploration camps in the Kitikmeot Region. At times, Inukshuk Enterprises hires southern employees if the needed skill sets are not available locally (e.g., carpenters, electricians, plumbers; Back River Project Research Program 2012).

Kugluktuk – Kikiak Contracting Ltd.

Kikiak Contracting was established in 1999 and provides heavy equipment, general contracting and home building, expediting and camp set-up, cargo handling, environmental reclamation, Inuit labour sourcing services, wildlife monitoring, road construction, and retail services. Kikiak employs certified trades people including plumbers, electricians, and mechanics. Main client groups include federal and territorial governments as well as mining companies. The main businesses in Kugluktuk include Kikiak, the Co-op, the Northern Store, and JMS Supplies (G. Newman, pers. comm.).

Gjoa Haven - CAP Enterprises

There are two aspects to CAP Enterprises: the first is a construction, heavy equipment, and expediting business; the second is a tourism business that operates a local bed and breakfast. The former business bids on contracts for industrial and other projects but performs the vast majority of work within Gjoa Haven. The latter business includes six houses that are commonly rented to construction workers and others working in the community (e.g., community health nurses) when the local hotel is at capacity. CAP Enterprises has operated since 2002 and, at times (i.e., 2008/2009), had up to 90 employees. The GN Housing Department was the company’s main client during the mid-1990s, accounting for approximately 80% of their business. To date the company has not experienced benefits from mine exploration and development in the region. The company experienced a downfall in 2010 when the manager/owner became ill, and is currently working towards rebuilding the success experienced in earlier years (C. Cahill, pers. comm.).

Taloyoak – Lyall Construction Ltd.

Lyall Construction Ltd. and associated businesses include the Boothia Inn and Aqsaqniq Aviation (mining services). The business also holds contracts to provide medevac services and operates the First Air agency in Taloyoak. The business owns a number of houses which are rented for use as GN staff housing units. Although some construction was underway in the fall of 2012, Lyall Construction Ltd. did not have a large inventory of construction projects underway at that time. Retail businesses in Taloyoak include the Co-op, the Northern Store, and Taluq Designs (C. Lyall, pers. comm.).

Kugaaruk – Koomiut Co-op

In Kugaaruk, the Koomiut Co-op includes the following businesses and services: Co-op grocery store, hotel (Inns North), construction company, coffee shop, cable (holder of the local service contract), fuel delivery (holder of the supply contract for the community), home construction, equipment rental, and the Yamaha and Polaris dealership, as well as 11 rental properties. In addition to groceries, the Co-op also provides furniture, electronics, clothing, and sewing products for sale. The Co-op is the only business in the community and employs approximately 45 to 50 people. The Koomiut Co-op has been very successful in the community, paying out over $1.5 million in dividends to members in 2011 and expecting to pay out approximately $2 million in dividends in 2012 (L. Flynn, pers. comm.).

6.6 CHALLENGES TO LOCAL BUSINESS AND COMMUNITY ECONOMIC DEVELOPMENT

As noted in the interviews with local business owners and operators, the main challenges to local businesses in the Kitikmeot Region included the cost of freight, lack of skilled employees, and the exclusionary policies of local organizations and governments. Additionally, the increasing presence of southern construction and contracting companies was also noted as a challenge, as these companies do not have the same operating costs as companies physically located in the region. Local business owners in the Kitikmeot communities also noted some single proprietors (namely local people operating small construction/maintenance/repair businesses) struggle with the necessary tax payments, accounting, and other management requirements of a business to remain in good standing, as many individuals do not have the educational experience to run a small business and accounting/business management services are generally unavailable in the Kitikmeot communities.

In the western Kitikmeot, the demand for skilled and semi-skilled workers has increased and is higher than available labour. At the same time, local residents in the Kitikmeot Region have expressed frustration at the type of jobs perceived to be available to Inuit people (i.e., lower skill-level positions). Inuit Impact and Benefit Agreements, typically required for larger projects needing regulatory approval, usually define a specific target for the level of Inuit employment. However, if local skills do not meet job requirements, it can be difficult for companies to meet targets. Those who facilitate training initiatives in the Kitikmeot Region noted there may be misunderstanding among the public related to the amount of training or education required to obtain different types of employment and the end result of becoming employed (Back River Project Research Program 2012). In addition, the limited number of jobs in communities does not inspire local people to complete education or other training, as the benefit is unclear (S. Novak, pers. comm.; L. Flynn, pers. comm.).

The cost of transporting goods into the region causes consumer prices to remain high. All goods must be flown or shipped via sea lift into each community. Generally, sea lift is the less costly alternative than air cargo. Challenges associated with sea lift include a short shipping season, as goods are only shipped during open water months, and the need to anticipate needs and place orders well in advance for the one shipment received each year. However, a recent study revealed that subsidies provided to offset shipping costs and reduce the cost of local goods are not always reflected in the price to consumers (AANDC 2010).

Overall, perhaps the biggest challenges to any business and economic growth are the lack of economies of scale (i.e., servicing a small population) and the lack of income-generating private sector activity that is independent of government spending. Approximately 51% of individuals in the region receive social assistance (Section 6.3.3.1) and the majority reside in subsidized housing (Section 7.5.5), meaning spending power is limited and government dependent. In addition, not only does the small population mean a limited local demand for goods and services, but many people wait to shop in southern centres such as Yellowknife or Edmonton as the cost is much less. For example, women that are travelling to Yellowknife to give birth typically use the opportunity to purchase any items needed to prepare for having a new baby at home. Because of the lower costs of goods in Yellowknife and

Edmonton as compared to the cost in the Kitikmeot communities, residents use any opportunity to travel south to purchase goods rather than spending the money in their home communities.

6.7 CURRENT TRENDS AND FUTURE DIRECTIONS

The Nunavut Economic Development Strategy (NEDS) was developed to guide economic development in Nunavut over the period from 2003 to 2013 (SEDS Group 2003). The NEDS identifies four key pillars and 13 strategic priorities for Nunavut's economic development (Table 6.7-1; SEDS Group 2003; Elias et al. 2009).

Table 6.7-1. Key Economic Pillars and Strategic Priorities for Economic Development in Nunavut

Economic Pillars	Strategic Priorities
The Land	Respecting the land
	Maintaining the mixed economy
	Building on the knowledge of Elders
The People	Economic development for the youth
	Education and training
	Basic needs—housing, hospitals, and schools
The Community Economies	Community capacity building and organizational development
	Small and Inuit business development
	Building the knowledge base in the communities
The Territorial Economies	Putting the NLCA to work
	Sector development and support systems
	Infrastructure – from buildings to broadband
	Accessing the global marketplace

Source: SEDS Group (2003); Nunavut Economic Forum (2009).

In addition to the NEDS, community economic development plans provide a vision for economic development and guide local efforts to support economic growth. Sector strategies and goals as described by the community economic development plans for the Kitikmeot communities are provided in Table 6.7-2. Information was unavailable for Taloyoak and Kugaaruk.

Table 6.7-2. Identified Sector Strategies and Goals for Economic Development

Community	Sector Strategy	Goal
Cambridge Bay	Canadian High Arctic Research Station (CHARS)	• Establish Cambridge Bay as the site of the CHARS with 55 or more employees undertaking and supporting research throughout the Arctic.
	Mineral Exploration and Mining	• Expand employment, training, and business opportunities related to mineral exploration and mining.
	Tourism	• Develop and promote tourism products and services that attract tourists and business travellers to Cambridge Bay.
	Small Business	• Develop opportunities within the business sector that create more local services, employment, and income, reduce leakage, and keep money circulating within the community.
	Other Sectors	• Expand and diversify arts and crafts, and expand commercial meat and fish harvesting and processing with more value-added products.
	Community Wellness	• Improve community wellness to support community economic development.

(continued)

Table 6.7-2. Identified Sector Strategies and Goals for Economic Development (completed)

Community	Sector Strategy	Goal
Kugluktuk	Mining and Mineral Exploration	• Develop opportunities within the mining and mineral exploration sector, including joint ventures and training that generate local employment, income, and business opportunities.
	Tourism	• Develop, promote, and market more quality products and services that attract more tourists and business travellers.
	Small Business	• Develop more locally owned and operated new and expanded businesses that serve residents and regional markets.
	Arts and Crafts	• Develop and market more local arts and crafts with a strong product-market match.
	Renewable Resources strategy	• Develop sustainable renewable resource commercial activities that generate employment, income, and business opportunities for harvesters and local residents.
	Social Development	• Improve Kugluktuk's social environment to support economic development.
Gjoa Haven	Arts and Crafts	• Increase the opportunity for artists and crafts people to participate in the wage economy.
	Small and Micro Business	• Support small and micro businesses by hamlet policy, programs, and initiatives. • Ensure the success and increase the number of small and micro businesses in the community.
	Community Infrastructure	• Provide infrastructure that meets the needs of the community.
	Commercial Food	• Sustainable utilization of country foods for local consumption and for the economic benefit of hunters, businesses, and employees.
	Health, Wellness, Education, and Training	• A healthy community with a positive environment in which to live. • An educated, skilled, and literate workforce. • Provision of qualified personnel for the mining sector. • Employment of residents in all three levels of government.
	Tourism	• Tourism to be a leading contributor to the economy of Gjoa Haven.
	Transportation	• Improve the availability of transportation services within Gjoa Haven. • Costs of importing and exporting goods will not be a barrier to economic development.

Sources: Aarluk Consulting (2007b); RT Associates (2005, 2009).

There are multiple investment support programs offered by the GN to encourage the development of local business. Funding to small businesses, individuals, organizations, and municipal governments is provided by the Nunavut Department of Economic Development and Transportation and is administered by the Community Economic Development regional office based in Kugluktuk. The four main funding programs include: the Small Business Support Program, Arts and Crafts Program, Strategic Investment Program, and Policy on Program Partnership (NDEDT 2011). Other business development support is available from the Nunavut Business Credit Corporation in the form of venture debt financing. Nunavut Business Credit Corporation programming is focused on small- and medium-sized enterprises and offers loans, loan guarantees, bid security, and investment support (NBCC 2011). The Atuqtuarvik Corporation, which is governed by NTI, also offers loans, loan guarantees, bid security, and investment placement to small- and medium-sized enterprises that are Inuit-owned (Atuqtuarvik Corporation 2011).

7. Health Status and Community Well-being

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7. Health Status and Community Well-being

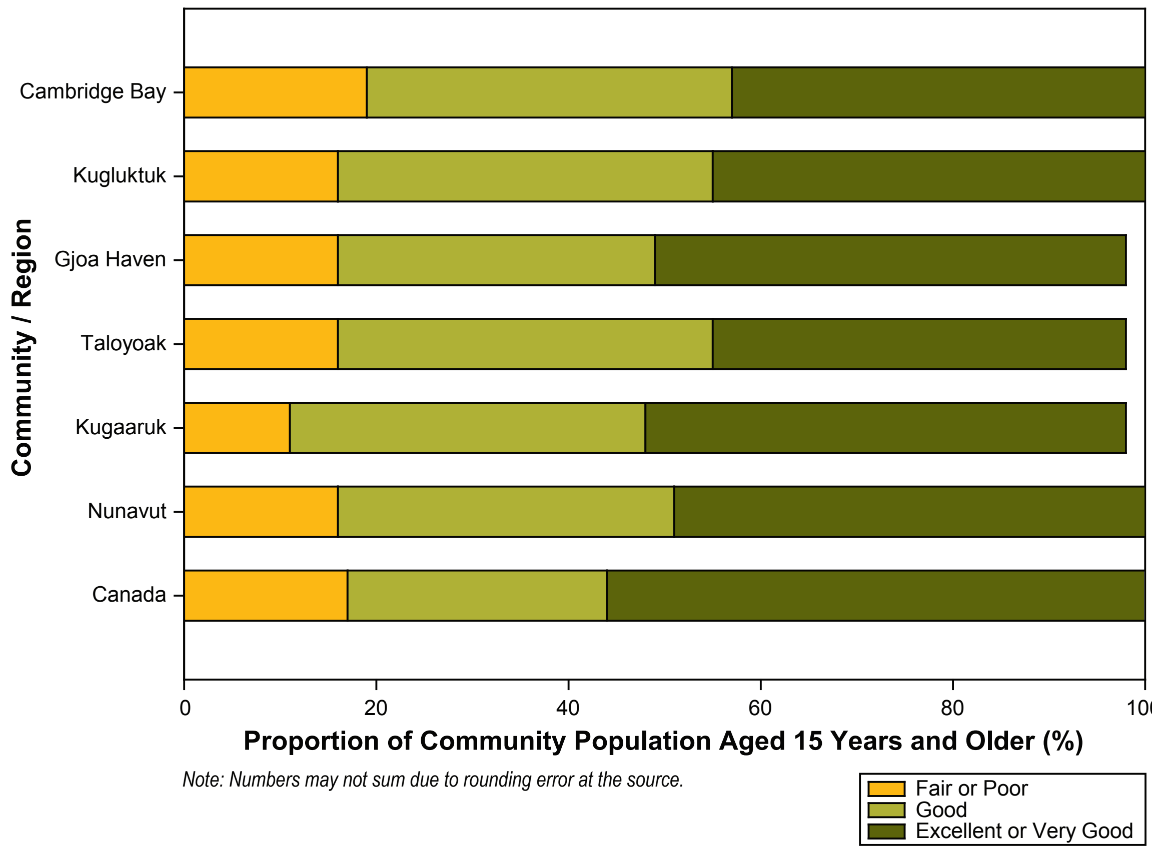
A recent report from Inuit Tuttarvingat (2010) outlines the Inuit vision of individual, family, and community health. Individual Inuit health "is about how you live and how you connect with others." The characteristics of a healthy Nunavummiut include having a healthy lifestyle (eating country foods, participating in physical activity, and avoiding addictions); combining traditional and modern ways of life; showing kindness; maintaining knowledge of the land; knowing personal limitations; being self-reliant, self-sufficient, and independent; supporting the community; and acting as a role model. A healthy Inuit family is "a strong unit that supports all its members," which includes sharing leadership in the family; respecting and caring for children, youth, and Elders; adapting to change in non-violent ways; maintaining active lifestyles; and being mindful of the future. Inuit community health focuses on "strong traditions of working together and [having] the resources to help each other." Healthy Inuit communities work for the good of the group, share resources, maintain traditions, pass on traditional knowledge, have recreation facilities and programs, have sufficient infrastructure (e.g., health centre, justice committee, and Elders' council), treat all people fairly, and maintain access to spiritual guidance (Inuit Tuttarvingat 2010).

Inuit have a holistic view of health in that health is more than the absence of illness but rather encompasses healthy environments, education and employment opportunities, adequate and safe housing, and social supports, as well as access to health care. Identified determinants of health for Inuit residing in Nunavut include acculturation, productivity (harvesting traditional foods, sewing, paid and voluntary work, etc.), income distribution, housing, education, food security and nutrition, health care services, quality of early life, addictions, social safety nets, and the environment (Inuit Tapiriit Kanatami 2007). Human health results from complex interactions between multiple social, environmental, and economic conditions. These conditions are often context- and place-specific. A number of agencies have investigated determinants and indicators of health for Nunavummiut, and they have found the following to be important indicators: housing and community infrastructure, education and training, food security, life expectancy, infant mortality and birth weight, mental health, suicide, rates of infectious diseases, chronic health conditions, productivity and employment, income distribution, social networks and safety nets, addictions, environment, quality of early life, and provision, accessibility, and quality of services (DHSS 2004; Inuit Tapiriit Kanatami 2007; NTI 2008). Many of these, for which information is available, are profiled here and in other sections of this report.

7.1 HEALTH STATUS

Self-reported health status provides an overall estimate of perceived health. Results are fairly consistent across the Kitikmeot communities (Figure 7.1-1), with 43 to 50% of residents reporting excellent or very good health, 33 to 39% reporting good health, and 11 to 19% reporting fair or poor health. These scores compare to the Canadian average of 56% excellent or very good, 27% good, and 17% fair or poor (Statistics Canada 2008a).

Although updated data specific to the Kitikmeot Region were not available at the time of writing, perceived health has been calculated for Nunavut as a whole. In 2010, fewer Nunavummiut (45.9%) perceived their overall health condition as very good or excellent as compared to Canadians (60.3%) (Statistics Canada 2012c). Overall, Nunavummiut experience lower rates of arthritis, diabetes, asthma, and high blood pressure as compared to the Canadian average. However, more Nunavummiut are overweight and obese, and have a higher incidence of cancer (512.1 per 100,000) as compared to the general Canadian population (404.9 per 100,000). The incidence of lung cancer (206.8 per 100,000) is particularly high at approximately four times the rate in Canada (56.9 per 100,000; Table 7.1-1).



Source: Statistics Canada 2008a

Figure 7.1-1

Self-rated Health Status in Kitikmeot Communities, Nunavut and Canada

Table 7.1-1. Perceived Health and Prevalence of Selected Chronic Conditions

Health Conditions	Nunavut	Canada
Perceived health, very good or excellent (%)	45.9%	60.3%
Overweight or obese (%)[1]	55.8%	52.0%
Arthritis (%)[1]	10.3%	15.8%
Diabetes (%)[1]	3.3%[1]	6.2%
Asthma (%)[1]	3.6%[1]	8.3%
High blood pressure (%)[1]	10.6%	17.0%
Cancer incidence (per 100,000 population)[2]	512.1	404.9
Colon cancer incidence (per 100,000 population)[2]	122.0	49.9
Lung cancer incidence (per 100,000 population)[2]	206.8	56.9

Source: Statistics Canada (2012a).
[1] *Data for 2009/2010.*
[2] *Data for 2007/2009.*

7.1.1 Community Health

Despite population growth in the Kitikmeot communities, the total number of health centre visits per year decreased from approximately 42,236 visits in 2004 to 29,143 visits in 2010 (Nunavut Bureau of Statistics 2012e). Over that time period, the top three ailments people sought medical attention for were:

1. Factors including health status and contacts with health services.
2. Diseases of the respiratory system.
3. Injury, poisoning, and other consequences of external causes.

"Factors including health status and contacts with health services" refers to visits related to communicable diseases, reproductive services, and other contact with health professionals for socio-economic and psychosocial reasons. This diagnostic group accounted for approximately one-fifth to one-third of all health centre visits in 2010 (Nunavut Bureau of Statistics 2012e).

The second highest percentage of visits to health centres were for "diseases of the respiratory system." In 2010, respiratory illnesses accounted for approximately 20% of health centre visits per year in Gjoa Haven, Kugaaruk, and Taloyoak, approximately 15% in Kugluktuk, and 12% in Cambridge Bay (GN et al. 2011). Community-based research indicates respiratory problems and related health issues are common among people of all ages in the Kitikmeot communities (Back River Project Research Program 2012).

As shown in Table 7.1-2, the third most commonly reported reason for visiting the health centre was "injury, poisoning and other consequences of external causes," which refers to poisoning, physical injuries (e.g., cuts and broken bones), burns, and the toxic effects of non-medical substances, among others. Between 2004 and 2010, the percentage of visits to Kitikmeot health centres for infectious and parasitic diseases increased for all Kitikmeot communities. Community based research indicates that sexually transmitted diseases are prevalent both in teens and adults. For mental health and behavioural disorders, the number of health centre visits either decreased or remained the same (GN et al. 2011). However, these data may also reflect increased access to mental health professionals (Back River Project Research Program 2012).

Table 7.1-2. Kitikmeot Region Community Health Centre Visits by Diagnostic Group, 2010

	Infectious and Parasitic Diseases	Mental and Behavioural Disorders	Diseases of the Respiratory System	Injury, Poisoning and Other Consequences of External Causes	Factors Influencing Health Status and Contact with Health Services
Cambridge Bay	4.0%	3.3%	12.1%	10.2%	22.2%
Kugluktuk	3.6%	2.1%	14.6%	7.8%	25.4%
Gjoa Haven	4.3%	1.8%	20.4%	7.8%	16.1%
Taloyoak	2.5%	0.9%	18.0%	7.9%	31.7%
Kugaaruk	3.4%	1.6%	19.7%	6.8%	21.1%
Nunavut	2.6%	4.2%	12.1%	7.8%	27.3%

Source: GN (2011).

7.1.2 Health Behaviours

Although data specific to the Kitikmeot Region are unavailable, indicators related to health behaviours have been calculated for Nunavut as a whole. According to the World Health Organization, health behaviours such as smoking and heavy drinking are thought to be important and preventable causes of death. Heavy drinking, defined as five or more drinks on one occasion at least once per month in the past year, can have detrimental health and social consequences (World Health Organization 2010).

Overall, daily smoking in Nunavut occurs at a rate three times higher (53%) compared to the rate for all Canadians (15.6%). In Nunavut, daily smoking is more common among females, whereas, within the general Canadian population daily smoking is more common among males (Table 7.1-3). Heavy drinking is less prevalent in Nunavut as compared to Canada generally, but is slightly higher among female Nunavummiut as compared to female Canadians (Statistics Canada 2012c).

Table 7.1-3. Health Behaviours (Canadian Community Health Survey 2009/2010)

	Nunavut			Canada		
	Total	Male	Female	Total	Male	Female
Current smoker, daily or occasional (%)	57.5	54.7	60.4	20.4	23.4	17.6
Current smoker, daily (%)	53.0	49.4	56.7	15.6	17.8	13.4
Heavy drinking (%)	16.0	19.6	12.3	17.3	24.8	10.0

Source: Statistics Canada (2012c).

Smoking, and particularly smoking among women, was noted as a main health concern by practitioners throughout the Kitikmeot Region. Concerns were expressed about women continuing to smoke during pregnancy and smoking while carrying a baby in the Amauti (a built-in pouch below the hood of the parka). Health practitioners linked these concerns to respiratory issues in children (Back River Project Research Program 2012).

In the Kitikmeot communities, there are no liquor stores, and alcohol for private consumption must be ordered and brought in by plane or sealift. The Nunavut *Liquor Act* (1988) is based on a three-level restriction system for the purchase and consumption of alcohol, meaning access to alcohol is prohibited, restricted, or unrestricted. In a prohibited community, absolutely no alcohol is allowed by law. In a restricted community, there is a panel of elected members who sit on an Alcohol Education Committee and are responsible for regulating the purchase, sale, and import of alcohol in the community. Specific restrictions are set by the Alcohol Education Committee and vary by community. In an unrestricted community there are general rules concerning the import, purchase, and consumption of alcohol set out under the Nunavut *Liquor Act* (1988). In the Kitikmeot Region, alcohol is prohibited in both Gjoa Haven and Kugaaruk; restricted in Cambridge Bay and Kugluktuk; and unrestricted in Taloyoak (GN n.d.).

Despite attempts to limit the consumption of alcohol, the sale and consumption of alcoholic beverages in Nunavut has increased over the past decade. In its 2012 report, the Kitikmeot Socio-Economic Monitoring Committee noted their preference to monitor trends related to the sale and consumption of alcohol in order to develop effective programs and enable change. Table 7.1-4 shows an overall increase in the alcohol sales and volumes purchased between 2002 and 2010 (GN Department of Economic Development and Transportation 2012).

Table 7.1-4. Nunavut Sales of Alcoholic Beverages, 2001 to 2010

	2002	2003	2004	2005	2006	2007	2008	2009	2010
	Value in Dollars ('000)								
Total	$3,790	$3,824	$3,928	$3,799	$4,263	$4,903	$5,077	$5,372	$5,921
Spirits	$891	$899	$923	$842	$1,003	$1,148	$1,188	$1,257	$1,386
Wines	$203	$211	$216	$293	$240	$274	$238	$300	$331
Beer	$2,695	$2,715	$2,788	$2,663	$3,021	$3,482	$3,606	$3,815	$4,204
	Volume in Litres ('000)								
Total	499	511	518	471	561	646	672	716	788
Spirits	25	23	24	19	26	29	30	32	35
Wines	13	14	16	25	18	21	22	23	25
Beer	461	474	478	427	517	596	620	661	728

Source: GN Department of Economic Development and Transportation (2012).
Notes: Derived from a census of provincial and territorial liquor authorities. Data do not include homemade alcoholic beverages, duty-free purchases, or unrecorded transaction. Volume totals have been added to this table and were calculated by summing the volumes reported for spirits, wines, and beer. The total should be interpreted with caution as the volumes for spirits, wines, and beer have been rounded.

Drug and alcohol workers indicated the level of alcohol and drug use in the Kitikmeot communities was high. Residents are able to access bootlegged alcohol that enters the community with other residents, visitors, and individuals working in the communities. For example, although Kugaaruk is a prohibited community, people have access to homebrew and bootlegged alcohol (Back River Project Research Program 2012).

7.1.3 Life Expectancy

Life expectancy is defined as the length of life an individual from a certain population could expect given their age; the definition does not account for the individual's quality of life. Nevertheless, life expectancy is an indicator of the population's general health and the quality of healthcare (DHSS 2004).

Although life expectancy data specific to the Kitikmeot Region are unavailable, this indicator has been calculated for Nunavut as a whole. Residents of Nunavut can expect a much shorter life than the average Canadian (Table 7.1-5; DHSS 2004; NTI 2008). On average, Nunavut residents have a life expectancy of 71.6 years at birth and 15.2 years at age 65 (2007/2009 average). These values are strikingly lower than the Canadian average life expectancies for the same period (i.e., approximately 81.1 years at birth and 20.2 years at age 65). Nunavut males could expect a lifespan that is almost 10 years shorter than the average Canadian male at birth and almost five years shorter at age 65.

Table 7.1-5. Life Expectancy in Nunavut and Canada, 2005/2007 to 2007/2009

	Age Group	Gender	2005/2007	2006/2008	2007/2009
Nunavut	At birth	Total	72.0	72.2	71.6
		Males	68.9	69.2	68.8
		Females	76.0	76.2	75.2
	At age 65	Total	14.4	15.2	15.2
		Males	13.3	14.2	13.9
		Females	16.3	16.8	17.0
Canada	At birth	Total	80.7	80.9	81.1
		Males	78.3	78.5	78.8
		Females	83.0	83.1	83.3
	At age 65	Total	19.8	20.0	20.2
		Males	18.1	18.3	18.5
		Females	21.3	21.5	21.6

Source: Statistics Canada (2012c).

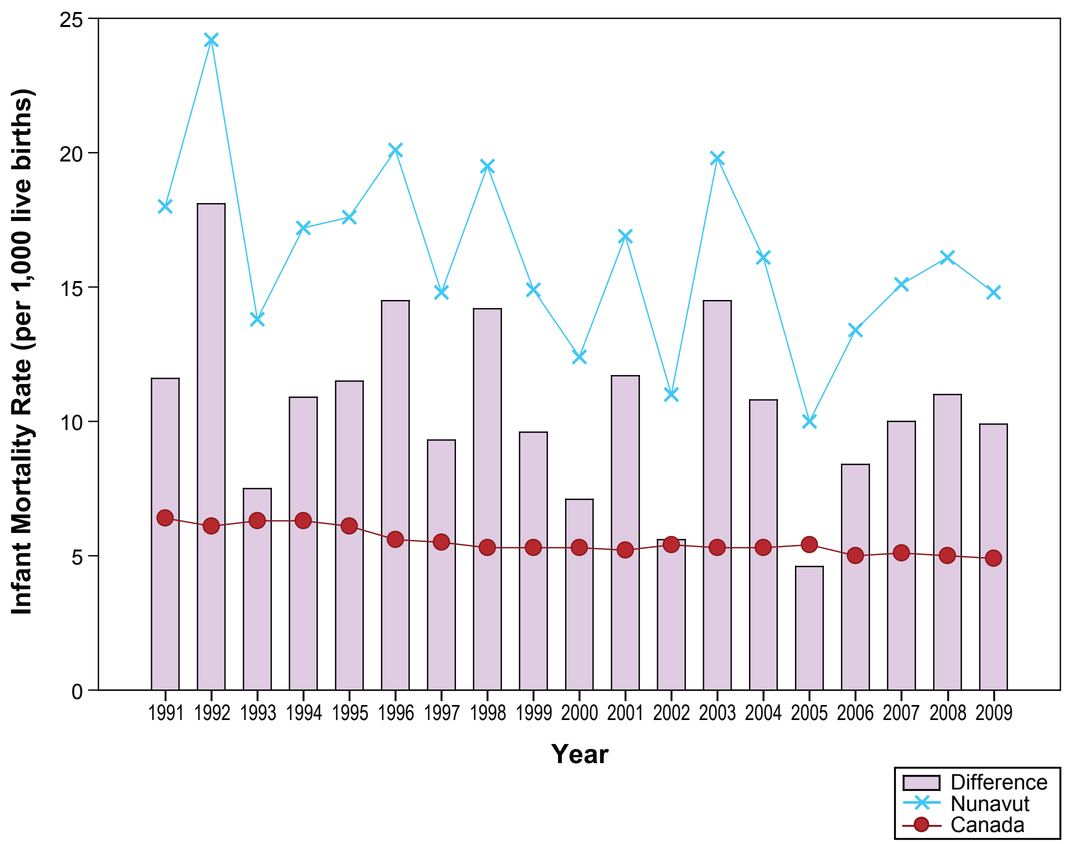
It has been estimated that Inuit people have the lowest life expectancy among all of Canada's Aboriginal groups; Inuit currently live as long as the average Canadian in the 1940s (Spicer 2008). Comparisons of the two-year averages shown in Table 7.1-5 indicate that the life expectancy at birth of Nunavut residents is not only lower than that of Canadians, but is decreasing over time, while Canadian residents continue to experience small gains in their life expectancy at birth. Lastly, although Nunavut residents have experienced greater gains in life expectancy at age 65 over time (Table 7.1-5), Canadians continue to live longer (Statistics Canada 2012c).

7.1.4 Infant Mortality and Birth Weight

Infant mortality refers to the number of infants who die in the first year of life and is usually expressed as a rate per 1,000 live births each year. The population health, quality of healthcare provision and access, preventative care effectiveness, and the level of maternal and child care are all reflected in this indicator. Infant mortality is closely related to birth weight, as low birth weight infants have a smaller chance of survival. High rates of infant mortality and low birth weight (i.e., greater than 500 g but less than 2,500 g) are associated with pre-term births; low socio-economic status; exposure to tobacco smoke; and other social, economic, and environmental conditions (DHSS 2004; NTI 2008).

Infant mortality rates and proportion of low birth weight statistics are not available for the Kitikmeot Region, but are available for Nunavut as a whole (Figures 7.1-2 and 7.1-3). In general, Nunavut has a much higher average infant mortality rate than Canada as a whole (Figure 7.1-2; Statistics Canada 2012c). In 2007, Nunavut's infant mortality rate was nearly three times that of Canada. In addition, the proportion of low birth weight babies is usually higher in Nunavut than in Canada, although there have been specific years (1996 and 2007) when these proportions have been similar (Figure 7.1-3; Statistics Canada 2012c).

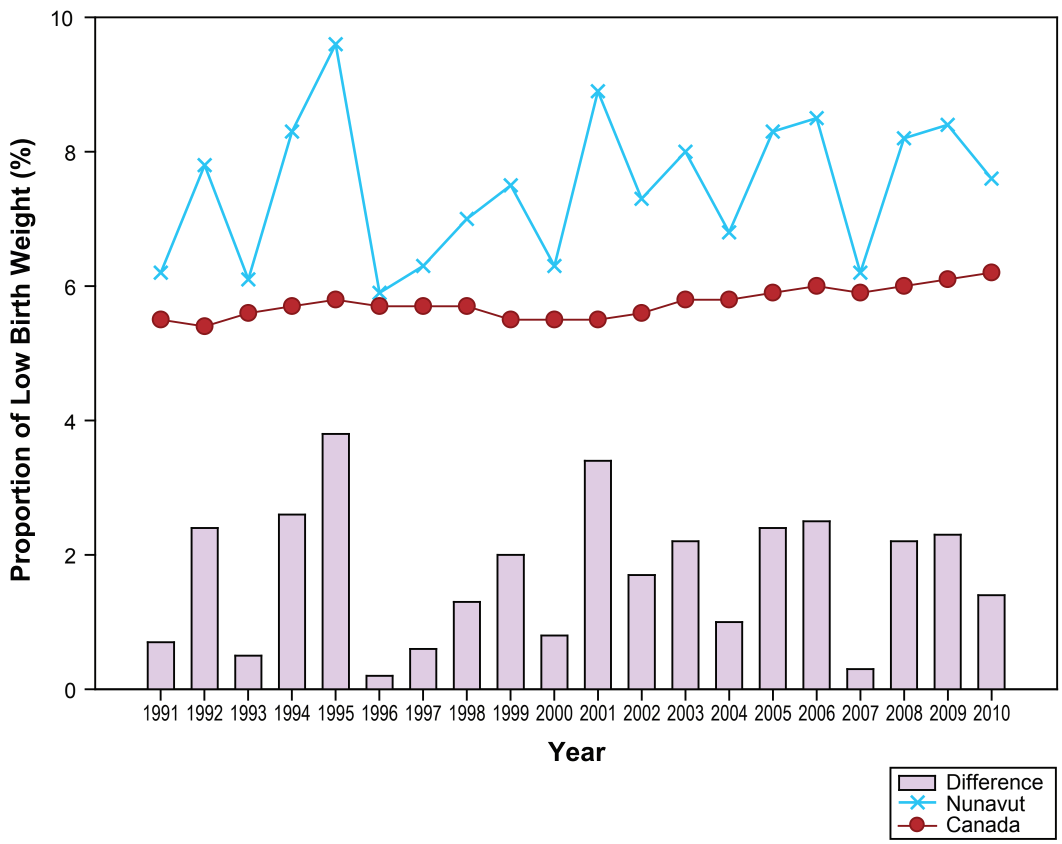
Nunavut's infant mortality rate remained approximately three times higher than the Canadian average between 2006 and 2009 (Table 7.1-6). The proportion of babies born in Nunavut that are considered to have a low birth weight has effectively remained unchanged between 2006 and 2010. Although the difference between the percentage of low birth weight babies born in Nunavut and in Canada has both increased and decreased over time, in 2010, the percentage of low birth weight babies in Nunavut (7.6%) remained higher as compared to the Canadian average (6.2%; Table 7.1-6).



Source: Statistics Canada 2011b

Figure 7.1-2

Infant Mortality Rates for all Birth Rates in Nunavut and Canada, 1991 to 2009



Source: Statistics Canada 2011c

Figure 7.1-3

Proportion of Low Birth Weight Births in Nunavut and Canda, 1991 to 2010

Table 7.1-6. Infant Mortality and Low Birth Weight in Nunavut and Canada

		2006	2007	2008	2009	2010
Infant mortality rate per 1,000 live births	Nunavut	13.4	15.1	16.1	14.8	n/a[1]
	Canada	5.0	5.1	5.0	4.9	n/a[1]
Low birth weight (% of live births)	Nunavut	8.5	6.2	8.2	8.4	7.6
	Canada	6.1	6.0	6.0	6.1	6.2

Source: Statistics Canada (n.d.).
[1] *data are unavailable.*

7.1.5 Food Security

"Country foods play a vital role in food security, as well as the nutritional, social, cultural, economic and spiritual well-being of Inuit communities in Nunavut" (Thompson 2005). Food security, or rather insecurity, is an issue of concern in Nunavut. Although traditional foods (i.e., those acquired through traditional activities, such as hunting, fishing, and gathering) still comprise a significant portion of local diets, changing social conditions and the high cost of hunting are limiting the supply of traditional foods to communities. In addition, nutritious store-bought foods are often expensive or unavailable. As a result, Nunavut had more than four times the percentage of people reporting both moderate and severe food insecurity than Canada as a whole (NTI 2008). Food security in Canada was approximately 25% higher than in Nunavut (Statistics Canada 2011a).

At times, access to food can be a challenge for communities in Nunavut due to the isolated nature of the region and distance from commonly used shipping and transport routes. Generally, perishable food items are air lifted into the Kitikmeot communities while dry goods are brought in during the annual sealift (see Section 10). A number of circumstances can impact the quality of food delivered, for example, bad weather, delayed deliveries, and improper food handling. Food services in the Kitikmeot Region are for the most part limited to grocery stores, specifically the Northern Store and the Co-op, although there is a fast food outlet (KFC/Pizza Hut) housed in the Northern Store in Cambridge Bay. With the exception of Kugaaruk, which only has one grocery—the Co-op—each of the Kitikmeot communities have a Co-op and a Northern Store that provide grocery and other household items. Additionally, each community has a hotel that has restaurant food services; however, other than in Cambridge Bay this service is for hotel guests only. In the fall of 2012, a newly established coffee shop in Kugaaruk was providing some food and beverage items within limited business hours.

In the Kitikmeot Region, food is shipped from Yellowknife and subsidized as part of the Food Mail Program. Although Edmonton is a supply centre, it is not an entry point for Kitikmeot communities. Through AANDC's program called the Northern Food Basket (now called the Revised Northern Food Basket [RNFB]) Program, food price surveys were conducted in each of the Kitikmeot communities from 2005 to 2009. The program aims to estimate the cost of a typical basket of groceries and other household items for a family of four by comparing similar products and brands in a northern community to the cost of the same products in the most appropriate southern communities. The basket includes both perishable and non-perishable goods (approximately two-thirds of the basket are perishable goods). Costs were estimated for both Edmonton and Yellowknife. In 2008, surveys were conducted in March and September in Edmonton, Yellowknife, Gjoa Haven, and Kugaaruk to account for any seasonal variation in food prices. The results of the program are displayed in Table 7.1-7.

Overall, the cost of food is increasing in both northern and southern communities. However, the cost difference between southern centres and the Kitikmeot communities is substantial. In 2009, the weekly cost of the RNFB in Taloyoak was almost double the cost in Yellowknife. Although Cambridge Bay had the lowest RNFB cost of the Kitikmeot communities in 2009, the weekly cost of food and household items remained almost $200 higher than the weekly cost in Yellowknife and $171 higher than Edmonton (Table 7.1-7). For Kitikmeot families (of four people) calculating a monthly household budget, this equates to anywhere between $680 and $800 additional dollars per month.

Table 7.1-7. Weekly Cost of the Revised Northern Food Basket for a Family of Four

	Total: Perishables and Non-perishables			
	2005	2006	2008	2009
Edmonton	$196	$202	$230/$251	$254
Yellowknife	$212	$206	$217/$235	$239
Cambridge Bay	$398	$382	$401	$429
Kugluktuk	n/a	n/a	$445	$452
Gjoa Haven	n/a	$392	$423/$457	$452
Taloyoak	n/a	$423	$477	$471
Kugaaruk	$338	$360	$425/$431	$436

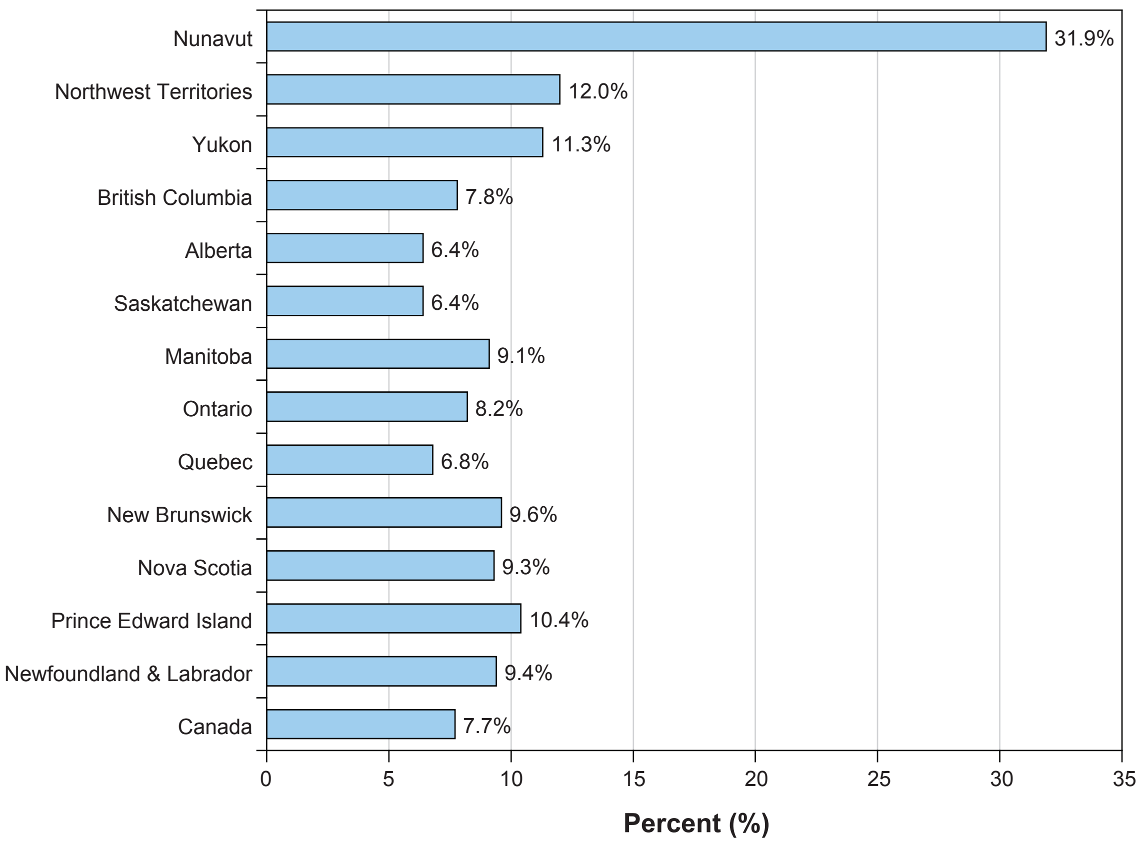
Source: AANDC (2010).
n/a = surveys were not completed.

Food security was discussed during community-based research as an issue affecting the Kitikmeot residents. Public demonstrations were held in the Kitikmeot communities in fall 2012 to promote awareness of the high cost of food (see Section 6.3.3.2; Back River Project Research Program 2012). In the recent roundtable discussion, Issues and Ideas for Change, Kitikmeot residents described hunger, poverty, food security, nutrition, and access to country foods as key issues (Nunavut Roundtable for Poverty Reduction 2011). In Cambridge Bay, the Wellness Center operates a food bank where families can shop once per month (if assessed as being in need) and also provides coffee, toast, and cereal on a drop-in basis (C. Hogaluk, pers. comm.).

The International Polar Year Inuit Child Health Survey (Egeland 2010) was conducted by the Qanuippitali Steering Committee and McGill University and included participants from each of Nunavut's 25 communities. The goal of the survey was to obtain an overview of the health status and living conditions of Nunavummiut living in Nunavut. The study concluded that food insecurity is a problem in homes in Nunavut communities. The survey indicated that 35.1% of homes were severely food insecure (defined as disrupted eating patterns and reduced food intake among adults and/or children), and another 35.1% of homes were moderately food insecure. Homes with children were more likely to be food insecure as compared to homes without children. Specifically, 38.4% of homes with children were reported as severely food insecure and another 33.0% were reported as moderately food insecure (Egeland 2010). This indicates that over two-thirds of Nunavummiut homes with children struggle with food security.

The Canadian Community Health Survey 2007/2008 indicated Canada's national average for food insecurity was approximately 7.8% (Figure 7.1-4). Nunavut's rate of food insecurity (31.9%) was more than four times the national average (Statistics Canada 2010).

There has been a recent focus on the issue of food security in Nunavut by Statistics Canada, the United Nations, and academics (Statistics Canada 2010; De Schutter 2012; Northern Public Affairs 2012). This issue is expected to be further highlighted in coming years, as the United Nation's Special Rapporteur's final report discussing the right to food in Canada will be presented to the United Nations Human Rights Council in Geneva in March 2014. The report reviews findings related to food insecurity in First Nations and Inuit communities and ranks food security in the Canadian north in comparison to other developed and under-developed counties (Hicks 2012).



Source: (Statistics Canada 2010).

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Percentage of Household with Food Insecurity, 2007 to 2008

Figure 7.1-4

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7.2 HEALTH AND WELLNESS ISSUES

7.2.1 Community Health and Wellness Issues

Overall, food security and poverty were the two most commonly reported issues facing Kitikmeot communities (Back River Project Research Program 2012). Results of the 2012 research program indicate the health and wellness issues facing the communities, children, teens, adults, and Elders include:

- *Addictions* – drugs, alcohol, tobacco use, and gambling. Service providers link substance abuse to high levels of domestic violence (C. Evalik, pers. comm.). Solvent abuse was noted as an issue for residents of Kugluktuk (C. Lee, pers. comm.).
- *Suicide* – a number of individuals described suicide as an important issue and stated that communities are focusing on prevention and education (J. Glasgow, pers. comm.).
- *Overcrowding* – the lack of housing in all Kitikmeot communities was noted as a main issue and was linked to poor outcomes in education, health, and mental health, and was also linked to domestic violence (Back River Project Research Program 2012).
- *Domestic violence* – violence and abuse were described as very problematic for all segments of the population (children, teens, adults, and Elders) and has been connected to the legacy of residential schools, which is thought to have caused dysfunction within the family unit. Drug and alcohol use have been linked to other issues such as domestic violence (E. Fredlund, pers. comm.).
- *Food security* – the high cost of food and availability of nutritious foods were noted as issues during recent focus group sessions.
- *Respiratory disease* – was the most commonly mentioned community health issue for children, teens, adults, and Elders (Back River Project Research Program 2012).

7.2.2 Children, Teen, Adult, and Elder Health and Wellness Issues

In addition to the health and wellness issues described above, the results of the 2012 research program indicated issues facing children specifically include lack of parenting, stress, ear and chest infections, sinus infections, colds and flus, neglect, child abuse, and respiratory health issues. Exposure to alcohol and drug use in the home was also noted as an important issue. Issues facing teens include STIs, stress, and lack of recreation activities. Young mothers were thought to experience high levels of stress and lack adequate information on parenting. Issues facing adults include gastro-intestinal problems, diabetes, obesity, hypertension, and heart issues, among others. Community-based research indicated the main health and wellness issue for adult women is domestic violence. Wellness issues among men may be related to feelings of low self-worth that arise from unemployment, which may result in issues related to substance abuse and suicide. Issues facing Elders include alcohol and abuse, specifically physical and financial abuse. In some cases, Elders are the sole providers for children, an issue linked to financial and other stress. Health practitioners noted an increase in the need for palliative care (Back River Project Research Program 2012).

7.3 HEALTH FACILITIES

Each of the Kitikmeot communities has a health centre that provides access to health professionals and various health programs. Health centres in the region coordinate with the Stanton Hospital in Yellowknife, which is the nearest full service hospital. Stanton doctors work closely with Kitikmeot Region nurses, travel to the Kitikmeot communities on a rotational basis, and are on call for emergencies (C. Evalik, pers. comm.). Patients can be transported via Medevac to either Yellowknife or Edmonton when in need of medical services unavailable in the community (Back River Project Research Program 2012).

Physicians visit the communities to see patients for one week every six to eight weeks (excluding Cambridge Bay, as the health centre has a doctor on duty throughout the year). Typically, health centre nurses see patients in the morning and run clinics/health programs in the afternoons. Health programs include well woman, well man, well child, a prenatal clinic, and a communicable disease clinic; the programs are discussed in greater detail in Section 6.4 (Back River Project Research Program 2012). Community health nurses assess, triage, diagnose, treat, and refer patients (E. Garneau, pers. comm.). The health centres are generally open during office hours Monday to Friday and have a nurse on call after hours and overnight.

Each of the Kitikmeot health centres are equipped with a telehealth machine, which enables patients to meet with health specialists in the south through audio-visual communication. Telehealth also facilitates specialized counselling sessions and enables communication between mental health counsellors and patients who have been transferred to in southern facilities. The use of telehealth for medical reasons has caused a notable reduction in the number of Medevac transports required (Back River Project Research Program 2012).

In addition to regular clinic services, Kitikmeot residents have access to a number of specialists who travel to the communities two times per year to provide services, including a paediatrician; an obstetrician; an ears, nose and throat specialist; an audiologist, an optometrist, an internal medicine physician, a psychologist, an occupational therapist, and a speech therapist. Dentists provide services approximately every two months. There is also a visiting ultrasound technician who provides services as needed (Back River Project Research Program 2012).

7.3.1 Cambridge Bay

Cambridge Bay has the largest health centre in the region, a modern two-story building that opened in 2005. In addition to the typical medical services and health programs, the centre in Cambridge Bay also provides laboratory and X-ray services, as well as midwifery services through the birthing centre that opened in 2010. The Cambridge Bay health centre is unique in that it is always staffed with a doctor. Doctors in Cambridge Bay work on a three- to five-month rotation schedule. Cambridge Bay is also unique in that it has an ambulance, which is operated by the Hamlet. Cambridge Bay is the only Kitikmeot community with ambulance service. Generally, health services provided in Cambridge Bay are described as comprehensive and accessible (C. Evalik, pers. comm.).

The second floor of the health centre was established to provide an in-patient care unit and a physiotherapy unit. Although funding has been approved for various full-time positions that would see the second floor of the health centre operational, in the fall of 2012, there were 33 positions that had not been filled primarily due to the lack of available staff housing. Currently, the health centre is staffed with 14 full-time employees and 11 casual employees (C. Evalik, pers. comm.).

Prior to establishing the birthing centre in Cambridge Bay (2010), all women residing in the Kitikmeot Region travelled to Yellowknife to give birth. The new birthing centre in Cambridge Bay uses community-trained mid-wives to perform births. As of September 2012, 26 births had been performed at the birthing centre since it opened. Currently, birthing services are available to women with low-risk pregnancies who reside in Cambridge Bay, while women with high-risk pregnancies and those residing in the other Kitikmeot communities continue to travel to Yellowknife to give birth. Once a boarding facility or residence is established, women from the other Kitikmeot communities will have the option to travel to Cambridge Bay to give birth. The birthing centre enables families to take part in the birth and provide continued support in the last month of pregnancy, which helps the family to bond (C. Evalik, pers. comm.).

7.3.2 Kugluktuk

The health centre in Kugluktuk has five community health nurses, one mental health counsellor, two social workers, one home care worker, three community heath representatives (CHRs), as well as clerical and janitorial staff. The health centre has an emergency room, holding room (obstetrical room), physician's office, four clinic rooms, a pharmacy, a dentist's office, and a CHR office. The health centre also provides X-ray services (M. Paul, pers. comm.). Recently, the home care worker has relocated outside the health centre due to lack of office space (Evalik 2012).

7.3.3 Gjoa Haven

Services at the Gjoa Haven health centre are provided by three community nurses, one head nurse, a community health representative, a mental health counsellor, two social workers, one homecare worker, two clerical staff, one travel clerk, one caretaker, and one janitor. The health centre has one emergency room, four exam rooms, and one paediatric room. The health centre would benefit from an additional nurse, as the number of staffed positions has not changed over the past seven years (E. Garneau, pers. comm.).

7.3.4 Taloyoak

The Taloyoak health centre has three community health nurses, one mental health counsellor, two social workers, one home care nurse, as well as clerical and janitorial staff. The facility includes an emergency room, three exam rooms, one combined use room (telehealth, X-ray, holding room, and CHR office), and two offices for mental health and social work. There are approximately 450 to 600 visits to the health centre per month. Health centre resources and equipment are described as adequate; however, the health centre is slated to be replaced with the new health centre for which plans have been drawn up (Back River Project Research Program 2012). As in Kugluktuk, the homecare worker has recently relocated outside the health centre due to lack of office space (Evalik 2012).

7.3.5 Kugaaruk

The Kugaaruk health centre has three community health nurses, six support staff, one CHR, one social worker, and one mental health counsellor. Facilities include one emergency room, two exam rooms, one holding room, one lab room, one X-ray room, and one dentist room. The lack of office space in the health centre is an ongoing problem (Evalik 2012). For example, the mental health worker operates from the holding room and CHRs use the dentist's office when the dentist is not in the community. The Kugaaruk health clinic is busy enough to employ another nurse as both population and demand have increased over time. In August 2012, there were 245 sick clinic visits, 17 prenatal clinic visits, 29 well child clinic visits, and 85 after-hours calls (R. Dugas, pers. comm.).

7.3.6 Women's Shelters

Women's shelters in both Cambridge Bay and Kugluktuk provide shelter for women and children who are victims of domestic violence (C. Hogaluk, pers. comm.). The Cambridge Bay women's shelter is operated by GN Health and Social Services department and is currently in need of funding. The shelter is for abused women and is continuously staffed (24/7) when there is a client there. Health providers in Cambridge Bay feel there is also a need for a men's shelter because men also experience abuse (C. Hogaluk, per. Comm. 2012).The Kugluktuk women's shelter has recently been repositioned as Kugluktuk Women's Crisis Centre; service providers note this may have discouraged victims as, prior to the conversion individuals would frequent the shelter for counselling and now believe they must be in a crisis situation to seek assistance (E. Fredlund, pers. comm.).

Although Kugaaruk does not have a women's shelter, a safe house is currently operating in an old trailer (previously an RCMP facility). The safe house provides food and shelter to victims of domestic violence. The absence of an official women's shelter in Kugaaruk is described as a pressing issue (Back River Project Research Program 2012). Federal funding has recently (fall 2012) been approved for renovation of a one bedroom house that will serve as a women's shelter. The approved funding includes an allocation for one full-time employee at the shelter (G. Deni and G. Holitzki pers. comm.).

Gjoa Haven does not have an emergency shelter; however, many service providers in the community noted a shelter was greatly needed for individuals who are homeless and those who are affected by domestic violence (S. Bucknor, pers. comm.).

Taloyoak has a building for emergency shelter, but the program is no longer operating. As such, in the event of a crisis situation related to domestic violence, the victim and her children are typically flown to a shelter outside the community for up to six weeks. Approximately 10 to 12 women are sent out of Taloyoak for this reason each year (Back River Project Research Program 2012).

7.3.7 Extended Care Facility in Gjoa Haven

The $10.6 million extended care facility in Gjoa Haven opened in November 2009. In the past, people requiring long-term care were sent to facilities outside of Nunavut. The facility has 13 full-time employees, including graduates of the Arctic College's home and continuing care program who speak both Inuktitut and Inuinnaqtun. A registered nurse oversees the 10-bed facility, which provides palliative, acute, and respite care (Northern News Services Online 2009). The extended care facility is currently at full capacity and fully staffed. The facility has been very successful, as Nunavut residents living in southern institutions have been repatriated (C. Evalik, pers. comm.).

7.3.8 Addictions Treatment Centre in Cambridge Bay

Funding for a 28-day residential (in-patient) treatment centre in Cambridge Bay was announced early in 2012 and was called the Mobile Addictions Treatment Pilot Program. The program will be operated through the wellness centre and will incorporate aftercare and family involvement in patient care. Plans to open the addictions treatment centre have since been delayed and are currently on hold (George 2012b).

7.3.9 Daycare Facilities

Cambridge Bay, Kugluktuk, and Gjoa Haven have daycare facilities that typically operate as non-profit organizations. The Cambridge Bay Daycare Society provides care between 8 a.m. and 5 p.m. and includes breakfast and lunch as well as morning and afternoon snacks, and recreation activities (e.g., swimming, gym time, and fieldtrip). Rates are approximately $40 per day or $25 per half day (Cambridge Bay Childcare Society 2013). Kakayak Daycare Society in Kugluktuk has incorporated the Aboriginal Head Start Program and provides bilingual care for children up to seven years of age with the possibility of evening space for childcare upon request (Kugluktuk Wellness Working Group 2011). Originally operated through the Gjoa Haven hamlet, the Nutarqanut Pairivik Daycare has struggled to maintain funding in recent years but is the only facility providing services to children less than five years of age. Daycare services are offered to children of all ages and have been supported by lunchtime fundraisers and donations of groceries from the Northern Store (Northern News Services Online 2008). Despite funding challenges that have at times resulted in interrupted daycare services in the community, the daycare was operational during community research conducted in winter 2012.

7.4 HEALTH PROGRAMS

7.4.1 Health Centres

In addition to providing medical services, the Kitikmeot health centres also provide access to mental health counsellors, social workers, home care, and a variety of community-based programs. There are a wide range of services available in health centres in the Kitikmeot communities. Programs offered through Kitikmeot health centres include the Canadian Pre-natal Program, chronic disease clinic, well women clinic, well man clinic, and well child clinic. Generally, all programs are well attended with the exception of the well man clinics. Men were reported to be more likely to attend the chronic disease clinic as opposed to a well man clinic. Health service providers noted the need for men to seek medical attention for prevention and early detection of disease (Back River Project Research Program 2012).

Table 7.4-1 below provides the annual number of visits to the health centre, as well as the annual number of Medevac transports per year in each of the Kitikmeot communities. A sick clinic is held every morning, Monday to Friday, while pre-natal care, well clinic, and chronic disease clinics are held one afternoon per week. Health service providers indicated that a majority of visits are concentrated in the winter months. Many service providers in the Kitikmeot Region also note a decrease in clients in the summer months and a subsequent increase in clients during the winter months. Many families leave the communities in the spring and summer to spend time on the land hunting and fishing (Back River Project Research Program 2012).

Table 7.4-1. Annual Health Centre Workload 2011/2012 (Monthly Average)

	Total Visits to Health Centre	Visits to Sick Clinic	Visits for Prenatal Care	Well Clinic Visits	Chronic Disease Visits	Medevac Transports
Cambridge Bay	7,179	5,880	363	203	394	78
Kugluktuk	6,382	5,321	276	221	149	78
Gjoa Haven	5,423	3,994	307	60	285	76
Taloyoak	5,838	4,879	169	36	43	57
Kugaaruk	4,225	2,786	280	61	43	36
Total	29,047	22,860	1,395	581	914	325

Source: Evalik (2012).

Typically, each community has a CHR who is responsible for health promotion and prevention through the delivery of educational health and wellness programming. Educational programs include nutrition, dental health, suicide prevention, diabetes, sexual health, and smoking cessation. Kitikmeot communities that have developed wellness programs also typically have an alcohol and drug counsellor who works with individuals suffering from addiction or substance abuse and who also promotes community awareness. The drug and alcohol counsellors work closely with wellness program coordinators, as well as community social and mental health workers, as discussed further in Section 7.5.3 (Back River Project Research Program 2012).

7.4.2 Home Care

Each community in the Kitikmeot Region employs an individual responsible for home care who provides support to the elderly, disabled, and people recovering from major surgery. As shown in Table 7.4-2, recent (2012) community health profiles indicate there are approximately 113 people receiving home care and seven people receiving palliative care in the Kitikmeot communities (Evalik 2012).

Table 7.4-2. Home Care Patients in Kitikmeot Communities (2012)

	Cambridge Bay	Kugluktuk	Gjoa Haven	Taloyoak	Kugaaruk	Region Total
Patients in Home Care	28	30	21	15	19	113
Palliative Patients	0	5	1	0	1	7

Source: Evalik (2012).

7.4.3 Social Work and Protective Services

Each community in the Kitikmeot Region employs at least one social worker who provides child and family services, as well as social services such as child and adult protection. Social workers also provide crisis intervention and support services, as well as family counselling to deal with issues related to family violence. Social workers work with a number of other individuals in the community, namely nurses, teachers, RCMP officers, the wellness coordinator, the justice worker, the mental health counsellor, and housing managers. Social workers are typically on-call 24 hours per day, seven days per week (Back River Project Research Program 2012).

While there are foster homes in some Kitikmeot communities, the demand for this service is reportedly greater than the resources available. Participants of the 2012 research program indicated it can be difficult to identify suitable foster homes in the community. It is not uncommon to have to send an apprehended child to foster or group homes outside of the child’s home community. Community social workers indicated there has been an increase of the acceptance of social workers as individuals providing support for families. The most prominent challenges faced by social workers include the lack of external facilities and support agencies (e.g., emergency shelter, in-patient addictions treatment programs). In southern communities, organizations external to a department of social work provide a great deal of support to social workers and their clients, whereas in the Kitikmeot Region, communities have a limited number of social workers tasked with providing or facilitating all services and accommodations required by clients.(Back River Project Research Program 2012).

Regionally, there were approximately 38 children in care; 15 children were in care outside the territory, and 39 adults were in care outside the territory in September 2012 (Table 7.4-3; Evalik 2012). Children and adults who require residential care (e.g., people who have behaviour issues, disabilities, or are incarcerated) are relocated outside the territory, as this level of care is not available in Kitikmeot communities. Cambridge Bay provides group homes for the region’s youth, as not all Kitikmeot communities have foster and group homes. Individuals that require residential care must be sent out of the territory. A typical active caseload in Kugluktuk is about 40 adults and 9 children/youth. In Taloyoak, a typical caseload includes 8 on-going cases and 40 to 60 walk-ins per month. In Kugaaruk, an average monthly caseload includes approximately 30 cases. In Gjoa Haven, the typical caseload is 23 ongoing cases (Back River Project Research Program 2012).

Table 7.4-3. Individuals in Care (September 2012)

	Cambridge Bay	Kugluktuk	Gjoa Haven	Taloyoak	Kugaaruk	Region Total
Children in Care	27	6	4	4	0	38
Children in Care Outside Territory	4	6	4	1	0	15
Adults in Care Outside Territory	6	12	13	2	6	39

Source: Evalik (2012).

7.4.4 Recreation Facilities and Programs

Community recreation facilities and programs are operated by the hamlets. Recreation coordinators are responsible for the delivery of recreation programs to meet the needs of the community residents, as well as the management of recreation facilities (i.e., ice arena and community hall). A list of the public recreation infrastructure in each Kitikmeot community is provided in Table 7.4-4. Infrastructure listed in Table 7.4-4 may or may not be in use. The recreational programs available vary by community in response to local demands, infrastructure, funding, and staff available to support the programs.

Table 7.4-4. Public Recreation Infrastructure in Kitikmeot Communities

Community	Public Buildings and Infrastructure	
Cambridge Bay	• Community hall • School gymnasiums and field/playground • Exercise facility • Pool (summer operation only) • Youth centre	• Elders' centre (Elders' Palace) • Basketball courts • Ballpark • Arena with ice and curling rinks
Kugluktuk	• Community hall • Cultural centre • School gymnasiums and field/playgrounds	• Basketball park • Ballpark • Arena with ice and curling rinks
Gjoa Haven	• Old community hall • New community hall, with assembly area, kitchen, and exercise room • School gymnasiums and field/playground • Elders' Palace	• Golf course • Ball park • Arena
Taloyoak	• Community hall • Elders' Palace • School gymnasium and field/playground	• Pool (summer operation only) • Arena with ice
Kugaaruk	• Hamlet gymnasium • School gymnasium and field/playground	• Arena

Source: Back River Project Research Program (2012).

7.5 COMMUNITY WELL-BEING

Factors that contribute to Inuit well-being include health status, environment, food security, housing and infrastructure, community and family, economy and governance, knowledge and learning, culture and language, health behaviours, and access to health services (Inuit Qaujisarvingat Knowedge Centre n.d.). Information for many of these components is presented elsewhere in this report. Specific information on acculturation, wellness programs, mental health and suicide, housing, and crime, as well as a measure of overall community well-being is detailed below.

7.5.1 Community Well-being Index

Well-being is a broad concept that approximates the overall wellness or quality of life in communities based on the complex interactions between existing social, economic, and cultural conditions. AANDC (formerly Indian and Northern Affairs Canada [INAC]) calculates an index of Community Well-being (CWB) based on four components: education, labour force, income, and housing. Although it is likely that additional components contribute to overall well-being, using these four components to estimate well-being is reasonable given what is known about the existing conditions in the communities and current data gaps. The CWB scores can then be used to compare well-being, at least as measured by the index, across Aboriginal and other Canadian communities and over time (INAC 2010a).

For 2006, the most recent data available, Nunavut had an overall CWB index score of 65.1, the lowest of all the Canadian provinces and territories. The next lowest score was Newfoundland and Labrador at 75.4, and the Province of Alberta had the highest score at 84.3; the NWT scored 79 (INAC 2010a).

Overall, the Kitikmeot communities also ranked low on the CWB index (Table 7.5-1). Taloyoak, Kugaaruk, and Gjoa Haven scored very low (53, 55, and 56, respectively). Kugluktuk scored near the average for Nunavut as a whole, while Cambridge Bay fared somewhat better at 73, although it was still below the scores of other Canadian provinces and territories.

Table 7.5-1. Community Well-being Index for Kitikmeot Communities, 2006

Community	Income Score	Education Score	Housing Score	Labour Force Activity Score	CWB Score
Cambridge Bay	85	43	80	85	73
Kugluktuk	75	33	75	75	64
Gjoa Haven	67	26	59	74	56
Taloyoak	62	27	54	70	53
Kugaaruk	61	29	52	75	55

Source: INAC (2010a).

A review of trends in the well-being of Inuit in Canada concluded that, on average, Inuit CWB scores were 15 points lower as compared to non-Aboriginal communities in 2006. There were 34 Inuit communities among the “bottom 500” Canadian communities, and no Inuit communities ranked among the “top 500” Canadian communities. The review noted a decrease in the gap between Inuit and non-Aboriginal communities between 1981 and 1991; however, between 2001 and 2006 the gap widened. Of the four components analyzed, the largest gap between Inuit and non-Aboriginal communities was in housing (AANDC n.d.).

7.5.2 Acculturation

Prior to the 1950s, most Inuit lived on the land in extended family groups, following the migration of wildlife across the Arctic. During this time men and women had very specific roles as hunters and care-givers that were tied to the land and linked to a way of life based on survival in harsh conditions. During the 1950s, the Canadian government actively encouraged Inuit to settle in permanent communities and provided low cost housing, medical facilities, and modern services. Traditional land use activities still persist (Section 9), but the change from a traditional subsistence-based economy to a wage economy has disrupted Inuit life and, in a number of ways, negatively affected Inuit well-being. The effect of residential schools on Inuit includes disconnect from familial, communal, and socio-cultural connections and has disrupted the inter-generational exchange of knowledge, cultural values, parenting skills, and language that forms the basis of Inuit identity. The trauma of residential schools and disruption to the exchange of knowledge and culture continues to affect Inuit health and mental well-being today (Inuit Tapiriit Kanatami 2007).

7.5.3 Wellness Programs

Each Kitikmeot Region hamlet operates a wellness centre and administers programs aimed at promoting healthy living habits and the development of community. These programs also work closely with health care, social services, and the RCMP. Wellness programs aim to take a holistic approach to improving the health and well-being of community members. Community wellness programs have been implemented that include the following (DHSS 2006).

- *Pre-natal care* – administered under the federally funded Canadian Pre-natal Program, this program provides instruction in nutrition, cooking, sewing, and the use of country foods.
- *Aboriginal head start* – a pre-school program developed by the Government of Canada to promote child health by supporting children's physical, personal, and social development (Public Health Agency of Canada 2011). The focus of the program is on early intervention covering a number of components, including education, health promotion, culture and language, nutrition, social support, and parental involvement.
- *Children* – administered under the Canada Action Program for Children, this program is focused on providing food and education services. Other program services include arts and crafts, story time, and moms and tots drop-in sessions.
- *Youth* – this program typically involves operation of a youth centre, which provides structured activities, such as sports, games, and movie nights, to present youth with options and a place to go outside of the home environment.
- *Elders* – this program typically involves group activities at an Elders' Palace (a centre for Elders) and the operation of Health Foods North (food delivery to the home).
- *Family violence* – this initiative includes emergency shelter services for women and children and the delivery of support programs.
- *Alcohol, gambling, and drug additions* – locally, programs consist of counselling services and public education and awareness campaigns, which may include Alcoholics Anonymous and Alateen programs (i.e., weekly discussion group for teens with abuse in the family due to alcohol abuse).

Community wellness centres typically employ a drug and alcohol counsellor who works closely with the RCMP, community nurses, mental health counsellors, social workers, and family members. This person also organizes activities for suicide prevention, such as the Embrace Life Walk. The majority of individuals who seek assistance through the wellness centres are women (Back River Project Research Program 2012). As an example of case load, the drug and alcohol counsellor in Kugluktuk sees approximately 120 to 150 clients per month, most of whom, in the case of this community, are males between the ages of 25 and 35 (C. Lee, pers. comm.).

The wellness centre in Cambridge Bay is well developed and provides many of the secondary health programs provided through health centres in the other Kitikmeot communities. In Cambridge Bay, the wellness centre facilitates a food bank, clothing program, Resolution Health Support Program (which supports residential school survivors), Family Violence Prevention Program, Youth Outreach Program, Canadian Pre-natal Program, as well as a cultural support program for Elders. The wellness centre has a breakfast program and bathroom, shower, and laundry facilities available to those in need. The Cambridge Bay Wellness Centre is described as well-resourced and has a director and 10 employees (C. Hogaluk, pers. comm.).

The wellness centre in Kugluktuk operates through a coordinator who works from the Hamlet offices. In addition to offering the programs discussed above, the Kugluktuk Wellness Centre coordinates with the department of justice, on crime prevention and victim services, and the women's shelter, to assist victims of domestic violence to seek and receive assistance. The newly introduced Early Childhood Intervention Program seeks to identify developmental delays at an early age to provide appropriate assistance to developmentally delayed children at an earlier stage in their education (E. Fredlund, pers. comm.). The hamlet of Gjoa Haven has recently (October 2012) hired a community wellness coordinator who will oversee the alcohol and drug program (Evalik 2012).

In all communities, health and wellness program coordinators indicated that fall and winter are typically the busiest times, with a higher number of clients accessing programs and services, whereas during the spring and summer there are less people accessing services, as many residents are out on the land (Back River Project Research Program 2012).

Most drug and alcohol counsellors reported that drug and alcohol use in communities is increasing. The level of commitment from community service providers (e.g., social work and mental health) who do not intend to stay in the community for a longer term is reportedly lacking. This results in a lack of trust between clients and service providers and ultimately leads to a discontinuity of service (S. Bucknor, pers. comm.).

7.5.4 Mental Health and Suicide

7.5.4.1 Mental Health Care

Each of the Kitikmeot communities has a mental health counsellor who develops mental health plans for individuals with diagnosed conditions and helps ensure patients' conditions are managed. The mental health counsellor works with the RCMP, nurses, social workers, drug and alcohol counsellors, community justice workers and wellness coordinators. Mental health workers provide services in conjunction with a psychiatrist who prescribes treatments, provides continual support and guidance to the mental health counsellor, and visits the community twice a year to review files and see patients. Mental health counsellors are responsible for the overall ongoing care of psychiatric patients, including making home visits to ensure compliance to treatment and medication (Back River Project Research Program 2012).

One of the main challenges associated with mental health and counselling services has been the ability to develop trusting relationships between the counsellor and patient, as there has been high staff turnover in this position in the past. A portion of clients seen by mental health counsellors seek service as a result of substance abuse and domestic violence. Mental health counsellors throughout the region link increases in substance abuse to increases in domestic violence. A separate segment of mental health patients include individuals damaged by residential schools. The majority of mental health patients in the Kitikmeot Region are women, with the exception of Gjoa Haven. Counsellors believe there continues to be a stigma associated with seeking assistance for mental health issues, particularly among men (J. Glasgow, pers. comm.). Several health service providers mentioned mental health as one of the main issues affecting the community. Specifically, health service providers noted a higher than average incidence of schizophrenia in the Kitikmeot communities (Back River Project Research Program 2012).

Mental health counsellors are called upon when the RCMP apprehends individuals who are suffering from addiction or other issues and are suicidal. In Gjoa Haven, the mental health counsellor assists the RCMP approximately seven to eight times per month (S. Bucknor, pers. comm.). Mental health counsellors may also become involved in situations in which Elders' abuse necessitates the removal of a family member from the home through the enforcement of a protective order (D. Cameron, pers. comm.). Lastly, if a mental health counsellor is unable to effectively treat someone because of the severity of the illness or other reasons, the individual may be sent to a southern institution to receive treatment (Back River Project Research Program 2012).

In addition to regular responsibilities, the mental health counsellor in Kugluktuk holds stress management counselling groups to address the lack of coping skills among people who attempt suicide. Mental health counsellors have provided suicide prevention workshops in health centres and community schools, which have been described as very successful (Back River Project Research Program 2012).

Mental health counsellors in a number of communities link mental health issues to housing circumstances, stating that individuals residing in overcrowded homes are more likely to have negative experiences such as stress, depression, anxiety, and panic attacks, which may result in contact with mental health counsellors, social workers, or the RCMP (R. Bilta, pers. comm.; Back River Project Research Program 2012). Overall, mental health in the Kitikmeot communities is described as improving (Back River Project Research Program 2012).

7.5.4.2 Suicide

Suicide is a prominent social issue and health concern in Nunavut communities. The number of deaths by suicide and the degree of suicide-related trauma are higher in Nunavut than in other Canadian jurisdictions. In 2009, the RCMP responded to approximately 983 calls where persons were threatening or attempting suicide in Nunavut (GN et al. 2010). In a recent survey, 43.6% of respondents reported suicide ideation (i.e., thoughts of committing suicide) over the course of a week and 30% reported attempting suicide over a six-month period, 16% on multiple occasions (Table 7.5-2; Haggarty et al. 2008). Suicide-related deaths are highest among young Inuit males (GN et al. 2010).

Table 7.5-2. Nunavut-wide Rates of Suicide Ideation and Suicide Attempts

Suicide Ideation (Past Week)	Share of Respondents (%)	Suicide Attempt (Six Past Months)	Share of Respondents (%)
None	56.4%	Never	70%
Sometimes	40.0%	Once	14%
Very often	3.6%	Several	13%
All the time	0.0%	Many	3%

Source: Haggerty et al. (2008).

Kugluktuk has a particularly high annual suicide rate (190 per 100,000 population; 22 suicides from 1999 to 2008), followed distantly by the other communities (Table 7.5-3). Although reporting the same number of suicides from 1999 to 2008 as Kugaaruk and Taloyoak (five suicides), Gjoa Haven has the lowest annual average suicide rate (52 per 100,000 population; Hicks 2009). For purposes of comparison, the average annual suicide rate for all of Canada from 2000 to 2007 was 9.5 per 100,000 population, which is significantly lower than the rate for any Kitikmeot community (Statistics Canada 2013a).

Table 7.5-3. Suicides in Kitikmeot Communities, 1999 to 2008

Community	Total Number of Suicides[1]	Average Annual Rate (per 100,000 population)[2]
Kugluktuk	22	190
Cambridge Bay	7	65
Gjoa Haven	5	55
Kugaaruk	5	80
Taloyoak	5	70

Source: Hicks (2009).
[1]*Values estimated from original graphic source and rounded to nearest one.*
[2]*Values estimated from original graphic source and rounded to nearest five.*

Comparatively over time, the Kitikmeot Region had the lowest number of suicides in Nunavut in 2008 and 2009 (Table 7.5-4). There were 33 suicides recorded in Nunavut in 2011 and 7 of those occurred in the Kitikmeot communities, concentrated in Cambridge Bay and Kugaaruk (CBC News 2012a; Evalik 2012).

Table 7.5-4. Number of Suicides in Nunavut, 2000 to 2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Kitikmeot Region	4	2	1	5	4	3	9	7	4	3
Baffin Region	15	19	19	26	22	16	16	9	20	19
Kivalliq Region	7	7	5	6	1	5	4	6	5	5
Nunavut Total	26	28	25	37	27	24	29	22	29	27

Source: GN Department of Economic Development and Transportation (2012).

Suicide is a multifaceted issue in Nunavut, with high rates attributed to recent and rapidly occurring social change, which has led to a general sense of discontinuity and a loss of self-reliance among Nunavummiut. The GN has identified the following factors contributing to risk of suicide: personal characteristics of depression, deficits in problem-solving skills, and substance abuse; situational factors of living in a troubled family, physical or sexual abuse, loss of a parent or caregiver, and exposure to suicidal acts of family or friends; social network, including loss of relationships, isolation, and inter-personal problems; and socio-cultural factors of poverty, social disorganization, and loss of tradition. Factors reducing suicide risk include having a stable home life, being educated, being employed, and receiving mental health care as required (GN et al. 2010).

The GN, NTI, the Embrace Life Council, and the RCMP have partnered to develop the Nunavut Suicide Prevention Strategy. Commitments under this strategy include: 1) a more focused and active approach to suicide prevention; 2) improved provision of mental health services; 3) better equipping youth to cope with adverse life events and negative emotions; 4) delivering suicide intervention training; 5) supporting research to better understand suicide in Nunavut and the effectiveness of suicide prevention strategies; 6) communicating and sharing information with Nunavummiut; 7) fostering opportunities for healthy development in early childhood; and 8) support for communities to engage in community development activities (GN et al. 2010).

Overall, the strategies are aimed at increasing the participation of youth and families in projects and activities that promote mental health, increase community awareness and knowledge of healthy behaviours, increase community level of ownership and capacity to identify and address issues, and improve public service provision. In addition, governments are also undertaking initiatives guided by *Inuit Qaujimajatuqangit,*[6] to improve mental wellness and address some of the causes of social discontinuity at the community level; the initiatives include on-the-land camps for youth, sport and recreation activities, substance abuse information programs, development of community wellness plans, and provision of wellness worker training (GN et al. 2011).

Following the release of the Nunavut Suicide Prevention Strategy, the GN, NTI, Embrace Life Council, and the RCMP formed the Nunavut Suicide Prevention Implementation Committee with the objective of establishing guidelines that outline the actions required to implement the strategy. The Nunavut Suicide Prevention Strategy Action Plan (September 2011 to March 2014) commits the Implementation Committee to ongoing evaluation and monitoring of the Strategy's goals and objectives over the three-year implementation period. The action plan identifies a partner or other stakeholder to undertake specified actions or task to meet each objective listed in the strategy (GN et al. 2011).

[6] *Inuit Qaujimajatuqangit* is "[t]he traditional, current, and evolving body of Inuit values, beliefs, experience, perceptions, and knowledge regarding the environment, including land, water, wildlife and people, to the extent that people are part of the environment" (Qikiqtani Inuit Association 2009).

Since the NSPS was established, the GN has also announced further financial support of the Embrace Life Council, additional trainers to provide suicide prevention workshops, as well as the addition of a suicide prevention specialist to be employed in the mental health and wellness division to provide ongoing support and direction to the Department of Health and Social Services (GN 2012).

7.5.5 Housing

The availability of suitable housing is an important issue for all Kitikmeot communities and "the overcrowding of housing is a clear non-medical health indicator for Inuit" (Inuit Tapiriit Kanatami 2007). Insufficient availability of quality housing leads to a number of health-related challenges in Inuit communities, including family violence, depression, stress, and a higher incidence of infectious diseases (Inuit Tapiriit Kanatami 2007; NTI 2008). Community-based research indicates that individuals in the Kitikmeot Region who are part of a nuclear family residing with the nuclear unit of extended family members consider themselves homeless (Back River Project Research Program 2012).

A large number of dwellings in the Kitikmeot Region are crowded according to the National Occupancy Standard (Table 7.5-5). These rates are slightly higher than in Nunavut as a whole, where approximately 35% of dwellings are overcrowded. The problem is particularly prevalent in the eastern Kitikmeot communities of Taloyoak, Gjoa Haven, and Kugaaruk, where approximately 57, 56, and 50% of dwellings are crowded, respectively. Kugluktuk has the lowest percentage of crowded dwellings (34%), slightly below Cambridge Bay (35%).

Recent census data further highlights overcrowded conditions in the Kitikmeot communities. In the eastern Kitikmeot communities of Gjoa Haven, Taloyoak, and Kugaaruk, more than 50% of households have four or more persons per home and approximately 20% are two-or-more family households. Approximately 46% of households in Kugluktuk and 38% of households in Cambridge Bay have four or more persons per household (Table 7.5-6; Statistics Canada 2012b). Overall, there are more households in the Kitikmeot Region with four or more persons (52%) as compared to the territorial average (47%), and there is also has a higher percentage of two-or-more family households (13%) as compared to the territorial average (10%; Statistics Canada 2012b).

Total dwelling counts in the Kitikmeot range from approximately 170 in Kugaaruk to 540 in Cambridge Bay (Table 7.5-7). The vast majority of these are occupied by residents, with only 4 to 17% either occupied by temporary residents or unoccupied. The most common types of dwellings are single detached houses (59%) and row houses with three or more units (28%). The majority of dwellings are rented—approximately three out of every four dwellings across the region. Rented housing includes public housing, government staff housing (GN and Government of Canada), non-government employer-provided staff housing, and private market rental units. Public housing units are subsidized rented dwellings under the Nunavut Housing Corporation (NHC) and are available to Nunavummiut who meet certain eligibility requirements. Private market rental units are owned by private individuals, corporations, or other organizations and are made available on the rental market (Nunavut Bureau of Statistics 2011a).

Public housing is the most common type of housing tenure in the region (Table 7.5-8). Cambridge Bay has a slightly lower percentage of public housing (49%) than the other communities (ranging from 64 to 77%). Prevalence of owner-occupied dwellings ranges from approximately 13% in Taloyoak to 30% in Cambridge Bay. Staff housing and private market rental units form less substantial proportions of available housing in the communities (Table 7.5-8). Gjoa Haven, which had 40 owner-occupied dwellings in 2009/2010, experienced a number of foreclosures and evictions in 2011 (C. Cahill, pers. comm.). Figure 7.5-1 provides a summary of housing tenure by type in the Kitikmeot Region.

Table 7.5-5. Dwellings Occupied by Usual Residents Classified as Crowded (2009/2010)

Community	Crowded Dwellings		Crowded Dwellings Regularly Using the Living Room as a Sleeping Area	
	Number	Proportion of Total	Number	Proportion of Total
Cambridge Bay	170	35%	80[E]	17%
Kugluktuk	130	34%	50	13%
Gjoa Haven	130	57%	70	30%
Taloyoak	100	56%	50	28%
Kugaaruk	70	50%	30	20%
Kitikmeot Region	610	43%	280	20%
Nunavut	**2,930**	**35%**	**1,470**	**18%**

Note: a dwelling is classified as crowded if there is a shortfall of bedrooms based on the National Occupancy Standard.
[E] *= estimated.*
Source: Nunavut Bureau of Statistics (2011a).

Table 7.5-6. Housing in Kitikmeot Communities (Census 2011)

	Total Number Private Dwellings	Total Number of Persons in Private Households	Household Size						Two-or-More Family Households
			I Person	2 Persons	3 Persons	4 Persons	5 Persons	6 or More Persons	
Cambridge Bay	505	1,590	110	125	85	80	55	55	35
Kugluktuk	400	1,440	70	75	75	70	40	75	40
Gjoa Haven	275	1,280	30	20	40	40	45	100	50
Taloyoak	205	895	25	25	30	30	30	65	40
Kugaaruk	155	770	10	15	15	35	20	65	30
Kitikmeot	1,540	5,980	240	255	245	250	190	355	195
Nunavut	8,660	31,700	1,575	1,590	1,380	1,360	1,095	1,655	920

Source: Statistics Canada (2012b).

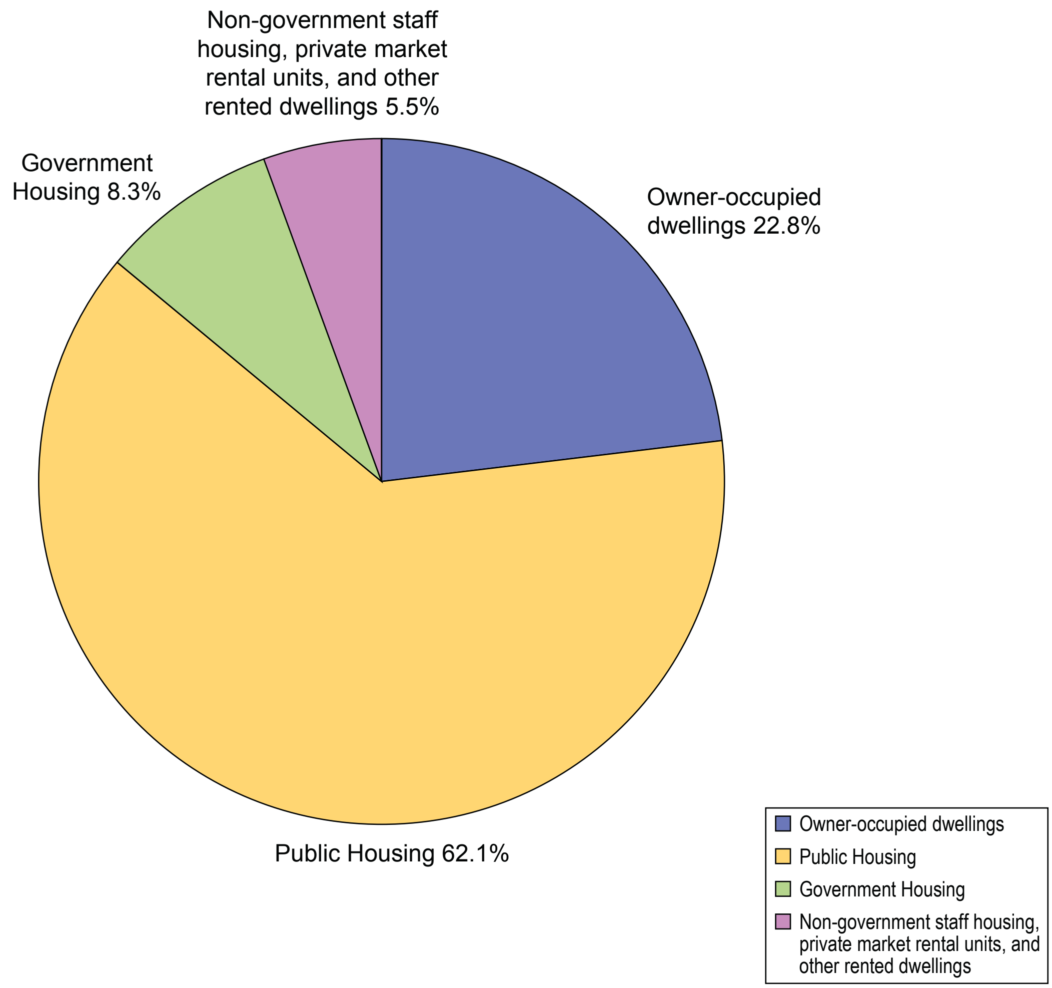

Figure 7.5-1

Housing Tenure by Type, Kitikmeot Region, 2009 to 2010

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Table 7.5-7. Housing Infrastructure by Community (2009/2010)

Community	Total Dwellings[1]		Dwellings Occupied by Usual Residents[2]		Dwellings Occupied Solely by Temporary Residents or Unoccupied Dwellings[3]	
	Number	Proportion	Number	Proportion	Number	Proportion
Cambridge Bay	540	100%	480	90%	60	10%
Kugluktuk	430	100%	400	93%	30	7%
Gjoa Haven	230	100%	230	96%	10	4%
Taloyoak	220	100%	190	83%	40	17%
Kugaaruk	170	100%	150	87%	20	13%
Kitikmeot Region	1,600	100%	1,450	90%	150	10%
Nunavut	**9,400**	**100%**	**8,550**	**91%**	**850**	**9%**

[1] The total number of dwellings excludes collective dwellings that are used for commercial, institutional, or communal purposes (e.g., hotels, hospitals, work camps, etc.).
[2] Defined as a dwelling in which a person or a group of persons are permanently residing, or a dwelling in which the residents have no usual home elsewhere.
[3] Defined as a dwelling in which all occupants have a usual place of residence elsewhere or a dwelling in which no usual, temporary, or foreign resident is living at the time of the survey.
Source: Nunavut Bureau of Statistics (2011a).

Table 7.5-8. Housing Tenure by Community (2009/2010)

Community	Total Dwellings Occupied by Usual Residents	Owner-occupied Dwellings		Rented Dwellings: Public Housing		Rented Dwellings: Government Staff Housing		Rented Dwellings: Non-government Staff Housing and Private Market Rental Units	
		Number	Proportion	Number	Proportion	Number	Proportion	Number	Proportion
Cambridge Bay	480	140	30%	230	49%	70[E]	15%[E]	n/a	n/a
Kugluktuk	400	90	22%	250	64%	30	8%	20[E]	6%[E]
Gjoa Haven	230	40	18%	170	75%	10	4%	10	3%
Taloyoak	190	20	13%	140	77%	10	5%	10	6%
Kugaaruk	150	30	22%	100	69%	0	2%	10	7%
Kitikmeot Region	1,450	330	23%	900	63%	120	9%	80[E]	5%[E]
Nunavut	**8,550**	**1,880**	**22%**	**4,400**	**52%**	**1,350**	**16%**	**830**	**10%**

[E] = number estimated.
n/a = number considered unreliable.
Source: Nunavut Bureau of Statistics (2011a).

Even though public housing is common, it is in high demand; there is currently a shortage of public housing with relatively large waiting lists for applicants (Table 7.5-9). Again, the issue is more prevalent in the eastern Kitikmeot communities where the percentage of the population (15 years old or older) on the waiting list for public housing ranges from approximately 23% in Kugaaruk to a high of 33% in Taloyoak (Table 7.5-9). In contrast, only about 12% of the population in Cambridge Bay is on a waiting list.

The populations of the Kitikmeot communities are expected to continue to grow (Section 3.1). Based on the projected growth, in conjunction with the current challenges of overcrowding and long waiting lists for public housing, there will be an additional need for new housing units. As part of the development of community plans for the hamlets, new housing units needs have been estimated for each community (Table 7.5-10). Projected housing needs range from approximately 100 additional units in both Gjoa Haven and Kugluktuk by 2020 to an additional 325 units in Cambridge Bay by 2026. Taloyoak and Kugaaruk also require a significant number of additional units, approximately 216 by 2030 and 170 by 2028, respectively. In addition, these estimates are likely conservative, as the community population growth estimates on which these housing needs were based are out-dated and are generally lower than more recent growth estimates (see Section 3.1).

Table 7.5-9. Number of Applicants Waiting for Social Housing (2009/2010)

Community	Total Population 15+	Population 15+ on Waiting List for Public Housing	
		Number	% of Total
Cambridge Bay	1,330	150[E]	12%
Kugluktuk	1,030	170	19%
Gjoa Haven	720	160	25%
Taloyoak	540	170	33%
Kugaaruk	460	100	23%
Kitikmeot Region	4,090	760	20%
Nunavut	**22,780**	**3,780**	**18%**

[E] = *estimated.*
Source: Nunavut Bureau of Statistics (2011a).

Table 7.5-10. Projected Housing Needs by Community

Community	Projected Housing Need (Number of Units)	By the Year	Source
Cambridge Bay	325	2026	Municipality of Cambridge Bay (2007)
Kugluktuk	100	2020	Hamlet of Kugluktuk (2007)
Gjoa Haven	100	2020	Hamlet of Gjoa Haven (2008)
Taloyoak	216	2030	Hamlet of Taloyoak (2009)
Kugaaruk	170	2028	Hamlet of Kugaaruk (2009)

Source: Nunavut Bureau of Statistics (2011a).

In 2004, a 10-year action plan was developed to address housing needs. The action plan notes that private sector housing development is hindered in Nunavut due to the climate, geography, small population base, isolation, underdeveloped infrastructure systems, and high cost of building; consequently, the creation of an adequate housing supply is dependent on public sector involvement (NHC and NTI 2004). In 2004, the action plan identified the immediate need for approximately 3,000 new housing units and the renovation of an additional 1,000 units across Nunavut to raise the housing standards to the level found elsewhere in Canada. With forecasted growth to 2016, it was estimated that an average of about 275 new units would need to be constructed in Nunavut each year to keep pace with the change in population and avoid further crowding; in total, it was estimated that approximately 500 housing units would need to be renovated and constructed each year to address the existing core housing need and accommodate future growth (Bayswater Consulting Group 2004).

The NHC is responsible for public and GN staff housing units. The NHC's annual budget increased from approximately $138 million in 2009/2010 to $151 million in 2010/2011; the budget increase was primarily for the addition of new public housing units in Nunavut (NHC 2011). There are two programs under which new housing is being constructed: the Nunavut Housing Trust and Canada's Economic Action Plan. The federal government provided $200 million for the Nunavut Housing Trust, which was created in 2006 to build new affordable housing for Nunavummiut. The project will wrap up in spring 2013 as construction of the last 19 units is completed (NHC 2006). The Canadian Mortgage and Housing

Corporation entered into an agreement with the NHC under Canada's Economic Action Plan to construct 285 units; as last reported, 5 of the 285 housing units have been completed (NHC 2011).

7.5.5.1 Housing Issues and Challenges

Despite the clear need for additional housing units in the Kitikmeot communities, construction of new units has not kept up with demand.[7] A notable portion of individuals currently waiting for housing have applied for bachelor or one bedroom units; however, the available housing stock consists mainly of two and three bedroom single detached units or row houses (J. Peckham, pers. comm.).

Public housing in Nunavut is highly subsidized by the GN and is linked to social assistance and employment. Individuals who are unemployed are eligible for social assistance and housing for a nominal monthly rent. However, for those who are employed, the housing subsidy is scaled back according to household income, meaning that the cost of rent for public housing increases considerably in comparison. This can create a disincentive for employment (e.g., in interviews, the comment was made a number of times that employees have been known to refuse wage increases because it would result in an increase in the housing rent that they paid; Back River Project Research Program 2012). GN employees receive subsidized housing units as part of their employment contacts. In a recent attempt to transition GN employees residing in subsidized housing units in Iqaluit to rent-to-own or home ownership situations, many employees ended up leaving the territory (NHC 2012).

In a recent report, the NHC (NHC 2012) indicates that the corporation would like to step away from the current system of housing subsidy (in which 60% of Nunavummiut reside in subsidized housing and the majority of remaining 40% reside in subsidized GN employee units). Going forward, the NHC intends to establish more housing and work with the GN to:

- ensure that land is planned, zoned, and supported by the appropriate infrastructure and made available for construction;
- improve housing affordability by reducing costs; and
- increase housing investment from within the GN, from birthright organizations, as well as from private and non-profit sectors.

These measures are meant to change the Nunavut housing market and motivate those in subsidized employee and social housing units to use GN programs and move towards rent-to-own or home ownership situations (NHC 2012).

7.5.6 Utilities and Communications Services

In the Kitikmeot communities, water and sewer services are provided by the hamlet and include water delivery and sewage pump-out by truck. In addition to trucked water and sewer services, Cambridge Bay has a "utilidor" system connecting a few municipal buildings. The system runs above ground to transport water and sewage (GN Department of Health and Social Services n.d.). Qulliq Energy Corporation (QEC) provides electricity to all communities in Nunavut. Electricity needs are met by imported fossil fuel supplies distributed through an independent electricity generation and distribution system in each community (Quilliq Energy Corporation 2008).

[7] In Cambridge Bay, seven three-bedroom household units were constructed in 2011 and no new units were constructed in 2012. In Kugluktuk, eight units were constructed in 2011 and none were constructed in 2012. In Gjoa Haven, seven households and one five-plex were constructed in 2011 and two five-plex's and one household were constructed in 2012.

Communication services in the Kitikmeot Region include internet and phone services; both are provided via satellite. High-speed internet services are available in all Kitikmeot communities through Qiniq, Netkaster, and NorthwesTel. Qiniq is an Inuit-owned service provider offering wireless broadband internet via satellite in 25 Nunavut communities. Qiniq and NorthwesTel both introduced improved broadband internet services in early 2013. NorthwesTel now provides DSL services in Cambridge Bay (Nunatsiaq News 2013) while Qiniq introduced two new service options that include download speeds equal to that of DSL services in all Nunavut communities (Qiniq 2013).

7.5.7 Crime and Law Enforcement

Total numbers of police-reported incidences of crime are highest in Cambridge Bay, which also has the highest overall crime rate (Table 7.5-11; Figure 7.5-2). Non-violent crimes (e.g., breaking and entering, possession of stolen property, theft, and fraud) have the highest rate among all types of crime, with Cambridge Bay again having the highest rate, followed by Kugluktuk and Gjoa Haven. The rate of violent crime (e.g., homicide, attempted murder, assault, sexual assault, and robbery) is also greatest in Cambridge Bay and Kugluktuk, followed closely by Gjoa Haven. Comparatively, crime rates were substantially lower in Kugaaruk and, to a lesser extent, Taloyoak (Nunavut Bureau of Statistics 2010b).

Table 7.5-11. Police Calls for Service and Prisoner Count, 2010 to 2012

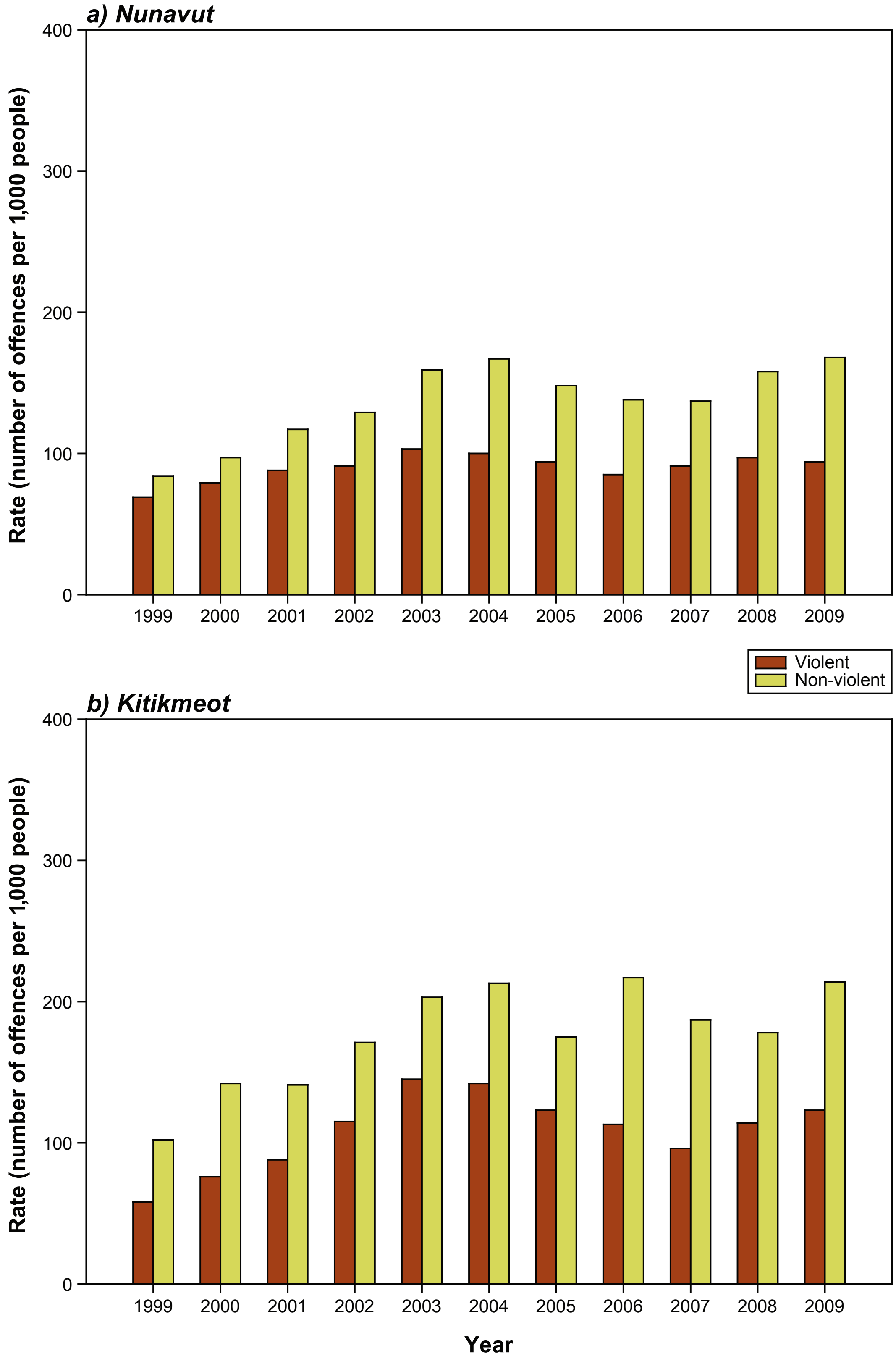
	Calls for Service (Number of Calls)			Prisoner Count (Number of Admissions)		
Community	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
Cambridge Bay	1408	1541	1718	842	892	894
Kugluktuk	804	1010	1180	289	378	414
Gjoa Haven	426	444	576	166	146	251
Taloyoak	394	540	450	146	147	151
Kugaaruk	76	192	217	17	30	29

Source: G. Elliot, pers. comm.

Violent and non-violent crime rates generally increased from 1999 to 2011 across the Kitikmeot Region, peaking in 2003 and 2004 and then declining (Figure 7.5-2). The notable exceptions were the 2008 and 2009 increase in violent crime and the persistence of a relatively high rate of non-violent crime in Cambridge Bay (Figure 7.5-3), the sharp increase in violent crime in Gjoa Haven in 2009, the sharp increase in violent crime in Taloyoak in 2011 (Table 7.5-11), and the increase in the non-violent crime rate in Gjoa Haven. Over time, Kugaaruk stands out as consistently having the lowest rates of violent and non-violent crime within the Kitikmeot Region (RCMP 2012b).

The number of calls for service (Table 7.5-11) is also an important indicator of the level of demand on policing services in each community, as a call for service may not necessarily result in a police-reported incidence of crime (Table 7.5-12). For each community in the Kitikmeot Region, the number of calls for service has increased between 2010 and 2012, most notably in Kugaaruk where the increase was approximately 186% over the two years. The overall increase over that period was lowest in Taloyoak (14%, although there was a 37% increase from 2010 to 2011), followed by Cambridge Bay (22%), Gjoa Haven (35%), and Kugluktuk (47%).

Prisoner counts (number of admissions or arrests) have also increased from 2010 to 2012 in each community (Table 6.5-12). However, the increase has been small in Taloyoak (3%) and Cambridge Bay (6%), despite relatively larger increases in calls for service in those communities. The increase in prisoner counts has been much more substantial in Kugluktuk (43%), Gjoa Haven (51%), and Kugaaruk (71%), and is more reflective of the increase in calls for service (Table 7.5-12).



Source: Nunavut Bureau of Statistics 2010e

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Violent and Non-violent Crime Rates in the Kitikmeot Region and Nunavut

Figure 7.5-2

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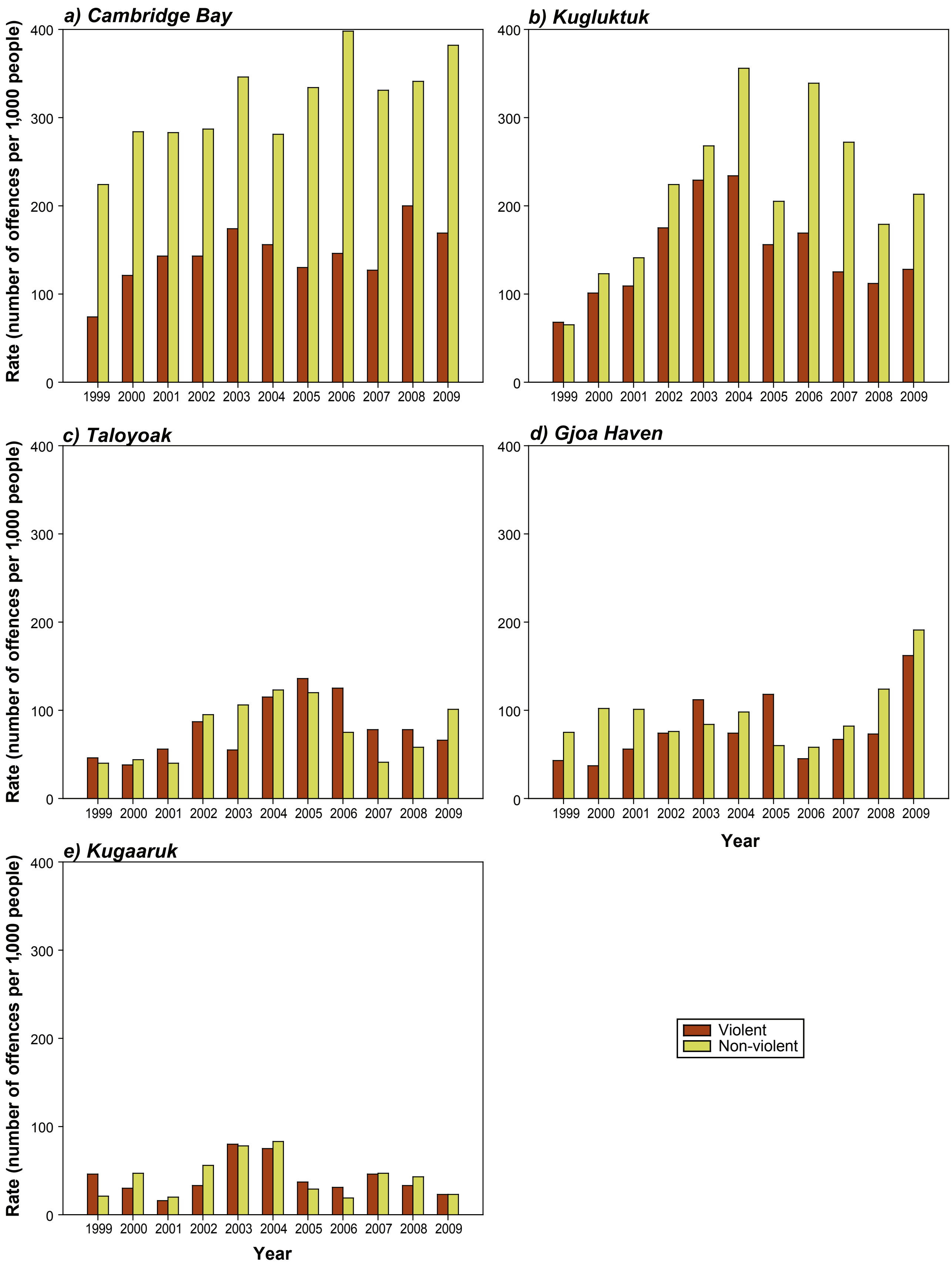

Source: Nunavut Bureau of Statistics 2010e

Figure 7.5-3

Violent and Non-violent Crime Rates in Kitikmeot Communities

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Table 7.5-12. Police-reported Incidents by Type of Offence, 2011

Community	Criminal Code Offences								Federal Statues		Total Violations	
	Violent Crime		Non-violent Crime		Other Violations		Traffic					
	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Cambridge Bay	228	0.13	461	0.27	235	0.14	23	0.01	20	0.01	947	0.56
Kugluktuk	189	0.13	268	0.18	121	0.08	8	0.006	13	0.009	586	0.4
Gjoa Haven	78	0.07	118	0.1	74	0.06	4	0.003	6	0.005	274	0.24
Taloyoak	146	0.17	77	0.09	80	0.09	6	0.007	12	0.01	309	0.35
Kugaaruk	20	0.03	28	0.04	8	0.01	0	0.0	9	0.01	56	0.08
Kitikmeot Region	661	0.11	952	0.16	518	0.09	41	0.007	60	0.01	2,172	0.37
Nunavut	**3,328**	**0.1**	**5,604**	**0.17**	**4,017**	**0.12**	**238**	**0.007**	**469**	**0.01**	**13,229**	**0.4**

Notes: rate is the number of offences per 1,000 people, based on 2009 population estimates in police jurisdictions. Violent crime involves the use or threatened use of violence against a person, and includes homicide, attempted murder, assault, sexual assault, and robbery. Non-violent crime includes unlawful acts against property, such as breaking and entering, possession of stolen property, theft, and fraud. Other violations include mischief, bail violations, disturbing the peace, arson, prostitution, and offensive weapons. Traffic offences include the dangerous or impaired operation of a motor vehicle and driving a motor vehicle while prohibited to do so. Federal statues include drug-related offences.
Source: Nunavut Bureau of Statistics (2012e).

RCMP in the Kitikmeot Region provide basic policing services and, when possible, hold educational sessions that aim to reduce substance abuse. The RCMP also participate in the Junior Rangers program and facilitate the Aboriginal Shield Program, which is a youth-driven program that provides substance abuse prevention and healthy lifestyles coaching to Aboriginal communities (Back River Project Research Program 2012; RCMP 2012a). The RCMP also deliver the Drug Abuse Resistance Program in certain Kitikmeot communities and plan to offer the program in additional communities in 2013 (Back River Project Research Program 2012). The RCMP are also responsible for issuance of driver's licences; commissioning of oaths; and provide emergency transportation, in lieu of an ambulance, when needed (L. Morrison, pers. comm.).

RCMP in the Kitikmeot Region characterize the majority of crime in the communities as related to substance abuse and violence, while property crime and vehicles theft are also common. The RCMP in Cambridge Bay have recently established a successful Crime Stoppers hotline through which community members can call in to report a crime and remain anonymous (K. Wood, pers. comm.). RCMP in the Kitikmeot Region estimate a lower number of emergency calls in communities where alcohol is prohibited or restricted (L. Morrison, pers. comm.). The number of police officers per community range from two in the smaller eastern communities to five in the larger communities (Back River Project Research Program 2012).

8. Land and Resource Use

8. Land and Resource Use

The following section describes land title and tenure, industrial and commercial land use activities, and relevant land and resource management plans. These uses were examined within the context of the land use LSA and RSA.

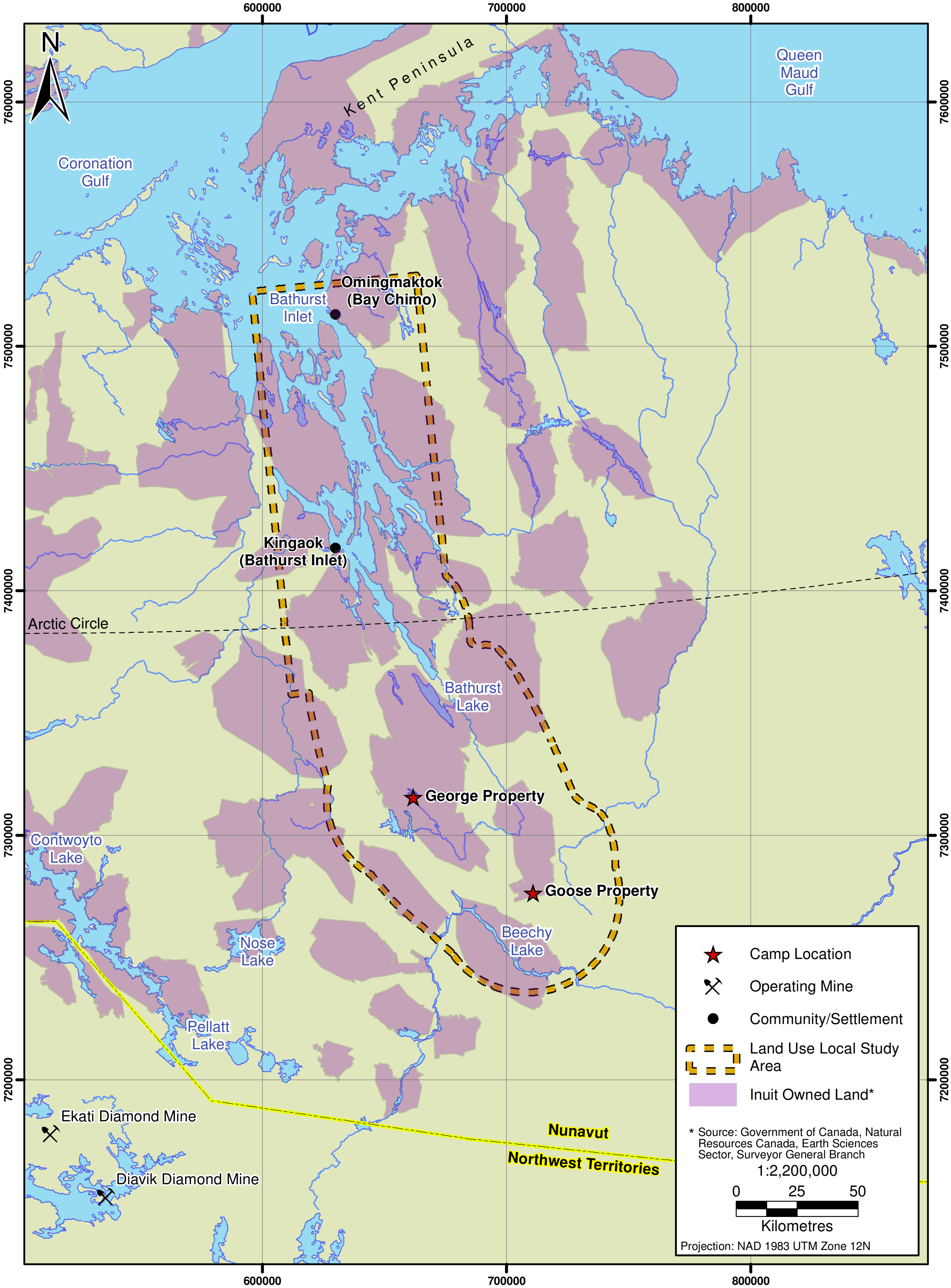
8.1 NUNAVUT LAND TITLE AND TENURE

There are two main types of land title and tenure within Nunavut: IOL and Crown lands (Figure 12.2-1 in NTI 2004). The Back River Project properties are located on both IOL and Crown land and, as such, will require land use permits from both AANDC and the KIA (Rescan 2012). IOL is designated under the NLCA as lands that vest in a Designated Inuit Organization, while Crown land refer to lands currently held by the federal government (NTI 2004). IOL comprises 356,000 square kilometres in Nunavut, the majority of which includes surface rights; however, 36,000 square kilometres are designated to include surface and sub-surface rights (NPC 2012). The NTI is responsible for IOL and AANDC for most Crown lands. Management of IOL is guided by NTI bylaws (Johnson 2009). The Land Administration Division of AANDC administers surface and subsurface rights on Crown land in accordance with the *Territorial Lands Act* (1985) and the *Federal Real Property and Federal Immovables Act* (1991) under the guidance of the Territorial Land Use Regulations for surface rights and the Northwest Territories and Nunavut Mining Regulations for subsurface rights (INAC 2005).

8.1.1 Inuit Owned Lands

The NTI Department of Lands and Resources manages IOL on behalf of all Inuit. There are two main types of title to IOL—surface and subsurface. The subsurface IOL title includes the land and all specified substances (e.g., carving stone and aggregate, earth, soil, and peat), which are held by the RIAs, and the mineral and mine deposits, which are held by NTI. The surface IOL title, which is held by the RIAs, includes the land and all specified substances but does not include rights to mineral and mine deposits. Subsurface rights on surface IOL are held by the Crown and are administered by AANDC (NTI 2004; Johnson 2009). Figure 8.1-1 illustrates the location of both surface and subsurface IOL in relation to the Project.

The RIAs administer access to surface IOL rights through the provision of land use licences (three classes); commercial leases (three classes); right-of-way, residential, and recreational leases; and quarry rights. Class 2 and 3 land use licences are required for the use of explosives, construction, establishment of a campsite, use of machinery, and storage of fuels, among over activities. Class 3 land use licences are generally for activities that are potentially more intrusive than those described under Class 2 licences. Class 1 land use licences are required for preliminary investigative or exploratory work, as well as commercial guiding. Class 2 and 3 commercial leases are required for the construction and operation of facilities related to industry (e.g., extraction, compression, processing, transportation, and refining), power generation, storage of various materials (e.g., fuel, hazardous materials and goods), and employment of individuals, among other activities. As with land use licences, Class 3 commercial leases are generally required for activities that are potentially more invasive or intensive than those found under Class 2 leases. Class 1 leases are required for commercial activities in support of wildlife harvesting, renewable resource use, or tourism development. Leases are issued by the RIAs after considering the advice of community committees (Johnson 2009).



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Inuit Owned Land in the Land Use Local Study Area

Figure 8.1-1

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The NTI administers access to subsurface IOL rights. Exploration agreements may be granted by the NTI for a term of one year, renewable in up to 20 subsequent years, with an annual fee and work requirement, for areas limited to 10,000 hectares (NTI 2004; Johnson 2009). Once it can be proven that a resource exists, the proponent can apply for a production lease with an original term of 10 years. The original production lease can be renewed for two subsequent five-year terms, if sufficient proof of progress is received by the NTI. Once production is initiated the production lease is automatically renewed for 21 years and an IOL royalty is paid on production. If mineral rights were held on subsurface IOL prior to the signing of the NLCA, the NTI retains ownership of the minerals, but the rights are administered by AANDC.

8.1.2 Crown Land

Crown land in Nunavut is administered by the Land Administration Division of AANDC, although Inuit have rights to portions of the resource royalties from extractions on Crown land and must be consulted about all resource developments (NTI 2004; INAC 2005). The Canada Mining Regulations govern exploration rights in the form of prospecting claims, mineral claims, and mineral leases. A licence to prospect is required to prospect, record a mineral claim, apply for a prospecting permit, or acquire a mineral lease. Exclusive exploration rights are provided through prospecting permits within assigned boundaries for regions ranging in size from 8,319 to 29,000 ha. Applications for prospecting permits must include an overview of the exploratory work as well as an application fee and a deposit for the first work period of exploration. Before the prospecting permit expires, a mineral claim can be staked. Mineral claim holders have exclusive rights to develop mineral deposits found during the exploratory work. No surface rights are associated with mineral claims. Claims can be held for up to 10 years and allow the holder to remove, sell, or dispose of minerals or ores up to a gross value of $100,000 per year-amounts in excess are only allowed once the claim has been taken to lease. Mineral leases allow the holder to extract more than $100,000 worth of minerals or ores and are issued for a 21 year period, after which they can be renewed. Mineral leases also do not award any surface rights (INAC 2005).

Surface tenure on Crown land is governed by the Territorial Land Use Regulations , which are used to guide the provision of land use permits. There are two types of land use permits-Class A and Class B. Class A permits are generally for more intensive operations than Class B. Applicants for land use permits must hold a licence to prospect, a prospecting permit, or mineral rights. Although not required by the Territorial Land Use Regulations, INAC encourages applicants to complete community consultations prior to submitting land use permit applications and to incorporate the feedback into the original submission, as it will be used in environmental and public screenings (INAC 2005).

The screening process for a land use permit application begins with an NPC conformity check to ensure the proposed land use complies with existing land use plans. If the conformity check is passed, the application moves on to the next round of review. Class B applications are exempt from the NIRB environmental assessment process and are instead screened by AANDC’s Land Advisory Committee, whereas Class A applications are screened by the NIRB. During this process, water licences may also be reviewed by the NWB. Both Class A and B applications are also screened by an AANDC Resource Management Officer, who provides feedback and suggests alternate land use practices, if necessary, taking into account the recommendations from the Land Advisory Committee or NIRB, as relevant. Land use permits can be suspended at any time if compliance with the conditions, determined by the screening process, is not achieved (INAC 2005).

8.2 LAND USE PLANNING AND DESIGNATION

8.2.1 Draft Nunavut Land Use Plan (2012)

The NPC, as established under the NLCA, has developed a draft Nunavut Land Use Plan (NLUP) for all Nunavut regions that are outside of municipal boundaries. The draft NLUP provides guidance for resource use and development and contains goals, objectives, and policies for land use planning in Nunavut. Land use designations include: protecting and sustaining the environment, encouraging conservation planning, building healthier communities, encouraging sustainable economic development, and mixed use. The draft NLUP also includes recommendations meant to advise proponents and regulators of issues that should be considered during the review of the project proposals (NPC 2012).

The draft NLUP is now public and next steps include workshops hosted by NPC in every Nunavut municipality, as well as with the Inuit of Nunavik and the Athabasca and Manitoba Denesuline, to receive comments and feedback. Once completed, the NLUP must be approved by the NTI, the RIAs, the GN, and the Government of Canada. The NLUP will be periodically reviewed and revised as necessary (NPC 2012).

Proposed uses that are not compatible with the land use designations will be discouraged. Uses that are not prohibited may be considered if it can be adequately demonstrated that the use maintains the intent of the land use designation and 1) does not detract or interfere with the existing uses or interests, 2) supports and compliments the existing uses or interests, or 3) the existing uses or interests are no longer present (NPC 2012).

The location of the Project in relation to the land use designations identified in the draft NLUP is shown in Figure 8.2-1. Each land use designation is described in more detail below. It should be emphasized that the NLUP is a draft yet to be fully reviewed by community stakeholders and the public, and may be subject to revision at a later date.

8.2.1.1 Protecting and Sustaining the Environment/Encouraging Conservation Planning

These land use designations-Protecting and Sustaining the Environment and Encouraging Conservation Planning-were adopted by the draft NLUP to support environmental protection and management needs, including wildlife conservation, protection, and management. These designations also take into account the natural resource base and existing patterns of natural resource use; environmental considerations, including wildlife habitat; cultural factors and priorities; as well as special local and regional considerations.

The Protecting and Sustaining the Environment land use designation addresses issues related to key bird habitat sites, caribou habitat, Atlantic Cod lakes, cumulative impacts, transboundary considerations, and climate change. The Encouraging Conservation Planning designation addresses issues related to national parks awaiting full establishment, proposed national parks, proposed national marine conservation areas, Thelon Wildlife Sanctuary, Migratory Bird Sanctuaries, National Wildlife Areas, historic sites, and heritage rivers (NPC 2012).

8.2.1.2 Building Healthier Communities

The Building Healthier Communities land use designation was adopted to support community needs and cultural priorities, while taking into account transportation and communication services and corridors; energy requirements, sources, and availability; community infrastructural requirements, including health, housing, education, and other social services; cultural factors and priorities; and special local and regional considerations.

Figure 8.2-1

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Draft Nunavut Land Use Plan Designations in the Vicinity of the Project

Figure 8.2-1

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The Building Healthier Communities land use designation addresses issues related to community interests, transportation infrastructure, unincorporated communities, alternative energy sources, community drinking water supplies, land remediation, northern contaminated sites program, aerodromes, Canadian Forces Stations, and Northern Warning systems (NPC 2012).

8.2.1.3 Encouraging Sustainable Economic Development

The Encouraging Sustainable Economic Development land use designation was adopted to support economic opportunities and needs, while taking into account the natural resource base and existing patters of natural resource use; transportation and communications services and corridors; energy requirements, sources, and availability; and special local and regional considerations.

The Encouraging Sustainable Economic Development land use designation address issues related to mineral exploration and production, oil and gas exploration and production, and commercial fisheries. The goal of encouraging diversified economic development includes long-term strategies for mineral and petroleum resource development and use, among others. The draft NLUP also states NPC will take into account geographic areas of value for non-renewable resources or other commercial values and identify development opportunities associated with those areas. In order to achieve diversified economic development, the NPC has adopted the following policies, among others.

- Provide for a mix of economic sectors to secure balanced economic development. The weighting of economic sectors with respect to any community shall depend on the actual and potential economic development opportunities at hand, the particular community or regional preferences, and the priorities or values of residents in the planning region.
- Provide clear direction and guidance regarding the conservation, development, management, and use of land to provide certainty to land users, encourage investment, minimize risk and cost, and streamline the regulatory process to ensure Nunavut resources can compete in a global market place.

Pertaining to mineral exploration and production, the NPC states a commitment to supporting further development of the mining industry and enabling its continued growth (NPC 2012).

8.2.1.4 Mixed Use

The mixed use land use designation was adopted to support a variety of opportunities and land use activity, while taking into account the potential for economic opportunity and conservation initiatives, as well as the social well-being of residents. NPC states that providing for a diverse mix of land uses creates a positive environment for potential growth and the exploration of opportunities (NPC 2012).

8.2.2 Parks and Protected Areas

The largest protected area close to the Project is the Queen Maud Gulf Migratory Bird Sanctuary (Table 8.2-1; Figure 8.2-2), which is a legislated conservation area that supports nearly the entire global population of Ross' Geese, giving it international importance (NPC 2004). Designated conservation zones are also found near Hood River in the Wilberforce Falls area and the Hiukitiak River watershed, east of the Bathurst Inlet area. These zones are of cultural importance for local Inuit and serve as a destination for eco-tourists (NPC 2004). There are also a number of areas within the Kitikmeot Region that are identified as Wildlife Areas of Significant Interest by the NPC, including a circular area around Elu Inlet (NPC 2008b).

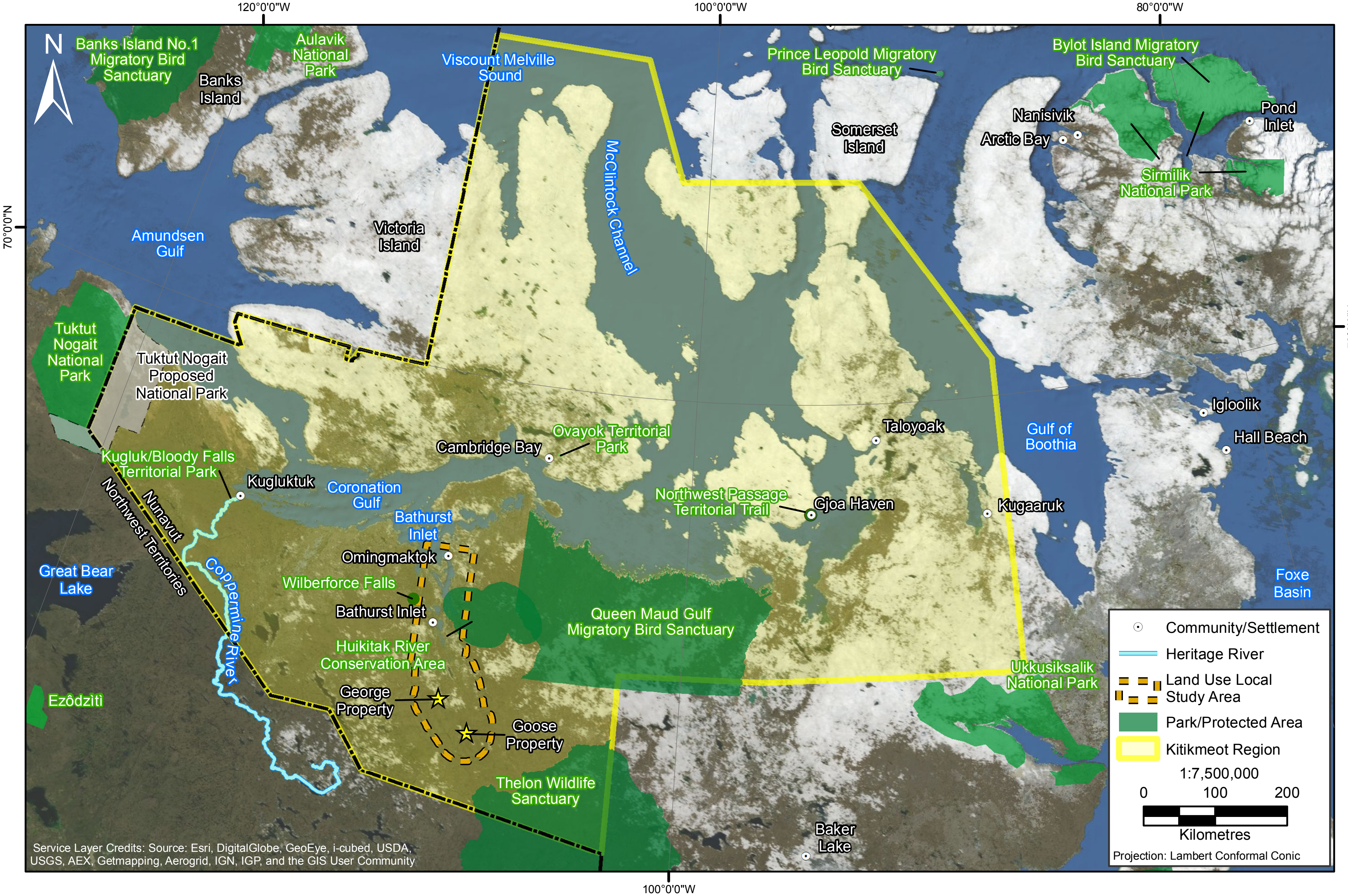

Figure 8.2-2

Parks and Protected Areas in the Kitikmeot Region

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Table 8.2-1. Designated Protected Areas Proximal to the Back River Project

Protected Area	Importance	Location Relative to George Property	Location Relative to Goose Property
Queen Maud Gulf Migratory Bird Sanctuary (Iluilik Sanctuary)	Migratory bird sanctuary and Ramsar* site. The sanctuary supports virtually the total world population of Ross' geese and about 15% of the Canadian population of lesser snow geese.	120.9 km	109.2 km
Huikitak River Conservation Area	Proposed territorial park, national historic site, national wildlife area, or a national park to be conserved for traditional land use activities.	88 km	122 km
Wilberforce Falls	Area of Special Significance.	143.9	202.9 km
Ovayok (Mount Pelly) Territorial Park	Located in Cambridge Bay; important for tourism, and a viewing area for landscape and wildlife.	378.2	407.9 km

** designated under the international Ramsar convention on wetlands (Ramsar 2011).*

In addition, the Kitikmeot Region includes numerous territorial parks, such as Ovayok (Mount Pelly) Territorial Park, which is located approximately 15 km east of Cambridge Bay, the Northwest Passage Trail, located on King William Island near Gjoa Haven, and Kugluk/Bloody Falls, which is located on the west side of the Coppermine River, approximately 15 km from Kugluktuk (Figure 8.2-2; Nunavut Parks 2013).

Other sites of importance include the Coppermine River, which was nominated as a Canadian Heritage River in 2002. The Canadian Heritage Rivers Systems gives national recognition to rivers that have outstanding natural or human heritage values and significant recreational opportunities. A management plan for the Coppermine River was completed in 2008 and submitted to the Canadian Heritage Rivers Board. In accordance with the NLCA, the management plan was coordinated by the Kugluktuk HTO and the KIA. Table 8.2-1 outlines the designated protected areas closest to the Project.

8.3 INDUSTRIAL LAND USE

8.3.1 Mining and Mineral Development and Exploration

To help manage development, the NTI has adopted several policies related to exploration and mining, including a general mining policy in 1997, a uranium policy in 2007, and a reclamation policy in 2008 (INAC 2010b).

A Memorandum of Understanding (MOU) between the Canadian Northern Economic Development Agency and the KIA was signed on November 15, 2012. The MOU confirms both parties' commitment to advance responsible resource development while promoting regional benefit in the Kitikmeot Region. Specifically, the MOU states the two parties recognize the importance of major resource and infrastructure development projects to the economic prosperity of the people and communities in the Kitikmeot Region and agree to cooperate and coordinate in their efforts to develop strategies that advance positive economic outcomes for the region (CanNor and KIA 2012).

The first Inuit-owned mining development company, Nunavut Resources Corporation, was established in 2012 and has received a $1 million commitment from the KIA to start exploration activity. The Nunavut Resources Corporation is partnered with HTX Minerals Corp. and will now seek to raise $18 million for exploration which will focus on unstaked portions of the 11,509 square kilometres of IOL (surface and mineral rights) within the Kitikmeot Region (Nunatsiaq News 2012).

Natural Resources Canada's initial 2012 estimate of annual spending on exploration and deposit appraisal by all companies active in Nunavut was $569 million, which was later revised downward to $427 million (a 25% decrease), likely linked to the cessation of activities associated with Newmont Mining Corporation's Hope Bay Belt Project. The revised estimate represents a 20% decrease as compared to spending in 2011. In Nunavut, exploration and deposit appraisal expenditures totalled an estimated $263.8 million in 2010, up from $187.6 million in 2009 (NRCan 2012). As shown in Table 8.3-1, mineral exploration in the territories has varied over the past seven years. Together the territories accounted for 20.8% of Canadian mineral exploration spending in 2012, down from 22.7% in 2011 (up here business 2012).

Table 8.3-1. Mineral Exploration in the Canadian Territories 2006 to 2012

	Mineral Exploration Spending (Millions)						
	2006	2007	2008	2009	2010	2011	2012
Nunavut	$210.6	$338	$432.6	$187.6	$256.7	$536	$427
Northwest Territories	$176.2	$193.7	$147.7	$44.1	$81.7	$94	$136
Yukon	$106.4	$144.7	$134	$90.9	$156.9	$332	$292

Source: Natural Resources Canada (2013).

In 2012, there were 65 active exploration projects in Nunavut, including 22 in the Kitikmeot Region and 18 near the communities of Bathurst Inlet, Cambridge Bay, and Kugluktuk. This is a reduction of from 95 active exploration projects in the Kitikmeot in 2011, including 35 near the project. Currently, there are no active mines in the Kitikmeot Region. In 2012, there were 22 active mineral explorations in the Kitikmeot Region, including 17 in the western Kitikmeot (Table 8.3-2) and an additional 5 in the in the eastern Kitikmeot at Committee Bay. Western Kitikmeot projects included base metals (5), gold (15), and diamonds (2; Nunavut Geoscience 2012). In 2011, Hope Bay Mining Ltd. was the most active project in the region; however, in 2012, a number of projects were put on "care and maintenance status," including the Hope Bay Belt Project (George 2012a). The Hope Bay Project has been acquired by TMAC Resources and permitting for Phase 2 is ongoing.

Table 8.3-2. Active Exploration Projects in the Regional Study Area, 2012

Closest Community	Project Name	Commodity	Operator
Bathurst Inlet	Hackett River	Base Metals	Xstrata Zinc Canada
	Chicago	Gold	North Country Gold Corp.
	George (Back River Project)	Gold	Sabina Gold & Silver Corp.
	Goose (Back River Project)	Gold	Sabina Gold & Silver Corp.
	High Lake	Base Metals	MMG Resources Inc. (Minmetals)
	Izok Lake	Base Metals	MMG Resources Inc. (Minmetals)
	Jericho Mine	Diamonds	Shear Diamonds Ltd.
	Lupin Mine	Gold	Elgin Mining Inc.
	Ulu	Gold	Elgin Mining Inc.
	Wishbone	Base Metals	Xstrata Zinc Canada
	Wishbone Gold	Gold	Sabina Gold & Silver Corp.
Cambridge Bay	Boston (Hope Bay Project)	Gold	North Country Gold Corp.
	Chicago (Hope Bay Project	Gold	North Country Gold Corp.

(continued)

Table 8.3-2. Active Exploration Projects in the Regional Study Area, 2012 (completed)

Closest Community	Project Name	Commodity	Operator
Cambridge Bay *(cont'd)*	Doris (Hope Bay Project)	Gold	North Country Gold Corp.
	Madrid (Hope Bay Project)	Gold	North Country Gold Corp.
	Oro	Gold	North Arrow Minerals Inc.
Kugluktuk	Hammer	Diamonds	Stornoway Diamond Corporation
	Hood	Base Metals	MMG Resources Inc. (Minmetals)

Source: Nunavut Geoscience (2012).

8.3.2 Oil and Gas Development and Exploration

The issuance of oil and gas exploration rights in Nunavut began in 2000 and follows an open, competitive bidding process. Oil and gas resources on Crown land in Nunavut are managed by the Northern Oil and Gas Branch of AANDC (INAC 2009b). Current exploration and development are concentrated in the eastern Arctic (northern Hudson Bay and around Baffin Island), the Arctic Islands, and Sverdrup Basin (INAC 2011b, 2011a). A number of exploratory and delineation wells are located in the northwest of the Qikiqtani Region (NPC 2008a). The Arctic Islands overlie one of Canada's largest petroliferous basins. Two of the largest undeveloped gas fields in Canada are in the Arctic Islands (INAC 2000).

As of 2008, the only oil and gas infrastructure in the Kitikmeot Region was an exploratory well in northern Kitikmeot, on Prince of Wales Island. The majority of southern Kitikmeot is not considered to have oil and gas potential (NPC 2008a).

Northern oil and gas resources in Nunavut and elsewhere may become increasingly important as conventional resources in the traditional oil and gas production areas of western Canada are depleted. Oil and gas supplies in Nunavut and offshore in the Arctic are estimated at approximately 51.3×10^6 m^3 and 449.7×10^6 m^3, respectively (Table 8.3-3). Known gas supplies in the Arctic islands are comparable to those in the Beaufort Sea-Mackenzie Delta Region. However, industry has not responded to the Arctic Islands of Nunavut Call for Nominations in recent years. There was no industry exploration or development activity in the Arctic Islands or offshore in the eastern Arctic in 2009 (INAC 2009a).

Table 8.3-3. Oil and Gas Resources in Nunavut and Arctic Offshore

	Discovered Resources		Undiscovered Resources		Ultimate Potential	
	10^6 m^3	MMbbls	10^6 m^3	MMbbls	10^6 m^3	MMbbls
Oil Resources	51.3	322.9	371.8	2339.4	423.1	2,662.3
Gas Resources	449.7	16.0	1191.9	42.3	1641.6	58.3

Source: INAC (2009a).

8.4 COMMERCIAL ACTIVITIES

8.4.1 Hunter and Trapper Organizations

Each community in Nunavut has an HTO that shares responsibilities with respect to the management of hunting, trapping, and fishing activities, as well as management of the environment and wildlife with the GN. Each HTO typically employs one local person as a manager and performs various functions based on local need. For example, HTO functions may include:

- facilitation of programs and services for local hunters and trappers (e.g., the Nunavut Harvesters Support Program);

- coordination of research projects (e.g., polar bear monitoring, fish tagging);
- assistance with the commercial hunt (e.g., identify local hunters available for short-term employment who can obtain animals for commercial sale; Section 8.4.2);
- coordination of community hunts that include adult/Elders and youth to promote youth involvement in hunting activities, as well as the transfer of cultural knowledge generally;
- organization and implementation of the community harvest;
- coordination of the sport hunt (e.g., connect clients with local hunters able to provide service; Section 8.4.3); and
- production of annual reports, reporting to members, and participation in local and regional meetings.

The HTOs in Cambridge Bay and Kugluktuk are active and currently facilitate a variety of programs and projects. The HTOs at Bathurst Inlet and Omingmaktok did not employ an HTO manager at the time of writing, but continue to be actively managed by an HTO board and chair. Support to hunters from those communities is provided through the Cambridge Bay HTO at this time (Back River Project Research Program 2012).

The Nunavut Harvesters Support Program, funded and administered through the Nunavut Department of Economic Development and Transportation, provides $97,000 annually to each community in Nunavut for equipment purchases. Equipment is usually distributed through a community raffle once per year. Equipment typically raffled includes all-terrain vehicles (ATVs), snow machines, welded boats, aluminum boats, and boat motors, among other items (Back River Project Research Program 2012).

In Cambridge Bay, the HTO supports the commercial hunt of muskox, which in turn are processed and sold by Kitikmeot Foods (Section 8.4.2). The HTO retains the muskox wool obtained from the hunt. Muskox wool is now processed in Cambridge Bay. In the past, wool was sent to Peru to be processed and was then shipped back to Nunavut for sale internationally and for use in naturally produced clothing and other arts and crafts. Within the past year, the company that purchases the wool travelled to Nunavut to provide training in wool shearing to local people in order to have the wool processed locally. Training was coordinated through the Cambridge Bay HTO (Back River Project Research Program 2012).

Challenges faced by HTO managers include keeping up with administration duties and office work associated with the hunter support programs, project funding proposals (e.g., to obtain a community freezer), and providing a means though which local people can become engaged in seeking out available support. Other challenges to hunting and trapping generally include the decrease in the number of young people becoming engaged and proficient in these activities, which increases the burden placed on older hunters and the HTOs to maintain activities such as the community harvest (Back River Project Research Program 2012).

8.4.2 Kitikmeot Foods and the Commercial Food Harvest

Established in 1990, Kitikmeot Foods is a food processing facility located in Cambridge Bay that is owned by the Nunavut Development Corporation and the Ekaluktutiak (Cambridge Bay) HTO. Kitikmeot Foods specializes in muskox and Arctic char for sale in commercial markets. The facility operates year round, processing fish from July to September and muskox from October till March, creating employment for local people including harvesters. Normally, approximately 200 muskox are harvested during the commercial hunt which takes place annually on Victoria Island in late February to early March (Dawson 2012; Nunavut Development Corporation n.d.).

Kitikmeot Foods employs approximately 30 people, including hunters, to help with the annual commercial harvest, which must take place within 30 to 35 miles of the community. The annual muskox hunt typically provides horns, qiviuq (muskox wool), and about 25,000 pounds of meat to Kitikmeot Foods. Once the animal has been processed at the Kitikmeot plant, the hide and horn of the animal is provided to the HTO for other uses (Dawson 2012). Kitikmeot Foods is a Health Canada-approved facility that must abide by federal health and safety regulations such as those required by the Canadian Food Inspection Agency, as related to how animals are harvested and processed. For example, in order for meat to be exportable outside of Nunavut, the harvest and operation must be approved by the Canadian Food Inspection Agency, which, among many other regulations, requires the delivery of animal carcasses to the processing facility within one hour of harvesting (Back River Project Research Program 2012).

In 2013, however, the annual muskox hunt-which usually takes place between February and mid-March-has been cancelled due to low numbers of muskox near Cambridge Bay. As a result, it is estimated that Kitikmeot Foods will lose between $140,000 and $145,000 dollars in revenue for 2012. Kitikmeot Foods reported profits in 2011, but showed a loss of $99,153 in 2012 despite an increase in sales (Dawson 2012).

8.4.3 Sport Hunting

Sport hunting in Nunavut is usually organized through the community HTO office. Each community is allocated a specific number of tags per year by species and can use those tags to accommodate a sport hunt if so desired. Typically, a local hunter, who is also a licenced outfitter, is identified to take a client out on the land to hunt an animal. Some portion of the animal is usually retained by the client as a trophy, while the rest of the harvested animal remains with the HTO for community use and benefit. Revenues from the sport hunt provide financial support to local HTOs (Back River Project Research Program 2012). Species typically targeted for sport hunting include caribou, muskox, grizzly bear, polar bear, and wolf (Back River Project Research Program 2012; Nunavut Tourism 2012).

The sport hunt in Cambridge Bay usually takes place during late April or early May, following the commercial hunt. A sport hunt also occurs in the fall (October). Sport hunting in Cambridge Bay is offered through private individuals, Canada North Outfitting, and Ekaluktutiak HTO (George 2012a). At the time research was conducted (2012), the Kugluktuk HTO was not offering a sport hunt; however, the HTO may offer sport fishing in the future (Back River Project Research Program 2012). In 2012, sport hunts operating from Cambridge Bay began to focus on Victoria Island muskox as territorial restrictions on others animals were increased. Sport hunters typically pay $5,500 (not including travel) to hunt a muskox. In 2012, the Kitikmeot Region has a total allowable harvest of 400 muskox, about half of which belonged to Kitikmeot Foods (George 2012a).

Owners of the Bathurst Inlet Lodge coordinate with the Bathurst Inlet HTO to also organize an annual sport hunt, separate from lodge operation. A hunt for caribou takes places on Contwoyto and Pellatt Lakes in August and September. A hunt for muskox and wolf takes place in March and April and a hunt for grizzly bear takes place in May. The commercial hunts are not associated with the lodge business (Back River Project Research Program 2012).

8.4.4 Fisheries Licences

Fisheries licences in Canada are guided by the DFO's New Emerging Fisheries Policy which defines the three stage process that must be undertaken to obtain a commercial fisheries licence. The first stage is the preliminary feasibility stage which determines feasibility and whether harvestable quantities of the species exist and can be captured by a particular gear type. During this stage multi-species and habitat impacts as well as next steps are also identified. Once feasibility has been demonstrated, an exploratory licence can be granted to begin the commercial stock assessment stage (stage two). The purpose of an exploratory licence is to determine if the stock can sustain a commercially viable operation and to collect additional biological data. Once it has been determined the species can sustain (commercially and biologically) a commercial fishing operation, a phase three, or commercial fishery licence can be obtained and a formal Integrated Fisheries Management Plan is introduced (DFO 2009).

There is one exploratory licence for an Arctic char fishery located within the land use RSA at 66˚ 47' N, 108˚ 10' W (Figure 8.4-1). Stage two, the commercial stock assessment stage, requires the completion of an exploratory harvesting strategy for the new fishery as well as the proposed processing and marketing strategies, specifically the processing plants to be used and market destinations, among other tasks (DFO 2009).

8.4.5 Ecotourism Lodges

Seasonal lodges and adventure tourism companies operate throughout the Kitikmeot Region, and two are located in the Bathurst Inlet area: the Bathurst Inlet Lodge and the Elu Inlet Lodge.

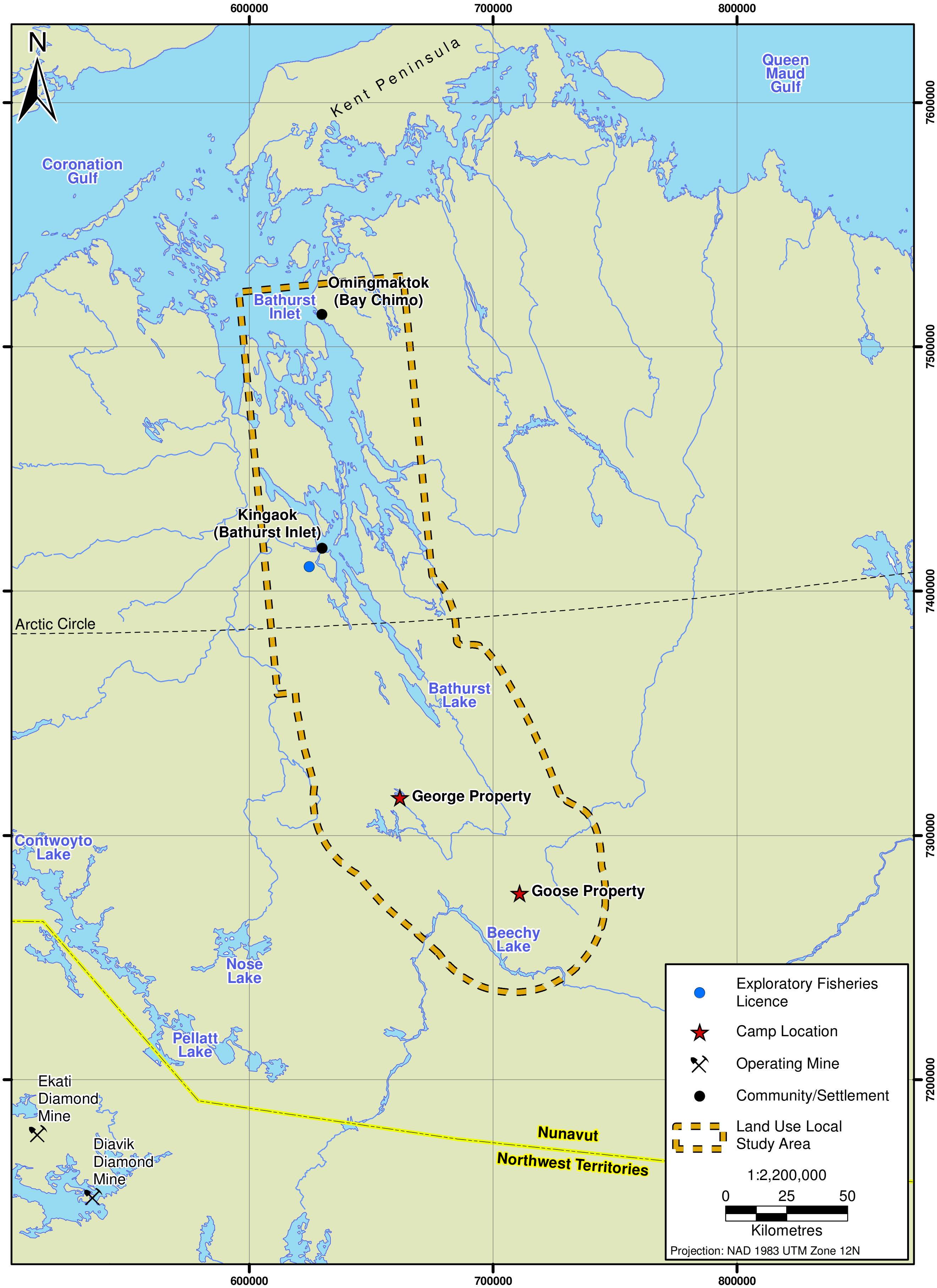
8.4.5.1 The Bathurst Inlet Lodge

The Bathurst Inlet Lodge is an ecotourism venture operating during the short tourist season, from June to September, near the community of Bathurst Inlet and is one of the primary tourist destinations in the region. Established in 1969, the lodge can accommodate 30 people and occupies an old Hudson's Bay Company post. The business is co-owned by local people and Kingaunmiut, a local Inuit company. Ecotourism activities include boating in Bathurst Inlet, hiking, sightseeing, and culture and nature interpretation (Back River Project Research Program 2012).

The Bathurst Inlet Lodge offers an outfitting and equipment rental service including, for example, kayaks, canoes, and camping gear. Clients that rent equipment are generally interested in self-guided tours. The lodge offers assistance with logistics, transportation, bear and other safety training, and other necessary precautions, as well as providing expertise on where to go and what to look for during a self-guided tour. The lodge also offers packages in partnership with Nahanni River Trips, a company offering adventure vacations. These fully guided tours, most commonly canoeing tours, include catering (provided by the lodge) and often take place on the Burnside, Hood, and Mara Rivers. Another option provided to clients is an all-inclusive package which includes seven nights at the lodge, seven days of guided tours, and transportation from Yellowknife. Guided trips focus on significant historical, archaeological, and wildlife locations. Weekly packages for self-guided tours and accommodations range from $2,500 to $3,000 and from approximately $6,000 and up per week for the all-inclusive package (Back River Project Research Program 2012).

Typically, the lodge accommodates approximately between 100 and 130 clients per year. However, in recent years there has been a lower average of about 100 clients per year. Approximately 70% of clients are Canadian and another 30% are American, while a few clients are from elsewhere. The lodge has four permanent employees and an additional 15 to 20 employees during the summer, depending on the number of clients (Back River Project Research Program 2012).

In addition to the main lodge, the Bathurst Inlet Lodge has several small lodges and camps at various locations including Fishing Creek, Burnside Lake, Pellatt Lake, and Bathurst Lake. Typically, these areas would be visited during fully guided tours, which take place on Fishing Creek, Bathurst Lake, Burnside River, Pellatt River, Mara River, and Hood River (Back River Project Research Program 2012).



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Fisheries Licences in the Land Use Local Study Area

Figure 8.4-1

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Lodge owners believe the attraction to their business results from the area's remote wilderness and relative isolation.

> *Clients expect there be no other activity or development in the area; this includes people, boats, towers, radios, or anything else that would detract from the sense of being in a totally secluded wilderness area. The aesthetics of the area are very important to the business* (Back River Project Research Program 2012).

Challenges currently faced by owners of the Bathurst Inlet Lodge include marketing to reach individuals likely interested in ecotourism and the Bathurst Inlet Lodge. However, this has been a continual challenge that will likely remain into the future (Back River Project Research Program 2012).

8.4.5.2 The Elu Inlet Lodge

The Elu Inlet Lodge has been operational for over a decade and is located on the shores of the Elu Inlet near the mouth of the Itibiak River, which is east of Bathurst Inlet. The lodge is owned and operated by local Inuit. During the summer season (July and August) it offers eco-tourism adventures, including hiking, boating, wildlife and bird observation, Inuit culture and heritage tours, and fishing excursions. The Elu Inlet Lodge is accessed by floatplane from Cambridge Bay, and facilities include lodging, an outdoor hot tub, canoes, and kayaks. The lodge specializes in facilitating conferences and corporate retreats. Visitors to the lodge can expect to see muskox, grizzly, caribou, seal, gyrfalcon, and peregrine falcon. Visitors to the lodge may participate in catch and release fishing (Back River Project Research Program 2012).

The Elu Inlet Lodge can comfortably accommodate 15 people but has hosted as many as 26 when needed. The lodge has a large conference room and typically hosts Nunavummiut companies for corporate retreats. Approximately 90% of lodge clientele are Nunavummiut, and the remaining 10% are typically from the US, Sweden, and other European countries. The lodge uses camps located at Pellatt Lake and Burnside River as points of interest to visit during tours. In 2011, the lodge hosted six clients. The lodge did not open last year as there were no clients (Back River Project Research Program 2012).

8.4.6 Tourism and Recreation

In addition to the lodges, there are other tourism companies operating in the area. Adventure Canada is a tour company that specializes in small ship expeditionary cruises in Canada's North. Programs offered by the company explore local art, culture, wildlife, and natural scenery with Canadian and international experts and local guides (Nunavut Tourism 2011). Their advertised "Into the Northwest Passage" tour includes travel through Gjoa Haven, Bathurst Inlet, Coronation Gulf, and Kugluktuk. Shore visits include hikes on the open tundra at Bathurst Inlet.

Cambridge Bay is the regional tourism hub, with flight access to many other communities in western Nunavut and direct flights to both Edmonton and Yellowknife. Ships travelling the Northern Passage also stop at Cambridge Bay. Cambridge Bay's community plan identifies goals to enhance the community's role as a regional service centre, as well as to develop local business and tourism interests (Aarluk Consulting 2007a).

Other tourism activities in the Kitikmeot Region include hiking, hunting, fishing, dog sledding, cross-country skiing, and snowmobile riding, among others (Nunavut Tourism 2011). In 2012, a total of eight cruise ship stops involving four ships were recorded in the Kitikmeot Region, including:

- one in Taloyoak, the Chipper Adventurer with 118 passengers;

- two in Kugluktuk, the Akademik Ioffe and the Clipper Adventurer, with 100 and 118 passengers, respectively;
- four in Cambridge Bay-the MV Hanseatic with 180 passengers, the Akademik Ioffe landed twice with 100 passengers, and the World with 200 passengers; and
- one in Bathurst Inlet, the Clipper Adventurer with 118 passengers.

All cruise ships travelled through the area in August or September, and many stopped in other Nunavut communities as well (J. Case, pers. comm.). The main attractions in Cambridge Bay are the Arctic Coast Visitors' Centre and the Kitikmeot Heritage Centre, which report approximately 2,000 visitors each year. The community is also recognized as a destination for bird-watching and research, and is a base for visitors to the Queen Maud Bird Sanctuary—the world's largest migratory bird sanctuary. The community's eco-tourism industry is noted to have significant growth potential (NEDA 2008). Tourist attractions in Kugluktuk include the Heritage and Visitors' Centre and the Kugluk or Bloody Falls Territorial Park, which is located approximately 15 km from the community. During summer, there is also access to the Kugluktuk Golf Club, which is located along the Arctic Ocean (Nunavut Tourism 2011).

9. Subsistence Economy, Harvesting, and Land Use Activities

Engineers and Scientists

9. Subsistence Economy, Harvesting, and Land Use Activities

The following section describes the subsistence economy, harvesting activities, and current land use activities associated with Cambridge Bay, Bathurst Inlet, Omingmaktok, and Kugluktuk residents. Land use activities are characterized within the land use LSA and RSA.

9.1 LAND USE VALUES

The Inuit culture and way of life are intrinsically connected with the land. The Inuit people of the Kitikmeot have always depended on Inuit Qaujimajatuqangit, or knowledge of the land and environment, and continue adapt to challenges posed by geography and climate. Practices such as hunting, fishing, and gathering have endured over thousands of years and remain important for maintaining social relationships and cultural identity, as they define a sense of family and community within Inuit culture. These practices link people to their histories, their present cultural settings, and provide a forward way of thinking about livelihoods (ACIA 2005). In Inuit culture, the environment is valued as a whole: the value of one ecosystem component cannot be ranked or differentiated from the value of another. The values that guide traditional activities and subsistence harvests are reflected in the Inuit approach to historic and contemporary land and resource use activities in the Kitikmeot Region.

Maintaining the health of the land and the ability of the land to support the traditional subsistence economy, including hunting, trapping, fishing, and gathering, is essential to the Inuit lifestyle. This includes ensuring the sustainability of wildlife populations in the area. Muskox, caribou, grizzly bear, wolf, and wolverine are among the species people in the Kitikmeot Region rely upon, with caribou being the most harvested terrestrial mammal.

9.2 THE SUBSISTENCE ECONOMY

Traditional economic activities are of great importance to residents of the Kitikmeot communities. The subsistence economy includes non-commercial hunting, fishing, trapping, and gathering, as well as the transformation of harvested products into useful items such as clothing or arts and crafts. The value of subsistence harvesting is social, cultural, and economic as the need for store bought food and other household items is reduced in households that participate in subsistence harvesting. In many communities in Nunavut, obtaining country foods for personal consumption is an economic necessity. Country food obtained by Inuit hunters is often shared with neighbours and other community members. Products made or sourced from land-based materials (e.g., furs, clothing, and arts and crafts) may also be sold, thus providing income to households from the cash economy.

In 2006, the latest year for which published statistics are available, the majority of Cambridge Bay and Kugluktuk residents hunted, fished, trapped, or gathered wild plants and berries, in comparable proportions to Nunavut as whole (Table 9.2-1). In addition, the number of community members participating in traditional economic activities is increasing over time. Statistics Canada (2008a) reports that the number of adult residents (aged 15 years and older) in Kugluktuk and Cambridge Bay who reported hunting activity in 2006 was approximately 14% greater than the number reported in 2001. In contrast, there was virtually no change in participation rates for fishing between census years. Participation in gathering activities, as reported in 2006, greatly varied, from a low of 45% in Cambridge Bay to a high of 89% in Kugluktuk; this is likely related to the availability of plants and berries for harvesting near to the communities.

Table 9.2-1. Harvesting Activities during the Past 12 Months, 2006

Community/Region	Proportion of Population Harvesting (Population 15+ Years)			
	Hunt	Fish	Gather Plants	Trap
Cambridge Bay	62%	68%	45%	n/a
Kugluktuk	64%	71%	89%	30%[E]
Nunavut	71%	76%	79%	30%

[E]: estimated
n/a: data not available
Source: Statistics Canada (2008a, 2008b).

The main government program for the direct support of subsistence activities is the Nunavut Harvesters Support Program (Section 8.4.1). In addition, the GN and Canadian Northern Economic Development Agency have invested $190,000 to support and promote the Nunavut Seal and Long Fur Marketing Project which seeks to develop high-quality products and expand the market for those products domestically and abroad. The project includes:

- delivering fur workshops in Nunavut communities that provide information related to the fur handling requirements of the fur garment and taxidermy trades;
- producing instructional videos on pelt handling for use by active hunters and trappers throughout the territory, as well as videos that showcase the process to increase awareness about the industry in Canada;
- advertising to promote Nunavut sealskins as well as ongoing marketing and communications initiatives; and
- participating in relevant industry events to increase awareness.

The program will take place over two years with the GNs Department of Environment leading the implementation of the project through advertising campaigns, participation in industry events, and by delivering the pelt-handling workshops in Nunavut communities (CanNor 2012).

9.2.1 Participation in Subsistence Harvest Activities

9.2.1.1 Nunavut Wildlife Harvest Survey (2004)

The Nunavut Wildlife Harvest Survey, conducted between 1996 and 2001, remains the most current and comprehensive information source on subsistence harvests in the Kitikmeot Region (H. Priest and Usher 2004). The survey collected data on subsistence harvesting activities, including non-commercial hunting, trapping, gathering, and fishing. Hunters, for the purposes of this survey, were defined as beneficiaries of the NLCA who were 16 years of age or older and who participated in the hunting, fishing, or trapping of animals at any time during the year. Three major categories of hunting frequency were defined for the analysis.

- Intensive land users are those who are repeatedly and regularly engaged in most of the various hunting activities throughout the year.
- Active land users are those who are engaged in a limited number of major harvesting activities, often with a short but intense commitment.
- Occasional land users are those who are generally short-term and irregular hunters who are focused on day trips and weekend outings.

Figure 9.2-1 shows the total number of hunters registered annually between 1996/1997 and 2000/2001 in Bathurst Inlet, Omingmaktok, Cambridge Bay, and Kugluktuk and provides a breakdown of the number of intensive, occasional, and active hunters for each community.

Approximately 17 to 18 hunters were registered annually in Bathurst Inlet; three were classified as intensive land users, four as active, and the remainder reported occasional activity. Harvest data indicate that the majority of hunters harvested caribou, with an annual mean harvest of approximately 93 animals, while Arctic ground squirrel, Arctic fox, red fox, wolverine, grey wolf, Arctic hare, and seal were also common prey. Ptarmigan (willow ptarmigan and rock ptarmigan) were the most commonly hunted bird species, and seagull eggs were also popular. Fishing was practised by nearly all hunters, with catches including Arctic char, cod, lake trout, and whitefish. Many hunters leave Bathurst Inlet for the winter to live in other centres (e.g., Cambridge Bay and Kugluktuk), returning to the community for the summer months (H. Priest and Usher 2004).

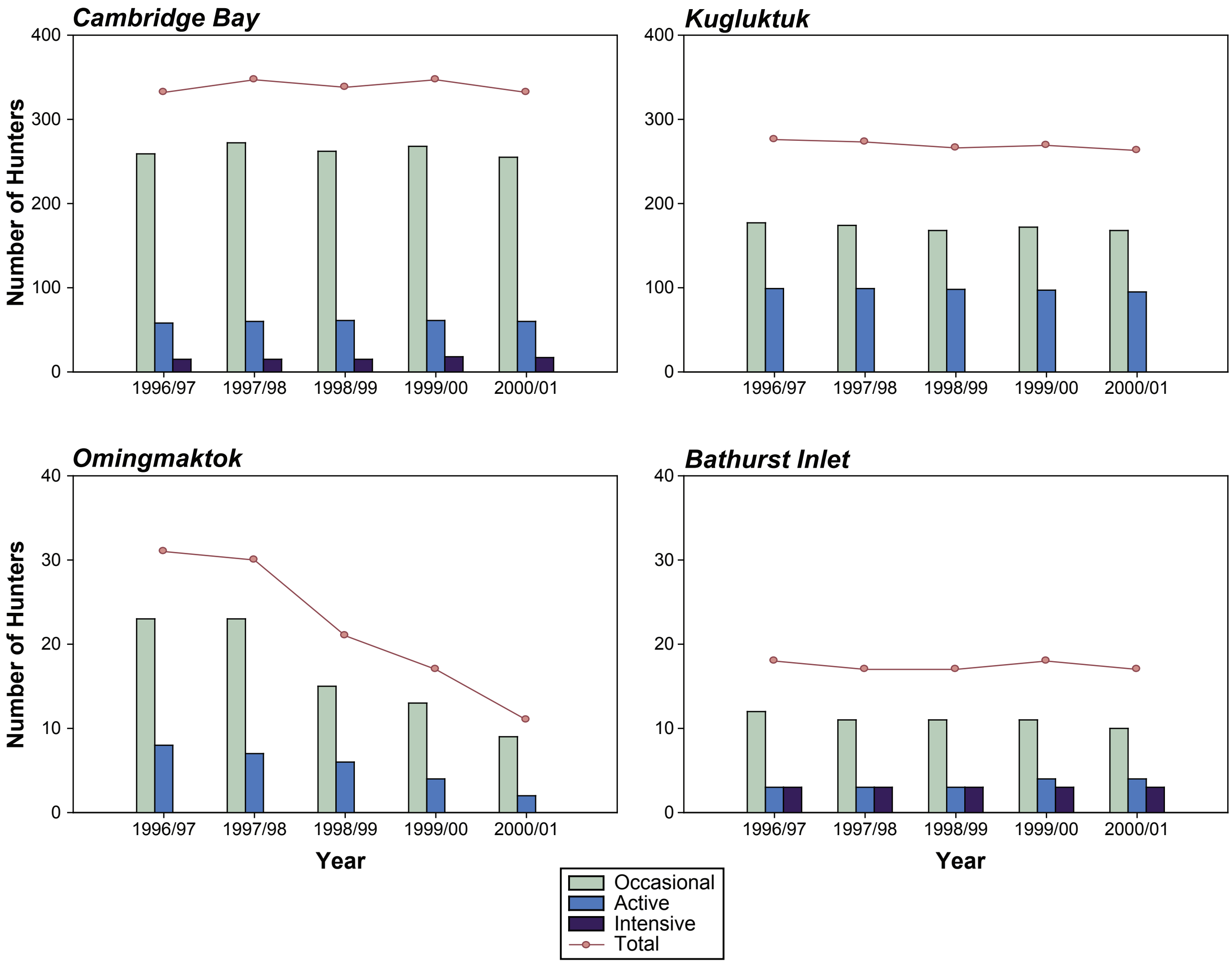
In Omingmaktok, the number of hunters decreased from a reported 31 in 1996/97 to only 11 in 2001, which likely reflects an overall decline in the community population. There were no intensive hunters in any year, while approximately three hunters were classified as active; however, actual numbers varied greatly with changes in the population. Caribou was the most-hunted game, with an annual average of approximately 176 kills, and Arctic ground squirrel, grey wolf, Arctic and red fox, wolverine, and seal were also common. Canada goose, eider duck, and ptarmigan were the most popular game among birds, and goose, duck, and seagull eggs were also collected. Similar to Bathurst Inlet, fishing activity focused on Arctic char, cod, and lake trout (H. Priest and Usher 2004).

Cambridge Bay reported between 330 and 350 hunters each year, utilizing an area that includes much of Victoria Island, Queen Maud Gulf, and sections of the mainland (H. Priest and Usher 2004). Each year, 15 to 17 hunters were classified as intensive, and approximately 60 were classified as active. Caribou was the most popular game with an average of approximately 811 harvests per year, followed by Arctic fox with 226 harvests, and seal at 97 harvests. Waterfowl, including geese and ducks, also showed high harvest levels, and fishing harvests focused on Arctic char, lake trout, and whitefish (H. Priest and Usher 2004; NPC 2004).

Kugluktuk was estimated to have between 263 and 294 hunters annually between 1996 and 2001; approximately 170 were classified as occasional hunters and another 95 to 100 were classified as active hunters (annually). There were no intensive hunters in any year. Caribou and Canada goose were the two most hunted game, with annual averages of 1,560 and 1,422 kills, respectively. Arctic ground squirrel, fox, and ringed seal were also common. Arctic Char were the most commonly harvested fish with approximately 5,053 harvested annually. Other fish species commonly harvested include whitefish, cod, and lake trout (H. Priest and Usher 2004).

9.2.1.2 Aboriginal Peoples Survey (2006)

The 2006 Aboriginal Peoples Survey (Statistics Canada 2008a) surveyed Inuit in the Nunatsiavut, Nunavik, Nunavut, and Inuvialuit regions. Together these areas constitute the Inuit Nunaat, or "Inuit homeland." Portions of the survey included questions related to country foods and harvesting. The continued importance of country food as a nutritional and cultural component of Inuit lifestyle cannot be overstated. As shown in Table 9.2-2, at least half the meat and fish that 66% of Nunavut residents consume is country food obtained from harvesting, as opposed to store bought food. Another 38% of Nunavut residents consume more meat and fish obtained through harvesting as compared to the amount that is purchased.



Source: NWMB 2004

Number of Hunters in Cambridge Bay, Kugluktuk, Omingmaktok, and Bathurst Inlet (2004)

Figure 9.2-1

Table 9.2-2. Amount of Meat and Fish Eaten in the Household that is Country Food (Inuit Aged 15 and Over)

	Nunavut (%)	Total, Inuit Nunaat (%)
None	1[E]	1[E]
Less than half	29	27
About half	28	29
Subtotal, at least half	**66**	**65**
More than half	38	37
Don't know/not stated	4	7

Source: Statistics Canada (2008a).
[E] Use with caution. Does not include "don't know" responses.

The 2006 Aboriginal Peoples Survey also reported that approximately 57% of Nunavut children, ages 6 to 14, ate wild meat, caribou, walrus, and/or muktuk three or more days per week (Tait 2006).

In 2006, over two-thirds of Nunavut residents harvested country foods in the previous year, with a higher portion of males participating in harvesting (74%) as compared to females (59%). The portion of the population harvesting country food was slightly lower for those aged 15 to 24, but remained relatively stable for both males and females from the age of 25 to 54, and increased slightly for males and decreased slightly for females aged 55 and over (Table 9.2-3). Although youth and older females appear to harvest country food at a lower rate as compared to adult males, there is a strong tradition of sharing country food in Inuit culture. Eight of ten Inuit adults reported living in households that shared country food with others during the previous year (Tait 2006). As such, it can be assumed that Inuit who are not harvesting continue to access and consume country food through sharing networks.

Table 9.2-3. Harvesting Country Food in Previous Year, Nunavut, 2006

	Yes			No			Not Stated		
	Both Sexes	Male	Female	Both Sexes	Male	Female	Both Sexes	Male	Female
Total	67%	74%	59%	25%	18%	33%	8%	8%	7%
15 to 24	59%	66%	52%	25%	18%	33%	16%	16%	15%
25 to 34	70%	78%	62%	26%	18%	35%	4%	4[E]%	3[E]%
35 to 44	71%	79%	65%	26%	18%	33%	3[E]%	3[E]%	X
45 to-54	71%	78%	64%	27%	18[E]%	35%	X	X	X
55 and over	72%	82%	61%	23%	15[E]%	31%	6[E]%	x	9[E]%

Source: Statistics Canada (2006).
Note: survey sample size was 15,490, and includes Inuit adults age 15 years and over.

As part of Inuit tradition, nearly every part of a harvested animal is used. For example, the meat is eaten; the skin is used as clothing or for arts and crafts; while bones, tusks, and antlers are carved into tools, toys, or other useful items (Inuit Tapiriit Kanatami 2013). Nutritionally, traditional foods such as caribou, seal, and Arctic char contain antioxidants, vitamins, phytochemical, and micronutrients believed to prevent diabetes and cardiovascular disease due to the concentration of fatty acids in these foods (Fergurson 2011). On the other hand, store-bought foods that are consistently available in the Kitikmeot communities tend to have higher levels of unsaturated fats, salt, sugar, and carbohydrates, which contribute to negative health outcomes.

Current challenges to harvesting and country foods consumption were reviewed in a recent report by the National Aboriginal Health Organization (NAHO) and included:

- fewer skilled hunters;

- fewer younger people skilled in the harvest and preparation of traditional foods;
- reliance on easy-to-prepare store foods;
- the wage economy and employment (leaving little time available for subsistence hunting);
- changes to traditions such as sharing as more individuals become engaged in the wage economy and western lifestyles generally; and
- increased costs associated with harvesting, such as equipment, fuel, and repairs (Carry and Carafagnini 2012).

These challenges were confirmed during community research conducted in winter 2012 with land users in the Kitikmeot Region (Section 9.3). Another challenge associated with continued country foods consumption is climate change, specifically the later freeze and earlier melt of sea ice which further restricts harvest activities. Continued country food harvest and consumption aids families in reducing the amount of food items they require from the local grocery stores. A recent study noted several issues associated with reduced country food consumption including digestive difficulties, food cravings, stress from worrying about food, and loss of identity (Statham 2012).

The harvesting and consumption of country foods is, in many ways, the basis for much of Inuit culture. Traditional gender roles that persist today were established to ensure the survival of the family and are grounded in the tasks or actions required to obtain and consume country foods. For example, within the family, the role of the male is defined by the physical ability to kill and retrieve large animals such as seal and caribou, while the role of the female is to prepare the animal for consumption and other uses (e.g., storage of fat for use in traditional lanterns). The role of younger males and females has been to watch and learn to perform tasks for which they will eventually take responsibility (Bruce n.d.). Although integration with the wage economy and other ideations of western society have no doubt altered these traditional gender roles to some extent, for many Kitikmeot families the division of household resources and responsibilities continues to reflect these traditional values.

There are also social activities within Inuit culture that are supported by the harvesting and consumption of country foods. The caribou harvest consists of a number of activities that: 1) support the maintenance and transfer of Inuit knowledge, 2) reinforce the traditional Inuit gender roles, and 3) guide interaction between Inuit. A community hunt provides an opportunity for adult males to transfer knowledge to younger males and creates a venue through which to display or model appropriate behaviours. For example, Inuit hunters are guided by respect for animals and demonstrate this by never beating or poking an animal after it has been killed (InterGroup Consultants Ltd. 2008). Modelling behaviour in a way that is culturally appropriate with the expectation that younger people will learn from this and adopt the behaviour is one component of social control, a mechanism used by Inuit to raise children, reduce social ills, and generally guide all individuals to act for the betterment or benefit of the family or group (Pauktuutit Inuit Women of Canada 2006). A community harvest is an opportunity to showcase or model Inuit values and behaviours, as is the case for the community feast, an event that traditionally highlighted the different roles in providing for the family. The benefits of harvesting and consumption of country foods for Inuit of all ages are both nutritional and cultural. Future policy and community programming will likely seek to support the continuation and enhancement of these activities.

9.2.2 Youth Participation in Harvesting Activities

There are GN-funded programs offered through the high schools in the region that aim to engage youth in activities on the land to facilitate the transfer of cultural knowledge and skill. Day trips on the land include teachings related to basic survival (Cambridge Bay Hunter Focus Group 2012). However, local hunters note that youth today are very different compared to youth in the past, preferring to stay within the communities. For example, even though experienced land users understand that an igloo provides much more warmth compared to a tent, youth prefer to stay in a tent out on the land. Youth are not currently learning certain skills, such as construction of an igloo (Cambridge Bay Hunter Focus Group 2012). Similarly, Kugluktuk land users reported that most youth do not learn traditional land use skills and believe this is linked to lower levels of hunting and trapping by community members overall. Specifically, during recent community research, participants noted the introduction of wage employment has decreased the amount of time people spend on the land, including time spent by experienced harvesters teaching land use skills: “It’s like the youth build a bubble over the community and don’t want to go outside of the bubble” (Kugluktuk Hunter Focus Group 2012).

In contrast, Bathurst Inlet or Omingmaktok youth reportedly participated in hunting, fishing, and trapping from a young age and are proficient in many of these skills and others that enable them to live off the land (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

9.3 HARVESTING ACTIVITIES, COUNTRY FOOD, AND WELL-BEING

Kitikmeot Region land users harvest food from the land for themselves, their families, and their neighbours. Animals typically consumed include caribou, muskox, rabbit, ptarmigan, fish, and berries, among others (Section 9.4). Sharing of country food takes place with Elders, widows, and women who are unable to harvest country food themselves, although Elders receive first priority (Cambridge Bay Hunter Focus Group 2012). “People share what they catch with everyone, especially those who can’t hunt for themselves. If someone asks you for country food you never say no.” Land users from Bathurst Inlet and Omingmaktok describe sharing country foods as a traditional act as country food belongs to everyone and sharing is an inherent Inuit tradition. Individuals offered country food will always accept; even if their freezers are already full (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). In discussing the system that governs the distribution of country foods, Bathurst Inlet and Omingmaktok hunters also reported community members do not typically request country foods; rather, Inuit know each other and know who is able to harvest and who is not. Hunters automatically share their take, and at times sharing takes place between communities. Each hunter has their own circle of friends and family they provide for (Cambridge Bay Hunter Focus Group 2012).

For some Inuit, participation in harvesting activities may be limited to evenings and weekends due to employment in the wage economy (employment rates among Inuit in the Kitikmeot communities ranges from approximately 39 to 56%; Section 7.1). However, for many individuals in the Kitikmeot communities, participation in harvesting is limited by factors associated with not being engaged in the wage economy, resulting in a lack of income and the means through which to purchase the necessary equipment and fuel. Many individuals are unemployed or do not participate in the labour force (in the Kitikmeot communities between 44 and 62% are either unemployed or do not participate in the labour force; Section 7.1). Within Inuit culture the ability to provide for one’s family and participate in harvesting activities has been linked to well-being and is a highly valued.

Although food subsidy programs such as Nutrition North and Food Mail aim to provide an affordable healthy diet for Inuit people, the composition of this diet is quite different from the foods Inuit have traditionally consumed to sustain themselves for generations. Fruit and vegetables thought to be an essential part of healthy diet are not naturally available in Nunavut and must be flown into the community at costs that make fresh produce often inaccessible to the majority of community members. The length of time to transport fresh food into the north usually results in short shelf lives and less appealing produce than what is available from southern retailers (National Aboriginal Health Organization 2004). The appropriateness of a traditional diet is best described by the following:

> *When one eats meat, it warms your body very quickly. But when one eats fruit or other imported food, it doesn't help you keep very warm. With imported food… you're warm just a short period of time. But [our] meat is different; it keeps you warm. It doesn't matter if it's raw meat or frozen meat… it has the same effect* (Freeman et al. 1998).

However, this is not a new issue for Inuit. In a discussion of the importance of whaling that took place in 1993, approximately 20 years ago, Walter Audla from Resolute Bay stated "…Not only do we like our own food better than the white man's, but we can't afford to live from the white man's food… That's why it is so important for us to protect our own food… Our hunting, our land, and our lives are ultimately connected; they cannot be separated" (Freeman et al. 1998). For these reasons, there are strong linkages between harvesting activities, country foods, and well-being of the Inuit.

9.4 CURRENT LAND USE IN THE REGIONAL STUDY AREA

Primary information about current land use activities was obtained through interviews with HTO representatives and local hunters. Additionally, in November and December 2012, land use focus groups were held with active hunters from Kugluktuk, Cambridge Bay, Omingmaktok and Bathurst Inlet; the land use information obtained from these focus groups is summarized in Figures 9.4-1 to 9.4-3. Travelling on the land, hunting, and fishing remain important cultural and subsistence activities for Inuit people in the Kitikmeot Region.

9.4.1 Land Users

Residents of Bathurst Inlet and Omingmaktok have recently relocated to Cambridge Bay; residents of Bathurst Inlet relocated approximately five years ago, while residents of Omingmaktok relocated in fall 2012. Both groups continue to return to their home communities each spring/summer and also make shorter trips throughout the year (e.g., at Christmas and during spring break). People from Bathurst Inlet and Omingmaktok would prefer to reside in their home communities if they could obtain employment locally. Approximately 10 years ago, the communities had services such as a health centre and schooling; however, these services were discontinued when the communities were re-designated as outpost camps (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Traditionally, Cambridge Bay Elders, who relocated approximately 40 to 50 years ago, would travel south to Bathurst Inlet and Omingmaktok in mid-April and would stay until October. Recent residents continue to return to the communities a number of times annually, from June to mid-August, again in December for approximately two weeks for the Christmas holidays, and also during the spring break in March for approximately two weeks (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Cambridge Bay residents have year-round access to the land and resources of Victoria Island. Some residents travel south to the mainland to hunt and fish in November; however, the timing of departure is dependent on weather and ice conditions. Many individuals travel to the mainland because they were born near Bathurst Inlet (Back River Project Research Program 2012).

A notable portion of Kugluktuk land users engage in harvesting activities close to the community and head out on to the land mainly on weekends and holidays. For this reason and others related to competition among land users, Kugluktuk land users were hesitant to map their personal hunting areas and reveal to their peers in the focus group which hunting locations had provided them with the most success. Land users noted the recent increase in pelt prices had created healthy competition among hunters and trappers, which furthered the preference to not disclose specific hunting areas. Rather, the group identified common travel routes used for hunting and other harvesting as well as specific locations that are locally known. As such, Figure 9.4.3 identifies travel routes used by hunters and trappers, and the location of animals rather than specific individual hunting areas.

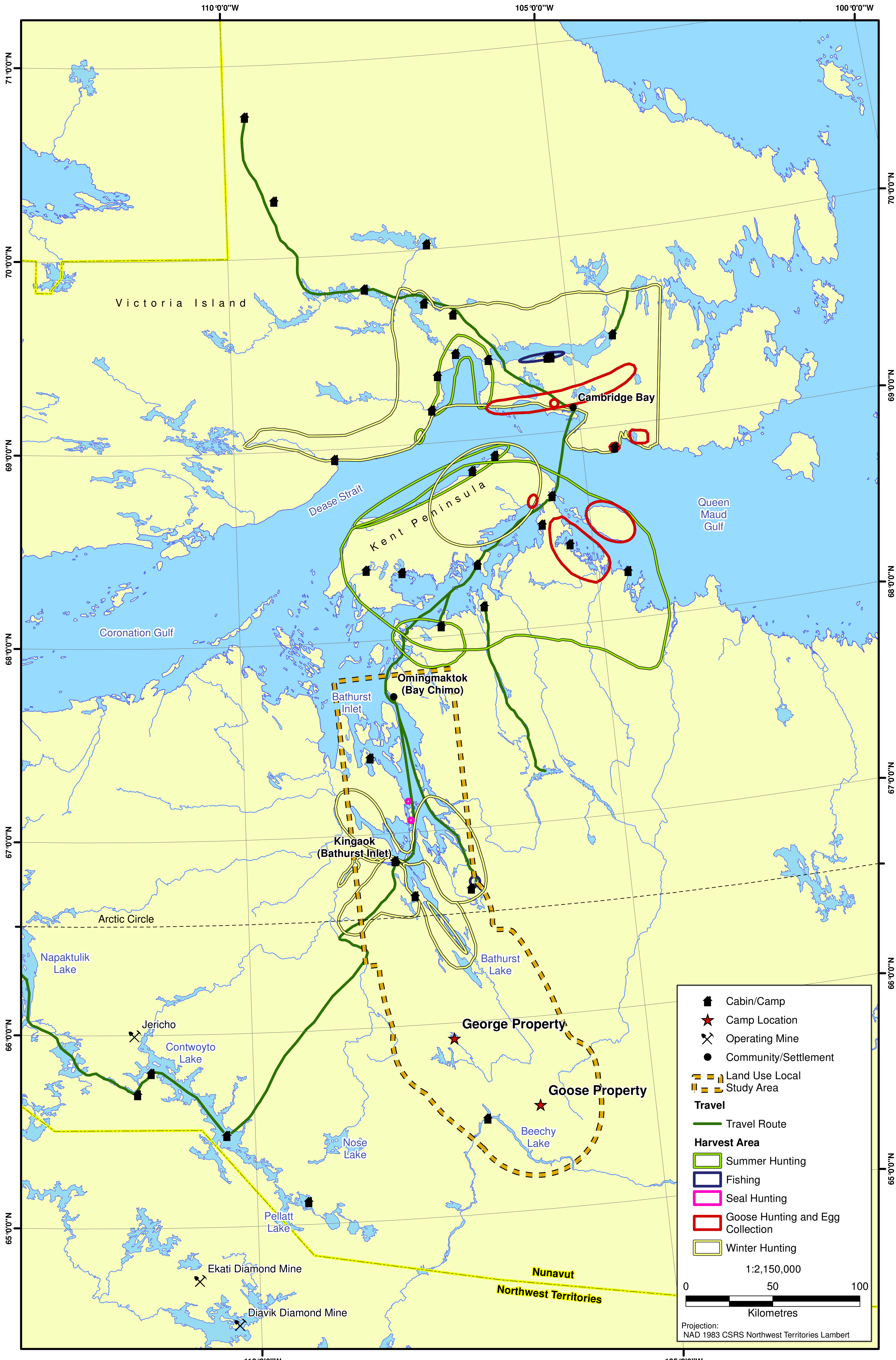


Figure 9.4-1

Sabina GOLD & SILVER CORP.

Land and Resource Use, Cambridge Bay (2012)

Figure 9.4-1

Rescan Engineers & Scientists

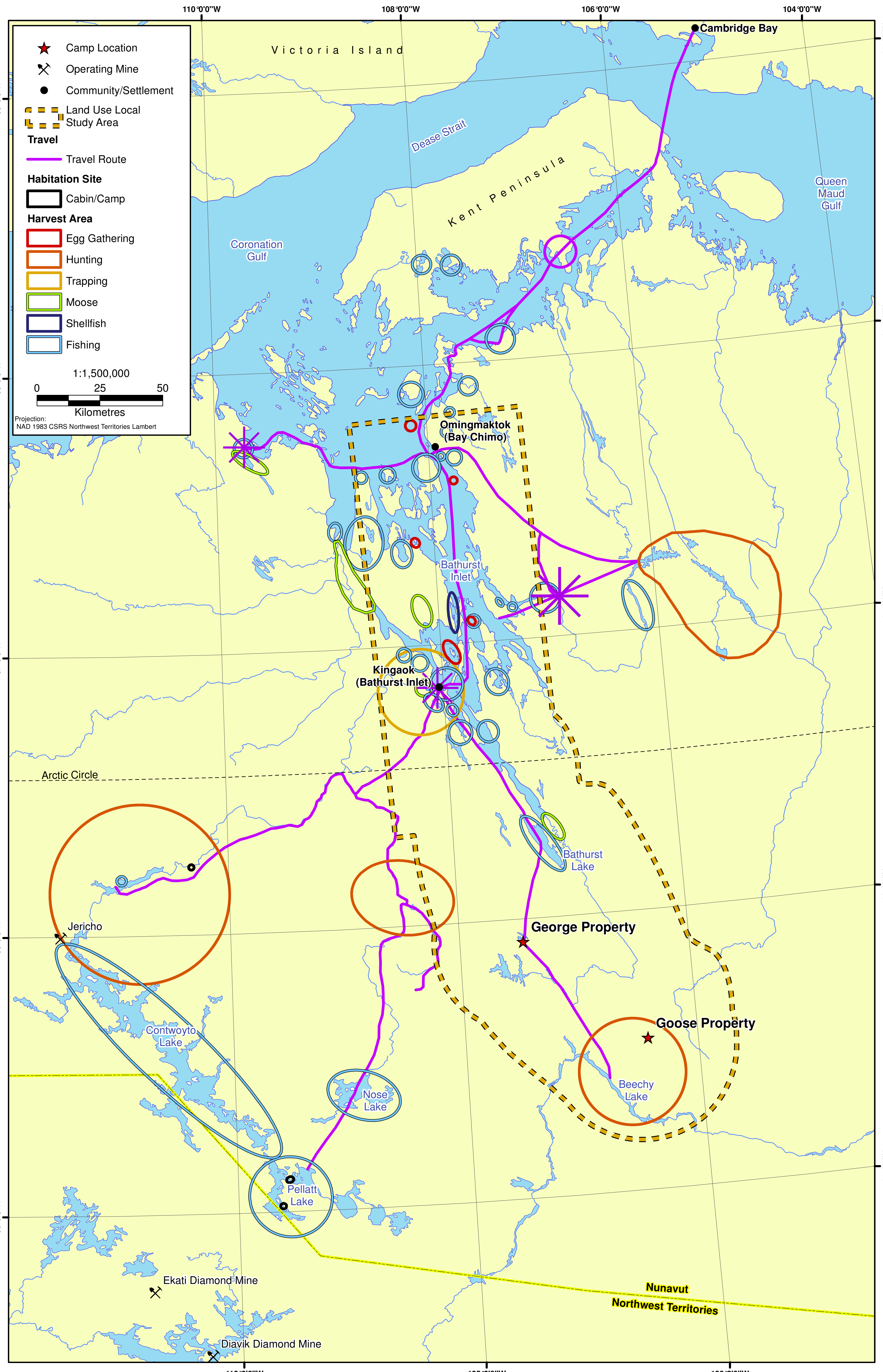


Figure 9.4-2

Land and Resource Use, Omingmaktok/Bathurst Inlet (2012)

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists

PROJECT # 0194096-0021 GIS # BAC-19-006c August 19 2013

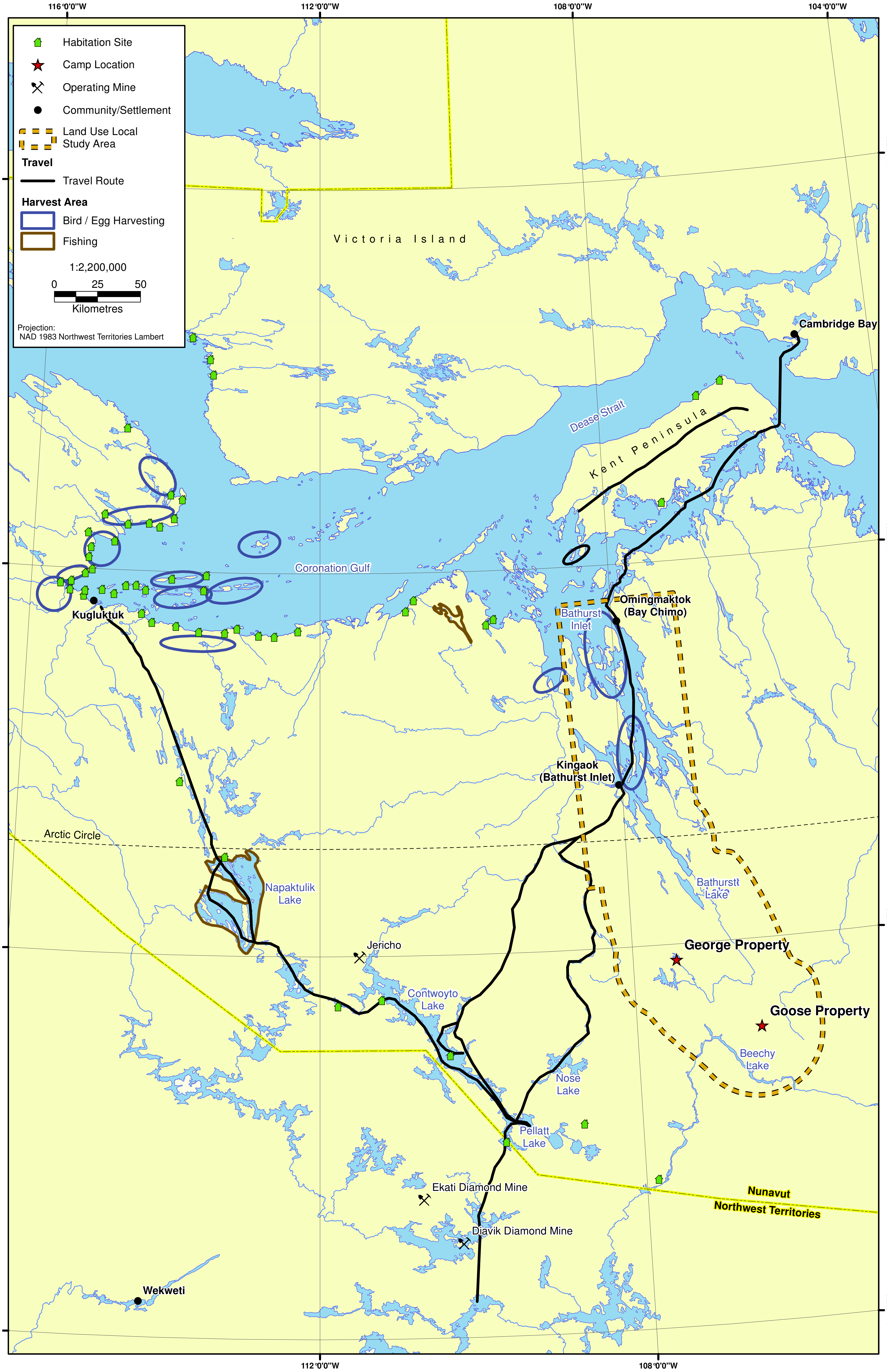


Figure 9.4-3

Land and Resource Use, Kugluktuk (2012)

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists

Although most Kugluktuk hunters and trappers are engaged in these activities near the community, some spend time travelling and harvesting across the mainland to Bathurst Inlet, as well as northeast to Victoria Island and elsewhere. Land users from Kugluktuk also travel from their community to Contwoyto, Nose and Pellatt Lakes, on to Bathurst Inlet, and north from there to Cambridge Bay. Certain land users noted that others travel by boat along the Coronation Gulf coastlines, in and around the Kent Peninsula, and beyond the community of Cambridge Bay (Kugluktuk Hunter Focus Group 2012).

Land users from Kugluktuk describe the integration of employment and subsistence living as requiring development of new land use patterns. The majority of land users who participated in the Kugluktuk focus group reported that those who effectively hunt and trap are able to do so because they are employed and have the means to purchase the fuel and equipment needed. However, those individuals are also limited in the amount of time they are able to spend on the land because they are employed and, consequently, spend the majority of their time on the land during weekends and holidays (Kugluktuk Hunter Focus Group 2012).

9.4.2 Hunting and Trapping

While the area is geographically difficult to access, hunting, trapping, fishing, and camping does take place throughout the RSA. Within Cambridge Bay, approximately 75% of people are active hunters, although this includes people originally from Omingmaktok and Bathurst Inlet (Cambridge Bay Hunter Focus Group 2012). Residents of Bathurst Inlet and Omingmaktok estimate there are between 10 to 20 active hunters who continue to hunt in the Bathurst Inlet area; these hunters noted seeing other hunters when spending time on the land (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Land users from Kugluktuk indicated approximately 80 to 90% of the community's population are active hunters and describe Kugluktuk as a hunting community. The group distinguishes between full-time hunters-those who are out on the land almost 365 days per year-and other hunters who mainly go out on weekends and holidays (Kugluktuk Hunter Focus Group 2012).

Hunters from Cambridge Bay stated that they travel in all directions from the community to hunt, fish, and partake in other traditional activities on the land. One travel route leads south to the areas east and south of Bathurst Inlet (Figure 9.4-1). The main species of focus for hunters from Cambridge Bay include caribou, wolf, and wolverine. Hunters from Cambridge Bay also hunt seal and geese and have recently begun to hunt grizzly bear as they are now present in the area. Although grizzly are not a species of focus, and are harvested due to opportunity or necessity, hunters consume grizzly when the occasion arises (Cambridge Bay Hunter Focus Group 2012). Similarly, hunters from Bathurst Inlet/Omingmaktok indicated grizzly are mainly hunted for sport, but will also be hunted on an opportunistic basis (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Hunters from Kugluktuk also noted an increase in the grizzly population; consequently, there has also been an increase in the number of grizzly harvested and consumed (Kugluktuk Hunter Focus Group 2012).

Land users from Bathurst Inlet and Omingmaktok hunt and fish in and near Bathurst Inlet, south to Contwoyto and Pellatt Lakes, east to Ellice River, and also north to Cambridge Bay and beyond (Figure 9.4-3). Much like hunters from Cambridge Bay, hunters from Bathurst Inlet and Omingmaktok travel out from their home communities and from Cambridge Bay in all directions and have adapted their land use since relocating to Cambridge Bay (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Land users from Kugluktuk reported travelling to areas around Bathurst Inlet to hunt, fish, trap, and harvest plants (Figure 9.4-3). Animals harvested in or near the Bathurst area include wolf, wolverine, moose, muskox, grizzly, weasel, martin, muskrat, lynx, Arctic hare, and various birds (Kugluktuk Hunter Focus Group 2012).

Species hunted and trapped near Kugluktuk and along the main travel route (Figure 9.4-3) from the community to Contwoyto Lake and eventually Bathurst Inlet, include muskox, caribou (Peary caribou, Bathurst caribou, Dolphin Union caribou, Beverly caribou, and Blue Nose caribou), wolf (including Arctic wolf, Western wolf, and Eastern wolf), fox (including cross fox, white fox, blue fox, and kit fox), wolverine, ptarmigan (willow ptarmigan and rock ptarmigan), geese (Canada goose, lesser goose, Brant goose, and snow goose), eider duck, trumpeter swan, and loons (red throated loons and common loons). Loons are mainly hunted for medicine and for use in making clothing and are only consumed when there is lack of other food. Similarly, seagulls and their eggs are harvested and consumed only if other food is unavailable (Kugluktuk Hunter Focus Group 2012).

As shown in Figure 9.4-1, geese, ducks, and other birds and their eggs are harvested along the shores of Bathurst Inlet in the spring, although eggs are also harvested more inland (Cambridge Bay Hunter Focus Group 2012). The goal of a one-week goose hunt that occurs in May is to harvest a quantity large enough to last through the winter (i.e., reported to be approximately 100 geese). Eggs are also collected during a goose hunt; typically, one family would fill four containers that measure about two feet by 36 inches and are 16 inches deep (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Much like hunters from Cambridge Bay, the species of focus for hunters from Bathurst Inlet and Omingmaktok are caribou, wolf, and wolverine, which can all be obtained near Beechy Lake (Figure 9.4-2). Other species of focus include fox, muskox, and eider duck. Hunters from Bathurst Inlet/Omingmaktok also harvest geese in the Bathurst Inlet area; the best time of year to harvest geese is reported to be in May and June and again in September. During the harvest in May/June, the eggs of geese and seagulls are also collected (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Hunters from Kugluktuk also identified a number of bird and egg harvesting areas. Harvesting of birds and eggs takes place in the spring and fall (Kugluktuk Hunter Focus Group 2012). Bird and egg harvest areas are shown in Figures 9.4-1 to 9.4-3.

Polar bear hunting was discussed by hunters from Kugluktuk who reported the community receives a set number of tags each year to hunt polar bear. Hunters from Kugluktuk also reported harvesting "grolar bears," a grizzly/polar bear hybrid that has become well known in western Nunavut (Kugluktuk Hunter Focus Group 2012).

Caribou hunting takes place year-round but is reported to be optimal just before the rut in the fall. In the summertime, caribou are hunted along the shores of the Coronation Gulf. Hunters from Cambridge Bay harvest approximately 20 to 30 caribou before the rut and approximately 5 or 6 more over the course of the year. Approximately half of these (25 to 35 caribou per year) would be kept by one family for personal use and the remainder would be distributed throughout the community. Another local hunter from Cambridge Bay noted his usual take was 30 to 40 caribou per year, with an additional 5 or 6 throughout the year; this amount provides food for himself, his family, and others in the community (Cambridge Bay Hunter Focus Group 2012). Hunters from Bathurst Inlet and Omingmaktok reported taking between 20 and 50 caribou per year, for personal consumption and to be shared with others (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Hunters from Bathurst Inlet and Omingmaktok reported that they often harvest moose on the shores of Bathurst Inlet and stated moose hunting is particularly successful near Omingmaktok and south of the community of Bathurst Inlet. Moose are hunted in both the summer and fall and because they are not regulated by a tag system, both cows and bulls can be harvested (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Moose harvest areas are identified in Figure 9.4-2.

Seal are hunted both traditionally and with a rifle. Traditional seal hunting includes standing over a hole in the ice (the breathing hole), often for hours at a time, until a seal appears. Land users report seal hunting is optimal in the spring. A hunter would typically harvest 20 to 30 seal per year, for both personal consumption and distribution. Some rivers are very deep and stay open year round; this type of environment is ideal for seal harvesting (Cambridge Bay Hunter Focus Group 2012). Seal and other marine harvest areas are indicated in Figure 9.4-1 and Figure 9.4-2, which indicates various hunting areas within the Bathurst Inlet. In Kugluktuk, marine harvesting mainly takes places on the western shores of the Coronation Gulf.

Land users from Bathurst Inlet and Omingmaktok harvest seal throughout the Bathurst Inlet area, along shores in the spring and fall, and on ice during the winter. The focus group indicated that there is a large seal population in Bathurst Inlet. Seal harvesting, as well as whaling, also take places closer to the community of Cambridge Bay. The species of focus for whalers is typically narwhal, although it is not uncommon to harvest beluga (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Land users from Kugluktuk also reported whaling activities that focus on beluga, narwhal, and bowhead whales. Killer whale, walrus, and the common minke whale have been observed near Kugluktuk but are not hunted. Harp seals and sea lions have also been recently observed near the community and are hunted (Kugluktuk Hunter Focus Group 2012). Marine mammals and other sea creatures harvested by land users from Kugluktuk include ringed and bearded seals, clams, lobsters, and crabs. Hunting for ringed and bearded seal takes place near Kugluktuk, on or near the western shores of the Coronation Gulf (Kugluktuk Hunter Focus Group 2012).

Wolf hunting is reported to be optimal near the wolf dens south of Bathurst Inlet; species hunted include timber wolf and Arctic wolf (Figure 9.4-1). Wolverine hunting takes place west of the southern end of Bathurst Inlet, near the Hackett River area, which is relatively rocky and hilly. Local hunters noted the area near Hackett River has “lots of wolverine… there’s a wolverine highway that is thirty feet wide with their tracks. You just have to sit there for one hour (along the Mara River) and you will see wolverine.” Ptarmigans, fox, and rabbits are also harvested around the Bathurst Inlet area. Ptarmigan are harvested for food during hunting trips. Wolverine are typically harvested in the winter when their furs are thicker. Wolves are hunted in March and April and are shot, rather than trapped. In the summer, people travel in boats along the shores of Bathurst Inlet, hunting caribou and fishing. The areas around Beechy Lake and Contwoyto Lake are used for hunting, fishing, and camping among other activities (Cambridge Bay Hunter Focus Group 2012).

Trapping activities are much less common today as compared to the past. Cambridge Bay land users report trapping activities are almost non-existent today. Land users link the decline in trapping activities to declining fur prices, pressure from international environmental organizations (i.e., Greenpeace and People for the Ethical Treatment of Animals) and the associated stigma which brought unwarranted shame on the traditional harvesting activities, and a lack of youth participation in harvesting activities. Some trapping continues to occur on Victoria Island; however, furbearers, such as wolverine, are shot rather than trapped since most hunting is done with a rifle (Cambridge Bay Hunter Focus Group 2012). Harvesters from Bathurst Inlet and Omingmaktok continue to trap animals during hunting trips (Figure 9.4-2); however, hunters did note a general decrease in trapping activities, as well as a decrease in discussions among hunters about trapping. While harvesters from Bathurst Inlet/Omingmaktok agreed furbearers are now shot rather than trapped, one harvester indicated he continues to use trapping as the method of harvest for wolf, wolverine, and fox near the community of Bathurst Inlet, as shown in Figure 9.4-2 (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Kugluktuk trappers did report a recent increase in trapping activities due to an increase in pelt prices that has occurred over the past year (Kugluktuk Hunter Focus Group 2012). The main travel route from the community of Kugluktuk to Contwoyto Lake is shown in Figure 9.4-3. This route is used by many different people who hunt, fish, trap, and harvest plants up to 200 km either east of west of the route. Furbearing animals are trapped along this route, specifically, wolf, wolverine, fox, marten, muskrat, and mink. However, the species of focus for trappers, due to pelt prices, are wolf, wolverine, and fox. Although Inuit do not use a trapline system, trappers know the boundaries of each other’s trapping areas and look out for each other (Kugluktuk Hunter Focus Group 2012). Despite the recent increase in trapping activities by Kugluktuk residents, land users believe overall trapping levels continue to be much lower as compared to the past (Kugluktuk Hunter Focus Group 2012).

9.4.3 Fishing

Prominent fishing areas are identified in Figures 9.4-1 to 9.4-3. Fishing occurs throughout the RSA and is not limited to specific areas. Although focus group participants note certain lakes and rivers are preferred, new lakes and rivers are often and commonly sought out and explored for pleasure and variety. Focus group participants stated the taste of the same type of fish is different depending on where the fish is caught (Cambridge Bay Hunter Focus Group 2012). People typically fish along travel routes as they make their way towards a hunting area. Methods of fishing include jigging and set net. Typically, people fish using nets in the winter and rods in the summer. Set net, which involves stringing a net down through two holes in the ice, is the main method through which Char are harvested (Cambridge Bay Hunter Focus Group 2012). People from Bathurst Inlet and Omingmaktok indicated that they return to their communities at spring break, a time of year that is ideal for jigging through the ice (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Focus group participants from Bathurst Inlet and Omingmaktok reported that fishing is common on the shores of Bathurst Inlet and in various lakes including Nose Lake and Pellatt Lake, which are both known as ideal fishing spots for lake trout. Contwoyto Lake is also a focus for people fishing for Arctic char. Lakes near Bathurst Inlet may be fresh water, salt water, or a mix of fresh and salt water (brackish). Marine areas around Omingmaktok are reported to be ideal for fishing cod. In the past, Bathurst Inlet and Omingmaktok land users fished cisco regularly; today, however, cisco is not as available. Species of focus for people who fish from Bathurst Inlet and Omingmaktok include Arctic char, lake trout, Arctic grayling, whitefish, and wolfish (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Land users from Bathurst Inlet and Omingmaktok harvest clams, seaweed, mussels, sea urchin, crabs, and star fish (Figure 9.4-2). Winter fishing occurs during travel south from Cambridge Bay, and for those from Bathurst Inlet and Omingmaktok, fishing efforts including ice fishing and jigging are concentrated in December and January and again over the summer from April until September/October (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Species caught include Arctic char, whitefish and roe, Arctic grayling, and cod from the ocean. Bathurst Inlet/Omingmaktok people return to the communities at Christmas break for approximately two weeks, as this time of year is ideal for ice fishing (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Focus group participants from Kugluktuk reported they “hunt the lakes” for Arctic char, whitefish, lake trout, burbot, cisco, Arctic grayling, wolfish, black cod, halibut, sculpin, and other species. The group indicated that Arctic char spawning takes place under high banks (Figure 9.4-3; Kugluktuk Hunter Focus Group 2012).

Land users generally harvest as many fish as they can carry, for their own consumption and that of their family and neighbours, and noted the ability of snow machines to pull up to 2,000 pounds of fish (Cambridge Bay Hunter Focus Group 2012). Land users from Bathurst Inlet and Omingmaktok reported taking as many fish as possible to feed the community, which was estimated at approximately 200 to 400 fish per year (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Equipment used for fishing depends on the season and may include boats, fishing rods, and nets (Cambridge Bay Hunter Focus Group 2012).

9.4.4 Plant Gathering

Plant harvesting commonly takes place during trips on the land for hunting, but also takes place on a regular semi-daily basis near the communities of Bathurst Inlet and Omingmaktok. Berries and vegetation are harvested on the mainland near Bathurst Inlet for consumption; harvesters gather as much as they can store. Species harvested include cloudberry, crowberry, mountain sorrel, and alpine berry. Plant harvesters indicated other plants are also gathered, but were unsure of the plant names. For example, one plant is used in the same way, and for the same purpose as a mosquito coil; this plant was described as one that doesn't flower, has a sweet and sour smell, grows low to the ground with pointed small leaves, and was green and red in color (Cambridge Bay Hunter Focus Group 2012). During a hunting trip, harvesters actively look for certain berries, particularly cloudberries, as these are preferred for consumption. While harvesters don't necessarily look for mahok (liquorice root) they can always find it if needed and do consume the plant root. Another species harvesters can find if needed is willow bark, which produces the same effect as aspirin when peeled from the bark and chewed (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012).

Plant harvesters from both Bathurst Inlet and Omingmaktok discussed harvesting seaweed from Bathurst Inlet. Kugluktuk harvesters explained that seaweed is dried and used as medicine or to preserve food (Kugluktuk Hunter Focus Group 2012). Although cotton grass is present in areas near and south of Bathurst Inlet, Cambridge Bay plant harvesters noted this was used traditionally in lamps, a practice that is no longer common. Fireweed is also present in the area but is no longer used (Cambridge Bay Hunter Focus Group 2012).

Land users from Bathurst Inlet and Omingmaktok consume sweet leaves, either raw as fresh greens or boiled as tea; the bearberry leaf and flower of Labrador tea are also used as teas. Other plants and vegetation gathered and consumed near Bathurst Inlet include mahok (liquorice root), crowberries (aka blackberries), bog cranberry, cloudberries, and blueberries. Bog cranberry may also be used as medicine and cloudberries are the preferred berry for consumption. Unlike plant harvesters from Cambridge Bay, plants harvesters from Bathurst Inlet and Omingmaktok continue to use cotton grass, specifically during traditional shows performed as part of tours offered through the Bathurst Inlet and Elu Inlet Lodges. Vegetation at Bathurst Inlet is described as lush and green and much taller than vegetation elsewhere on the mainland (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

9.4.5 Cabins and Camping

As shown in Figure 9.4-3, there are a number of cabins located near Bathurst Inlet. These include both personally owned cabins and trapper cabins used by anyone travelling in the area. In addition, there are campsites with permanent poles or tent posts, as well as preferred camping locations that do not have structures left in place (Cambridge Bay Hunter Focus Group 2012). People from Bathurst Inlet and Omingmaktok also identified a number of camps, cabins, and sites with tent posts as well as cabins developed by the government. A few years ago, the government provided funding to establish permanent cabins and camping sites, called survival cabins, to assist hunters during their travels. Focus group participants noted these are used often by hunters from Bathurst Inlet, Omingmaktok, and Cambridge Bay (Cambridge Bay Hunter Focus Group 2012). Land users from Kugluktuk indicated there are several cabins and camps along the main route from the community southeast to Nose Lake and Contwoyto Lake as well as along the shores of the Coronation Gulf (Figure 9.4-3). Kugluktuk land users identified a number of cabins at Pellatt Lake and Beechy Lake: "There are thousands upon thousands of cabins on there on the land, but not many are used anymore" (Kugluktuk Hunter Focus Group 2012).

9.4.6 Travel Routes

"We travel anywhere the animals are. We find tracks and we follow them" (Cambridge Bay Hunter Focus Group 2012).

The main travel route utilized by Kugluktuk land users stems from the community, south to Contwoyto Lake, and at times, land users travel beyond to Bathurst Inlet. The main travel route from Cambridge

Bay stems from the community, south to Kent Peninsula and on to Omingmaktok, and eventually the southern Bathurst Inlet area, on to Contwoyto Lake. Some land users take a more direct route from Cambridge Bay to Kent Peninsula and directly south to the Beechy Lake area, located southeast of Bathurst Inlet. However, Contwoyto Lake is also a destination for land users from Cambridge Bay. The main travel route for land users from Bathurst Inlet and Omingmaktok is now similar to those from Cambridge Bay, due to their recent relocation from Bathurst Inlet and Omingmaktok to Cambridge Bay; common destinations are Contwoyto, Pellatt and Beechy Lake. Land users from Bathurst Inlet and Omingmaktok may continue as far as the Ekati Diamond Mine, located approximately halfway between Bathurst Inlet and Yellowknife (Figures 9.4-1 to 9.4-3). Typically, this trip would take approximately two weeks. From this main route, hunting occurs everywhere within approximately 200 km of the route (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). There are other general travel corridors that are commonly used, but the exact route varies each time and is dependent on ice conditions and the purpose of the trip.

Some Cambridge Bay land users travel to a cabin at Akumak (Figure 9.4-1) in late March or early April; after April the ice starts to thaw and is no longer safe for travel. The amount of time each trip typically takes depends on the length of time land users choose to spend hunting. The distance travelled is often dependent on the amount of fuel carried. At times people travel just to see new land and enjoy the experience (Cambridge Bay Hunter Focus Group 2012).

Travel in the fall to the mainland from Victoria Island usually starts the last week of October or the first week of November, but lately this trip has been postponed later into the year as freeze-up has occurred later. During research conducted on November 2012, the ice was not stable enough for travel to the mainland. In 2011, the ice was not stable enough for travel until the first week of December (Cambridge Bay Hunter Focus Group 2012). Land users who travel south from Cambridge Bay (Figure 9.4-1) to the Beechy Lake area report the trip takes approximately one to two days. There are different areas to rest or make camp along the way. Most people travel this route from Cambridge Bay on snow machines and choose to overnight at cabins in Omingmaktok and make camp in the Beechy Lake area once they arrive (Cambridge Bay Hunter Focus Group 2012).

There is a main winter travel route from Cambridge Bay south through Elu Inlet, down to the community of Bathurst Inlet and the surrounding areas (Figure 9.4-1). However, there are many auxiliary routes that stem from this main route, some of which are alternative routes with the same end point, while others lead inland to different locations. Once land users reach the community of Bathurst Inlet, there are many directions that continue on to other harvesting areas. Two main areas people travel to include Contwoyto Lake and Pellatt Lake, both of which are preferred harvesting areas reported to be ideal for hunting and fishing, with several cabins located proximally. This route, from the community at Bathurst Inlet to the Contwoyto and Pellatt Lakes, is preferred for trapping due to the abundance of wolverine in this area, which is characterized by rocky and hilly terrain. People from Bathurst Inlet and Omingmaktok continue to travel, hunt, and fish along the historic route from Bathurst Inlet to Contwoyto Lake, and then northwest to Kugluktuk (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Land users also travel southeast to the Beechy Lake area from the community of Bathurst Inlet to camp or tent while they hunt, fish, and trap in the area. This area is reported to be ideal for harvesting caribou, wolf, and wolverine. Another popular area that Bathurst Inlet and Omingmaktok land users travel to is the Pellatt Lake area, where a few individuals own cabins. Other cabins at Pellatt Lake belong to the Bathurst Inlet Lodge (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

People travel from Cambridge Bay, south of Bathurst Inlet and almost halfway to Yellowknife, to the area around Lac du Grais Lake where the Ekati Diamond Mine is located. There are only a few places to cross the mountains south of Bathurst Inlet. The area near Hackett River is reported to be very rocky and difficult to travel across. This travel route passes through the area around Contwoyto Lake where there are many camps and a portion of the travel might include portage (Cambridge Bay Hunter Focus Group 2012). A longer trip, taken by a family, may begin in March and end in May. People typically travel with approximately 1,000 pounds of gear including food, gas, fish net, tent, chisel, scoop, and many other items. Travellers must carry everything they need to camp and cook, including food itself in case the hunt is not successful (Cambridge Bay Hunter Focus Group 2012). During trips on the land, travellers obtain water from the ice and snow (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Land users also travel for pleasure and discussed travelling to Kugluktuk and other communities to visit relatives (Cambridge Bay Hunter Focus Group 2012). Focus group participants reported using the same travel routes and area as there are only so many ways one can travel across a particular terrain (Kugluktuk Hunter Focus Group 2012).

In the past, people would travel by dog team; today people mainly travel by snow machine (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012). There is a travel route from the old weather station to Kugluktuk and back; a trip that was usually undertaken in April (Cambridge Bay Hunter Focus Group 2012). As recently as 15 years ago, people often travelled from Kugluktuk southeast to Pellatt Lake and on to Nose Lake. Travelling as a family, this trip would take approximately three days, whereas a hunter on their own could make the trip in approximately one day. The purpose of this trip was usually to visit family residing at Bathurst Inlet (Kugluktuk Hunter Focus Group 2012).

Travel can be made difficult because of weather and climate. The greatest challenge for hunters from Cambridge Bay is the lack of ice and snow that usually facilitates travel. Hunters stated their lifestyles have changed along with the change in climate. For example, since Cambridge Bay hunters must wait longer to travel south to the mainland, they tend to spend time harvesting inconnu (white fish) and their eggs on the island. Although these hunters state a preference for Bathurst Inlet Arctic char, they enjoy whitefish and lake trout while they are waiting to travel south: “We harvest what we can until we can get across and have learned to adapt since we can’t get to the mainland” (Cambridge Bay Hunter Focus Group 2012). Kugluktuk land users note the equipment required for going out on the land today is expensive to purchase and expensive to maintain. They further noted modern equipment is a liability when it breaks down (Kugluktuk Hunter Focus Group 2012).

9.4.7 Changes in Wildlife

During focus groups, hunters provided a number of observations regarding changes in wildlife. Changes to caribou migration were the most commonly discussed in all three focus groups. Overall, land users noted that caribou migrate in different directions at different times of year and link these changes to climate change (later than normal ocean freeze-up), development in the region, and human impacts (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Land users noted that muskox populations have recently declined (winter 2012) and link this to the increase in predator populations (specifically wolf and grizzly bear). Hunters noted they must travel further to obtain muskox (Cambridge Bay Hunter Focus Group 2012). This sentiment is echoed by hunters from Bathurst Inlet and Omingmaktok who report declining numbers of muskox and other animals preferred for food, such as caribou (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Grizzly bears are travelling further north, causing an increase in the number of grizzly bears in the Bathurst Inlet area. Local hunters also noted an increase in wolf populations in the Bathurst Inlet area. Wolves have been seen by local hunters in packs of over 30 wolves. Local hunters noted other animals are killing the muskox and not consuming the whole animal. For example, one local hunter remembered tracking a grizzly that killed seven adult bull muskox and only ate the fat and brisket, leaving the remainder of the animal to be scavenged by wolves and foxes. At the time research was conducted, local Cambridge Bay hunters were not taking muskox in order to allow the herd to recover. The number of wolves hunting muskox has also reportedly increased and one hunter noted that, recently, wolves were not interested in hunting caribou, but focused mainly on muskox (Cambridge Bay Hunter Focus Group 2012).

As a result of the increase in grizzly bear population, local hunters have made a recommendation to the GN Department of Environment that a bounty be established for grizzly in order to help control the population. Hunters with cabins near Bathurst Inlet noted difficulties with grizzlies breaking into their cabins and causing extensive damage (Cambridge Bay Hunter Focus Group 2012). Hunters from Kugluktuk also noted an increase in the grizzly population (Kugluktuk Hunter Focus Group 2012).

Land users from Kugluktuk have recently seen wolverine on the ocean ice, whereas in the past these animals were only seen in more southerly areas on the mainland (Kugluktuk Hunter Focus Group 2012). Cambridge Bay hunters noted changes in the migration patterns of caribou near Bathurst Inlet. When caribou cross from Victoria Island to the mainland, many reportedly migrate south on the east side of Bathurst Inlet, and then on to their calving grounds west of Bathurst Inlet near the shores of the Coronation Gulf (Cambridge Bay Hunter Focus Group 2012).

Land users from Bathurst Inlet and Omingmaktok noted there has been a dramatic decrease in cisco fish populations over the past 15 years. In the past, cisco could be found in water bodies containing trout and char. Another change noted by this group was related to animal health: “sometimes when we cut open the fish there are big blobs of yellow stuff, or sometimes when we cut open the caribou there is a really bad smell.” According to the focus group participants, both are signs of poor animal health, and in this situation harvesters will not consume or use the animal (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Similarly, harvesters from Kugluktuk stated: “We have seen changes in the animals, especially caribou. There are yellow spots on caribou and we can’t eat that. Dead fish have been seen floating down rivers where we haven’t seen this before” (Kugluktuk Hunter Focus Group 2012). Other changes seen by Kugluktuk harvesters include the presence of bowhead, killer whale, beluga, common minke whale, sea lion, and walrus in the Coronation Gulf (Kugluktuk Hunter Focus Group 2012). Hunters from Bathurst Inlet and Omingmaktok reported seeing new insects in areas those species haven’t been seen before and are uncertain how these insects came to be in these areas (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Kugluktuk land users also noted the presence of insects that haven’t been seen before. For example, grasshoppers are now present in Kugluktuk (Kugluktuk Hunter Focus Group 2012).

9.5 LAND USE ACTIVITIES IN THE LOCAL STUDY AREA

The following section describes land users, hunting, trapping, fishing, gathering, and travel within the land use LSA.

9.5.1 Land Users

Land use focus group sessions were held with participants from Kugluktuk, Cambridge Bay, Omingmaktok, and Bathurst Inlet. Subsistence land use in the LSA and nearby areas is illustrated in Figures 9.4-1, 9.4-2, and 9.4-3. Taloyoak, Gjoa Haven, and Kurtairojuark (based in Kugaaruk) HTO representatives indicated they are not aware of any of their members hunting or trapping in or near the Back River land use LSA. While land users from Kugluktuk did indicate hunting, fishing, and trapping within the land use LSA on occasion, their primary areas of activity are west of the LSA, near Contwoyto and Napaktulik Lakes, along the main route leading to Kugluktuk, and along the shores of the Coronation Gulf (see Figure 9.4-3).

Land users from Cambridge Bay, Omingmaktok, and Bathurst Inlet indicated that they hunt, trap, fish, and gather throughout the land use LSA. Individuals previously residing in Omingmaktok and Bathurst Inlet continue to spend a notable portion of the year in their home communities. Local hunters from the aforementioned communities indicated the land use LSA is used overall and is important for subsistence hunting, fishing, trapping, and gathering, as opposed to particular locations being important. While there are main travel routes within the area, land users follow animals and may take different routes at any time depending on weather conditions, the purpose of the trip, and other variables (Cambridge Bay Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

9.5.2 Hunting, Travel, and Cabins

Caribou was the commonly hunted species, during both the summer and winter. During the summer months, moose and caribou are hunted along the western shores of Bathurst Inlet in the summer and fall, at times while travelling Bathurst Inlet by boat (Figure 9.4-2). Bathurst Inlet residents reported that three moose were seen in the area in summer 2012. Hunters from Bathurst Inlet and Omingmaktok report harvesting a total of between 20 and 50 caribou annually (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Other commonly harvested species include wolf and wolverine. Within the land use LSA, there are many different destinations for hunters. For example, the area south of Bathurst Inlet, near Hackett River, is a destination for hunters seeking wolverine and wolves. This area is described as rocky and difficult to traverse, but also as having rich wolverine and wolf populations. As such, the area is a common destination and was specifically reported to be the trapping area of one focus group participant (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Within the land use LSA, Beechy Lake, a long narrow lake-expansion of the Back River, is a common destination for land users from Bathurst Inlet, Omingmaktok, and Cambridge Bay. The Beechy Lake area is used for hunting, trapping, fishing, gathering, camping, and variety of other recreation activities and is known as a particularly good area for caribou hunting. Bird hunting and egg collection also takes place at Beechy Lake; eider duck and Canada goose are a focus. Within the Beechy Lake area, the species of focus are caribou, wolf, and wolverine (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Beechy Lake is also a main destination for hunters from Cambridge Bay who travel south from the community during the winter and typically overnight at Omingmaktok; these individuals continue their travel south through Bathurst Inlet on snow machines while fishing Arctic char along the way. Upon arrival at the Beechy Lake area, there are numerous places to make camp, including many old cabins and some currently used cabins. The Beechy Lake area is a destination land users choose to spend longer periods of time, sometimes when travelling with their families, due to the rich wildlife and scenic nature views. Hunters from Cambridge Bay reported participating in caribou hunts at the Goose and George Lakes. Areas along the Mara River, just west of the land use LSA, were reported as particularly important for wolverine and wolf hunting/trapping. Ptarmigan and rabbit are also found in areas along the Mara River, which is a commonly used travel area leading from the community of Bathurst Inlet. Hunters often travel along the Mara River, hunting wolverine and wolves as they travel south to Contwoyto Lake. Wolf and wolverine hunting is common in March and April (Cambridge Bay Hunter Focus Group 2012).

Seal are hunted throughout Bathurst Inlet, within the land use LSA. Prominent seal harvest areas are located on the western shores of Bathurst Inlet, north of the community of Bathurst Inlet (see Figure 9.4-1). Focus group participants made numerous references to open water in and near Bathurst Inlet, noting these areas are particularly optimal for seal harvesting (Cambridge Bay Hunter Focus

Group 2012). Hunters from Omingmaktok and Bathurst Inlet hunt seal in the spring and fall along the shores of Bathurst Inlet (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

There are many camping areas and cabins located within the land use LSA, including older locations that are no longer used, old locations that continue to be used, and new cabins constructed recently by current land users. One focus group participant indicated the location of his new cabin which was constructed in 2011 within the land use LSA (Cambridge Bay Hunter Focus Group 2012). Additionally, each focus group participant from Cambridge Bay, Omingmaktok, and Bathurst Inlet had hunting areas either completely or partially within the land use LSA (Cambridge Bay Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Hunters from Bathurst Inlet and Omingmaktok noted four different moose hunting areas on the shores of Bathurst Inlet and Bathurst Lake. Additionally, numerous bird and egg harvesting areas were indicated along the shores of Bathurst Inlet, Bathurst Lake, Beechy Lake and many others. One focus group participant's main caribou hunting area, specifically an area through which the Bathurst herd migrate, is partially within the land use LSA and north of the Hackett River. Grizzly is hunted as part of a sport hunt or on an opportunistic basis. Fox is also harvested near and south of the community of Bathurst Inlet. Muskox is harvested east of the land use LSA (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

9.5.3 Fishing

Within the land use LSA, fishing takes places throughout Bathurst Inlet, on surrounding lakes such as Beechy Lake, and at many others lakes; fishing is not limited to the specific identified areas. Species harvested in the land use LSA include Arctic char, lake trout, whitefish, cod, wolfish, and Arctic grayling (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Areas along Bathurst Inlet are also reported to be good for harvesting clams, mussels, sea urchin, starfish, and crab. There are many fishing areas in, along, and near Bathurst Inlet. Harvesters take approximately 200 to 400 fish each per year, enough to feed their families and neighbours. Fishing often takes place in the Beechy Lake area as people camp there and hunt, fish, trap, and gather. In the past, cisco was also a species of focus and was harvested mainly from brackish water; however, focus group participants indicated cisco is no longer plentiful (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

Fishing occurs throughout the year and includes both jigging and set net methods. Focus group participants from Bathurst Inlet and Omingmaktok indicated ice fishing takes places over the Christmas holidays and jigging takes place during spring break, in and near Bathurst Inlet within the land use LSA (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Land users from Cambridge Bay target Arctic char, using the set net method, as they travel south to the Beechy Lake area. Deep lakes are reported to be the best environments for fishing Arctic char and lake trout, which are often harvested during the course of hunting trips. Species of focus for fishers from Cambridge Bay include Arctic char, whitefish, Arctic grayling, cod, and clams. Cambridge Bay fishers reported the southern end of Bathurst Bay is known as the best place to fish Arctic char in the region. Similarly to land users from Bathurst Inlet and Omingmaktok, Cambridge Bay residents harvest fish primarily for food to provide for their families and neighbours (Cambridge Bay Hunter Focus Group 2012).

9.5.4 Plant Gathering

Within the land use LSA, cloudberries are regularly harvested and frozen for later consumption (Cambridge Bay Hunter Focus Group 2012). Bathurst Inlet and Omingmaktok land users reported harvesting plants and other vegetation in the land use LSA, including sweet leaves, bearberry, blueberries, mahok, bog cranberry, crowberry, and cloudberry, which have the following uses:

- Sweet leaves (mountain sorrel) are eaten raw as fresh greens or are used as tea.

- Bearberry leaves are used as tea and are called “kublakot” or “Kublak.”
- Mahok is liquorice root which is consumed.
- Bog cranberry is consumed and also used as a form of medicine.
- Crowberries (black berries) are consumed and are called “paungak.”
- Cloudberries are the preferred berry for consumption and are referred to as “akpik (Bathurst Inlet and Omingmaktok focus group participants reported keeping their freezers stocked with cloudberries as much as possible).

Focus group participants from Bathurst Inlet and Omingmaktok indicated that although cotton grass is not widely used now, it continues to be used during shows performed as part of local eco-tours offered through the lodges. Participants also made note that vegetation and plant life in and around the Bathurst Inlet area is quite different from what is available on Victoria Island, and stated vegetation near Bathurst Inlet is more lush (grows higher and is more green in colour; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

9.5.5 Travel

Residents of Bathurst Inlet and Omingmaktok travel from Cambridge Bay to their home communities multiple times throughout the year. A number of Cambridge Bay residents were born in or near the communities at Bathurst Inlet and relocated to Cambridge Bay as children. These individuals also continue to spend time in the Bathurst Inlet area hunting, trapping, fishing, and gathering. Most travel within the land use LSA is by snow machine over ice and land. During the ice-free months, travel is mainly by ATV and boat (Cambridge Bay Hunter Focus Group 2012).

Within the land use LSA, there are many travel routes. One common route used by focus group participants from Bathurst Inlet, Omingmaktok, and Cambridge Bay extends from Cambridge Bay to the community of Bathurst Inlet and on to either Beechy Lake or Contwoyto Lake. Local travel patterns are seasonally dependent and often depend on ice conditions, as travel by snow machine between the mainland and the island can only take place once the ice has formed. Travel over the Coronation Gulf is beginning later in the year, typically during the first or second week of December, as the ice is freezing later as compared to past years. Travel on the land is facilitated by a number of camps and cabins located in known areas throughout the region (Figures 9.4-1 and 9.4-2; Cambridge Bay Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012).

10. Regional Transportation

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As there are no roads between the Kitikmeot communities, aircraft is the main method of travel in the region. Other types of traffic include marine vessel and ATV in the summer months, and snowmobile during winter months. Cruise ships also operate in the area, especially through the renowned Northwest Passage. Barges (the sealift) deliver annual provisions to communities during the ice-free period. The sealift includes food, household items, construction supplies, heavy equipment, and fuel, among other supplies. Most communities have a barge dock facility that receives barge service from the Northern Transportation Company Ltd. (NTCL) or Nunavut Sealift and Supply Inc. (NSSI) each year. NTCL has provided shipping services to the Kitikmeot Region since the mid-1960s and since the completion of a mine rail line through the primary shipping point at Hay River. NSSI first began to provide services to the region in 2008, providing competition to NTCL (Mariport Group 2009). The western Kitikmeot communities, including Bathurst Inlet and Omingmaktok (NTCL 2013), are usually serviced by NTCL, while Gjoa Haven and Taloyoak are typically serviced by NSSI; however, both companies may provide shipping services to these Kitikmeot communities (NSSI 2011).

Kugaaruk, the most easterly located Kitikmeot community is grouped, for shipping purposes, as one of the High Arctic communities along with Arctic Bay, Pond Inlet, and Resolute Bay. Sealift arrives in Kugaaruk via transhipment from Nanasivik by Coast Guard vessels, typically from the eastern sealift service providers such as Mariport and NEAS. Prior to 1994, all cargo was airlifted into Kugaaruk due to access issues through Pelly Bay. In 2008, Kugaaruk received three sealift shipments, one from NEAS and two from NSSI (Mariport Group 2009).

The GN contracts sealift services for itself and all Nunavut communities collectively. Sealift is facilitated by the GN Department of Community and Government Services (CGS) who have worked since 2005 with the aim of enhancing the annual sealift by updating contract concepts, provisions, and language. This resulted in relatively stable shipping costs despite increases in fuel costs. Coupling GN cargo requirements with community cargo needs guarantees volume to the shipper, which in turn enables the negotiation of lower shipping rates. Sealift contracts require service to all communities by shipment region and extended contract periods; two conditions that have enabled major carriers in the region to significantly upgrade and enhance their fleets (Mariport Group 2009).

In 2008, NSSI made one community call to each Kugluktuk, Cambridge Bay, Gjoa Haven, and Taloyoak. The same year, NTCL made four community calls to Kugluktuk, three to Cambridge Bay, one to Bathurst Inlet, two to Gjoa Haven, and two to Taloyoak. NEAS and NSSI both provided service to the eastern Kitikmeot communities of Gjoa Haven and Taloyoak in 2008. In 2009, sealift services were offered by NEAS and NSSI as a private venture and the companies were able to offer the same low rate per revenue tonne, $508.46, while NTCLs rate per tonne for GN contracted shipping out of Hay River was $956.97. Notably, the private venture had comparative advantage. In 2009, Mariports rate per revenue tonne to Nanasivik was $387.38, notably lower as compared to GN contract rates in other Kitikmeot communities. Being one of the smaller, difficult to access communities, sealift costs for Kugaaruk would likely be much higher without the GN contract system (Mariport Group 2009).

Cambridge Bay received a shipment from eastern arctic shipper NEAS which originates from Valleyfield, QC in 2009 at the rate of $508.46 per 1,000 kg or 2.5m^3. In comparison, NTCL also shipped to Cambridge Bay that year, at rates of $839.92 per 1,000 kg or 2.5m^3 from Hay River and $452.03 per 1,000 kg or 2.5m^3 from

Richmond, BC. Comparatively, the cost to ship from Richmond, BC is advantageous (Mariport Group 2009). Rates per revenue tonne to Kitikmeot communities were as follows in 2009:

- GN contract via Hay River - $676.97;
- private via Richmond, BC: $452.09; and
- private via Montreal area: $508.46.

The coupling of GN and community sealift cargo in contracts aims to guarantee service to all communities and lower, stable shipment rates. In 2009, NTCL began using shipping routes starting near Vancouver, BC and extending north along the coast. NTCL's shipping route for the western Arctic travels north along the coast from Delta, BC, around Point Barrow and east to the Kitikmeot communities of Kugluktuk, Cambridge Bay, Gjoa Haven, and Taloyoak. This route enabled NTCL to offer rates lower than NEAS and NSSI in 2009. However, in mid-2011, NTCL cancelled shipping along the British Columbia coast route due to loss of a major mining-related contract with Newmont Mining (CBC News 2011).

In 2013, shipping costs to Kugaaruk were less than shipping costs to the other Kitikmeot communities (the NEAS and NSSI rate per revenue tonne to Kugaaruk via transhipment from Nanasivik was approximately $350.70, while other Kitikmeot communities paid $427.99 per revenue tonne). NSSI and NEAS will provide sealift to each of the Kitikmeot Region communities in 2013, with the exception of Bathurst Inlet and Omingmaktok, but including Kugaaruk (via Nanasivik). For 2013, NTCL's general cargo rate was $420 per revenue tonne (1,000 kg or 2.5 m^3) for Kugluktuk, Bathurst Inlet, Cambridge Bay, Omingmaktok, Gjoa Haven, and Taloyoak. NTCL has scheduled one trip to Taloyoak and Gjoa Haven and two trips to Kugluktuk and Cambridge Bay (NEAS 2013; NSSI 2013; NTCL 2013).

All Kitikmeot communities, with the exception of Bathurst Inlet and Omingmaktok, are accessible by scheduled air travel provided by First Air and Canadian North. Air travel is used for cargo deliveries as well as passenger travel. All communities are also serviced by chartered air travel by a number of companies based in Yellowknife and Edmonton. There is a weekly charter flight from Yellowknife that travels to Bathurst Inlet during the operating season of the Bathurst Inlet Lodge (usually a six week period in the early summer).

11. Summary

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Nunavut was created as a separate territory in 1999 in accordance with the *Nunavut Land Claim Agreement Act* (1993b) and the *Nunavut Act* (1993a). As part of the creation of Nunavut, the NLCA was negotiated between the Government of Canada and the people of Nunavut. In accordance with the NLCA, numerous governance institutions were created to operate separately, yet often cooperatively, with the GN. In addition to territorial governance, there is hamlet governance for each community. Hamlet governments are typically responsible for public works, operations and maintenance, water, sewer, waste management, fire protection, wellness, justice, and economic development. Hamlet governments also lead community planning with the assistance of the GN.

Within the Kitikmeot Region there are seven communities—Bathurst Inlet, Omingmaktok, Cambridge Bay, Kugluktuk, Gjoa Haven, Taloyoak, and Kugaaruk. Cambridge Bay, a traditional hunting and fishing location, is the largest community, acting as a regional hub for government and business, as well as transportation to and from the region. Kugluktuk and Gjoa Haven have slightly smaller but growing populations, with growth primarily attributed to opportunities in the government and mining sectors. Gjoa Haven, Taloyoak, and Kugaaruk have economies that are mainly based on the public sector and traditional subsistence land-based activities (Statistics Canada 2007b). Bathurst Inlet and Omingmaktok have seasonal populations related to traditional land-based activities and the tourism industry. All communities have exceptionally young populations as compared to the rest of Canada, with Kugaaruk's population being the youngest.

Formal education levels are low in all the Kitikmeot communities when compared to Canadian averages. The proportion of the population with formal education is slightly higher in Cambridge Bay, but is still well below the Canadian average. Kitikmeot communities have high rates of unemployment among men and women. In 2006, the potential labour for the region was approximately 3,490 people, with an active labour force of 2,200 people, indicating a 63% participation rate—lower than the Nunavut average of approximately 65% (Statistics Canada 2007b). Among Kitikmeot communities, unemployment rates are typically higher than the Nunavut average (15.6%), ranging from 29.6% in Gjoa Haven to 21.3% in Kugaaruk, with the exception of Cambridge Bay, where the unemployment rate was 9.7%. Income, both individual and household, is typically higher in Cambridge Bay than in the other Kitikmeot communities, and a greater percentage of income in Cambridge Bay comes from employment than in other Kitikmeot communities. The proportion of income from government transfers in Kitikmeot communities, other than Cambridge Bay, is typically higher than the Nunavut average.

With respect to health within Kitikmeot communities, relatively high suicide rates are a concern. This has been attributed to recent rapid social change, resulting in a loss of self-reliance and a sense of discontinuity (GN et al. 2010). Crime rates among Kitikmeot communities are highest in Cambridge Bay, Kugluktuk, and Gjoa Haven. Kugaaruk typically has low crime rates in relation to other Kitikmeot communities. General community well-being, as described by AANDC's CWB indicator, was relatively low within Kitikmeot communities. Cambridge Bay and Kugluktuk scored somewhat higher, on or above the Nunavut average. Taloyoak, Kugaaruk, and Gjoa Haven scored exceptionally low (53, 55, and 56, respectively), particularly on the housing component of the index (27, 29, and 26, respectively). Housing challenges exist in all Kitikmeot communities. A high proportion of homes are crowded, especially in Gjoa Haven, Taloyoak, and Kugaaruk (57, 56, and 50%, respectively). Public housing is the most common type of tenure, and dependence on the public sector for housing is likely to continue given severe economic, climatic, and geographic constraints on private sector involvement.

Overall, the Kitikmeot economy is characterized as mixed and is focused across three major sectors—public, private, and traditional. The public sector dominates and acts as a major economic driver for local communities. Cambridge Bay has a more diversified economy than the other communities, and is increasingly expanding into the private sector. Regional economic development is constrained by a lack of skilled labour, lack of infrastructure, and difficulties with transportation and distance from outside markets. The traditional subsistence economy is of great importance to livelihoods in the Kitikmeot Region. Many individuals within the communities are actively engaged in the traditional economy, and there is evidence that participation is increasing. Harvest activities include hunting, fishing, trapping, and gathering. Maintaining cultural knowledge, education, language, activities, and values are of high importance in Kitikmeot communities. Traditional camps and other education activities are organized for youth, which allows them to learn about Inuit cultural and traditional practices through direct involvement.

As outlined in the NLCA, there are two main types of land tenure in Nunavut-IOL and Crown land. IOL is land that is vested in a Designated Inuit Organization, while Crown land is administered directly by the federal government. Access and rights are administered by RIAs for IOL and by AANDC for Crown land. Various licences are required to access both types of land depending on the nature of the proposed projects. The Back River Project properties are located on both IOL and Crown land.

There are both cultural and commercial land uses in the vicinity of the Project. Cultural land use typically consists of hunting, trapping, fishing, camping, and travelling, and is guided by a longstanding relationship of reciprocity and respect between Inuit people and their environments. Commercial land use consists primarily of sport hunting, tourism, mineral exploration, and transportation and shipping. Participation in the subsistence economy remains high and includes the majority of Kitikmeot residents.

Subsistence land use such as hunting, fishing, trapping, and gathering, takes place throughout the RSA. Caribou, wolf, and wolverine were the most commonly hunted species; however, marine harvesting for seal and other species was also common. Beechy Lake is a preferred destination for hunters who are active in this area and is reported to have rich wildlife, scenic nature views, and availability of camps and cabins. While there are main travel routes within the area, land users follow animals and may take different routes at any time depending on weather conditions, the purpose of the trip, and other variables.

Fishing also takes place throughout the land use LSA, in Bathurst Inlet, and in various lakes and rivers. Species of focus within the LSA include Arctic char, lake trout, whitefish, cod, wolffish, and Arctic grayling. Other species harvested from Bathurst Inlet include clams, mussels, sea urchin, starfish, and crab. Cloudberries, sweet leaves, bearberry, blueberries, mahok, bog cranberry, crowberry, and cloudberry are harvested throughout the LSA (Cambridge Bay Hunter Focus Group 2012; Omingmaktok/Bathurst Inlet Hunter Focus Group 2012). Land users travel within the LSA by snowmobile in the winter and by boat or ATV in the summer following seasonally dependent travel routes.

Land use within the LSA reflects current land use patterns throughout the western Kitikmeot region. Land users indicated specific locations of use within the land use LSA but also use the surrounding areas to conduct harvesting activities.

References

References

1985. *Territorial Lands Act*, RSC. C. T-7.

1988. *Liquor Act*, RSNWT (Nu). C. L-9.

1991. *Federal Real Property and Federal Immovables Act*, SC. C. 50.

1993a. *Nunavut Act*, SC. C. 28.

1993b. *Nunavut Lands Claim Agreement Act*, SC. C. 29.

2002. *Nunavut Water and Nunavut Surface Rights Tribunal Act*, SC. C. 10.

2008. *Inuit Language Protection Act*, SNu. C. 17.

AANDC. 2010. *Revised Nothern Food Basket* http://www.aadnc-aandc.gc.ca/eng/1100100035986/1100100035987#ktkm (accessed January 2013).

AANDC. n.d. *The Community Well-Being Index (CWB): Measuring Well-Being in Inuit Communities, 1981-2006*. http://www.aadnc-aandc.gc.ca/DAM/DAM-INTER-HQ-AI/STAGING/texte-text/rs_pubs_cwb_rotic_1344870003735_eng.pdf (accessed January 2013).

Aarluk Consulting. 2007a. *Ikaluktutiak/Cambridge Bay Community Plan, 2007 to 2027*. Draft. Prepared by Aarluk Consulting for the Council of the Hamlet of Cambridge Bay: Cambridge Bay, NU.

Aarluk Consulting. 2007b. *Uqsuqtuuq/Gjoa Haven Community Economic Development Plan, 2008 to 2012*. Prepared by Aarluk Consulting for the Gjoa Haven Hamlet Council Economic Development Committee: Gjoa Haven, NU.

ACIA, ed. 2005. *Arctic Climate Impact Assessment*. New York, NY: Cambridge University Press.

Association of Canadian Community Colleges. 2010. *Colleges Serving Aboriginal Learners and Communities: 2010 Environmental Scan – trends, programs, services, partnerships, challenges, and lessons learned*. http://www.afn.ca/uploads/files/accc-communities.pdf (accessed November 2012).

Atuqtuarvik Corporation. 2011. *Corporate Profile*. http://www.atuqtuarvik.com/english/vision.php (accessed August 2011).

Back River Project Research Program. 2012. *Rescan Research Program, Back River Project: Interviews in Kugluktuk, Cambridge Bay, Gjoa Haven, Kugaaruk, and Taloyoak (September 17 to October 2, 2012) and Focus Groups in Cambridge Bay and Kugluktuk (November 24 to December 7, 2012)*. Rescan Environmental Services Ltd., September 17 to October 2, 2012 and November 24 to December 7, 2012, Interviews and focus groups.

Bayswater Consulting Group. 2004. *Nunavut Housing Requirements, Needs and Demand to 2016: Background report for a Ten-year Nunavut Housing Strategy*. Prepared for the Government of Nunavut and Nunavut Tunngavik Inc. by Bayswater Consulting Group Inc.: Ottawa, ON. http://www.tunngavik.com/category/nti-documents/housing/ (accessed March 2011).

Bruce, K. n.d. *A Comparison of Ju/'hoansi and Inuit Gender Roles and the Division of Labour*. http://www.academia.edu/1980516/Gender_and_Gender_Role_Comparison_Between_the_Ju_hoansi_and_the_Inuit (accessed July 2013).

Cambridge Bay Childcare Society. 2013. *About Us*. http://www.cambridgebaydaycare.com/registrationrates.html (accessed July 2013).

Cambridge Bay Hunter Focus Group. 2012. *Hunter, Trapper Focus Group, Cambridge Bay, December 30, 2012*. Rescan: Cambridge Bay, NU.

Canada Northern Economic Development Agency. 2013. *Northern Economic Index*. http://www.north.gc.ca/aa/nei1112/nei1112-eng.pdf (accessed June 2013).

Canadian Northern Economic Development Agency. 2012. *Northern Economic Index 2011-2012*. http://www.north.gc.ca/aa/nei1112/nei1112-eng.asp#chp2e (accessed May 2013).

CanNor. 2012. *CanNor Invests in Nunavut's Traditional Economy* http://www.north.gc.ca/mr/nr/2012/cannor-12-018nr-eng.asp (accessed February 2013).

CanNor and KIA. 2012. *Memorandum of Understanding between the Canadian Northern Economic Development Agency and the Kitkmeot Inuit Association with respect to Cooperation for the Coordination and Management of Major Projects in the Kitikmeot Region*. http://www.north.gc.ca/aa/mouKIA-eng.pdf (accessed February 2013).

Carry, C. and L. Carafagnini. 2012. *Profiles of Food Security Activities in Inuit Communities*. http://www.naho.ca/documents/it/2012_Inuit_Food_Security_Profiles.pdf (accessed July 2013).

CBC News. 2011. *NTCL drops Arctic sealift route from B.C*. http://www.cbc.ca/news/canada/north/story/2011/06/20/ntcl-richmond-arctic-barge.html (accessed January 2013).

CBC News. 2012a. *Nunavut had near record-high suicides in 2011*. http://www.cbc.ca/news/canada/north/story/2012/01/31/north-nunavut-suicide-rate.html (accessed January 2013).

CBC News. 2012b. *Nunavut unveils new high school curriculum*. http://www.cbc.ca/news/canada/north/story/2012/02/10/north-nunavut-school-curriculum.html (accessed November 2012).

Centre for the North. 2012. *Mining Potential Gives the Territories Bright Economic Prospects*. http://www.centreforthenorth.ca/blogs/latestnews/miningpotentialgivestheterritoriesbrighteconomicpr (accessed April 2013).

City of Yellowknife. 2011. *Yellowknife Community Profile*. http://www.yellowknife.ca/Assets/Economic+Development/CommunityProfile-2011.pdf (accessed July 2011).

Cousins, G., D. E. Smither, D. St. Denis, R. Sinclaire-Chenier, and L. Thomas. 2006. *Banking with Broadband*. http://www.nunavut-broadband.ca/PDF/QINIQ_Financial_Services.pdf (accessed August 2013).

Dawson, S. 2012. Kitikmeot Foods cancels Cambridge Bay muskox hunt. *Nunatsiaq Online*, December 18, 2012. http://www.nunatsiaqonline.ca/stories/article/65674kitikmeot_foods_cancels_cambridge_bay_muskox_hunt/ (accessed February 2013).

De Schutter, O. 2012. *Mandate of the Special Rapportuer on the right to food*. Office of the United Nations and High Commissioner for Human Rights: n.p.

DFO. 2009. *New Emerging Fisheries Policy*. http://www.dfo-mpo.gc.ca/fm-gp/policies-politiques/efp-pnp-eng.htm (accessed March 2013).

DHSS. 2004. *Nunavut Report of Comparable Health Indicators*. Prepared by S. Healey et al. for the Department of Health and Social Services, Government of Naunvut.

http://www.nunavuteconomicforum.ca/public/files/library/healthy/Nunavut%20Report%20on%20Comparable%20Health%20Indicators%20-%202004%20%28English%29.pdf (accessed July 2011).

DHSS. 2006. *Inuit Wellness Programs in Nunavut 2004-2005*. Department of Health and Social Services, Government of Nunavut: Iqaluit, NU. http://pubs.aina.ucalgary.ca/health/61935.pdf (accessed August 2011).

Egeland, G. M. 2010. *The International Polar Year Nunavut Inuit Child Health Survey*. Qanuippitali Steering Committee and McGill University. http://www.mcgill.ca/cine/sites/mcgill.ca.cine/files/child_inuit_health_survey_aug_31.pdf (accessed January 2013).

Elias, E., K. Ejesiak, O. Eegeesiak, and Aarluk Consulting. 2009. *Sivummut III Economic Development Strategy Conference: Summary Report for Participants*. Prepared for the Nunavut Economic Forum. http://www.nunavuteconomicforum.ca/public/files/library/NEFREPOR/NEF%20Sivummut%20Report%20ENG%20Final%20Draft.pdf (accessed July 2011).

Evalik, C. 2012. *Kitikmeot Community Profiles: Health and Social Services* Regional Director, Kitikmeot Region: n.p.

Fergurson, H. 2011. Inuit Food (In)Security in Canada: Assessing the Implications and Effectiveness of Policy. *Queen's Policy Review*, 2 (2): 54-79. http://www.queensu.ca/sps/qpr/issues/vol2issue2/Ferguson.pdf (accessed July 2013).

Freeman, M., L. Bogolovskaya, R. Caulfield, I. Egede, I. Krupnik, and M. Stevenson. 1998. *Inuit, Whaling, and Sustainability*. Walnut Creek, CA: AltaMira Press.

George, J. 2012a. Big game sports hunters turning to Nunavut muskox. *Nunatsiaq Online*, April 16, 2012. http://www.nunatsiaqonline.ca/stories/article/65674big_game_sports_hunters_turning_to_nunavut_muskox/ (accessed February 2013).

George, J. 2012b. CamBay will host Nunavut addictions pilot treatment program: GN budget. *Nunatsiaq Online*, February 22, 2012. http://www.nunatsiaqonline.ca/stories/article/65674CamBay_will_host_nunavut_addictions_pilot_treatment_program_GN_budget/ (accessed January 2013).

GN. 2002. *Building Nunavut through Decentralization: Evaluation Report*. http://www.nunavuteconomicforum.ca/public/files/library/COMMUNIT/Building%20Nunavut%20Through%20Decentralization.pdf (accessed January 2013).

GN. 2012. *Government of Nunavut Continues Support for Nunavut Suicide Prevention Strategy Action Plan*. http://www.nunavutecho.ca/en/health-news/item/5017-world-suicide-day-2012 (accessed January 2013).

GN. n.d. *Buying alcohol in Nunavut*. http://www.orientation.hr.gov.nu.ca/i18n/english/pdf/Buying%20Alcohol_eng.pdf (accessed January 2013).

GN, Embrace Life Council, RCMP, and NTI. 2010. *Nunavut Suicide Prevention Strategy*. http://www.tunngavik.com/wp-content/uploads/2011/02/101301-layout-english.pdf (accessed March 2011).

GN, NTI, Embrace Life Council, and RCMP. 2011. *Nunavut Suicide Prevention Strategy* http://www.hss.gov.nu.ca/PDF/nsps%20Action%20Plan%20-eng.pdf (accessed November 2012).

GN Department of Community and Government Services. 2013. *About Us*. http://cgs.gov.nu.ca/en/ (accessed February 2013).

GN Department of Culture and Heritage. 2013. *Welcome: About the Department*. http://www.ch.gov.nu.ca/en/home.aspx (accessed February 2013).

GN Department of Economic Development and Transportation. 2012. *Kitikmeot Socio-Economic Monitoring Committee: Spring 2012 Report*. http://ftp.nirb.ca/03-monitoring/regional%20semc/KITIKMEOT/120905-Spring%202012%20Final%20Report%20SEMC-IA2E.pdf (accessed January 2013).

GN Department of Economic Development and Transportation. 2013. *Department of Economic Development and Transportation Website*. http://www.edt.gov.nu.ca/apps/authoring/dspPage.aspx?page=home (accessed February 2013).

GN Department of Education. 2012. *Multiple Options Brochure*. GN Department of Education: n.p.

GN Department of Education. 2013. *Department of Education Website*. http://www.edu.gov.nu.ca/apps/authoring/dspPage.aspx?page=home (accessed February 2013).

GN Department of Environment. 2013. *Welcome to the Department of Environment*. http://env.gov.nu.ca/ (accessed February 2013).

GN Department of Executive and Intergovernmental Affairs. 2013. *Departments* http://www.gov.nu.ca/en/Departments.aspx (accessed February 2013).

GN Department of Finance. 2013. *Welcome to the Department of Finance*. http://www.finance.gov.nu.ca/apps/authoring/dspPage.aspx?page=home (accessed February 2013).

GN Department of Health and Social Services. 2013. *Welcome to HSS*. http://www.hss.gov.nu.ca/en/Home.aspx (accessed February 2013).

GN Department of Health and Social Services. n.d. *Life in a Nunavut Community*. http://www.nunavutnurses.ca/english/documents/Life_in_a_Nunavut_Community.pdf (accessed May 2013).

GN Department of Human Resources. 2005. *About HR*. http://www.gov.nu.ca/hr/site/about.htm (accessed February 2013).

GN Department of Human Resources. 2012. *Towards a Respresentative Public Service*. http://www.gov.nu.ca/hr/site/doc/TRPS_updates/June%202012/TRPS%20June%202012%20English%20Final.pdf (accessed January 2012).

GN Department of Justice. 2013. *Welcome to the Department of Justice*. http://www.justice.gov.nu.ca/apps/authoring/dspPage.aspx?page=home (accessed February 2013).

Government of Canada. 2012. *Invest in Canada*. http://investincanada.gc.ca/eng/publications/nunavut-profile.aspx (accessed April 2013).

Government of Canada, Tungavik Federation of Nunavut, and Government of the Northwest Territories. 1993. *Nunavut Land Claims Agreement*. http://www.gov.nu.ca/hr/site/doc/nlca.pdf (accessed February 2012).

H. Priest and P. J. Usher. 2004. *Nunavut Wildlife Harvest Study*. Prepared by for the Nunavut Wildlife Management Board: Iqaluit, NU and Ottawa, ON.

http://www.nwmb.com/english/resources/harvest_study/NWHS%202004%20Report.pdf (accessed July 2011).

Haggarty, J. M., Z. Cernovsky, M. Bedard, and H. Merskey. 2008. Suicidality in a sample of Arctic households. *Suicide and Life-Threatening Behavior*, 38 (6): 699–707.

Hamlet of Gjoa Haven. 2008. *Gjoa Haven Community Plan By-Law No. 125*. Hamlet of Gjoa Haven: Gjoa Haven, NU.

Hamlet of Kugaaruk. 2009. *Kugaaruk Community Plan*. Hamlet of Kugaaruk: Kugaaruk, NU.

Hamlet of Kugluktuk. 2007. *Kugluktuk Community Plan By-Law No. 205-2007*. Hamlet of Kugluktuk: Kugluktuk, NU.

Hamlet of Taloyoak. 2009. *Taloyoak Community Plan*. Hamlet of Taloyoak: Taloyoak, NU.

Hicks, J. 2009. *Statistical Data on Deaths by Suicide in Nunavut, 1960 - 2008*. Working Group for a Suicide Prevention Strategy For Nunavut. Government of Nunavut, Nunavut Tunngavik Inc., and the Isaksimagit Innusirmi Katujjiqatigiit (Embrance Life Council). http://www.tunngavik.com/documents/publications/2009-04%20SP%20WG%20ENG%20discussion%20paper.pdf (accessed March 2011).

Hicks, J. 2012. *Hick's: Aglukkaq's shameful response to UN food envoy*. http://www.northernpublicaffairs.ca/index/hicks-aglukkaqs-shameful-response-to-un-food-envoy/ (accessed January 2013).

INAC. 2000. *Oil and Gas Nominations Invited for the Arctic Islands of Nunavut*. Bulletin 7(6). http://www.ainc-inac.gc.ca/nth/og/pubs/vol/7_6-eng.asp (accessed April 2011).

INAC. 2005. *Exploration and Mining on Crown Lands in Nunavut Guidebook*. Indian and Northern Affairs Canada: Ottawa, ON. http://dsp-psd.pwgsc.gc.ca/Collection/R2-369-2005E.pdf (accessed May 2011).

INAC. 2009a. *Northern Oil and Gas Annual Report 2009*. http://www.ainc-inac.gc.ca/nth/og/pubs/ann/ann2009/ann2009-eng.pdf (accessed April 2011).

INAC. 2009b. *Nunavut: Mineral Exploration, Mining and Geoscience Overview 2009*. Indian and Northern Affairs Canada. http://www.ntilands.com/pdfdoc/Nunavut_2009_%20Expl_Overview.pdf (accessed July 2011).

INAC. 2010a. *Nunavut: 2006 Community Well-Being Database*. http://www.ainc-inac.gc.ca/ai/rs/pubs/cwb/webdb/webdb_nu-eng.asp (accessed March 2011).

INAC. 2010b. *Nunavut: Mineral Exploration, Mining and Geoscience Overview 2010*. Indian and Northern Affairs Canada: n.p.

INAC. 2011a. *Northern Oil and Gas Branch. Oil & Gas Dispositions. Eastern Arctic Offshore*. Indian and Northern Affairs Canada. http://www.ainc-inac.gc.ca/nth/og/le/mp/ain/earct_pg.pdf (accessed March 2011).

INAC. 2011b. *Northern Oil and Gas Branch. Oil & Gas Dispositions. Sverdrup Basin*. Indian and Northern Affairs Canada. http://www.ainc-inac.gc.ca/nth/og/le/mp/ain/sverdrup_pg.pdf (accessed March 2011).

InterGroup Consultants Ltd. 2008. *Economic Valuation and Socio-Cultural Perspectives of the Estimated Harvest of the Beverly and Qamanirjuaq Caribou Herds*. http://www.arctic-caribou.com/PDF/Economic_and_Socio-Cultural_Value_of_Bev+Qam_Caribou_01May08.pdf (accessed July 2013).

Inuit Qaujisarvingat Knowedge Centre. n.d. *Inuit Health and Well-Being Data Organization*. Inuit Tapiriit Kanatami. http://www.inuitknowledge.ca/naasautit/data-organization (accessed January 2013).

Inuit Tapiriit Kanatami. 2007. *Social Determinants of Inuit health in Canada: A Discussion Paper*. http://ahrnets.ca/files/2011/02/ITK_Social_Determinants_paper_2007.pdf (accessed July 2011).

Inuit Tapiriit Kanatami. 2013. *Full Meal Deal*. https://www.itk.ca/about-inuit (accessed July 2013).

Inuit Tuttarvingat. 2010. *Inuit Tuttarvingat of the National Aboriginal Health Organization: Strategic Plan 2010-2015*. National Aboriginal Health Organization: Ottawa, ON. http://www.naho.ca/documents/it/2010_IT_NAHO_Strategic_Plan.pdf (accessed July 2011).

Johnson, W. 2009. *Inuit Owned Lands; Mining and Royalty Regimes*. NLCA Workshop Presentation by Nunavut Tunngavik Incorporated. http://www.tunngavik.com/documents/publications/administration/IOL%20and%20Minerals%2025Nov09.pdf (accessed May 2011).

KIA. 2011. *Kitikmeot Inuit Association: Community Profiles*. http://kitia.ca/en/our-region/community-profiles (accessed July 2011).

Kitikmeot Corporation. 2011. *Kitikmeot Corporation Home Page*. http://www.kitikmeotcorp.ca/index.htm (accessed April 2011).

Kitikmeot School Operations. 2011. *Kitikmeot School Operations Home Page*. http://kitikmeot.edu.nu.ca/ (accessed March 2011).

Kugluktuk Hunter Focus Group. 2012. *Hunter, Trapper Focus Group, Kugluktuk November 27, 2012*. Rescan: Kugluktuk, NU.

Kugluktuk Wellness Working Group. 2011. *Kugluktuk Community Wellness Plan*. http://www.tunngavik.com/files/2011/12/community-plan_kugluktuk_english_web.pdf (accessed July 2013).

Mariport Group. 2009. *Consideration Regarding an Open Market System for Annual Sealift Summary Report*. Prepared by the Mariport Group Ltd. for the Government of Nunavut Community and Government Services: n.p.

Municipality of Cambridge Bay. 2007. *Cambridge Bay Community Plan 2007-2027*. Municipality of Cambridge Bay: Cambridge Bay, NU.

NAC. 2008. *Nunavut Arctic College Annual Report 2007-2008*. http://www.arcticcollege.ca/publications/reports/2008NAC_annualreport_Eng.pdf (accessed July 2011).

NAC. 2011. *Nunavut Arctic College Home Page*. http://www.arcticcollege.ca/ (accessed March 2011).

NAC. 2013. *Camp Cook Program* http://www.arcticcollege.ca/en/skilled-trades-programs/item/4890-camp-cook (accessed May 2013).

National Aboriginal Health Organization. 2004. *Hunger in the Arctic: Food (In)Security in Inuit Commmunities - A Discussion Paper* Prepared by: David A. Boult, Ajunnginiq Centre. http://www.naho.ca/documents/it/2004_Inuit_Food_Security.pdf (accessed February 2013).

Natural Resources Canada. 2013. *Mining Statistics: Exploration Plus Deposit Appraisal Expenditures by Province and Territory, 2008-2013*. http://sead.nrcan.gc.ca/expl-expl/18-eng.aspx (accessed July 2013).

NBCC. 2011. *Nunavut Business Credit Corporation: Can NBCC Help Your Business?* http://www.nbcc.nu.ca/english/help.html. (accessed August 2011).

NDEDT. 2011. *Department of Economic Development and Transportation - Programs/Funding.* http://www.edt.gov.nu.ca/apps/authoring/dspPage.aspx?page=programs (accessed August 2011).

NEAS. 2013. *Shipping Rates and Schedule*. http://www.neas.ca/shippinginsurance.cfm (accessed August 2013).

NEDA. 2008. *Case Study: Arctic Coast Visitors Centre and Queen Maud Bird Sanctuary*. Community Economic Development Workshop Series of the Nunavut Economic Developers Association: Iqaluit, NU.

NHC. 2006. *Nunavut Housing Trust Delivery Strategy*. http://www.nunavuthousing.ca/apps/UPLOADS/fck/file/NHT%20Delivery%20Strategy.pdf (accessed January 2013).

NHC. 2011. *Nunavut Housing Corporation: Annual Report 2010-2011, Strengthening Community Partnerships*. Nunavut Housing Corporation: n.p.

NHC. 2012. *Igluliuqatigiilauqta: Let's Build a Home Together - Summary of the Framework for the GN Long-Term Comprehensive Housing and Homelessness Strategy*. Nunavut Housing Corporation: n.p.

NHC and NTI. 2004. *Nunavut Ten-Year Inuit Housing Action Plan. A Proposal to the Government of Canada*. http://www.tunngavik.com/category/nti-documents/housing/ (accessed April 2011).

NIRB. 2011. *Nunavut Impact Review Board Home Page*. http://www.nirb.ca/index.html (accessed April 2011).

Northern News Services Online. 2008. *Gjoa Haven's only daycare fills a critical role*. http://www.nnsl.com/frames/newspapers/2008-02/feb25_08gh.html (accessed July 2013).

Northern News Services Online. 2009. *Long-term care facility for Gjoa Haven*. http://www.nnsl.com/frames/newspapers/2009-10/oct5_09cn.html (accessed January 2013).

Northern Public Affairs. 2012. *LETTER - Community Needs should be priority for Kglukkaq at Arctic Council*. http://www.northernpublicaffairs.ca/index/letter-community-needs-should-be-priority-for-aglukkaq-at-arctic-council/ (accessed January 2013).

NPC. 2004. *West Kitikmeot Regional Land Use Plan: Preliminary Draft*. Nunavut Planning Commission: Cambridge Bay, NU.

NPC. 2008a. *Oil and Gas*. Nunavut Planning Commission. http://www.nunavut.ca/files/16_oil_&_gas.pdf (accessed April 2011).

NPC. 2008b. *Special Management Areas*. Nunavut Planning Commission. http://www.nunavut.ca/files/13_special_management_areas.pdf (accessed May 2011).

NPC. 2011. *About the Commission*. http://www.nunavut.ca/en/about-commission (accessed July 2011).

NPC. 2012. *Draft Nunavut Land Use Plan*. http://www.nunavut.ca/en/draft-plan (accessed January 2013).

NRCan. 2012. *Mineral Exploration*. http://mmsd.mms.nrcan.gc.ca/stat-stat/expl-expl/1-eng.aspx (accessed February 2013).

NSSI. 2011. *Arctic Supply Service List of Municipalities. Season 2011*. Nunavut Sealink and Supply Inc. http://www.arcticsealift.com/en/medias/calendrier%20%202011,%20liste%20des%20municipalites_0_1_2_3.pdf (accessed April 2011).

NSSI. 2013. *Shipping Rates and Schedule*. http://www.arcticsealift.com (accessed August 2013).

NTCL. 2013. *Communities we serve*. http://www.ntcl.com/wp-content/uploads/2012/06/NTCL-Upside-Down-Map.jpg (accessed January 2013).

NTI. 2004. *Tukisittiarniqsaujumaviit? A plain language guide to the Nunavut Land Claims Agreement*. Nunavut Tunngavik Incorporated. http://www.tunngavik.com/documents/publications/2004-00-00-A-Plain-Language-Guide-to-the-Nunavut-Land-Claims-Agreement-English.pdf (accessed May 2011).

NTI. 2008. *Nunavut's Health System. A Report Delivered as part of Inuit Obligations under Article 32 of the Nunavut Land Claims Agreement, 1993. Annual report on the State of Inuit Culture and Society*. Nunavut Tunngavik Inc. http://www.tunngavik.com/publications/ (accessed March 2011).

NTI. 2011a. *Nunavut Tunngavik Incorporated Inuit Firm Registry - Approved Businesses*. Nunavut Tunngavik Incorporated. http://inuitfirm.tunngavik.com/ (accessed March 2011).

NTI. 2011b. *Organizational Chart*. Nunavut Tunngavik Incorporated. http://www.tunngavik.com/about/ (accessed April 2011).

NTI. n.d. *Nunavut Land Claims Agreement - Article 23 Inuit Employment within Government*. Nunavut Tunngavik Incorporated. http://nlca.tunngavik.com/?page_id=2301 (accessed January 2013).

Nunatsiaq News. 2012. Kitikmeot Inuit org pumps $1 million into joint mineral exploraiton effort. *Nunatsiaq Online*, September 27, 2012. http://www.nunatsiaqonline.ca/stories/article/65674kitikmeot_inuit_org_pumps_1_million_into_joint_mineral_exploration_eff/ (accessed February 2013).

Nunatsiaq News. 2013. *Northwestel brings higher-speed internet to Cambridge Bay*. http://www.nunatsiaqonline.ca/stories/article/65674northwestel_brings_higher-speed_internet_to_cambridge_bay/ (accessed May 2013).

Nunavut Bureau of Statistics. 2008. *Nunavut Census Income and Earnings by Region and Community, 2005*. http://www.eia.gov.nu.ca/stats/community.html (accessed March 2011).

Nunavut Bureau of Statistics. 2010a. *Nunavut Community Population Projection 2010 to 2036 Methodological Document*. http://www.eia.gov.nu.ca/stats/population.htm (accessed March 2011).

Nunavut Bureau of Statistics. 2010b. *Nunavut Crime Data by Selected Offences, 1999 to 2009 (2 tables)*. Excel file prepared by the Nunavut Bureau of Statistics from the Statistics Canada, Canadian Centre for Justice Statistics, Uniform Crime Reporting Survey. http://www.eia.gov.nu.ca/stats/stats.html (accessed March 2011).

Nunavut Bureau of Statistics. 2010c. *Nunavut Median Total Income of Taxfilers with Income by Region and Community, 1999 to 2008*. http://www.eia.gov.nu.ca/stats/community.html (accessed March 2011).

Nunavut Bureau of Statistics. 2011a. *Nunavut Housing Needs Survey Fact Sheets*. http://www.eia.gov.nu.ca/stats/housing.html (accessed April 2011).

Nunavut Bureau of Statistics. 2011b. *Nunavut Population Estimates by Region and Community, 1996-2010*. http://www.eia.gov.nu.ca/stats/population.html (accessed March 2011).

Nunavut Bureau of Statistics. 2011c. *Nunavut Population Estimates by Sex and Age Group, 2010.* http://www.eia.gov.nu.ca/stats/population.html (accessed March 2011).

Nunavut Bureau of Statistics. 2012a. *Gross Domestic Product.* http://www.stats.gov.nu.ca/en/Economic%20GDP.aspx (accessed April 2013).

Nunavut Bureau of Statistics. 2012b. *Nunavut Bureau of Statistics.* http://www.stats.gov.nu.ca/en/home.aspx (accessed February 2013).

Nunavut Bureau of Statistics. 2012c. *Nunavut Bureau of Statistics - Nunavut Social Assistance Recipients by Community, Region, and Territory, 2005 to 2011.* Income Support Division of the GN Department of Education: Nunavut.

Nunavut Bureau of Statistics. 2012d. *Nunavut Census Language by Community, 2011.* http://www.stats.gov.nu.ca/en/Census%202011.aspx (accessed April 2012).

Nunavut Bureau of Statistics. 2012e. *Nunavut Quick Facts.* http://www.eia.gov.nu.ca/stats/index.html (accessed November 2012).

Nunavut Bureau of Statistics. 2013a. *Labour Force and Employment.* http://www.stats.gov.nu.ca/en/Labour%20and%20employment.aspx (accessed April 2013).

Nunavut Bureau of Statistics. 2013b. *Nunavut Average Weekly Earning, Including Overtime, for All Employees, 2001 to 2012.* http://www.stats.gov.nu.ca/en/Labour%20and%20employment.aspx (accessed April 2013).

Nunavut Development Corporation. n.d. *Purchasing Truely Wild Arctic Char.* http://www.trulywild.ca/where-buy-char (accessed February 2013).

Nunavut Geoscience. 2012. *Nunavut Geoscience Home Page.* http://nunavutgeoscience.ca/eo/YrRgn/8/19_e.html (accessed April 2013).

Nunavut Parks. 2013. *Parks and Special Places.* http://nunavutparks.ca/english/parks-special-places/kugluk-bloody-falls-territorial-park/overview.aspx (accessed January 2013).

Nunavut Roundtable for Poverty Reduction. 2011. *Issues and Ideas for Change: Kitikmeot Community Dialogues, Spring 2011.* Nunavut Roundtable for Poverty Reduction: Iqaluit, NU. http://www.makiliqta.ca/uploads/pdf/summ-KIT-ENGL.pdf (accessed January 2013).

Nunavut Tourism. 2011. *Nunavut Tourism Home Page.* http://www.nunavuttourism.com/explore/operator.aspx?o=228&l=0,2,4,6 (accessed April 2011).

Nunavut Tourism. 2012. *Hunting.* http://www.nunavuttourism.com/hunting.aspx (accessed February 2013).

NWB. 2011. *Nunavut Water Board Home Page.* http://www.nunavutwaterboard.org/en/home (accessed April 2011).

NWMB. 2011. *Nunavut Wildlife Management Board Responsibilities.* http://www.nwmb.com/english/about_nwmb/responsibilities.php (accessed April 2011).

NWT Bureau of Statistics. 2011. *Yellowknife - Statistical Profile.* http://www.stats.gov.nt.ca/community-data/community-profiles/Profile%20PDF/Yellowknife.pdf (accessed July 2011).

OECD. 2001. *Statistics Portal Glossary of Statistical Terms.* http://stats.oecd.org/glossary/index.htm (accessed April 2013).

Omingmaktok/Bathurst Inlet Hunter Focus Group. 2012. *Hunter, Trapper Focus Group, Omingmaktok/Bathurst Inlet, December 1, 2012*. Rescan Environmental Services Ltd.: Camrbridge Bay, NU.

Opportunities North. 2012. *Enrolment rate up at the Arctic College*. http://www.nnsl.com/business/pdfs/OPPS/oppsC_education.pdf (accessed November 2012).

Pauktuutit Inuit Women of Canada. 2006. *The Inuit Way: A Guide to Inuit Culture*. www.uqar.ca/files/boreas/inuitway_e.pdf (accessed February 2013).

Prime Mininster of Canada. 2012. *PM Announces support for Canadian High Arctic Research Station to bring jobs and growth to the north*. http://pm.gc.ca/eng/media.asp?category=1&featureId=6&pageId=26&id=4971 (accessed January 2013).

Public Health Agency of Canada. 2011. *Aboriginal Head Start in Urban and Northern Communities (AHSUNC)*. http://www.phac-aspc.gc.ca/hp-ps/dca-dea/prog-ini/ahsunc-papacun/index-eng.php (accessed April 2011).

Qikiqtani Inuit Association. 2009. *Comments on the Draft Environmental Impact Statement Guidelines for the Review of the Proposed Mary River Project*. Letter dated July 31, 2009 to the Nunavut Impact Review Board: Cambridge Bay, NU.

Qiniq. 2013. *Nunavut Broadband Internet*. http://www.qiniq.com/broadband-pricing-plans (accessed May 2013).

Quilliq Energy Corporation. 2008. *About Us*. http://www.nunavutpower.com/home/index.php?option=com_content&task=view&id=17&Itemid=32 (accessed May 2013).

Ramsar. 2011. *The Ramsar Convention on Wetlands*. http://www.ramsar.org/cda/en/ramsar-documents-list/main/ramsar/1-31-218_4000_0 (accessed July 2011).

RCMP. 2012a. *Aboriginal Shield Program*. http://www.rcmp-grc.gc.ca/aboriginal-autochtone/abo-aut-shield-bouclier-eng.htm (accessed January 2013).

RCMP. 2012b. *RCMP Iqauit, Calls for Service and Prisoner data*. RCMP, 2009 to 2012, Excel spreadsheet.

Rescan. 2012. *The Back River Project: Project Description*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, BC.

RT Associates. 2005. *Hamlet of Kugluktuk Community Economic Development Plan 2005*. Prepared by RT Associates for the Hamlet of Kugluktuk, NU: Thunder Bay, ON.

RT Associates. 2009. *Cambridge Bay 2009 Community Economic Development Plan*. Prepared by RT Associates for the Hamlet of Cambridge Bay, NU: Thunder Bay, ON.

SEDS Group. 2003. *Nunavut Economic Development Strategy: Building a Foundation for the Future*. The Sivummut Economic Development Strategy Group. http://www.nunavuteconomicforum.ca/public/files/strategy/NUNAVUTE.PDF (accessed July 2011).

Spicer, J. 2008. Inuit lifespan stagnates while Canada's rises. *Reuters*, January 23, 2008. http://www.reuters.com/article/2008/01/23/us-inuit-idUSN2362426520080123 (accessed July 2011).

Statham, S. 2012. Inuit Food Security: Vulnerability of the traditional food system to cliamtic extremes. diss., McGill University.

Statistics Canada. 2006. *Table 8-4. Harvesting country food in previous year, Inuit adults, aged 15 and over sex and age group, Nunavut 2006. Aboriginal Peoples Survey.* http://www.statcan.gc.ca/pub/89-637-x/2008002/tab/tab8-4-eng.htm (accessed January 2006).

Statistics Canada. 2007a. *2006 Aboriginal Population Profile: Cambridge Bay and Nunavut.* http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-594/details/page.cfm?Lang=E&Geo1=CSD&Code1=6208073&Geo2=PR&Code2=62&Data=Count&SearchText=Cambridge%20Bay&SearchType=Begins&SearchPR=01&B1=All&Custom= (accessed January 2013).

Statistics Canada. 2007b. *2006 Community Profiles.* http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CSD&Code1=6208073&Geo2=PR&Code2=62&Data=Count&SearchText=cambridge%20bay&SearchType=Begins&SearchPR=01&B1=All&Custom= (accessed January 2013).

Statistics Canada. 2007c. *2006 Community Profiles: Cambridge Bay and Nunavut.* http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CSD&Code1=6208073&Geo2=PR&Code2=62&Data=Count&SearchText=cambridge%20bay&SearchType=Begins&SearchPR=01&B1=All&Custom= (accessed January 2013).

Statistics Canada. 2007d. *North American Industry Classification System (NAICS) - Canada.* http://www.statcan.gc.ca/pub/12-501-x/12-501-x2007001-eng.pdf (accessed January 2013).

Statistics Canada. 2007e. *Review of Personal Disposable Income.* http://www.statcan.gc.ca/pub/13-605-x/2003001/chrono/2003prov/4151911-eng.htm (accessed June 2013).

Statistics Canada. 2008a. *2006 Profile of Aboriginal Children, Youth and Adults.* http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/89-635/index.cfm?Lang=eng (accessed March 2011).

Statistics Canada. 2008b. *Inuit Health, Education and Country Food Harvesting.* http://www.statcan.gc.ca/pub/89-637-x/89-637-x2008004-eng.pdf (accessed January 2013).

Statistics Canada. 2010. *Chart 4. Percentage of households with food insecurity, by province/territory, Canada, 2007-2008 – description.* Canadian Community Health Survey, 2007-2008. http://www.statcan.gc.ca/pub/82-625-x/2010001/article/desc/11162-04-desc-eng.htm (accessed January 2013).

Statistics Canada. 2011a. *CANSIM Table 105-0545. Household food insecurity measures, by living arrangement, Canada, provinces and territories, occasional.* (accessed July 2011).

Statistics Canada. 2011b. *Provincial and Territorial General Government Revenue and Expenditure, by Province and Territory, 2009.* http://www40.statcan.ca/l01/cst01/govt08c-eng.htm (accessed April 2011).

Statistics Canada. 2012a. *CANSIM Table 384-0038. Gross domestic product, expenditure-based, provincial and territorial, annual.* http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3840038&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid= (accessed April 2013).

Statistics Canada. 2012b. *Census of Canada 2011.* http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E (accessed January 2013).

Statistics Canada. 2012c. *Health Profiles* http://www12.statcan.gc.ca/health-sante/82-228/index.cfm (accessed January 2013).

Statistics Canada. 2012d. *National Household Survey Community Profiles* http://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=6208047&Data=Count&SearchText=Kugaaruk&SearchType=Begins&SearchPR=01&A1=All&B1=All&Custom=&TABID=1 (accessed July 2013).

Statistics Canada. 2013a. *CANSIM Table 102-056. Leading causes of death, total population, by age group and sex, Canada*. http://www5.statcan.gc.ca/cansim/a05?lang=eng&id=1020561 (accessed January 2013).

Statistics Canada. 2013b. *Payroll Employment, Earnings, and Hours*. http://www.stats.gov.nu.ca/Publications/Monthly/Payroll%20Employment%20Earnings%20and%20Hours%20StatsUpdate%20January%202013.pdf (accessed April 2013).

Statistics Canada. 2013c. *Table 1: Labour force characteristics by age and sex -seasonally adjusted*. http://www.statcan.gc.ca/daily-quotidien/130405/t130405a001-eng.htm (accessed April 2013).

Statistics Canada. n.d. *Table 102-0030 - Infant mortality, by sex and birth weight, Canada, provides and territories, annaul, CANSIM*. http://www5.statcan.gc.ca/cansim/a26 (accessed January 2013).

Tait, H. 2006. *Aboriginal Peoples Survey, 2006: Inuit Health and Social Conditions* http://www.nativiamericani.it/filevari/89-637-x2008001-eng.pdf (accessed July 2013).

The World Bank. 2013a. *General Government Final Consumption Expenditure (% of GDP)*. http://data.worldbank.org/indicator/NE.CON.GOVT.ZS (accessed April 2013).

The World Bank. 2013b. *Household Final Consumption Expenditure (Current $US)*. http://data.worldbank.org/indicator/NE.CON.PRVT.CD (accessed April 2012).

Thompson, S. 2005. Sustainability and Vulnerability: Aboriginal Arctic Food Security in a Toxic World. In *Breaking Ice: Renewable Resource and Ocean Management in the Canadian North*. Eds. F. Berkes, R. Huebert, H. Fast, M. Manseau, and A. Diduck. 47-69. Winnipeg, MB: University of Calgary Press.

up here business. 2012. *Nunavut down, NWT bounces back in latest exploration spending survey*. http://upherebusiness.tumblr.com/post/36314761072 (accessed February 2013).

World Health Organization. 2010. *Global strategy to reduce the harmful use of alcohol*. http://www.who.int/substance_abuse/msbalcstragegy.pdf (accessed January 2012).

<u>Personal Communications</u>

Aglukkaq, J. 2012. Economic Development Officer, Hamlet of Gjoa Haven, Gjoa Haven, NU. Personal Communication: September 19, 2012.

Apsaktaun, J. 2012. Instructor, Nunavut Arctic College, Kugaaruk, NU. Personal Communication: September 20, 2012.

Blita, R. 2012. Mental Health Nurse, GN Health and Social Services, Kugluktuk, NU. Personal Communication: October 2, 2012.

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Bucknor, S. 2012. Mental Health Consultant, GN Health and Social Services, Gjoa Haven, NU. Personal Communication: September 18, 2012.

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Case, J. 2012. Advisor, Business & Promotions, GN Economic Development and Transportation. October 19, 2012.

Cameron, D. 2012. Mental Health Consultant, GN Health and Social Services, Kugaaruk, NU. Personal Communication: September 21, 2012.

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Dickson, C. 2012. Senior Administrative Officer, Hamlet of Taloyoak, Taloyoak, NU. Personal Communication: September 25, 2012.

Dugas, R. 2012. Supervisor of Health Programs, GN Health and Social Services, Kugluktuk, NU. Personal Communication: September 21, 2012.

Elliot, G. 2013. RCMP Sargent, Iqaluit RCMP Detachment, Iqaluit, NU. Personal Communication: January 24, 2013.

Evalik, C. 2012. Executive Director of Health and Social Services, GN Health and Social Services, Cambridge Bay, NU. Personal Communication: September 27, 2012.

Flynn, L. 2012. Manager, Koomiut Co-op, Kugaaruk, NU. Personal Communication: September 20, 2012.

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Fredlund, E. 2012. Wellness Coordinator, Hamlet of Kugluktuk, Kugluktuk, NU. Personal Communication: October 2, 2012.

Garneau, E. 2012. Supervisor of Health Programs, GN Health and Social Services, Gjoa Haven, NU. Personal Communication: September 18, 2012.

Glasgow, J. 2012. Mental Health Consultant, GN Health and Social Services, Cambridge Bay, NU. Personal Communication: September 28, 2012.

Hogaluk, C. 2012. Alcohol and Drug Counsellor, Hamlet of Cambridge Bay, Cambridge Bay, NU. Personal Communication: September 27, 2012.

Holitzki, G. 2012. Housing Manger (former), Taloyoak Housing Association, Kugaaruk, NU. Personal Communication: September 21, 2012.

Kayaksak, M. 2012. Community Health Representative, GN Health and Social Services, Kugaaruk, NU. Personal Communication: September 20, 2012.

King, S. 2012. Senior Administrative Officer, Hamlet of Cambridge Bay, Cambridge Bay. Personal Communication: September 27, 2012.

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Klengenberg, R. 2012. Director, Cambridge Bay Health Centre, Cambridge Bay, NU. Personal Communication: September 27, 2012.

Lee, C. 2012. Alcohol and Drug Counsellor, Hamlet of Kugluktuk, Kugluktuk, NU. Personal Communication: October 2, 2012.

Lyall, C. 2012. Independent, Taloyoak, NU. Personal Communication: September 25, 2012.

McCallum, T. 2012. Manager Community Development, GN Community and Government Services, Cambridge Bay, NU. Personal Communication: September 28, 2012.

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Newman, G. 2012. Vice President of Operations, Kikiak Contracting Ltd. Personal Communication: October 3, 2012.

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Oogak, S. 2012. Recreation Coordinator, Gjoa Haven Recreation, Gjoa Haven, NU. Personal Communication: September 18, 2012.

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Pauloosie, E. 2012. Senior Administrative Officer, Hamlet of Gjoa Haven, Gjoa Haven, NU. Personal Communication: September 18, 2012.

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Pizzo, G. 2012. Principal, Netsilik School, Taloyoak, NU. Personal Communication: September 26, 2012.

Shabatai, J. 2012. Social Services Supervisor, GN Health and Social Services, Gjoa Haven, NU. Personal Communication: September 17, 2012.

Tucktoo, R. 2012. Recreation Coordinator, Hamlet of Taloyoak, Taloyoak, NU. Personal Communication: September 25, 2012.

Wood, K. 2012. Officer in Charge, RCMP, Cambridge Bay, NU. Personal Communication: September 28, 2012.

Zwennes, C. 2012. Recreation Coordinator, Hamlet of Kugaaruk, Kugaaruk, NU. Personal Communication: September 21, 2012.

Appendix 1a

Family Characteristics in the Kitikmeot Communities (2011)

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Appendix 1a. Family Characteristics in the Kitikmeot Communities (2011)

	Cambridge Bay	Kugluktuk	Gjoa Haven	Taloyoak	Kugaaruk	Kitikmeot Region	Kivalliq Region	Baffin Region	Nunavut	Canada
Total number of Census families	415 (100.0%)	365 (100.0%)	290 (100.0%)	225 (100.0%)	180 (100.0%)	1,480 (100.0%)	2,110 (100%)	4,190 (100.0%)	7,780 (100.0%)	9,389,695 (100%)
Size of Census family: 2 persons or more	155 (37.3%)	115 (31.5%)	60 (20.7%)	60 (26.7%)	45 (25.0%)	435 (29.4%)	585 (27.7%)	1,370 (32.7%)	2,385 (30.7%)	4,679,700 (49.8%)
Size of Census family: 3 persons or more	95 (22.9%)	95 (26.0%)	75 (25.9%)	60 (26.7%)	30 (16.7%)	360 (24.3%)	455 (21.6%)	1,020 (24.3%)	1,835 (23.6%)	2,048,560 (21.8%)
Size of Census family: 4 persons or more	75 (18.1%)	70 (19.2%)	55 (19.0%)	40 (17.8%)	45 (25.0%)	285 (19.3%)	385 (18.2%)	845 (20.2%)	1,515 (19.5%)	1,870,305 (19.9%)
Size of Census family: 5 persons or more	85 (20.5%)	90 (24.7%)	105 (36.2%)	65 (28.9%)	65 (36.1%)	405 (27.4%)	680 (32.2%)	955 (22.8%)	2,040 (26.2%)	791,130 (8.4%)
Total couple families by family structure and number of children	290 (69.9%)	260 (71.2%)	210 (72.4%)	155 (68.8%)	135 (75.0%)	1,045 (70.6%)	1,550 (73.5%)	2,990 (71.4%)	5,585 (71.8%)	7,861,855 (83.7%)
Married couples	145 (50.0%)	105 (40.4%)	90 (42.9%)	75 (48.4%)	85 (63.0%)	505 (48.3%)	1,015 (65.5%)	1,520 (50.8%)	3,040 (54.4%)	6,293,950 (80.1%)
Without children at home	50 (34.5%)	35 (33.3%)	5 (5.6%)	15 (20.0%)	15 (17.6%)	115 (22.8%)	140 (13.8%)	395 (26.0%)	650 (21.4%)	2,891,215 (45.9%)
With one child	30 (20.7%)	20 (19.0%)	15 (16.7%)	20 (26.7%)	10 (11.8%)	95 (18.8%)	195 (19.2%)	340 (22.4%)	630 (20.7%)	1,288,775 (20.5%)
With two children	25 (17.2%)	25 (23.8%)	30 (33.3%)	15 (20.0%)	25 (29.4%)	115 (22.8%)	180 (17.7%)	345 (22.7%)	640 (21.1%)	1,475,220 (23.4%)
With three or more children	45 (31.0%)	30 (28.6%)	40 (44.4%)	25 (33.3%)	35 (41.2%)	175 (34.7%)	495 (48.8%)	440 (28.9%)	1,115 (36.7%)	638,740 (10.1%)
Common-law couples	145 (50.0%)	150 (57.7%)	120 (57.1%)	80 (51.6%)	45 (33.3%)	540 (51.7%)	530 (34.2%)	1,470 (69.2%)	2,545 (45.6%)	1,567,910 (19.9%)
Without children at home	35 (24.1%)	30 (20.0%)	15 (12.5%)	10 (12.5%)	5 (11.1%)	90 (16.7%)	145 (27.4%)	340 (23.1%)	580 (22.8%)	861,350 (54.9%)
With one child	40 (27.6%)	40 (26.7%)	35 (29.2%)	25 (31.3%)	0 (0.0%)	145 (26.9%)	115 (21.7%)	330 (22.4%)	590 (23.2%)	321,865 (20.5%)
With two children	35 (24.1%)	30 (20.0%)	20 (16.7%)	15 (18.8%)	10 (22.2%)	110 (20.4%)	140 (26.4%)	365 (24.8%)	620 (24.4%)	273,620 (15.2%)
With three or more children	35 (24.1%)	50 (33.3%)	55 (45.8%)	30 (37.5%)	25 (55.6%)	195 (36.1%)	125 (23.6%)	435 (29.6%)	760 (29.9%)	111,075 (7.1%)
Total lone-parent families by sex of parent and number of children	120 (28.9%)	110 (30.1%)	80 (27.6%)	70 (31.1%)	45 (25.0%)	435 (29.4%)	656 (31.1%)	1,195 (28.5%)	2,195 (28.2%)	1,527,845 (16.3%)
Female parent	100 (83.3%)	85 (77.3%)	60 (75.0%)	50 (71.4%)	20 (44.4%)	320 (73.6%)	395 (60.2%)	845 (70.7%)	1,560 (71.1%)	1,200,295 (78.6%)
With one child	60 (60.0%)	40 (36.4%)	30 (50.0%)	25 (35.7%)	5 (25.0%)	160 (50.0%)	205 (51.9%)	420 (49.7%)	780 (50.0 %)	710,255 (59.2%)
With two children	20 (20.0%)	30 (27.3%)	20 (33.3%)	15 (21.4%)	10 (50.0%)	85 (26.6%)	100 (25.3%)	270 (32.0%)	460 (29.5%)	352,150 (29.3%)
With three or more children	20 (20.0%)	10 (9.1%)	15 (25.0%)	15 (21.4%)	5 (25.0%)	70 (29.1%)	95 (24.1%)	155 (18.3%)	325 (20.8%)	137,920 (11.5%)
Male parent	25 (20.8%)	20 (18.2%)	20 (25.0%)	20 (28.6%)	25 (55.6%)	115 (26.4%)	165 (25.2%)	350 (29.3%)	635 (28.9%)	327,545 (21.4%)
With one child	20 (80.0%)	10 (50.0%)	10 (50.0%)	10 (50.0%)	15 (60.0%)	65 (56.5%)	95 (57.6%)	215 (61.4%)	375 (59.1%)	216,910 (66.2%)
With two children	10 (40.0%)	5 (25.0%)	10 (50.0%)	5 (25.0%)	5 (20.0%)	35 (30.4%)	45 (27.3%)	80 (22.9%)	160 (25.2%)	85,770 (26.2%)
With three or more children	5 (20.0%)	5 (25.0%)	5 (25.0%)	5 (25.0%)	5 (20.0%)	15 (13.0%)	30 (18.2%)	55 (15.7%)	100 (15.7%)	24,860 (7.6%)

Source: (Statistics Canada 2012b).

Appendix 1b

Language Spoken Most Often at Home (2011)

Engineers and Scientists

Appendix 1b. Language Spoken Most Often at Home (2011)

	Total Population	Inuktitut Only	Inuinnaqtun Only	English Only	French Only	Other Language Only	English and Non-official Language	Other Multiple Responses
Cambridge Bay	1,600	90 (5.6%)	10 (0.6%)	1,475 (92.2%)	0 (0.0%)	10 (0.6%)	5 (0.3%)	0 (0.0%)
Kugluktuk	1,440	25 (1.7%)	90 (6.3%)	1,285 (89.2%)	10 (0.7%)	20 (1.4%)	15 (1.0%)	5 (0.3%)
Gjoa Haven	1,280	175 (13.7%)	0 (0.0%)	1,080 (84.4%)	0 (0.0%)	0 (0.0%)	20 (1.6%)	0 (0.0%)
Taloyoak	900	145 (16.1%)	0 (0.0%)	740 (82.2%)	0 (0.0%)	0 (0.0%)	10 (1.1%)	0 (0.0%)
Kugaaruk	770	150 (19.5%)	0 (0.0%)	605 (78.6%)	0 (0.0%)	5 (0.6%)	15 (1.9%)	0 (0.0%)
Kitikmeot Region	5,990	585 (9.8%)	100 (1.7%)	5,185 (86.6%)	10 (0.2%)	35 (0.6%)	65 (1.1%)	5 (0.1%)
Nunavut	31,770	16,490 (51.9%)	100 (0.3%)	14,440 (45.5%)	250 (0.8%)	235 (0.7%)	250 (0.8%)	na

Source: (Nunavut Bureau of Statistics 2012d)

Appendix V8-3B

Back River Project: 2015 Economic Impact Model Report

Sabina
GOLD & SILVER CORP.

Sabina Gold & Silver Corp.

BACK RIVER PROJECT
2015 Economic Impact Model Report

Sabina
GOLD & SILVER CORP.

Rescan an ERM company

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October 2015

BACK RIVER PROJECT
2015 ECONOMIC IMPACT MODEL REPORT

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Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

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Acknowledgements

Rescan™
an ERM company

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2015 ECONOMIC IMPACT MODEL REPORT

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Glossary and Abbreviations

Glossary and Abbreviations

Construction	The phase of the project during which the mine is constructed.
DEIS	Draft Environmental Impact Statement
Direct Impact	Employment, income, GDP and tax revenue generated directly by the Project, including the resulting employment, income, GDP and tax revenue generated by industries directly contracted to supply the on-site goods and services used by the Project.
EA	Environmental Assessment
Economic impact	The result or effect that the mine development has on the economy of a particular region. Often described in terms of employment, personal income, Gross Domestic Product (GDP), and government tax revenue effects.
EIS	Environmental Impact Statement
GDP	Gross Domestic Product. The value-added by economic activity, principally composed of personal income and corporate profits.
Indirect Impact	Employment, income, GDP and tax revenue associated with all industries that are ultimately supplying the goods and services used by the industries directly supplying the Project, and include all transactions to the beginning of the supply chain (excluding direct on-site suppliers to the Project and the Project itself).
Induced Impact	Employment, income, GDP and tax revenue associated with economic activity because of workers spending their incomes on goods and services, including those directly and indirectly employed because of the Project.
Operation	The phase of the project during which the mine is producing.
OPEX	Operating expenditures
Project, the	Back River Project

1. Introduction

1. Introduction

1.1 THE PROJECT

The Back River Project (the Project) is an advanced exploration gold project located in the West Kitikmeot region of Nunavut (Figure 1.1-1) at approximately 65° to 66° north latitude, and 106° to 107° west longitude. The Project includes the Goose Property Area and a Marine Laydown Area in southern Bathurst Inlet, to be connected by winter ice road. The George Property will remain as a focus of ongoing advanced exploration.

The closest communities to the Project are Kingaok, located approximately 160 km to the north of the Goose Property, and Omingmaktok, located approximately 250 km to the northeast of the Goose Property. The communities of Kugluktuk and Cambridge Bay are the closest major regional settlements. Kugluktuk and Cambridge Bay are likely sources of workers and contractors, as are communities of the Eastern Kitikmeot region. These communities include Gjoa Haven, Kugaaruk and Taloyoak.

The total life of the Back River Project is predicted to be 27 years (from mobilization and construction through post closure monitoring; Table 1.1-1). The operations phase is expected to continue for 10 years, based on the mineral deposits that are currently known. Sabina will continue exploration activities in the area and further discoveries may extend mine operation beyond ten years.

Table 1.1-1. Back River Project Phases

Activities	Duration	Project Year
Mobilization and Construction	4 years	-4 to -1
Operation	10 years	1 to 10
Reclamation and Closure	8 years	10 to 18
Post Closure Monitoring	5 years	18 to 23

Ore will be mined and trucked using conventional open pit and underground methods and processed using standard gravity and leach recovery processes at a process plant located at the Goose Property. Ore will be processed at this one location while waste rock will be stored in designated storage areas on surface or backfilled in mine workings on the property. Tailings from the process plant will be stored in a Tailings Storage Facility (TSF) in the vicinity of the process plant, in combination with mined out open pits.

The available gold mineralization will ultimately be exhausted, whereupon the mine will enter the closure and reclamation phase. This phase, expected to last about eight years, will decommission the mine, demolish the buildings, and return the site to a stable condition. Following that, post closure monitoring will be undertaken for a period of approximately five years to ensure the area remains both chemically and physically stable.

1.2 ECONOMIC IMPACT STUDY SCOPE

The economic impacts of the Project are a result of the direct procurement and workforce employment. Using this data as input, the indirect and induced employment, personal income, Gross Domestic Product (GDP), and government revenue effects are predicted. Estimation of this information requires a detailed economic impact analysis, the results of which are included as part of the

Environmental Impact Statement (EIS) for the Project. The purpose of this report is to describe the results of the economic impact model for the Project.

For the Project, Rescan with EcoTec Consultants employed a proprietary economic impact model that is based on Statistics Canada's Input-Output Model. This model has a number of benefits including the ability to: (1) adjust the model structure to be more specific to the Project rather than being based on general statistical averages from secondary data sources; (2) with the use of econometric modules, incorporate dynamic model behaviour rather than relying strictly on a linear, static input-output structure; and (3) generate estimates at the sub-provincial or sub-territorial level rather than only at the provincial or territorial level. This approach has been successfully used in over 250 projects across Canada. Some examples include the Mary River Project (Nunavut), the Jansen Mine Project (Saskatchewan), the KSM Mine Project (British Columbia), the Voisey's Bay Mine Project (Labrador), the Brunswick Mine (New Brunswick), various mine projects in northern Quebec, and a sector-wide analysis of mining impacts in the Yukon, as well as many other mining, oil and gas, forestry, and fisheries sector projects.

PROJECT # 0194096-0033 GIS # BAC-16-033 December 17, 2013

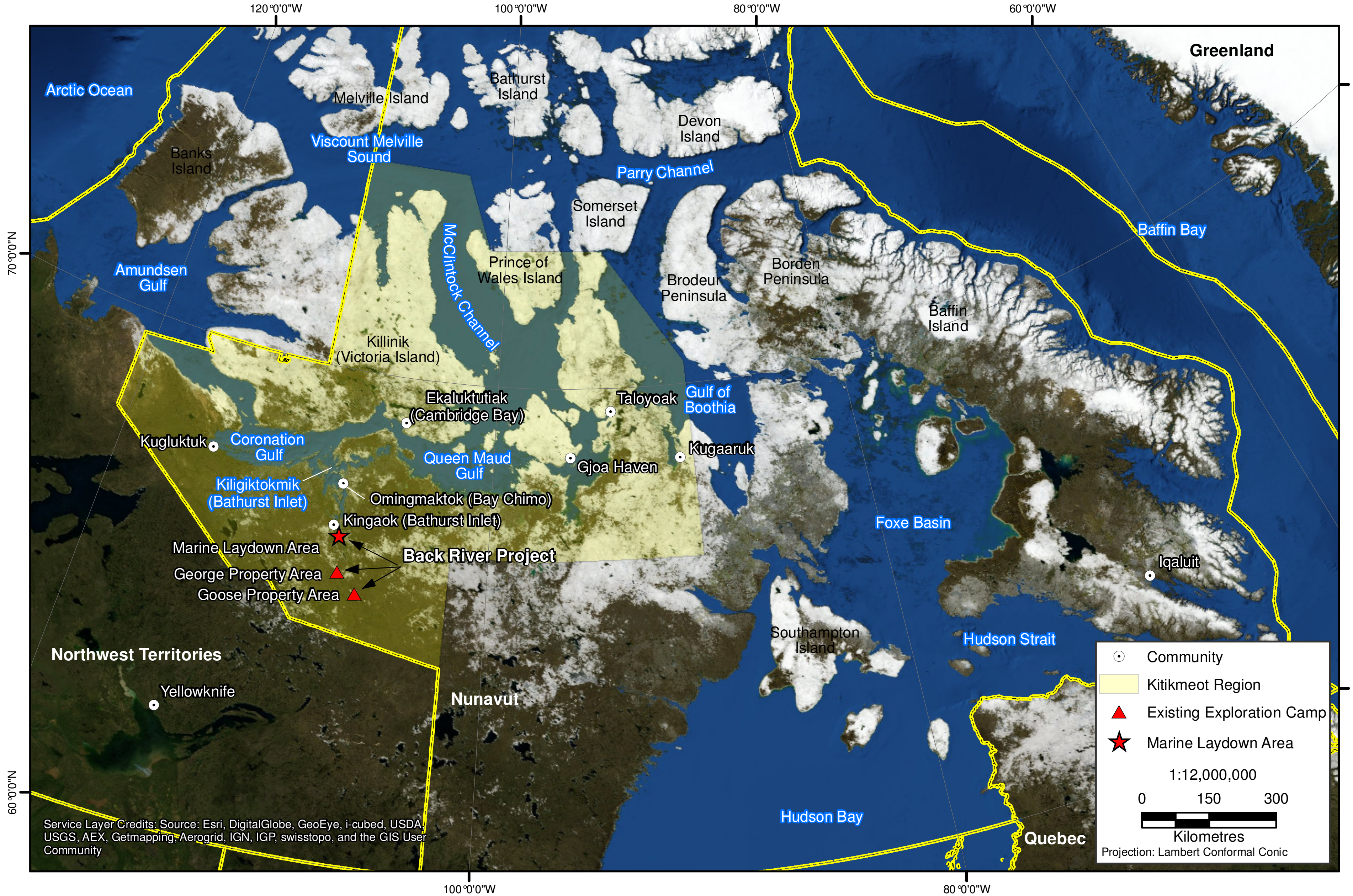

Figure 1.1-1

Sabina GOLD & SILVER CORP.

Back River Project Location and Kitikmeot Communities

Figure 1.1-1

Rescan an ERM company

2. Method

2. Method

2.1 BACKGROUND

An economic impact model was used to estimate the direct, indirect, and induced benefits of the Project. Each of these can be distinguished as follows:

- direct impacts are the employment, income, GDP and government tax revenue generated directly by the Project, including the resulting employment, income, GDP and tax revenue generated by industries directly contracted to supply the on-site goods and services used by the Project;
- indirect impacts are the employment, income, GDP and government tax revenue associated with all industries that are ultimately supplying the goods and services used by the industries directly supplying the Project, and includes all transactions to the beginning of the supply chain (excluding direct on-site suppliers to the Project and the Project itself); and
- induced impacts are the employment, income, GDP and government tax revenue associated with economic activity because of workers spending their incomes on goods and services, including those directly and indirectly employed because of the Project.

The DYNATEC model is based on Statistics Canada's Input-Output Model of the economies of Canada and the provinces and territories, but incorporates econometric modules to allow for dynamic, non-linear simulations of the likely effects. With the use of econometric modules, the linear behaviour of the base Input-Output Model is reduced to more closely mimic the real economy. The two most important econometric modules in the model are: (1) a labour market module, which considers the number of unemployed workers; and (2) a consumer expenditure module, which modifies expenditures based on expected changes in patterns of household behaviour according to changes in income.

The current version of the DYNATEC model uses the 2010 dataset of Statistics Canada's Input-Output Model, enhanced with data from various sources dating from 2010 to 2014. The core of the model operates at a level of aggregation consisting of 476 commodities and 117 industries. For the Back River Project both open and closed versions of the model were run. The open model is used to estimate indirect effects (effects from inter-industry purchases of goods and services), while the closed version is used to estimate induced effects (effects from spending of after-tax household income, primarily from wages and salaries, taking into account the propensity to save).

In addition to the model's ability to simulate the dynamic nature of the economy, a key characteristic of the models are their ability to provide estimates of the distribution of the effects by region (i.e., for the three regions of Nunavut, including the Kitikmeot Region). The model does this through a mathematical allocation that takes into account the characteristics of existing industries and business within each region, current economic structures and supplier relationships, and employment and skill base profiles.

The output statistics of the economic impact modelling are provided in constant 2015 Canadian dollars and include:

- employment;
- personal income;

- GDP; and
- government tax revenues.

2.2 OVERVIEW OF METHOD

Economic impact simulations begin with an input to the economy as represented by capital expenditures (CAPEX) and operation expenditures (OPEX). The main algorithm allocates the expenditures on each good and service purchased by the Project to the producing industries. These suppliers, in turn, purchase goods and services required to produce the items originally purchased directly by the Project.

The core of the model operates with a standard input-output algorithm. When expenditures first enter the model they are applied, for this Project, primarily to construction, machinery, and equipment sectors. Import coefficients are applied to account for the leakage of expenditures for items that are not produced within the province or territory. Sales within the province or territory are allocated to the industries that produce the specific goods and services purchased; each of these industries will, in turn, purchase goods and services to produce what they sell as determined by their technology mix and use of factors of production (labour and capital). For purchases outside of the province or territory, an interprovincial trade flow matrix is used to allocate production by industry and province or territory.

The model continues to iterate until all expenditures have dissipated (i.e., imports, taxes, and savings are all leakages that eventually reduce the amount of money available for purchases to zero). At this point, the model is stopped and the total effects as measured by gross production (sales) by industry are summed for all iterations. Using the estimate of gross production, industry-specific employment coefficients, and data on salaries by industry, employment numbers are estimated. GDP is estimated by subtracting the primary input components from gross production, also determined by industry-specific coefficients. The primary input components include indirect taxes, subsidies, salaries and benefits for employees, profits, and depreciation.

Tax revenue from personal income tax, corporate profit tax, and indirect tax (predominantly sales tax) is calculated with coefficients derived from Statistics Canada and Canada Revenue Agency information. The amount of money collected by governments is subtracted from wages and salaries and profits at each round of expenditures. Within the model, 32 personal income tax coefficients are used to account for different income tax brackets.

To calculate the distribution of economic impacts by region, regional weights are calculated and used to allocate expenditures. The mathematics used to allocate by region take into account:

- the nature of the industry and whether or not the purchased good or service is likely to be supplied by local firms or by firms from elsewhere;
- distance from the supplier (which can be more important for some industries than others);
- the regional economic structure (industries with a strong presence in a given region are likely to be suppliers);
- the size of the local economy (a local labour supply and market for goods and services supports the development of local business); and
- transportation networks (a region well-served by transportation will be in a better position to be a regionally important supplier).

2.3 INPUT DATA

Economic impact modeling was completed for the construction and operation phases of the project. Modeling was not conducted for the reclamation and closure or the post closure monitoring phases, which will have substantially lower expenditures and, thus, lower total impact on the economy. Annual capital and operating expenditures and workforce estimates from the Feasibility Study (JDS Energy and Mining Inc. 2015), as well as additional information on the likely sourcing of goods, services and workers from Sabina and its design engineers, were the main sources of Project data used as input for the model.[1] Detailed input data is described below and provided in Tables 2.3-1 to 2.3-5.

The following additional adjustments are made:

- Capital expenditures made after the start of operation (production) are included as part of operations (i.e., no distinction is made between true operation expenditures and capital investments that occur during operations, such as sustaining capital).
- Similarly, operating expenditures made during the construction phase (pre-production) are included as part of construction.
- All direct Nunavut employment for construction and operation is assumed to be based in the Kitikmeot Region, with no direct employment of Kivalliq and Qikiqtaaluk residents. This assumption was required lacking more specific information on the sourcing of workers within Nunavut, but is believed to be a reasonable approximation given the geographic location of the Project and existing socio-economic relationships between the regions, the Northwest Territories, and other Canadian jurisdictions.

2.3.1 Capital Expenditures

For the initial four-year construction phase (pre-production), assumed to begin in 2016, the Project involves a total capital investment of approximately $694.7 million, including $182.5 million in labour, $111.9 million in materials and $175.7 million in equipment costs. In addition, capital expenditures during operation (production) total an additional $440.4 million ($96.2 million in labour, $23.7 million in materials and $181.5 million in equipment costs), for a total CAPEX of approximately $1,135.1 million (Table 2.3-1). The distribution of CAPEX by year is shown in Table 2.3-2. The Project is expected to source the majority of the capital expenditures from Alberta and British Columbia, followed by imported goods and services and goods and services sourced from Nunavut.

2.3.2 Operating Expenditures

Operating expenditures (OPEX) for the Project are estimated to be a total of approximately $1,905.6 million, with $10.3 million in pre-production costs (Table 2.3-3). Operating expenditures are estimated at $160.1 million in the first year of Project operation, assumed to begin in 2020, increasing and reaching peak spending in year 8 of operation at $230.4 million (Table 2.3-3). The sourcing of operating expenditure is expected mainly from British Columbia, followed by Alberta, Northwest Territories, Quebec and Nunavut.

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[1] The Feasibility Study, which provided the input data for the economic impact model, includes development of the George Property Area. As defined for the Final Environmental Impact Statement (FEIS), the Back River Project excludes development of the George Property Area. However, it is not expected that the economic impacts would materially differ between the two cases because it is assumed that total Project expenditures and employment would be approximately the same. In other words, direct employment and procurement would be similar but focused on the development and mining of different deposits as defined for the FEIS.

Table 2.3-1. Pre-production and Production Capital Expenditures (Millions of Dollars) by Category

	Pre-Production Period						Production Period						Total
Area	Labour	Materials	Equipment	Usage	Other	Total	Labour	Materials	Equipment	Usage	Other	Total	CAPEX
Mining	$31.0	$14.0	$42.5	$14.9	$3.6	**$105.9**	$68.7	$1.0	$146.8	$63.5	$12.4	**$292.4**	**$398.3**
Processing	$28.4	$16.7	$41.9	$0.0	$24.6	**$111.7**	$0.0	$0.0	$0.0	$0.0	$0.0	**$0.0**	**$111.7**
On-Site Infrastructure	$28.8	$24.3	$65.9	$6.6	$46.8	**$172.3**	$3.0	$8.0	$27.4	$0.0	$16.4	**$54.7**	**$227.0**
Water & Waste Management	$0.9	$13.0	$2.7	$0.0	$3.1	**$19.7**	$1.5	$14.2	$3.9	$0.0	$12.4	**$31.9**	**$51.6**
Off-Site Infrastructure	$21.7	$4.0	$15.5	$8.9	$23.3	**$73.4**	$20.1	$0.0	$3.4	$11.6	$0.2	**$35.3**	**$108.7**
Owner's Costs	$22.4	$0.0	$0.0	$0.0	$7.9	**$30.3**	$0.0	$0.0	$0.0	$0.0	$0.0	**$0.0**	**$30.3**
Indirect Costs	$49.4	$39.8	$7.3	$3.4	$25.7	**$125.6**	$2.9	$0.6	$0.0	$0.3	$0.0	**$3.9**	**$129.5**
Contingency	$0.0	$0.0	$0.0	$0.0	$55.8	**$55.8**	$0.0	$0.0	$0.0	$0.0	$22.1	**$22.1**	**$77.9**
Total	**$182.5**	**$111.9**	**$175.7**	**$33.8**	**$190.9**	**$694.7**	**$96.2**	**$23.7**	**$181.5**	**$75.4**	**$63.5**	**$440.4**	**$1,135.1**

Table 2.3-2. Pre-production and Production Capital Expenditures (Millions of Dollars) by Year

	Year														Total
Area	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	CAPEX
Mining	$0.0	$0.0	$45.8	$60.0	$40.6	$48.4	$11.1	$18.2	$29.2	$64.5	$47.9	$24.9	$5.3	$2.1	**$398.3**
Processing	$0.0	$44.4	$48.6	$18.7	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	**$111.7**
On-Site Infrastructure	$0.0	$49.0	$87.4	$35.9	$1.2	$0.0	$0.0	$25.3	$11.5	$3.1	$12.2	$1.4	$0.0	$0.0	**$227.0**
Water & Waste Management	$0.0	$2.1	$6.5	$11.1	$3.5	$2.0	$2.0	$10.8	$12.7	$0.0	$0.9	$0.0	$0.0	$0.0	**$51.6**
Off-Site Infrastructure	$0.0	$40.2	$18.2	$15.0	$5.2	$4.1	$3.9	$3.5	$4.1	$3.7	$3.9	$3.7	$2.9	$0.3	**$108.7**
Owner’s Costs	$0.3	$3.2	$12.6	$14.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	**$30.3**
Indirect Costs	$12.8	$39.1	$35.5	$38.2	$0.0	$0.0	$0.7	$0.0	$2.5	$0.6	$0.0	$0.0	$0.0	$0.0	**$129.5**
Contingency	$1.2	$17.8	$22.2	$14.6	$2.3	$2.1	$1.0	$4.8	$4.2	$2.7	$3.2	$1.3	$0.5	$0.1	**$77.9**
Total	**$14.3**	**$195.8**	**$276.9**	**$207.7**	**$52.8**	**$56.6**	**$18.7**	**$62.6**	**$64.3**	**$74.6**	**$68.3**	**$31.3**	**$8.7**	**$2.5**	**$1,135.1**

Table 2.3-3. Pre-production and Production Operating Expenditures (Millions of Dollars) by Year

Area	Total Pre-Production OPEX	Total Production OPEX	Total OPEX	Year 2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Open Pit Mining	$0.0	$273.0	$273.0	$0.0	$0.0	$0.0	$0.0	$35.0	$38.8	$43.8	$43.1	$30.2	$31.8	$19.3	$16.1	$11.1	$3.9
Underground Mining	$0.0	$440.9	$440.9	$0.0	$0.0	$0.0	$0.0	$16.9	$30.8	$48.2	$41.2	$44.9	$50.4	$67.0	$73.8	$55.6	$12.3
Umwelt	$0.0	$221.5	$221.5	$0.0	$0.0	$0.0	$0.0	$0.0	$17.0	$29.1	$29.5	$29.2	$29.3	$28.8	$28.2	$25.2	$5.3
Llama	$0.0	$52.8	$52.8	$0.0	$0.0	$0.0	$0.0	$14.7	$11.6	$16.9	$9.6	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Goose Main	$0.0	$60.5	$60.5	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$13.2	$14.6	$16.0	$13.0	$3.8	$0.0
Echo	$0.0	$20.5	$20.5	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$4.0	$5.7	$6.5	$4.2	$0.0
LCP	$0.0	$15.0	$15.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$3.4	$8.0	$3.7	$0.0
LOC1	$0.0	$21.2	$21.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$4.5	$7.6	$7.9	$1.1
LOC2	$0.0	$28.5	$28.5	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$6.7	$8.6	$9.0	$4.2
Shared Services	$0.0	$21.0	$21.0	$0.0	$0.0	$0.0	$0.0	$2.2	$2.2	$2.1	$2.1	$2.5	$2.4	$1.9	$1.9	$1.9	$1.6
Processing	$10.3	$505.1	$515.3	$0.0	$0.0	$0.0	$10.3	$51.7	$55.7	$55.7	$55.7	$55.7	$55.7	$55.7	$55.7	$44.3	$19.3
Infrastructure & Site Services	$0.0	$258.9	$258.9	$0.0	$0.0	$0.0	$0.0	$22.3	$22.8	$23.0	$26.5	$28.7	$29.2	$29.8	$29.3	$29.3	$17.9
Ore Haul	$0.0	$59.3	$59.3	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$3.0	$13.5	$14.5	$14.5	$13.7
Sealift	$0.0	$5.4	$5.4	$0.0	$0.0	$0.0	$0.0	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7	$0.7	$0.0	$0.0
Freight	$0.0	$83.3	$83.3	$0.0	$0.0	$0.0	$0.0	$9.3	$9.6	$9.5	$12.9	$10.3	$11.3	$10.5	$9.8	$0.3	$0.0
General and Administrative	$0.0	$269.4	$269.4	$0.0	$0.0	$0.0	$0.0	$24.2	$25.9	$26.6	$26.2	$28.2	$29.3	$31.1	$30.6	$27.5	$19.9
Total OPEX	**$10.3**	**$1,895.4**	**$1,905.6**	**$0.0**	**$0.0**	**$0.0**	**$10.3**	**$160.1**	**$184.3**	**$207.4**	**$206.2**	**$198.5**	**$211.2**	**$227.5**	**$230.4**	**$182.6**	**$87.0**

Table 2.3-4. Direct Employment (Person-years) by Year

Year	Construction Nunavut	Construction Canada	Operation Nunavut	Operation Canada
2016	0	0	0	0
2017	20	135	0	0
2018	72	481	0	0
2019	131	878	6	38
2020	0	0	131	546
2021	0	0	151	638
2022	0	0	172	721
2023	0	0	164	687
2024	0	0	166	697
2025	0	0	178	745
2026	0	0	205	860
2027	0	0	213	895
2028	0	0	186	779
2029	0	0	87	362
Total	**223**	**1,494**	**1,659**	**6,968**

Table 2.3-5. Assumed Source of Direct Labour for the Back River Project (Contractors and Owner Employees)

Province or Territory	Construction	Operation
Nunavut	*15%*	*25%*
Northwest Territories	10%	10%
Yukon	0%	0%
British Columbia	20%	15%
Alberta	25%	20%
Saskatchewan	6%	8%
Manitoba	2%	2%
Ontario	5%	10%
Quebec	3%	5%
New Brunswick	2%	0%
Nova Scotia	2%	0%
Prince Edward Island	0%	0%
Newfoundland and Labrador	10%	5%

2.3.3 Workforce

The Project will create approximately 8,462 person-years of direct employment, including 1,494 person-years of employment during construction and 6,968 person-years during operation (Table 2.3-4). Construction employment will begin in 2017 at 135 person-years of employment, steadily increasing and reaching a peak or 878 person-years of employment in 2019. Operation workforce will begin in year 2019 at 38 person-years, sharply increasing to 546 in 2020 reaching a peak in 2027 at 895 person-years. The majority of employment will be in underground mining, general and administrative, surface and infrastructure, and open pit mining.

For the purpose of the economic model, it is further assumed that the source of direct labour for the Project will be as provided in Table 2.3-1.

2.4 MODEL CAVEATS

The main caveats associated with the economic impact modelling are:

- The structure of the economy is assumed to be largely as it was in 2010, the most recent baseline data year for the Statistics Canada Input-Output Model available at the time of the initiation of modeling work. Any substantive structural changes in the economy, including changes in the use of factors in production, changes in technology, and/or changes in inter industry purchase patterns, will result in a loss of model accuracy.
- Production technologies are assumed to be uniform and consistent. In estimating the distribution of economic impacts, the model is not able to account for any differences in the technologies used by firms or industries within the same sector.
- Because the model operates at a macro level, it is not able to predict how economic impacts may be distributed among or differ between socio-economic segments of society.
- The model is not able to take into account economies of scale. The presence of economies of scale means both that the proportional use of factors of production by the Project and inter industry relationships may change.

- It is assumed that the Project will have no measurable, permanent impact on wage levels, productivity or consumer behaviour, in aggregate. In other words, the model is not able to account for substantive changes in the structure or behaviour of the economy as a result of the impacts of the Project.
- The model assumes no limits to growth. All factors of production, including labour and capital, are assumed to be available for use, and there are no other exogenous factors that may affect economic production.
- The estimation of GDP impacts by the model does not include direct business operating profit from the Project. This component of GDP is excluded from all reported direct and total GDP figures. The direct GDP estimated by the model is principally labour expense. The estimates of indirect and induced GDP do include all components of GDP.
- The estimation of government tax revenues by the model is limited primarily to personal income tax, indirect corporate profit tax, and sales tax. It does not include direct taxes on the profit of the Project, land taxes or rents, or any royalties paid by the Project. Typically, these latter sources of government revenue are Project-specific and best estimated using separate financial modelling methods.

Economic input-output models are one of the best ways to meaningfully estimate regional, territorial and national level impacts of a project. However, the model necessarily is based on the structure and function of the economy as it has been in the recent past (i.e., largely as it was in 2010, the most recent year for which input-output data are available at the time of this report). The model is not able to take into account the changes that may occur in the economy over time, nor is it able to account for the effect of Project mitigation or benefit enhancement measures as they have been defined with respect to business development, human resources, or community investment. Thus, the output statistics of the model (employment, personal income, GDP, and government tax revenues) used to estimate the economic impacts of the Project may be conservative – that is, they provide a picture of what is expected based on the status quo performance of the economy. Actual economic benefits realized from the Project, particularly within the Kitikmeot Region, may be greater than predicted once mitigation and benefit enhancement measures are applied. Similarly, the development of other large projects in Nunavut, in particular other mine projects such as the Hope Bay Project, may result in changes to the labour and business markets, also potentially affecting the size and distribution of the benefits to Nunavut as predicted by the model.

3. Results

3. Results

For the Back River Project, employment, personal income, and GDP statistics were estimated for each of the three regions in Nunavut (Kitikmeot, Kivalliq, and Qikiqtaaluk) as well as at the provincial and territorial level for all of Canada. Government tax revenue statistics are provided at the territorial and provincial levels only.

3.1 CONSTRUCTION PHASE

Initial mobilization and construction of the Back River Project is expected to take approximately four years, assumed to start in 2016.

3.1.1 Canada

The construction phase of the Project is estimated to result in a total of 4,339 person-years of direct, indirect and induced employment across Canada (Table 3.1-1). In the first year of construction, it is expected that the Project will create 30 person-years of employment. In the following year the Project will provide 544 person-years of employment, increasing to 1,244 person-years in 2018 and reaching a peak at 1,801 person-years of employment in the fourth year of construction (Table 3.1-1). Thereafter, indirect and induced employment will continue as the construction expenditures cycle through the economy, dissipating by year 2027.

Table 3.1-1. Annual Economic Impacts of Back River Project Construction for Canada

Year	Employment (Person-years)	GDP (Millions of Dollars)	Tax Revenue (Millions of Dollars)		
			Federal	Provincial/Territorial	Total
2016	30	$3.2	$0.3	$0.3	$0.5
2017	544	$61.5	$6.5	$6.0	$12.5
2018	1,224	$144.7	$14.7	$13.6	$28.3
2019	1,801	$211.6	$18.9	$17.3	$36.2
2020	470	$51.9	$5.6	$5.2	$10.8
2021	169	$18.4	$2.0	$1.9	$3.9
2022	62	$6.6	$0.8	$0.7	$1.4
2023	23	$2.5	$0.3	$0.3	$0.5
2024	9	$0.9	$0.1	$0.1	$0.2
2025	3	$0.4	$0.0	$0.0	$0.1
2026	1	$0.1	$0.0	$0.0	$0.0
2027	0	$0.1	$0.0	$0.0	$0.0
Total	**4,339**	**$502.0**	**$49.2**	**$45.3**	**$94.5**

The total GDP impact is estimated to be approximately $502.0 million. The Project will also bring government revenues of approximately $49.2 million to the federal and $45.3 million to the provincial and territorial governments across Canada; this revenue will primarily come from personal income tax, indirect corporate profit tax and sales tax (Table 3.1-1).

Economic impacts of the Project's construction phase will occur in all provinces and territories (Table 3.1-2); however, as expected, the Project will benefit Nunavut as it will create an estimated total of 347 person-years of employment and contribute as much as $43.6 million in GDP. The Project is expected to create 1,034 person-years of employment in British Columbia with GDP benefits of $111.3 million. The province of Alberta is expected to gain 905 person-years of employment and $125.4 million in GDP benefits. Further, Ontario is expected to benefit in 882 person-years of employment and $95.2 million in GDP, all outweighing employment and GDP benefits in Nunavut. Significant economic impacts, both in terms of person-years of employment and GDP, will be also present in Quebec and the Northwest Territories (Table 3.1-2).

Table 3.1-2. Total Economic Impacts of Back River Project Construction by Province and Territory

			Tax Revenue (Millions of Dollars)		
Province or Territory	**Employment (Person-years)**	**GDP (Millions of Dollars)**	**Federal**	**Provincial/ Territorial**	**Total**
Nunavut	*347*	*$43.6*	*$4.3*	*$3.3*	*$7.6*
Newfoundland and Labrador	155	$19.0	$1.4	$1.1	$2.5
Prince Edward Island	6	$0.4	$0.0	$0.0	$0.1
Nova Scotia	53	$5.4	$0.4	$0.4	$0.9
New Brunswick	54	$6.0	$0.5	$0.6	$1.1
Quebec	474	$45.6	$4.2	$6.1	$10.4
Ontario	882	$95.2	$9.1	$10.6	$19.7
Manitoba	109	$10.9	$0.9	$1.0	$1.9
Saskatchewan	155	$17.9	$1.4	$1.3	$2.7
Alberta	905	$125.4	$14.9	$11.5	$26.4
British Columbia	1,034	$111.3	$10.0	$8.4	$18.5
Yukon	6	$0.6	$0.1	$0.0	$0.1
Northwest Territories	160	$20.7	$1.9	$0.9	$2.7
Total Canada	**4,339**	**$502.0**	**$49.2**	**$45.3**	**$94.5**

The strength of the benefits to the other provinces can be attributed to two main factors: 1) construction workers will come from those provinces, and 2) those provinces are expected to play a prominent role in providing goods and services directly to the Project. This can be seen in Table 3.1-3 in terms of the direct and indirect employment and GDP estimates. Businesses based in British Columbia and Alberta, in particular, are expected to be important suppliers to the Project.

Tax revenue to the Government of Nunavut is estimated to be approximately $3.3 million, with an additional $4.3 million to the federal government due to Project-generated economic activity in Nunavut. In terms of provincial tax revenue, the construction phase is predicted to contribute $11.5 million to the province of Alberta, while British Columbia is estimated to receive $8.4 million, Ontario $10.6 million, and Quebec $6.1 million (Table 3.1-2). Federal tax revenues due to economic activity in those provinces add substantially more to the total tax contributions. These total tax revenues include direct, indirect and induced taxes (primarily consisting of personal income, business and sales taxes), but exclude business taxes and royalties paid directly by the Project.

As estimated, the majority of direct employment is expected to be in the province of Alberta (373), followed by British Columbia (298) and Nunavut (223), with total person-years of direct employment of 1,494 across provinces. The majority of indirect employment is predicted to be in Ontario (559), followed by the British Columbia (485) and Alberta (374), with total person-years of indirect employment of 1,973 across Canada. And finally, induced employment is expected to be mainly in British Columbia (250) and Ontario (248), followed by Alberta (158), with total person-years of induced employment during the construction phase of 872 person-years (Table 3.1-3).

Table 3.1-3. Total Employment and GDP Impacts of Back River Project Construction by Province and Territory

	Employment (Person-years)				GDP (Millions of Dollars)			
Province or Territory	**Direct**	**Indirect**	**Induced**	**Total**	**Direct**	**Indirect**	**Induced**	**Total**
Nunavut	*223*	*103*	*21*	*347*	*$27.7*	*$11.1*	*$4.9*	*$43.6*
Newfoundland and Labrador	149	4	1	155	$18.3	$0.4	$0.3	$19.0
Prince Edward Island	0	4	1	6	$0.0	$0.3	$0.1	$0.4
Nova Scotia	31	16	6	53	$3.7	$1.1	$0.6	$5.4
New Brunswick	31	12	11	54	$3.7	$1.2	$1.2	$6.0
Quebec	44	296	133	474	$5.7	$26.4	$13.4	$45.6
Ontario	75	559	248	882	$10.0	$56.8	$28.4	$95.2
Manitoba	31	58	20	109	$3.7	$5.2	$2.1	$10.9
Saskatchewan	90	49	16	155	$11.0	$5.0	$1.9	$17.9
Alberta	373	374	158	905	$48.3	$51.8	$25.4	$125.4
British Columbia	298	485	250	1,034	$38.8	$43.1	$29.4	$111.3
Yukon	0	5	1	6	$0.0	$0.4	$0.1	$0.6
Northwest Territories	149	7	4	160	$18.3	$1.4	$1.1	$20.7
Total Canada	**1,494**	**1,973**	**872**	**4,339**	**$189.0**	**$204.1**	**$108.9**	**$502.0**

Note: Rounding error accounts for discrepancies in totals.

Direct GDP impacts are expected to be felt most in Alberta ($48.3 million), British Columbia ($38.8 million) and Nunavut ($27.7 million), with total direct GDP benefits of $189.0 million across Canadian provinces and territories. Indirect GDP benefits are expected to be primarily in Ontario ($56.8 million), followed by Alberta ($51.8 million), British Columbia ($43.1 million) and Quebec ($26.4 million); with total indirect GDP of $204.1 million in Canada. Finally, the majority of induced GDP impacts are predicted for the province of British Columbia ($29.4 million) followed by Ontario ($28.4 million) and Alberta ($25.4 million), with total induced GDP benefits of $108.9 million (Table 3.1-3).

The total personal income benefit for the construction of the Project is estimated at $316.8 million for Canada. Direct income impacts are expected to be highest in Alberta ($45.9 million) and British Columbia ($37.1 million), then Nunavut ($27.4 million), for a total of direct personal income impact of $183.5 million across Canada. Indirect income impacts are predicted from Ontario ($36.2 million), British Columbia ($29.4 million) and Alberta ($28.2 million), for a total impact of $125.9 million. Finally, induced income impacts are estimated at $45.4 million for Canada (Table 3.1-4).

Table 3.1-4. Total Personal Income Impacts of Back River Project Construction by Province and Territory

	Personal Income (Millions of Dollars)			
Province or Territory	**Direct**	**Indirect**	**Induced**	**Total**
Nunavut	*$27.4*	*$7.4*	*$1.4*	*$36.2*
Newfoundland and Labrador	$18.3	$0.2	$0.1	$18.6
Prince Edward Island	$0.0	$0.2	$0.0	$0.2
Nova Scotia	$3.7	$0.7	$0.3	$4.6
New Brunswick	$3.7	$0.6	$0.4	$4.7
Quebec	$5.5	$16.2	$6.5	$28.1
Ontario	$9.2	$36.2	$13.6	$59.0
Manitoba	$3.7	$3.1	$0.9	$7.6
Saskatchewan	$11.0	$2.8	$0.8	$14.5
Alberta	$45.9	$28.2	$9.1	$83.2
British Columbia	$37.1	$29.4	$12.0	$78.5
Yukon	$0.0	$0.3	$0.1	$0.3
Northwest Territories	$18.3	$0.5	$0.3	$19.1
Total Canada	**$183.5**	**$125.9**	**$45.4**	**$354.8**

3.1.2 Nunavut

Annually, within Nunavut, total employment (direct, indirect, and induced) increases from approximately 7 in the first year of Project construction to 170 in the last year, for a total employment impact of 347 person-years for Nunavut. Similarly, GDP benefits resulting from the construction phase increase from approximately $0.7 million in 2016 to $21.3 million in 2019, totaling $43.6 million for the phase. As a result of the construction phase, the Project contributes substantially to the federal and territorial governments; the total tax revenue to the federal government is $4.3 million, and the Government of Nunavut is predicted to receive $3.3 million (Table 3.1-5).

Table 3.1-5. Annual Economic Impacts of Back River Project Construction for Nunavut

			Tax Revenue (Millions of Dollars)		
Year	**Employment (Person-years)**	**GDP (Millions of Dollars)**	**Federal**	**Territorial**	**Total**
2016	7	$0.7	$0.1	$0.1	$0.2
2017	55	$6.7	$0.8	$0.6	$1.4
2018	108	$13.8	$1.4	$1.1	$2.5
2019	170	$21.3	$1.8	$1.4	$3.2
2020	6	$0.9	$0.1	$0.1	$0.2
2021	1	$0.1	$0.0	$0.0	$0.0
Total	**347**	**$43.6**	**$4.3**	**$3.3**	**$7.6**

With respect to Nunavut, the employment impacts are expected to be most strongly felt in the Kitikmeot Region with 260 person-years of employment created during the construction phase, followed by the Kivalliq and Qikiqtaaluk Regions. Similarly, the Kitikmeot Region is expected to have the highest GDP benefits of $33.2 million; this will represent 76.2% of GDP impacts in Nunavut, followed by Kivalliq at 16.7% and Qikiqtaaluk at 7.1%. The Kitikmeot Region benefits from the location of the Project in the west Kitikmeot (Table 3.1-6).

Table 3.1-6. Total Economic Impacts of Back River Project Construction for Nunavut by Region

Region	Employment (Person-years)	GDP (Millions of Dollars)	Tax Revenue (Millions of Dollars)		
			Federal	Territorial	Total
Qikiqtaaluk	19	$3.1	$0.3	$0.3	$0.6
Kivalliq	69	$7.3	$0.7	$0.7	$1.4
Kitikmeot	260	$33.2	$3.3	$2.3	$5.6
Total Nunavut	**347**	**$43.6**	**$4.3**	**$3.3**	**$7.6**

The Kitikmeot Region is estimated to benefit from a total of 223 person-years of direct employment. Indirect employment is expected to be mainly in the Kivalliq Region, representing 64.1% of total indirect employment in Nunavut, followed by the Kitikmeot and Qikiqtaaluk. The relatively strong indirect benefits to the Kivallliq Region are predicted by the economic model because of the current strength of the mining sector in that region. Some induced employment impacts are expected to take place in Qikiqtaaluk and Kitikmeot (Table 3.1-7).

Table 3.1-7. Total Employment, Personal Income, and GDP Impacts of Back River Project Construction for Nunavut by Region

	Employment (Person-years)			
Region	**Direct**	**Indirect**	**Induced**	**Total**
Qikiqtaaluk	0	11	8	19
Kivalliq	0	66	3	69
Kitikmeot	223	27	10	260
Nunavut	**223**	**103**	**21**	**347**
	Personal Income (Millions of Dollars)			
Region	**Direct**	**Indirect**	**Induced**	**Total**
Qikiqtaaluk	$0.0	$1.0	$0.8	$1.8
Kivalliq	$0.0	$4.5	$0.3	$4.8
Kitikmeot	$27.4	$1.9	$0.3	$29.6
Nunavut	**$27.4**	**$7.4**	**$1.4**	**$36.2**
	GDP (Millions of Dollars)			
Region	**Direct**	**Indirect**	**Induced**	**Total**
Qikiqtaaluk	$0.0	$1.6	$1.5	$3.1
Kivalliq	$0.0	$6.3	$1.0	$7.3
Kitikmeot	$27.7	$3.1	$2.5	$33.2
Nunavut	**$27.7**	**$11.1**	**$4.9**	**$43.6**

Note: Rounding error accounts for discrepancies in totals.

Direct personal income impacts and direct GDP impacts in the Kitikmeot Region are expected to represent 100% of the direct impacts in Nunavut. Indirect impacts will be mostly felt in the Kivalliq Region; some induced personal income impacts will be felt in the Qikiqtaaluk Region, whereas induced GDP benefits are estimated to be felt in the Kitikmeot (Table 3.1-7).

Overall, the Kitikmeot Region is expected to have 260 person-years of employment (direct, indirect, and induced) during the construction phase and this will represent 74.9% of total employment in Nunavut. The construction of the mine will benefit the residents of the Kitikmeot Region in the amount of $29.6 million in personal income (81.8% of the total personal income in Nunavut), and deliver GDP benefits of $33.2 million (76.1% of total GDP benefits in the Territory; Table 3.1-7).

3.2 OPERATION PHASE

The operation phase of the Back River Project has been estimated for a period of approximately 10 years from the completion of initial construction. Operation is expected to begin in 2020, with a relatively small amount of activity the year prior (2019, the last year of construction) associated with the initiation of ore processing.

3.2.1 Canada

During the operation phase, it is expected that the total direct, indirect and induced employment for Canada as a whole will be 20,828 person-years. Total employment increases sharply through the first and second years of operation, peaking in 2027 at 2,545 person-years and then dissipating by year 2037. Total Canadian GDP impacts of the Project's operation phase are predicted at $2,557.5 million. The total GDP will peak at $309.0 million in 2027 of production; thereafter, the total Canadian GDP benefits will fall, again effectively dissipating by 2037 (Table 3.2-1).

Table 3.2-1. Annual Economic Impacts of Back River Project Operation for Canada

Year	Employment (Person-years)	GDP (Millions of Dollars)	Tax Revenue (Millions of Dollars)		
			Federal	Provincial/Territorial	Total
2016	0	$0.0	$0.0	$0.0	$0.0
2017	0	$0.0	$0.0	$0.0	$0.0
2018	0	$0.0	$0.0	$0.0	$0.0
2019	65	$9.7	$1.3	$1.3	$2.6
2020	984	$130.4	$10.2	$9.9	$20.1
2021	1,453	$186.4	$15.3	$14.8	$30.1
2022	1,773	$224.2	$18.6	$18.0	$36.6
2023	1,969	$245.3	$20.3	$19.7	$40.1
2024	2,126	$263.3	$22.3	$21.6	$43.9
2025	2,264	$278.7	$23.7	$23.0	$46.6
2026	2,353	$290.5	$20.9	$20.3	$41.2
2027	2,545	$309.0	$22.5	$21.8	$44.3
2028	2,343	$282.2	$20.9	$20.2	$41.1
2029	1,846	$215.6	$18.6	$18.0	$36.6
2030	705	$79.0	$8.3	$8.0	$16.3
2031	253	$27.3	$3.0	$2.9	$5.8
2032	94	$10.0	$1.1	$1.1	$2.2
2033	36	$3.8	$0.4	$0.4	$0.8
2034	14	$1.5	$0.2	$0.2	$0.3
2035	4	$0.5	$0.1	$0.1	$0.1
2036	1	$0.1	$0.0	$0.0	$0.0
Total	**20,828**	**$2,557.5**	**$207.6**	**$201.2**	**$408.8**

Total government tax revenue during operation is estimated at $408.8 million, consisting of $207.6 in federal and $201.2 in provincial and territorial tax revenue (Table 3.2-1).

The total economic impacts of the operation phase by province or territory are shown in Table 3.2-2. British Columbia, Alberta and Ontario, followed by Nunavut and Quebec are expected to realize the majority of the benefits. British Columbia ranks first in terms of expected person-years of employment and GDP benefits (direct, indirect, and induced); it is estimated that the province will have 5,271 person-years of employment and $640.4 million in total GDP benefits due to the mine's operation. Alberta and Ontario will benefit respectively in 3,947 and 3,780 person-years of employment, and $568.6 million and $408.2 million in GDP, respectively. The Territory of Nunavut is expected to benefit by 2,928 person-years of employment, ranking fourth in terms of employment benefits; and the Project is projected to increase the territorial GDP by $382.2 million (Table 3.2-2).

Table 3.2-2. Total Economic Impacts of Back River Project Operation by Province and Territory

			Tax Revenue (Millions of Dollars)		
Province or Territory	**Employment (Person-years)**	**GDP (Millions of Dollars)**	**Federal**	**Provincial/ Territorial**	**Total**
Nunavut	*2,928*	*$382.2*	*$21.9*	*$23.0*	*$45.0*
Newfoundland and Labrador	472	$55.2	$3.3	$3.5	$6.9
Prince Edward Island	13	$0.9	$0.1	$0.1	$0.2
Nova Scotia	78	$6.8	$0.5	$0.6	$1.1
New Brunswick	67	$6.8	$0.5	$0.6	$1.1
Quebec	1,930	$188.2	$16.5	$23.8	$40.2
Ontario	3,780	$408.2	$36.6	$41.2	$77.8
Manitoba	471	$46.8	$3.3	$4.2	$7.6
Saskatchewan	860	$102.2	$6.2	$7.1	$13.3
Alberta	3,947	$568.6	$52.6	$40.0	$92.6
British Columbia	5,271	$640.4	$57.1	$49.9	$107.0
Yukon	17	$1.7	$0.1	$0.1	$0.3
Northwest Territories	997	$149.6	$8.8	$7.0	$15.9
Total Canada	**20,828**	**$2,557.5**	**$207.6**	**$201.2**	**$408.8**

With the increase in economic activity specifically in Nunavut, Project operation will contribute $23.0 million in tax revenue to the Government of Nunavut and $21.9 million in tax revenue to the Government of Canada. The provincial/territorial tax revenue will be the highest in British Columbia, followed by Ontario and Alberta (Table 3.2-2).

Total employment impacts (direct, indirect, and induced) will be most felt in British Columbia, at 25.3% of total employment, followed by Alberta at 18.9% and Ontario at 18.1%. Nunavut will have highest employment benefits in terms of direct employment at 1,659 person-years, followed by Alberta (1,444 person-years) and British Columbia (1,080). Indirect employment benefits will be highest in British Columbia, followed by Ontario and Alberta; a similar trend applies to induced employment benefits (Table 3.2-3).

Direct GDP impacts are most felt in Nunavut, while indirect and induced GDP impacts are most pronounced in British Columbia, Alberta, and Ontario. In particular, the Project is expected to contribute $191.7 million, $137.3 million, and $53.2 million in direct, indirect, and induced GDP benefits, respectively, to Nunavut. Overall, the majority of Nunavut GDP benefits will be direct (50.2%), while a smaller share is indirect (35.9% of total) and induced (13.9% of total; Table 3.2-3).

Table 3.2-3. Total Employment and GDP Impacts of Back River Project Operation by Province and Territory

	Employment (Person-years)				GDP (Millions of Dollars)			
Province or Territory	**Direct**	**Indirect**	**Induced**	**Total**	**Direct**	**Indirect**	**Induced**	**Total**
Nunavut	*1,659*	*1,014*	*254*	*2,928*	*$191.7*	*$137.3*	*$53.2*	*$382.2*
Newfoundland and Labrador	386	9	77	472	$44.9	$0.8	$9.5	$55.2
Prince Edward Island	0	7	5	13	$0.0	$0.5	$0.4	$0.9
Nova Scotia	18	34	26	78	$1.9	$2.6	$2.3	$6.8
New Brunswick	18	25	24	67	$1.9	$2.5	$2.4	$6.8
Quebec	330	897	703	1,930	$38.2	$80.3	$69.7	$188.2
Ontario	655	1,810	1,315	3,780	$75.4	$185.2	$147.7	$408.2
Manitoba	141	191	139	471	$16.0	$16.9	$13.9	$46.8
Saskatchewan	543	126	190	860	$62.2	$16.7	$23.3	$102.2
Alberta	1,444	1,587	916	3,947	$166.6	$261.5	$140.5	$568.6
British Columbia	1,080	2,798	1,393	5,271	$128.9	$350.8	$160.7	$640.4
Yukon	0	11	5	17	$0.0	$1.0	$0.6	$1.7
Northwest Territories	694	160	143	997	$80.5	$43.8	$25.3	$149.6
Total Canada	**6,968**	**8,670**	**5,190**	**20,828**	**$808.2**	**$1,100.0**	**$649.4**	**$2,557.5**

Note: Rounding error accounts for discrepancies in totals.

Finally, total personal income benefit for the operation phase is estimated at $1,684.5 million for Canada. Direct income impacts are expected to be highest in Nunavut ($190.7 million), Alberta ($165.1 million) and British Columbia ($125.1 million), with a total of direct personal income impact of $801.4 million across Canada. Indirect income impacts are predicted mainly for British Columbia ($178.7 million), Alberta ($127.3 million) and Ontario ($118.2 million), for a total impact of $607.2 million in Canada. Finally, induced income impacts are estimated at $276.0 million for Canada, with strongest impacts in Ontario and British Columbia (Table 3.2-4).

3.2.2 Nunavut

For Nunavut, the total annual employment impacts (direct, indirect and induced) for the operation phase are estimated at 2,928 person-years. Total employment benefits in the first year of production will start at an estimated 214 person-years, increasing to 367 person-years in 2027 and dissipating by 2032 (Table 3.2-5). Territorial GDP impacts follow a similar pattern; GDP benefits increase from an estimated $28.2 million in 2020, reaching a maximum of $47.7 million in 2027, thereafter ceasing by 2032. Federal and territorial tax revenues are approximately $3.4 million in the first year of production, peaking at $5.2 million in 2032. For the operation phase, total tax revenue due to economic activity in Nunavut is estimated to be $21.9 million to the federal government and $23.0 million to the territorial government (Table 3.2-5).

Table 3.2-4. Total Personal Income Impacts of Back River Project Operation by Province and Territory

Province or Territory	Personal Income			
	Direct	Indirect	Induced	Total
Nunavut	*$190.7*	*$90.7*	*$16.7*	*$298.1*
Newfoundland and Labrador	$44.9	$0.5	$3.6	$49.0
Prince Edward Island	$0.0	$0.3	$0.2	$0.5
Nova Scotia	$1.9	$1.6	$1.1	$4.7
New Brunswick	$1.9	$1.3	$1.1	$4.3
Quebec	$38.1	$50.2	$34.9	$123.2
Ontario	$75.3	$118.2	$73.3	$266.8
Manitoba	$16.0	$9.8	$6.2	$32.0
Saskatchewan	$62.2	$7.5	$8.7	$78.4
Alberta	$165.1	$127.3	$53.4	$345.8
British Columbia	$125.1	$178.7	$67.7	$371.5
Yukon	$0.0	$0.6	$0.3	$0.9
Northwest Territories	$80.1	$20.3	$8.8	$109.3
Total Canada	**$801.4**	**$607.2**	**$276.0**	**$1,684.5**

Table 3.2-5. Annual Economic Impacts of Back River Project Operation for Nunavut

Year	Employment (Person-years)	GDP (Millions of Dollars)	Tax Revenue (Millions of Dollars)		
			Federal	Territorial	Total
2016	0	$0.0	$0.0	$0.0	$0.0
2017	0	$0.0	$0.0	$0.0	$0.0
2018	0	$0.0	$0.0	$0.0	$0.0
2019	15	$2.0	$0.3	$0.3	$0.5
2020	214	$28.2	$1.7	$1.7	$3.4
2021	266	$34.7	$2.1	$2.2	$4.3
2022	297	$38.7	$2.3	$2.4	$4.7
2023	296	$38.6	$2.3	$2.4	$4.6
2024	303	$39.8	$2.4	$2.5	$4.8
2025	322	$42.0	$2.5	$2.6	$5.1
2026	355	$45.9	$2.5	$2.6	$5.1
2027	367	$47.7	$2.6	$2.7	$5.2
2028	305	$39.7	$2.0	$2.1	$4.1
2029	172	$22.7	$1.3	$1.3	$2.6
2030	13	$2.0	$0.2	$0.2	$0.4
2031	2	$0.2	$0.0	$0.0	$0.0
2032	0	$0.0	$0.0	$0.0	$0.0
2033	0	$0.0	$0.0	$0.0	$0.0
2034	0	$0.0	$0.0	$0.0	$0.0
2035	0	$0.0	$0.0	$0.0	$0.0
2036	0	$0.0	$0.0	$0.0	$0.0
Total	**2,928**	**$382.2**	**$21.9**	**$23.0**	**$45.0**

Within Nunavut, total employment benefits are felt most in the Kitikmeot Region where 66.2% of the total employment in the territory is created; this is followed by the Qikiqtaaluk and Kivalliq Regions. Similarly, total GDP benefits are predicted to predominantly occur within the Kitikmeot Region and are estimated at $263.0 million, or 68.8% of the total GDP impacts in the territory. Notably, tax revenues generated in the Kitikmeot Region are approximately 51.3% of that of the whole territory (Table 3.2-6).

Table 3.2-6. Total Economic Impacts of Back River Project Operation for Nunavut by Region

Region	Employment (Person-years)	GDP (Millions of Dollars)	Tax Revenue (Millions of Dollars)		
			Federal	Territorial	Total
Qikiqtaaluk	714	$95.1	$9.8	$8.2	$18.0
Kivalliq	276	$24.1	$2.2	$1.7	$3.9
Kitikmeot	1,938	$263.0	$9.9	$13.1	$23.1
Total Nunavut	**2,928**	**$382.2**	**$21.9**	**$23.0**	**$45.0**

For the Kitikmeot Region, the total employment (direct, indirect and induced) over the operational life of the Project is estimated to be approximately 1,938 person-years. Direct employment impacts of 1,659 are predicted only for Kitikmeot; however, the majority of indirect and induced employment impacts are predicted in Qikiqtaaluk (Table 3.2-7).

Table 3.2-7. Total Employment, Personal Income, and GDP Impacts of Back River Project Operation for Nunavut by Region

	Employment (Person-years)			
Region	**Direct**	**Indirect**	**Induced**	**Total**
Qikiqtaaluk	0	583	131	714
Kivalliq	0	226	50	276
Kitikmeot	1,659	206	73	1,938
Nunavut	**1,659**	**1,014**	**254**	**2,928**
	Personal Income (Millions of Dollars)			
Region	**Direct**	**Indirect**	**Induced**	**Total**
Qikiqtaaluk	$0.0	$55.4	$9.4	$64.8
Kivalliq	$0.0	$11.0	$3.3	$14.3
Kitikmeot	$190.7	$24.3	$4.0	$219.0
Nunavut	**$190.7**	**$90.7**	**$16.7**	**$298.1**
	GDP (Millions of Dollars)			
Region	**Direct**	**Indirect**	**Induced**	**Total**
Qikiqtaaluk	$0.0	$74.5	$20.7	$95.1
Kivalliq	$0.0	$16.8	$7.3	$24.1
Kitikmeot	$191.7	$46.1	$25.2	$263.0
Nunavut	**$191.7**	**$137.3**	**$53.2**	**$382.2**

Note: Rounding error accounts for discrepancies in totals.

Personal income effects (direct, indirect, and induced) are expected to be mainly in the Kitikmeot Region, estimated at $219.0 million in total. Moreover, the Kitikmeot is expected to have approximately $190.7 million from direct personal income effects. Indirect and induced personal income effects will be felt most in Qikiqtaaluk (Table 3.2-7).

Direct contributions to GDP during the operation phase will be generated solely from the Kitikmeot Region ($191.7 million). Indirect and induced GDP benefits are shared amongst Nunavut's three regions, with the Kitikmeot and Qikiqtaaluk experiencing the largest benefits (Table 3.2-7).

3.2.3 Impacts of Capital Expenditures during Operation

Capital costs that occur after the start of operation in 2020 were included in the economic impact modeling results for the operation phase as reported in Section 3.1 (Canada) and Section 3.2 (Nunavut). These capital expenditures (CAPEX) during the operation phase mainly include costs associated with sustaining infrastructure and equipment, as well as capital costs for the expansion of mining operations. In order to explore the economic impact of these expenditures, a separate accounting of the impacts of capital expenditures during the operation phase is provided.

The impacts of the sustaining capital alone are detailed in Tables 3.2-8 and 3.2-9. Total employment (direct, indirect and induced) benefits in Canada, as a result of this capital spending, are estimated at 4,175 person-years during the operation phase, with $464.5 million in GDP benefits, $83.3 million in government tax revenue, and $307.4 million in personal income. Employment impacts are expected to peak in year 2029 at 719 person-years, whereas GDP and government revenue benefits will peak in the same year at $78.0 million and $15.6 million, respectively (Table 3.2-8). A similar trend is seen with respect to personal income.

With respect to provincial and territorial benefits, Alberta (1,308 person-years), British Columbia (928 person-years) and Ontario (788 person-years) are expected to have highest total employment impacts. Total employment impacts in Nunavut due to operation phase capital expenditures are estimated at 241 person-years. GDP impacts are expected to be most felt in Alberta ($162.6 million), British Columbia ($92.7 million), and Ontario ($84.6 million). A similar trend is seen with respect to government tax revenue and personal income (Table 3.2-9). Total personal income benefits within Nunavut are predicted to be $24.3 million.

Table 3.2-8. Annual Economic Impacts of Back River Project Sustaining Capital Expenditures for Canada

Year	Employment (Person-years)				GDP (Millions of Dollars)				Tax Revenue (Millions of Dollars)				Personal Income (Millions of Dollars)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
2016	0	0	0	0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
2017	0	0	0	0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.6	$0.0	$0.7
2018	0	0	0	0	$0.0	$0.0	$0.1	$0.1	$0.0	$0.0	$0.1	$0.1	$0.1	$1.0	$0.1	$1.2
2019	0	0	0	0	$0.0	$0.0	$0.1	$0.1	$0.0	$0.0	$0.1	$0.1	$0.2	$1.3	$0.2	$1.8
2020	63	1	9	73	$7.8	$0.1	$1.3	$9.2	$0.9	$0.0	$0.5	$1.5	$7.6	$0.6	$0.6	$8.9
2021	81	34	15	130	$9.6	$3.2	$2.2	$15.1	$1.2	$0.6	$0.8	$2.5	$9.4	$2.2	$0.9	$12.5
2022	81	65	25	171	$10.1	$6.8	$3.3	$20.2	$1.3	$1.2	$1.1	$3.6	$9.8	$4.3	$1.4	$15.6
2023	79	177	41	298	$9.7	$18.5	$5.6	$33.8	$0.2	$3.2	$1.9	$5.4	$9.4	$11.6	$2.3	$23.4
2024	83	269	69	421	$10.5	$27.8	$9.2	$47.5	$0.3	$4.9	$2.9	$8.1	$10.2	$17.6	$3.7	$31.5
2025	85	315	94	494	$10.7	$32.6	$12.1	$55.4	$0.3	$5.7	$3.7	$9.8	$10.4	$20.6	$5.0	$36.0
2026	100	166	107	373	$12.2	$17.4	$13.0	$42.6	$0.1	$3.1	$3.5	$6.7	$11.9	$11.0	$5.4	$28.3
2027	97	292	89	478	$12.1	$28.2	$11.2	$51.5	$0.3	$5.1	$3.4	$8.7	$11.8	$17.9	$4.7	$34.4
2028	81	313	106	500	$10.2	$31.2	$13.0	$54.4	$0.3	$5.5	$3.8	$9.6	$9.9	$19.8	$5.5	$35.2
2029	40	569	110	719	$5.5	$58.2	$14.2	$78.0	$0.6	$10.3	$4.7	$15.6	$5.4	$36.7	$6.0	$48.1
2030	0	202	134	336	$0.0	$21.6	$15.6	$37.2	$0.0	$3.8	$3.9	$7.7	$0.0	$13.6	$6.6	$20.1
2031	0	46	69	116	$0.0	$4.9	$7.7	$12.6	$0.0	$0.9	$1.8	$2.7	$0.0	$3.1	$3.3	$6.4
2032	0	11	32	42	$0.0	$1.1	$3.4	$4.5	$0.0	$0.2	$0.8	$1.0	$0.0	$0.7	$1.5	$2.2
2033	0	2	13	16	$0.0	$0.2	$1.4	$1.7	$0.0	$0.0	$0.3	$0.4	$0.0	$0.2	$0.6	$0.8
2034	0	1	6	6	$0.0	$0.1	$0.6	$0.6	$0.0	$0.0	$0.1	$0.1	$0.0	$0.0	$0.3	$0.3
2035	0	0	1	1	$0.0	$0.0	$0.1	$0.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1
2036	0	0	0	0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total	**790**	**2,465**	**920**	**4,175**	**$98.5**	**$252.0**	**$114.0**	**$464.5**	**$5.5**	**$44.5**	**$33.3**	**$83.3**	**$96.3**	**$162.8**	**$48.3**	**$307.4**

Table 3.2-9. Total Economic Impacts of Back River Project Sustaining Capital Expenditures by Province and Territory

	Employment (person-years)				GDP (Millions of Dollars)				Tax Revenue (Millions of Dollars)				Personal Income (Millions of Dollars)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Nunavut	*118*	*105*	*18*	*241*	*$14.7*	*$12.3*	*$3.9*	*$30.9*	*$0.7*	*$1.8*	*$1.5*	*$4.1*	*$14.4*	*$8.7*	*$1.2*	*$24.3*
Newfoundland and Labrador	78	3	1	82	$9.6	$0.2	$0.1	$10.0	$0.3	$0.0	$0.0	$0.4	$9.6	$0.1	$0.1	$9.8
Prince Edward Island	0	3	1	4	$0.0	$0.2	$0.1	$0.3	$0.0	$0.0	$0.0	$0.1	$0.0	$0.1	$0.0	$0.1
Nova Scotia	18	12	5	35	$1.9	$0.9	$0.5	$3.3	$0.1	$0.2	$0.1	$0.4	$1.9	$0.5	$0.2	$2.7
New Brunswick	18	8	9	35	$1.9	$0.8	$0.9	$3.6	$0.1	$0.2	$0.3	$0.5	$1.9	$0.4	$0.4	$2.7
Quebec	22	295	134	451	$2.9	$26.0	$13.4	$42.3	$0.2	$5.3	$4.0	$9.4	$2.9	$16.5	$6.5	$25.9
Ontario	39	507	243	788	$4.8	$52.3	$27.4	$84.6	$0.2	$9.4	$7.5	$17.1	$4.8	$32.6	$13.4	$50.8
Manitoba	18	61	22	101	$1.9	$5.6	$2.2	$9.7	$0.1	$1.0	$0.6	$1.6	$1.9	$3.2	$1.0	$6.1
Saskatchewan	48	41	17	106	$5.8	$4.3	$1.9	$12.0	$0.2	$0.7	$0.5	$1.4	$5.8	$2.4	$0.8	$8.9
Alberta	196	883	228	1,308	$25.4	$101.9	$35.3	$162.6	$2.3	$18.5	$11.7	$32.4	$24.1	$66.2	$12.9	$103.1
British Columbia	157	534	237	928	$19.8	$45.7	$27.2	$92.7	$1.0	$7.1	$6.8	$15.0	$19.3	$31.1	$11.4	$61.8
Yukon	0	3	1	4	$0.0	$0.2	$0.1	$0.3	$0.0	$0.0	$0.0	$0.1	$0.0	$0.2	$0.0	$0.2
Northwest Territories	78	10	4	92	$9.6	$1.7	$0.9	$12.2	$0.3	$0.3	$0.2	$0.8	$9.6	$0.8	$0.3	$10.7
Total Canada	**790**	**2,465**	**920**	**4,175**	**$98.5**	**$252.0**	**$114.0**	**$464.5**	**$5.5**	**$44.5**	**$33.3**	**$83.3**	**$96.3**	**$162.8**	**$48.3**	**$307.4**

4. Summary

4. Summary

The Back River Project is predicted to result in employment, income, GDP, and government tax revenue benefits to the Kitikmeot Region, Nunavut, and Canada as a whole. The following is a summary of the direct and spin-off (indirect and induced) impacts as estimated by the economic model.

For the construction phase, key economic benefits of the Project include the following:

- direct Project employment of approximately 223 person-years for Nunavut (assumed mainly within the Kitikmeot Region) and 1,494 person-years for all of Canada;
- total employment (direct, indirect, and induced) of approximately 260 person-years for the Kitikmeot Region, 347 person-years for Nunavut, and 4,339 person-years for all of Canada;
- total GDP (direct, indirect, and induced) contributions of approximately $33.2 million in the Kitikmeot Region, $43.6 million in Nunavut, and $502.0 million in all of Canada; and
- total tax revenue (federal and provincial/territorial) contributions of approximately $5.6 million from economic activity in the Kitikmeot Region, $7.6 million in Nunavut, and $94.5 million for all of Canada.

For the operation phase, key economic benefits of the Project include the following:

- direct employment of approximately 1,659 person-years for the Nunavut (assumed mainly within the Kitikmeot Region) and 6,968 person-years for all of Canada;
- total employment (direct, indirect, and induced) of approximately 1,938 person-years for the Kitikmeot Region, 2,928 person years for Nunavut, and 20,828 person-years for all of Canada;
- total GDP (direct, indirect, and induced) contributions of approximately $263.0 million in the Kitikmeot Region, $382.2 million in Nunavut, and $2,557.5 million in all of Canada; and
- total tax revenue (federal and provincial/territorial) contributions of approximately $23.1 million from economic activity in the Kitikmeot Region, $45.0 million in Nunavut, and $408.8 million for all of Canada.

References

References

JDS Energy and Mining Inc. 2015. *Technical Report and Feasibility Study for the Back River Gold Property, Nunavut*. NI 43-101 Report. Prepared for Sabina Gold & Silver Corp., Vancouver, BC.

Appendix V8-5A

Back River Project: Country Foods Baseline Screening Level Risk Assessment

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BACK RIVER PROJECT
Country Foods Baseline Screening Level Risk Assessment

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September 2013

BACK RIVER PROJECT
COUNTRY FOODS BASELINE SCREENING LEVEL RISK ASSESSMENT

September 2013
Project #0194096-0040-0014

Citation:

Rescan. 2013. *Back River Project: Country Foods Baseline Screening Level Risk Assessment*. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd., an ERM Company

Prepared for:

Sabina Gold & Silver Corp.

Prepared by:

Rescan™ Environmental Services Ltd., an ERM Company,
Vancouver, British Columbia

Executive Summary

Executive Summary

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut. Exploration programs were run out of both the Goose and George camps in 2012.

For 2012, Sabina contracted Rescan Environmental Services (Rescan) to conduct a comprehensive baseline program that covered the geographical area of the Goose Property, the George Property, and a Marine Laydown Area located on the southern part of Bathurst Inlet. This report presents the results of the country foods baseline portion of the overall program.

This country foods baseline risk assessment integrated the results of the environmental media baseline data, human receptor characteristics, and regulatory-based Toxicity Reference Values (TRVs). In total, the quality of seven country foods from seven different groups was estimated prior to development of the potential Project, and thus was reflective of baseline risk associated with country foods consumption. The country foods evaluated included: a large terrestrial mammal (caribou, *Rangifer tarandus*), a small terrestrial mammal (Arctic ground squirrel, *Spermophilus parryii*), a bird species (Canada goose, *Branta canadensis*), a fish species (lake trout, *Salvelinus namaycush*), a shellfish species (bay mussel, *Mytilus trossulus*), a marine mammal (ringed seal, *Phoca hispida),* and berries (bog cranberry, *Vaccinium vitis-idaea* and bog blueberry, *Vaccinium uliginosum* combined).

A calculated Incremental Lifetime Cancer Risk (ILCR) below 1×10^{-5} is considered acceptable for metals that are potentially carcinogenic. The only carcinogenic metal in this assessment was arsenic. The Recommended Maximum Weekly Intakes (RMWIs) were calculated for non-carcinogenic effects from metal exposure and are representative of the highest intake rates of country foods that are safe for consumption at an acceptable risk level. Based on calculated ILCRs and RMWIs, caribou, Arctic ground squirrels, Canada geese, lake trout, ringed seals (both muscle and blubber tissue), bay mussels, and berries (bog blueberry and bog cranberry) were shown to not present health risks from metals to local human consumers. People in the area can continue to eat these foods at the consumption rates used in this report.

The duration for which the animals were assumed to be present within the country foods study area, consumption frequencies of country foods, and portion size of country foods consumed were conservative in nature. In addition, the highest measured or modelled country food tissue metal concentration was used in the calculation of RMWIs and ILCRs. Therefore, the current assessment provides a conservative measure of risk and may overestimate the true risk and the level of concern associated with the consumption of these country foods in most cases.

Acknowledgements

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an ERM company

Acknowledgements

This report was prepared for Sabina Gold and Silver Corp. (Sabina) by Rescan Environmental Services Ltd. (Rescan). The report was written by Golnar Zandpour (M.E.T.) and was reviewed by Lesley Shelley (Ph.D., B.I.T.) and Deborah Muggli (Ph.D., M.Sc., R.P.Bio.).

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COUNTRY FOODS BASELINE SCREENING LEVEL RISK ASSESSMENT

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Glossary and Abbreviations

Glossary and Abbreviations

AANDC	Aboriginal Affairs and Northern Development Canada
ALS	ALS Environmental
AMAP	Arctic Monitoring and Assessment Programme
BTF	biotransfer factor
BW	Body Weight
CCME	Canadian Council of Ministers of the Environment
CHHAD	Chemical Health Hazard Assessment Division
COPC	contaminant of potential concern
EDI	estimated daily intake
ELDE	estimated lifetime daily exposure
ER	exposure ratio
FAO	Food and Agriculture Organization of the United Nations
HTO	Hunters and Trappers Organization
ILCR	Incremental Lifetime Cancer Risk
INAC	Indian and Northern Affairs Canada
IQ	intelligence quotient
IR	ingestion rate
IRIS	Integrated Risk Information System
JECFA	Joint FAO/WHO Expert Committee on Food Additives
LOAEL	lowest observable adverse effect level
LSA	Local Study Area
NCP	Northern Contaminants Program
NLCA	Nunavut Lands Claim Agreement
NOAEL	no observed adverse effect level
NWHS	Nunavut Wildlife Harvest Study
NWMB	Nunavut Wildlife Management Board
POPs	persistent organic pollutants
PTDI	provisional tolerable daily intake
PTWI	provisional tolerable weekly intake
QA/QC	quality assurance and quality control
RDL	realized detection limit

RfD	reference dose
RMWI	Recommended Maximum Weekly Intake
TD_{05}	tumorigenic dose at which the incidence of tumours (or death from tumours) is increased by 5%
TDI	tolerable daily intake
the Project	Back River Project
TRV	toxicity reference value
US EPA	United States Environmental Protection Agency
WHO	World Health Organization

1. Introduction

1. Introduction

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corporation (Sabina) located in the West Kitikmeot region of Nunavut. Exploration programs were run out of both the Goose and George camps in 2012 (Figure 1-1).

For 2012, Sabina contracted Rescan Environmental Services (Rescan) to conduct a comprehensive baseline program that covered the geographical area of the Goose Property, the George Property, and a Marine Laydown Area located on the southern part of Bathurst Inlet. The following components were included in the 2012 baseline program:

- Meteorology
- Air Quality and Dust
- Noise
- Hydrology and Bathymetry
- Freshwater Water Quality, Sediment Quality, Aquatic Biology
- Freshwater Fish and Fish Habitat
- Marine Water Quality, Sediment Quality, Aquatic Biology
- Marine Fish and Fish Habitat
- Wildlife (Terrestrial and Marine)
- Wildlife DNA Study (Grizzly Bear and Wolverine)
- Ecosystem Mapping
- Vegetation and Wetlands (including Rare Plants)
- Soils and Terrain
- Country Foods
- Archaeology
- Socio-Economics
- Land Use
- Metal Leaching/Acid Rock Drainage (ML/ARD)

The baseline program was designed around potential infrastructure and known deposits at the Goose Property, the George Property, and the Marine Laydown Area. It was assumed that access from the Marine Laydown Area to George and Goose properties would be by winter road, and that access between the George and Goose properties would also be by winter road.

This report presents the results from the country foods portion of the baseline program.

Figure 1-1

Back River Project Location

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Country foods are animals, plants, and fungi used by humans for nutritional or medicinal purposes that are harvested through hunting, fishing, or gathering of vegetation. The quality of country foods is directly related to the quality of the surrounding environmental media (e.g., soil, water, and vegetation). This report provides the baseline concentrations of Contaminants of Potential Concern (COPCs) in country foods and the estimated consumption rates of each food by the harvesters. Calculations of the current Recommended Maximum Weekly Intakes (RMWIs) of country foods are also presented following Health Canada's guidance on health impact assessments (Health Canada 2010a, 2010d, 2010c).

2. Approach and Study Area

2. Approach and Study Area

2.1 APPROACH OF COUNTRY FOODS ASSESSMENT

The approach for the country foods study was based on Health Canada's guidelines for assessing food issues in environmental impact assessments (Health Canada 2010a, 2010c). As such, this study is divided into the following five stages:

1. Problem Formulation: The conceptual model for conducting the country foods study was developed in the problem formulation stage. This stage identified the COPCs and human receptor characteristics.
2. Exposure Assessment: The measured or predicted metal concentrations in country foods were integrated with human consumption characteristics to calculate the estimated daily intake (EDI) of COPCs.
3. Toxicity Assessment: The tolerable daily intakes (TDIs; levels of daily exposure that can be taken into the body without appreciable health risk) were identified.
4. Risk Characterization: The exposure and effects assessments were integrated by comparing the EDIs with TDIs to produce quantitative risk estimates. In addition, the Recommended Maximum Weekly Intake (RMWI) of each country food was calculated.
5. Uncertainty Analysis and Data Gaps: The assumptions made throughout the study and their effects on the conclusions were evaluated.

2.2 STUDY AREA

The Back River Project is located in the Southern Arctic Ecozone, which is characterized by short, cool summers (mean temperature: 5°C) and long cold winters (mean temperature: -28°C). Vegetation in this ecozone and within the study area consists of predominantly dwarf shrub vegetation, including *Betula* spp. (birch), *Salix* spp. (willow), and grasses. There is a continuous permafrost layer under the landscape that prevents water from penetrating deep into the soils. This creates surface run-off from precipitation and waterlogged soils that freeze regularly. There are numerous depressions, kettle lakes, ponds, and deposits in the study area that were left by retreating glaciers.

The closest communities to the Project are Kingaok, located approximately 160 km to the north of the Goose Property, and Omingmaktok, located approximately 250 km to the northeast of the Goose Property (Rescan 2012e). The communities of Kugluktuk and Cambridge Bay are the closest major regional settlements, and are located approximately 460 km and 400 km from the Goose Property (Rescan 2012e).

The study area for the country foods baseline assessment encompassed the George Property, Goose Property, Marine Laydown Area, and access corridors (Figure 2.2-1). Around potential infrastructure, the extent of the country foods study area was defined as 10 km for George and Goose properties, and 3.5 km for Marine Laydown Area in northerly, westerly, southerly, and easterly directions from infrastructure. In addition, a 1-km buffer zone was included along winter road access corridors.

This study area was selected based on proposed infrastructure layouts for the Draft Environmental Impact Statement (DEIS) for the Project. This same study area will be used in the country foods effects assessment in the DEIS as the country foods local study area (LSA), to allow direct comparison of baseline and predicted country foods quality.

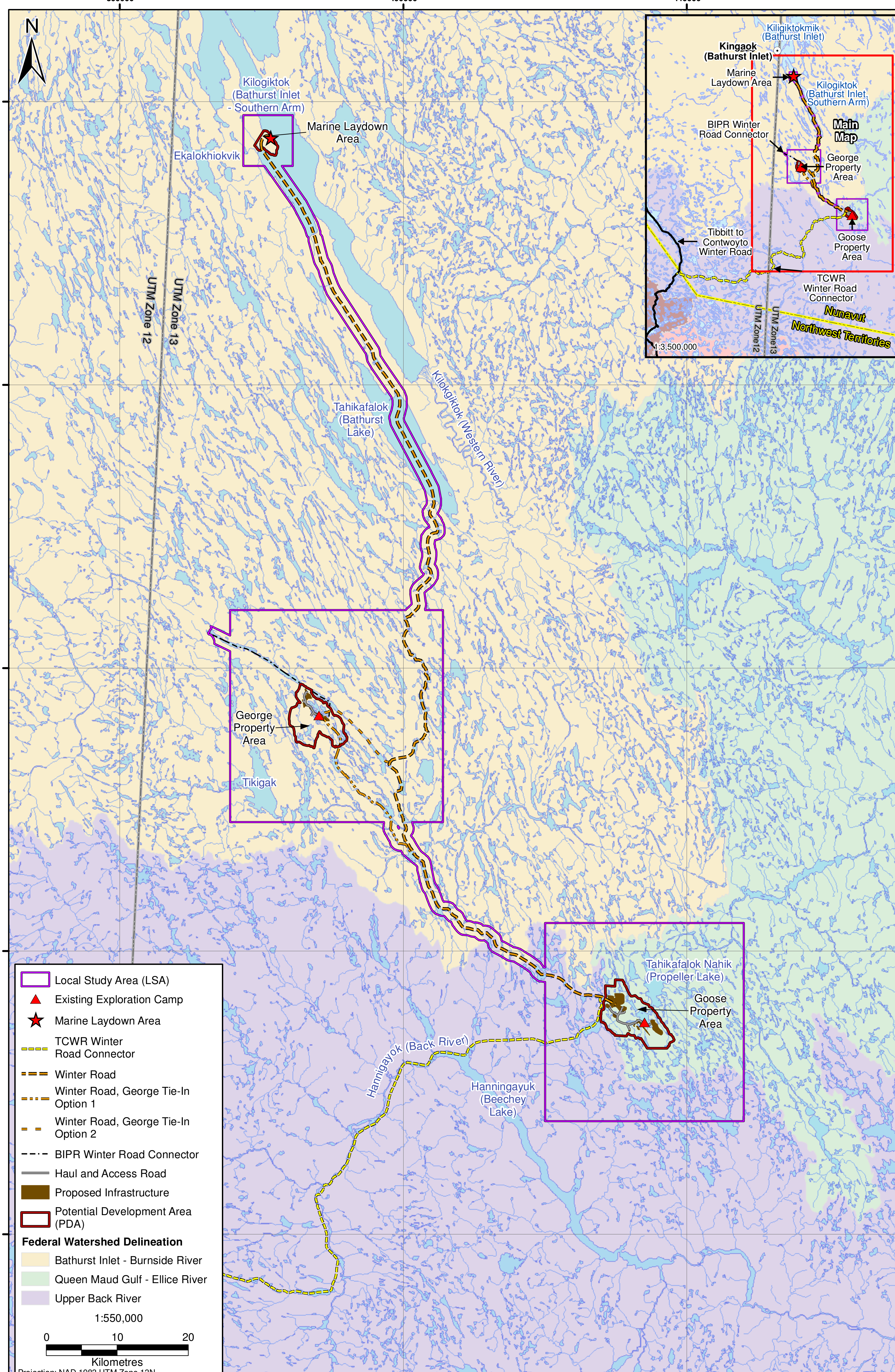

Figure 2.2-1

Country Foods Study Area, Back River Project

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3. Problem Formulation

3. Problem Formulation

3.1 INTRODUCTION

The purpose of the problem formulation is to create a conceptual model for the country foods baseline assessment. This stage requires the identification of data that are needed to accurately assess country foods in the country foods study area. The objectives of the problem formulation stage are to:

- identify the most relevant country foods harvested in the country foods study area;
- identify the COPCs in the country foods study area;
- identify the human receptors and the relevant life stages (e.g., adults and toddlers) that harvest and consume the foods; and
- identify the relevant human exposure pathways.

3.2 COUNTRY FOODS SELECTED FOR EVALUATION

Country foods include a wide range of animal, plant, and fungi species that are harvested for medicinal or nutritional use. The primary objective when selecting country foods is to identify the most relevant foods to evaluate. Key considerations when selecting the country foods to evaluate include:

- which country foods are currently collected in the country foods study area;
- how the country food is used (i.e., food, medicine, or both);
- what part of the country food is consumed (i.e., specific organs, plant leaves or roots);
- what quantities of each country food are consumed; and
- what the consumption frequencies are for each country food.

For Inuit populations whose main food source is from harvesting, it is not always feasible to assess all country foods. This is due to the large number of species that are harvested and also seasonal availability due to migration patterns of the harvested populations or accessibility to hunting grounds (e.g., lack of sea ice for seal hunting during the summer). For such populations, the foods selected for evaluation are those that result in the highest exposure to the COPCs (i.e., foods that are eaten most frequently and in the largest amounts). For instance, foods that are consumed every day are generally selected. Country foods that are consumed seasonally or infrequently may not be selected as they may not be a major exposure source of COPCs. These factors are considered when selecting the most relevant country food to evaluate.

The country foods selected for this study were largely based on information provided in the *Nunavut Wildlife Harvest Study* (Priest and Usher 2004), the *2012 Socio-Economic and Land Use Baseline Report* (Rescan 2013c), the *Inuit Traditional Knowledge of Sabina Gold and Silver Corp. Back River (Hannigayok) Project* (KIA 2012).

The *Nunavut Wildlife Harvest Survey*, conducted between 1996 and 2001, collected data on non-commercial hunting, trapping, gathering, and hunting of mammals, birds (and their eggs and feathers), fish, and shellfish. At a 2003 Inuit workshop, Elders from Omingmaktok, Bathurst Inlet, Kugluktuk, and Cambridge Bay stated that most of their food comes from the land (WKRLUP 2005). Recent government statistics indicate that at least half of the meat and fish eaten in the household of 66% of Inuit adults (aged 15 years and over) across Nunavut is country foods (Statistics Canada 2008). A slightly older study conducted by Aboriginal Affairs and Northern Development Canada (AANDC), indicated that although the Inuit are the primary harvesters of country foods in the study area, less than half (6 to 40%) of their total food energy consumed comes from country foods, depending on the degree of urbanization or remoteness of the community (INAC 2003).

The 2012 Socio-Economic and Land Use Baseline Report compiled information from several hunter focus groups including the Cambridge Bay Hunter Focus Group (2012), Omingmaktok/Bathurst Inlet Hunter Focus Group (2012), and Kugluktuk Hunter Focus Group (2012). The *Inuit Traditional Knowledge of Sabina Gold and Silver Corp. Back River (Hannigayok) Project* report relies on interviews conducted in 1995 and 1996 as well as interviews conducted between 1997 and 2000 (KIA 2012). Figure 3.2-1 provides a comprehensive map of the Inuit traditional land and use in relation to the country foods study area. Based on Figure 3.2-1, country foods study area overlaps with several identified hunting, trapping, and fishing areas.

Human receptor consumption characteristics were based on studies on the Inuit (Coad 1994; Chan and Ing 1998; Nancarrow 2007), general human characteristics outlined by Health Canada (Health Canada 2010a, 2010c), and best professional judgement.

Typically in country foods studies, one species is selected from the following groups of foods: large mammals, small mammals, birds, fish, and vegetation. In addition to the typical country foods groups mentioned above, a representative from the shellfish group and the marine mammal group were also included in this baseline country foods assessment. A species that represents the highest consumption level, and therefore results in the most exposure to COPCs, was selected within each of these groups. Theoretically, if foods that represent the highest rate of exposure are deemed safe for consumption, then all other foods within the given group would also be considered safe for consumption. The different groups are selected because the relative exposure of each group to the environmental media would vary with specific habitat and foraging behaviours.

3.2.1 Terrestrial Wildlife Species

Terrestrial species include large and small mammals as well as avian species. To identify the most common terrestrial species harvested by the Inuit, the Nunavut Wildlife Harvest Study (NWHS) was reviewed (Priest and Usher 2004). This study was mandated by the Nunavut Lands Claim Agreement (NLCA) and carried out under the direction of the Nunavut Wildlife Management Board (NWMB). Harvest data were collected monthly from Inuit hunters for a total of five years covering the harvest months from June 1996 to May 2001. The purpose of the study was to determine current harvesting levels and patterns of Inuit use of wildlife resources. Harvest data for the communities adjacent to the country foods study area were reviewed, including Omingmaktok, Cambridge Bay, and Bathurst Inlet communities (see Figure 1-1).

3.2.1.1 Large Terrestrial Mammals

Caribou (*Rangifer tarandus*) are the most commonly harvested large terrestrial mammal by Inuit in the west Kitikmeot Region as well as a main component of the country foods consumed in this area (MHBL 2005; WKRLUP 2005; KIA 2012; Rescan 2013b). Caribou have overlapping herding grounds and migration corridors within the study area (Rescan 2011, 2012f, 2013e). As such, caribou were selected for evaluation in this study. Although caribou do migrate over large areas well outside of the country foods study area, their importance to the Inuit diet supports their use in this study. However, any potential future increase in metals of caribou tissue, while useful to inform and protect local human health, may or may not be related to the Project due to their vast home range.

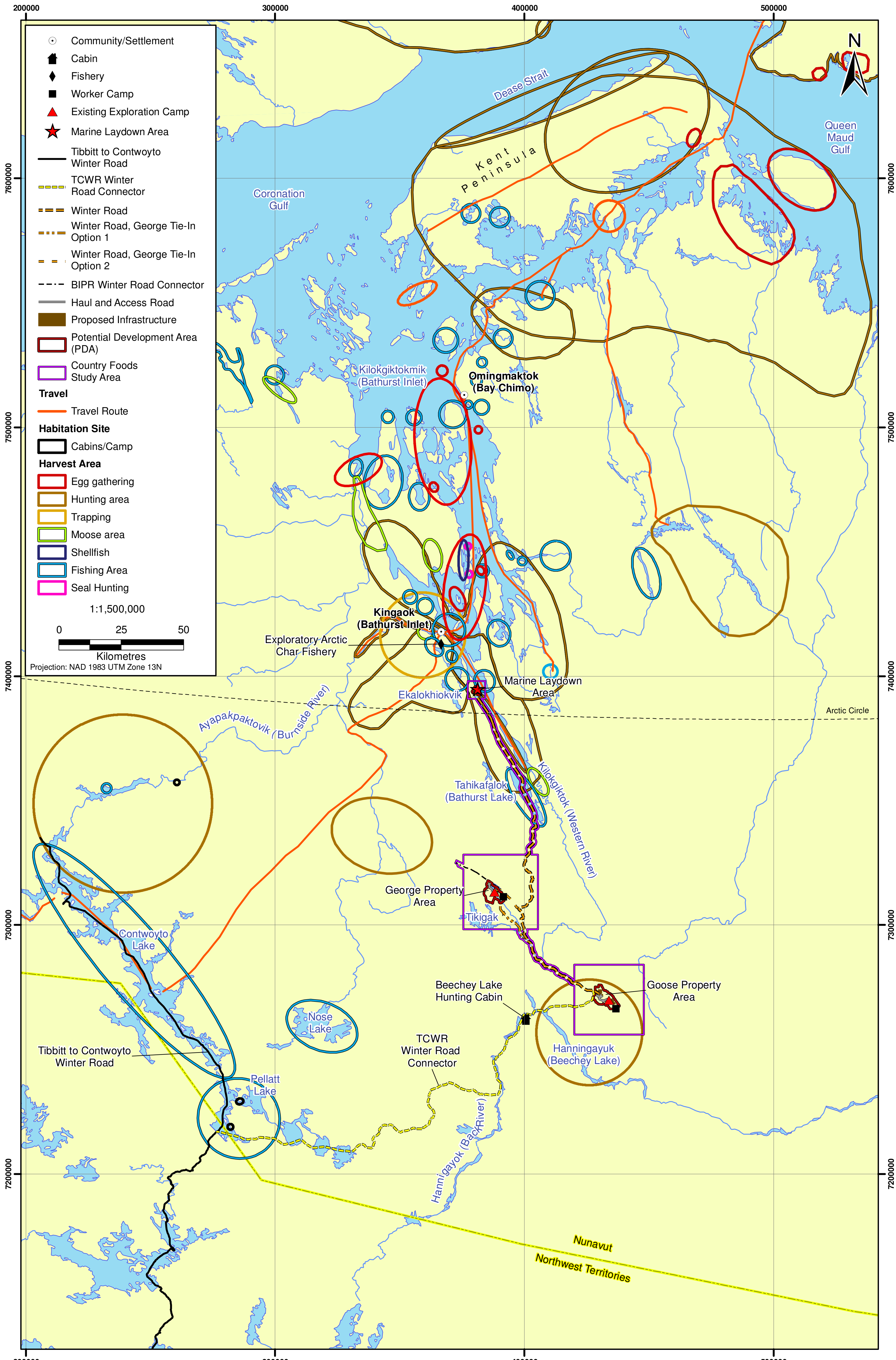

Figure 3.2-1

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Land and Resource Use of Inuit Populations (Bathurst Inlet, Omingmaktok, and Cambridge Bay) in relation to the Country Foods Study Area

Figure 3.2-1

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Chan and Ing (1998) reported that the mean consumption rate of all terrestrial animal tissue pooled was 147 g/day average annually, while Coad (1994) reported an average consumption rate of 355 g/day, on a daily basis. Based on the 2007 to 2008 Inuit Health Survey (Egeland 2010), Inuit in Nunavut consume 208 g/day of fresh caribou meat. Nancarrow (2007) reported that Inuit consume 270 g/serving of cooked/fresh/frozen caribou meat during 130 days of the year by over 98% of the population surveyed. It was assumed that caribou was consumed every day to account for other organs that may be consumed such as bone marrow, tongue, kidneys, liver, stomach, and intestine. This country foods baseline study adopted the more conservative caribou mean consumption rate of 270 g/serving (Nancarrow 2007) consumed 365 days per year by Inuit in Nunavut, to account for the consumption of other caribou tissues (e.g., intestines, kidney, brain, and heart).

It was assumed that caribou spend six months of the year residing entirely inside the country foods study area. This is considered to be a very conservative estimate. In addition, it was assumed that toddlers would eat caribou at the same frequency as adults, with a serving size of 43% of the adult serving size as described by Richardson (1997).

3.2.1.2 Small Terrestrial Mammals

The Arctic ground squirrel (*Spermophilus parryii*) is the most commonly harvested small terrestrial mammal by the harvesters from Omingmaktok and Bathurst Inlet (KIA 2012; Rescan 2013b). Arctic fox (*Alopex lagopus*) is the most common small mammal harvested from Cambridge Bay; however, it is likely harvested for its pelt. Consequently, the Arctic ground squirrel was the small terrestrial mammal selected for evaluation.

A small game consumption rate of 53 g/serving for Inuit from the Kitikmeot Region (Coad 1994) was adopted as the consumption rate of Arctic ground squirrels by local consumers. Although, Arctic ground squirrels are resident species of this area, they hibernate over winter from early September to late April. Thus, residency time of Arctic ground squirrel in the country foods study area is assumed to be five months. As such, hunting of Arctic ground squirrels is assumed to take place five months of the year. It is likely that some of the meat is preserved for future use when this species is not accessible during the remaining months of the year. Therefore, to be conservative, it was assumed that Arctic ground squirrels were consumed two times a week all year round. It was assumed that toddlers would eat Arctic ground squirrel at the same frequency as adults, with a serving size of 43% of the adult serving size as described by Richardson (1997).

3.2.1.3 Birds

The harvested birds include various species of ducks, geese, and ptarmigans (KIA 2012; Rescan 2013b). The common eider (*Somateria mollissima*) is closely tied to the marine habitat of the country foods study area. However, Canada geese (*Branta canadensis*) were selected for evaluation as their consumption is considered reflective of all avian species harvested from the country foods study area, and they are thought to be more commonly harvested (Rescan 2013b). Although ptarmigan (*Lagopus* spp.) provided an alternate subject, their harvest is primarily in the winter and early spring whereas Canada geese are typically harvested in the summer. As metal exposure would be greatest to foraging birds in the summer, consumption of Canada geese would likely represent the worst case exposure to metals in birds. Like caribou, Canada geese undergo large migrations and can take in metals and contaminants from outside the Arctic environment. Therefore, any potential increases in metal concentrations may or may not be related to the Project.

Canada geese arrive on the central Canadian Arctic barrens in early to mid-May, and generally depart by mid-September. If a pair of geese were to nest and raise young in the study area, it is conceivable that residency in the country foods study area would be for the entire time that they are in the Arctic.

Therefore, residency time and hunting of Canada geese in the country foods study area is at most, five months.

Chan and Ing (1998) reported the annual average consumption rate of birds was 2 g/day (averaged annually) as a result of infrequent harvesting frequencies. The Inuit Health Survey in 2007-2008 (Egeland 2010) reported that Inuit in Nunavut consumed 23 g/day of Canada goose on a daily basis. However, in this assessment, a more conservative consumption rate of 197 g/serving (based on swan meat consumption, assumed to be equivalent to Canada goose meat) consumed five times per year by Inuit in Nunavut was used (Nancarrow 2007). It was assumed that toddlers would eat Canada goose at the same frequency as adults, with a serving size of 43% of the adult serving size as described by Richardson (1997).

3.2.2 Aquatic Species

Freshwater Fish

A total of six freshwater fish species have been identified in the country foods study area, including Arctic grayling (*Thymallus arcticus*), lake trout (*Salvelinus namaycush*), round whitefish (*Prosopium cylindraceum*), ninespine stickleback (*Pungitius pungitius*), burbot (*Lota lota*), and slimy sculpin (*Cottus cognatus*; Rescan 2010, 2012a, 2012c).

Lake trout are a dominant fish within the study area and have been found in almost all lakes surveyed (Rescan 2012c). They are known to be a desirable eating fish (Rescan 2013b) (KIA 2012) and as such, lake trout were identified as the primary fish for inclusion in the country foods assessment. Lake trout are the largest freshwater piscivorous fish species in the country foods study area and could experience increased metal bioaccumulation in tissues relative to non-piscivorous fish. This contributes to its importance in the assessment. Figure 3.2-2 presents the fish sampling locations within the study area that were used for the country foods baseline assessment.

Overall, 42 g/day of fish are consumed by Inuit on a daily basis, which is a moderate quantity relative to the total consumption of 423 g/day of all country foods average annually (Chan and Ing 1998). Specific fish species were not identified during the food consumption survey by Chan and Ing. Coad (1994) found fish consumption by Inuit to be 190 g/day 356 days a year, while the Inuit Health Survey in 2007-2008 (Egeland 2010) reported that Inuit in Nunavut consume 113 g/day of Arctic char on a daily basis. An assessment by Nancarrow (2007) found that Inuit in Nunavut consume 254 g/serving of trout, five days per year. The trout consumption rate determined by Nancarrow (2007) was used in this baseline assessment because the assessment specifically quantified trout consumption rather than Arctic Char or total fish consumption. It was assumed that toddlers would eat lake trout at the same frequency as adults, with a serving size of 43% of the adult serving size as described by Richardson (1997).

Marine Species

Shellfish

Bay mussels (*Mytilus trossulus*) have been identified as a food source that is gathered from Bathurst Inlet (Rescan 2013b) and were collected for tissue metal analysis as part of the 2012 marine baseline sampling (Rescan 2013a). For country foods assessments, it is preferable to use organisms that have small home ranges, encompassed within the country foods study area. Mussels are sessile filter feeders and are often used as indicators of aquatic pollution. Due to the mussel's bioaccumulative capabilities, lack of mobility, and the potential for their collection and consumption within Bathurst Inlet, mussels were included in the country foods baseline assessment. Figure 3.2-2 presents the bay mussel sampling locations within the study area that were used for the country foods baseline assessment.

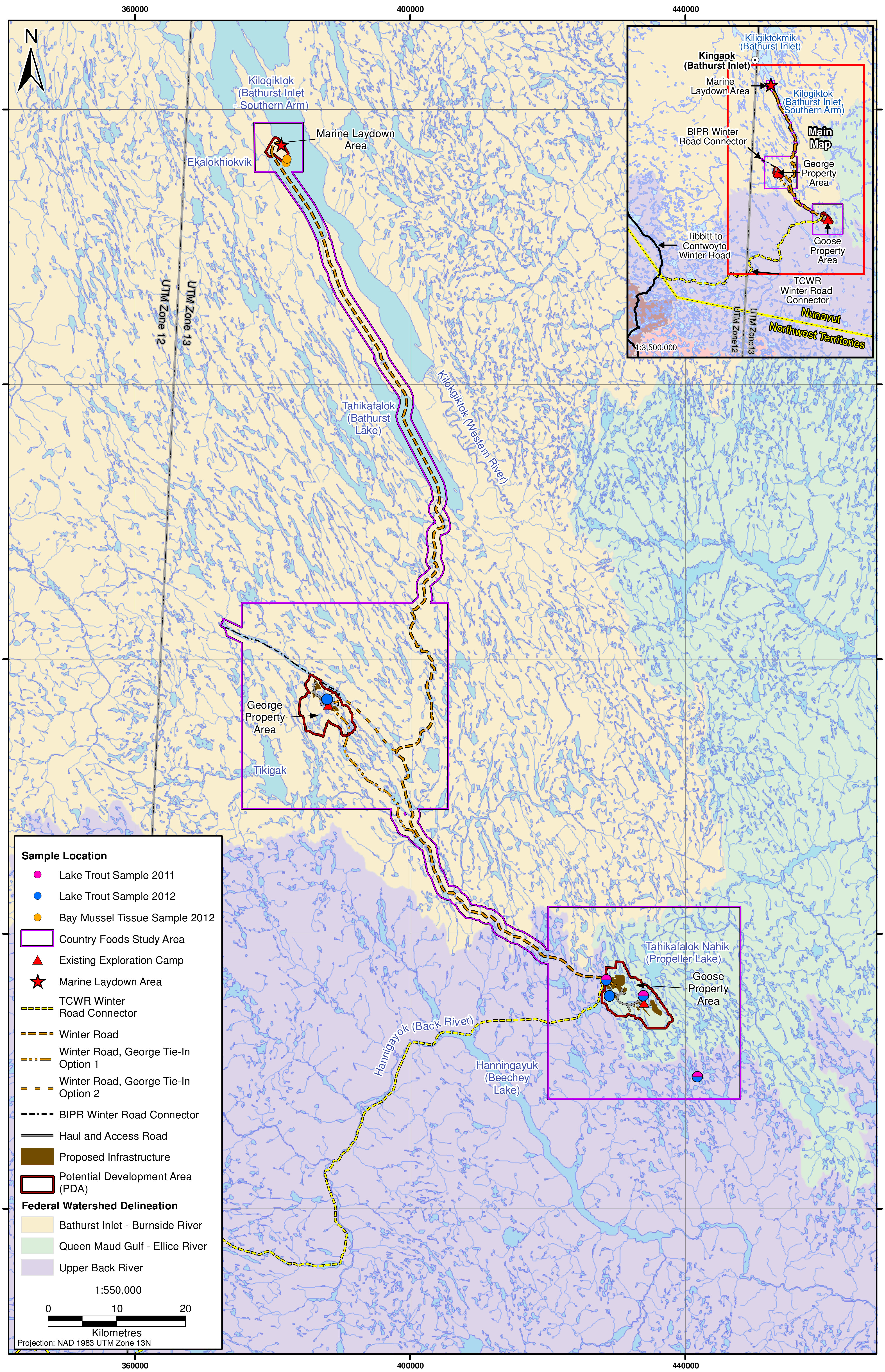

Figure 3.2-2

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Fish Tissue Sampling Locations within the Country Foods Study Area, Back River Project

Figure 3.2-2

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For bay mussel consumption, it was assumed that three grams/servings of mussels were consumed (Innis, Kuhnlein, and Kinloch 1988), three times a week, for four months. The serving size selected was based on a study on the intake of country foods by the Canadian Inuit obtained from surveys collected from 325 Inuit who participated in the study (Innis, Kuhnlein, and Kinloch 1988). It was assumed that bay mussels were only consumed three time a week for four months a year because of the seasonal nature of the Kingaok (Bathurst Inlet) community, the long distance from other communities, and the limitations of collecting mussels during ice-on periods (Rescan 2012e). It was assumed that toddlers would eat bay mussels at the same frequency as adults, with a serving size of 43% of the adult serving size (Richardson 1997).

Marine Mammals

Traditional hunting in the Bathurst Inlet area has included the harvest of ringed (*Pusa hispida*) and bearded seals (*Erignathus barbatus*; Priest and Usher 2004). Although not considered a migratory species, ringed seals are capable of moving distances of 1000 km or more during summer (Heide-Jørgensen, Stewart, and Leatherwood 1992; Kapel et al. 1998; Teilmann, Born, and Acquarone 1999). Kelly et al. (2010) documented summer movement of 1,800 km from winter/spring home ranges. However, site fidelity has also been documented in this species (Teilmann, Born, and Acquarone 1999). Therefore, ringed seals home range can encompass the Marine Laydown area portion of the country foods baseline study area. Interviews during the Hunter and Trappers Focus Group indicated that seal hunting occurs throughout Bathurst inlet, along shores in the spring, fall, and winter (Rescan 2013b). Therefore, ringed seals were selected as a marine mammal species for this baseline assessment.

No seals were sacrificed to obtain tissue samples from the country foods study area. Rather, seal tissue concentrations were estimated based on a food chain model using starry flounder (*Platichthys stellatus*) as food source. Starry flounder are an abundant and widely distributed species and are found throughout the eastern Pacific Ocean to Alaska, as well as Bathurst Inlet in Arctic Canada. They feed primarily on zooplankton and benthic invertebrates. The starry flounder has a demonstrated tendency to accumulate many contaminants it is exposed to in its environment due to its close association with benthos (Pacific States Marine Fisheries Commission 1996). Samples of 15 starry flounders were collected from southern Bathurst Inlet in August 2001 for a nearby project (Rescan 2007) and were used as food source in the food chain model to predict the ringed seal tissue metal concentration.

Ringed seals meat and many organs such as blubber, kidneys, liver, heart, flippers, and blood of the ringed seals are included in the Inuit diet. For ringed seals, meat (cooked, fresh, or frozen) comprised the largest portion size and highest frequency of country foods consumption among other organs consumed (Nancarrow 2007). It was assumed that 240 g/serving of seal meat and 87 g/serving of seal blubber were consumed by adults. The sum of consumption frequencies for all the ringed seals organs and meat indicated in the survey was calculated to be 82 days a year and was used as the consumption frequency of ringed seals by the Inuit, (Nancarrow 2007), and that toddlers would eat ringed seals muscle and blubber at the same frequency as adults, with a serving size of 43% of the adult serving size (Richardson 1997).

3.2.3 Berries

Berry species identified during the 2012 baseline vegetation survey (Rescan 2013d) included bog blueberry (*Vaccinium uliginosum*), bog cranberry or lingonberry (*V. vitis-idaea*), crowberry (*Empetrum nigrum*), and black bearberry (*Arctostaphylos alpine* spp. *alpina*).

Ecological knowledge from the Bathurst, Perry, and Ellice Elders showed that some Inuit consume various berry species, such as blueberries (*Vaccinium* spp.), crowberries (*E. nigrum*), cloudberries (*Rubus chamaemorus*), and salmonberries (*Rubus spectabilis*) during the short summers (Thorpe 2000). Although berries may not be harvested frequently within the country foods study area due to the distance away from communities, baseline tissue metal data were collected for bog blueberry

(*V. uliginosum)*, and bog cranberry (*V. vitis-idaea*; Rescan 2013d) and these were included in the baseline country foods assessment. Figure 3.2-3 presents the berry sampling locations within the country foods study area that were used for the country foods baseline assessment. For berry consumption, it was assumed that adults consumed 13 g/day of berries (Egeland 2010) every day, five months a year, and that toddlers would eat berries at the same frequency as adults, with a serving size of 43% of the adult serving size (Richardson 1997).

3.2.4 Summary of Country Foods Selected for Evaluation

A summary of the country foods selected for evaluation is presented in Table 3.2-1.

Table 3.2-1. Country Foods Selected for Evaluation

Category	Country Food	Species Name	Parts Consumed
Terrestrial Wildlife	caribou	*Rangifer tarandus*	muscle, liver, kidneys, tongue, stomach, intestine, blubber
	Arctic ground squirrel	*Spermophilus parryii*	muscle
	Canada goose	*Branta canadensis*	muscle
Fish	lake trout	*Salvelinus namaycush*	muscle
Marine Shellfish	Bay mussel	*Mytilus trassulus*	tissue
Marine Mammal	ringed seal	*Phoca hispida*	muscle, blubber
Vegetation	bog blueberry	*Vaccinium uliginosum*	fruit
	bog cranberry	*Vaccinium vitis-idaea*	fruit

In addition to the muscle, different organs of country foods may be a part of a stable diet of Inuit (Nancarrow 2007). For example muscle, fat, bone marrow, and organs such as tongue, kidneys, liver, stomach, and intestine of caribou, and muscle, blubber, kidneys, liver, heart, flippers, and blood of ringed seals are included in the Inuit diet and provide a valuable nutritional source (Nancarrow 2007). Although this assessment does not estimate the risk of consumption of individual organs, consumption frequencies and portion sizes related to caribou and ringed seals were selected to reflect the risk from consumption of these country foods as a whole.

For lake trout and Canada goose it was assumed that the entire country foods were consumed as the report only referred to meat of birds and fish and did not specify consumption of various organs in these country foods (Nancarrow 2007).

Blueberries were assumed to be consumed due to the absence data on other sections of these country foods that may be consumed.

3.3 CONTAMINANTS OF POTENTIAL CONCERN SELECTED FOR EVALUATION

The COPCs selected for this assessment were metals, which naturally occur in environmental media (e.g., water, soil, sediment), and their concentrations could potentially change due to Project activities. Many metals occur naturally in elevated concentrations due to local physical and geological processes. Other contaminants such as Persistent Organic Pollutants (POPs) and radionuclides are not typically associated with metal mining, and are unlikely to be affected by Project related activities. Therefore, the country foods assessment focused on metals.

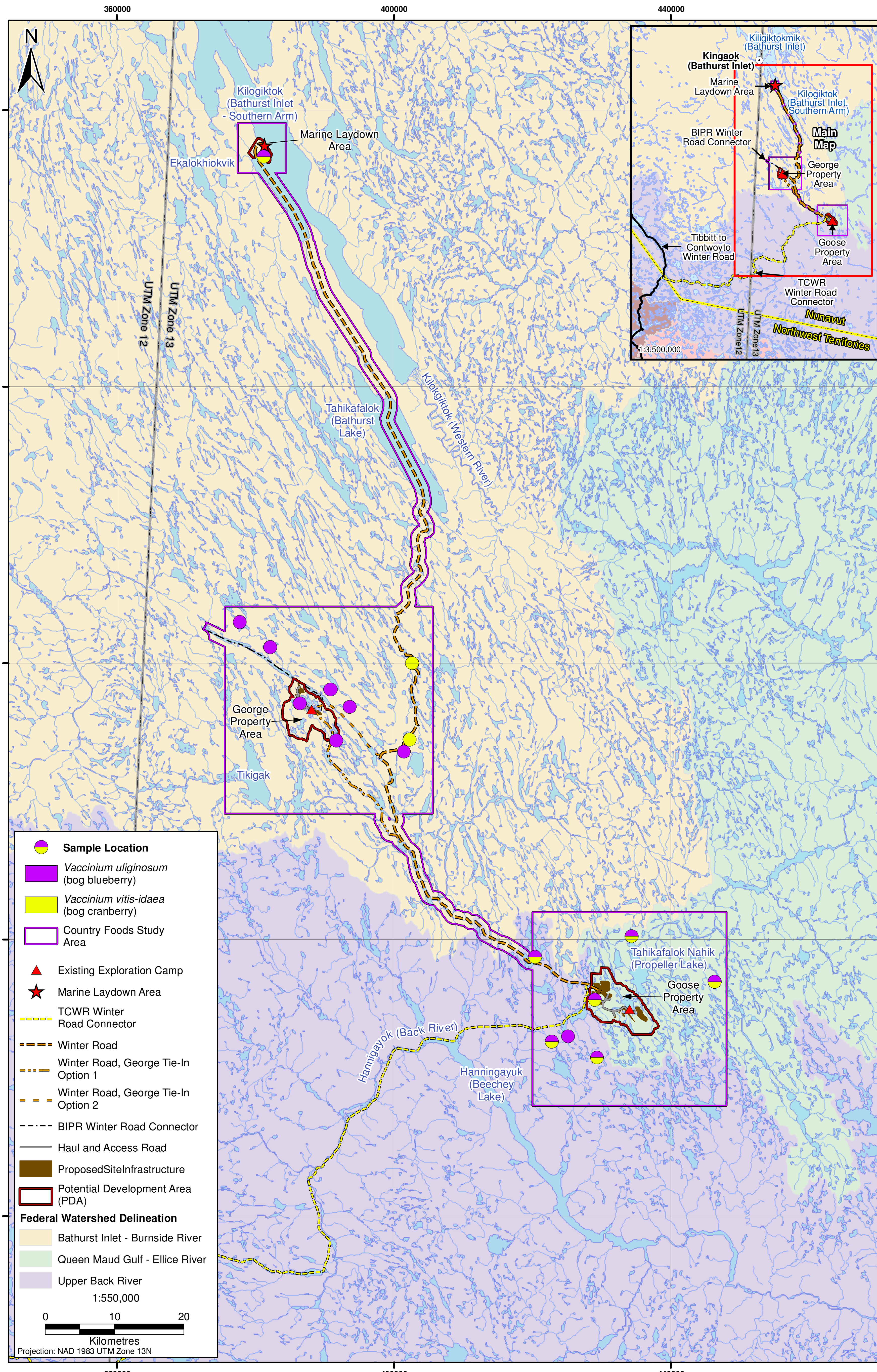

Figure 3.2-3

Berry Sampling Locations within the Country Foods Study Area, Back River Project

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Figure 3.2-3

Specific metals were selected as COPCs if they met at least one of the following four criteria:

1. The maximum metal concentration in soil measured during the soils baseline study (Rescan 2013c) exceeded the Canadian Council of Ministers of the Environment (CCME) soil quality guidelines for agricultural land (CCME 2012b).
2. The maximum total metal concentration in the surface waters measured during the freshwater and marine baseline studies exceeded its CCME water quality guideline for the protection of aquatic life (CCME 2012d). Mean and maximum annual concentrations from 2010 to 2012 collected from streams and lakes were included in the assessment (Rescan 2012b, 2012d). Water and sediment data collected from Bathurst Inlet in 2012 were also included in the screening process (Rescan 2013a). As a result of significant improvements in metal detection limits and accessibility to the collection and analysis methods, only data from 2010 to 2012 were included, although water quality data exist from earlier studies (Golder and Associates 2007; Gartner Lee Limited 2008).
3. The maximum metal concentration in sediment measured during the freshwater (Rescan 2012b, 2012d), marine (Rescan 2013a), and wetland baseline studies exceeded the CCME sediment quality guideline for the protection of aquatic life (CCME 2012a).
4. The metal has a potential to bioaccumulate in organisms or biomagnify in food webs, such that there could be significant transfer of the metal from soil to plants onto higher trophic levels. Information on the bioaccumulation/biomagnification potential of each metal of interest was obtained from a review of relevant documents from the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and the US EPA (JECFA 1972b, 1982b; US EPA 1997; JECFA 2000a; US EPA 2000b; JECFA 2005, 2007, 2011).

The locations of soil, fresh water and sediment, and marine water and sediment sampling are provided in Figures 3.3-1 and 3.3-2.

The realized detection limit (RDL) is the detectable concentration achievable by the analytical laboratory based on the chemistry of the sample. For the purpose of summarizing the data, when metal concentrations in water, sediment or soil were below the RDL, a value of half the RDL was used.

Table 3.3-1 presents the metals selected and the rationale for their selection. Appendices A1, A2-1, A2-2, A2-3, A2-4, A3-1, A3-2, A3-3, A3-4, and A3-5 present the mean and maximum concentrations measured in samples of soil, freshwater, marine water, freshwater sediment, marine sediment, and wetland sediment from the country foods study area. Raw data for wetland sediment metal concentrations are also provided in Appendix A3-6 since they are not presented in other baseline studies. All concentrations were screened against the available CCME Environmental Guidelines for the relevant environmental media.

Freshwater and marine sediment metal concentrations were only used in the screening process for selecting COPCs and were not used for modelling purposes in this assessment. This is because measured tissue concentrations in aquatic biota (fish and mussels) were available for the assessment. Marine sediment concentrations were not used in modelling the seal tissue concentrations since the model assumed that starry flounder comprised 100% of the seal's diet. Wetland sediment concentrations were used in predicting the Canada goose tissue metal concentrations as Canada goose may ingest wetland sediments while grazing.

The maximum concentration of cadmium exceeded the CCME freshwater quality guidelines for the protection of aquatic life (CCME 2012d) and the CCME sediment quality guidelines for the protection of aquatic life (CCME 2012a). Cadmium has the potential to bioaccumulate/biomagnify (JECFA 2011). As such, cadmium was included as COPCs in this assessment.

Chromium concentrations did not exceed the CCME soil or water quality guidelines (CCME 2012d, 2012a, 2012b); however, chromium concentrations exceeded the freshwater sediment quality guidelines for the protection of aquatic life (CCME 2012d) and chromium has the potential to bioaccumulate/biomagnify (JECFA 2011). Therefore, chromium was included as COPC in this assessment.

Copper concentrations exceeded the soil quality guidelines for agricultural land (CCME 2012b), CCME freshwater and marine quality guideline for the protection of aquatic life (CCME 2012d), and CCME sediment quality guidelines for the protection of aquatic life (CCME 2012a). Zinc concentrations exceeded the CCME sediment quality guidelines for the protection of aquatic life (CCME 2012a), while lead concentrations exceeded the CCME water quality guideline for the protection of aquatic life (CCME 2012d). Studies of the lead-zinc Red Dog mine in Alaska have shown that lead and zinc can accumulate in vegetation (Ford and Hasselbach 2001). Copper has low potential to accumulate/biomagnify (JECFA 1982a). Thus, lead, copper, and zinc were included as COPCs in this assessment.

Among CCME soil and water quality guidelines (CCME 2012d, 2012b), nickel exceeds the CCME freshwater quality guidelines for the protection of aquatic life (CCME 2012d). There are no CCME sediment quality guidelines for nickel (CCME 2012a). Nickel is accumulated by many plants, ruminant grazers, and birds (WHO 1991). Nickel was included COPC in this assessment.

Mercury was selected as COPC due to its potential to bioaccumulate as methylmercury (US EPA 1997); however, it is noted that total mercury concentrations did not exceed the CCME inorganic mercury guideline for the protection of freshwater or marine aquatic life in any of the samples collected. Thallium did not exceed the CCME guideline for the protection of aquatic life, but is readily taken up by plants and can bioaccumulate in aquatic and terrestrial food webs (Intrinsik 2010). Thallium was therefore included as COPC. Similarly, selenium did not exceed the above mentioned guidelines; however, selenium was included as COPC because it bioaccumulates in aquatic organisms and birds, and can biomagnify (Nagpal and Howell 2001).

It is noted that the maximum concentration of iron in surface waters exceeded the CCME guideline for the protection of freshwater aquatic life. Iron is the second most abundant metal in the earth's crust and is abundant in soils and sediment where it is often tightly bound and not largely available for biological uptake. There is no soil guideline for iron (CCME 2012c). Furthermore, iron is an essential element as it is a required component in the blood cells for the transportation of oxygen throughout the body (Adriano 2001). Iron toxicity is very rare and is often associated with large consumption of iron supplements by children who mistake the pills for candy (Tenenbein 2005). Because iron is an essential element for both wildlife and humans and since environmental exposure to iron from food consumption would not lead to adverse health effects, iron was not evaluated further in this study. Despite the exceedance in the surface waters, iron was not selected as a COPC.

3.4 HUMAN RECEPTORS

Both adults (older than 19 years of age) and toddlers (six months to four years of age) were evaluated for their susceptibility to selected COPCs (Health Canada 2010b, 2010c). Adults are the people most likely to harvest, process, and consume country foods. Country food consumption has also been determined to increase with age (Health Canada 2003). Adults comprise the largest section of the population and, among adults, pregnant women and breast-feeding mothers (Solomon and Weiss 2002) are considered to be a sensitive group. Therefore, women of child-bearing age were also assessed as a sensitive group when relevant toxicity reference values (TRVs) were available, such as for methylmercury in fish, shellfish, and seal (Health Canada 2010b, 2010c).

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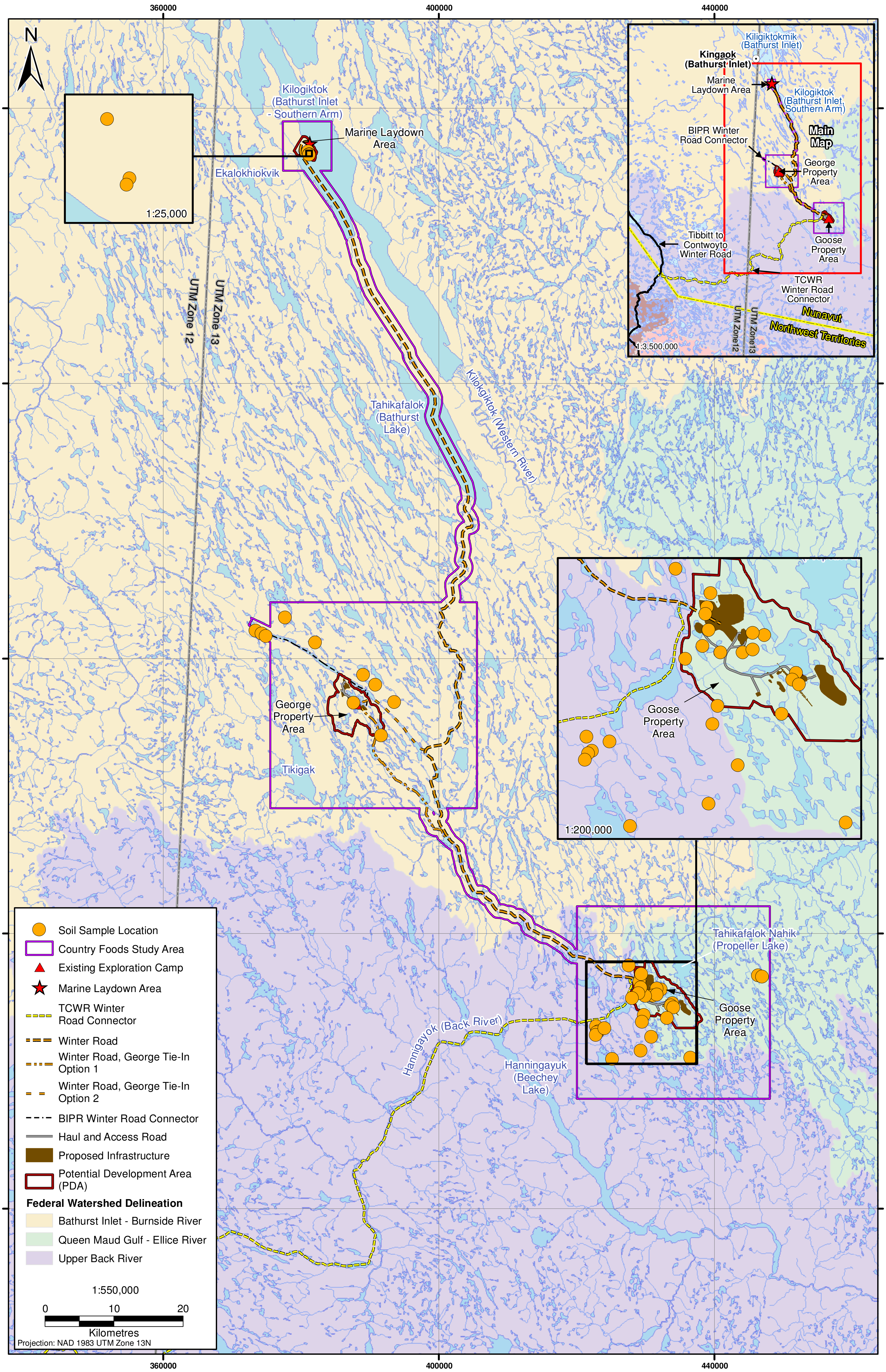

Figure 3.3-1

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Soil Sampling Locations within the Country Foods Study Area, Back River Project

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Figure 3.3-1

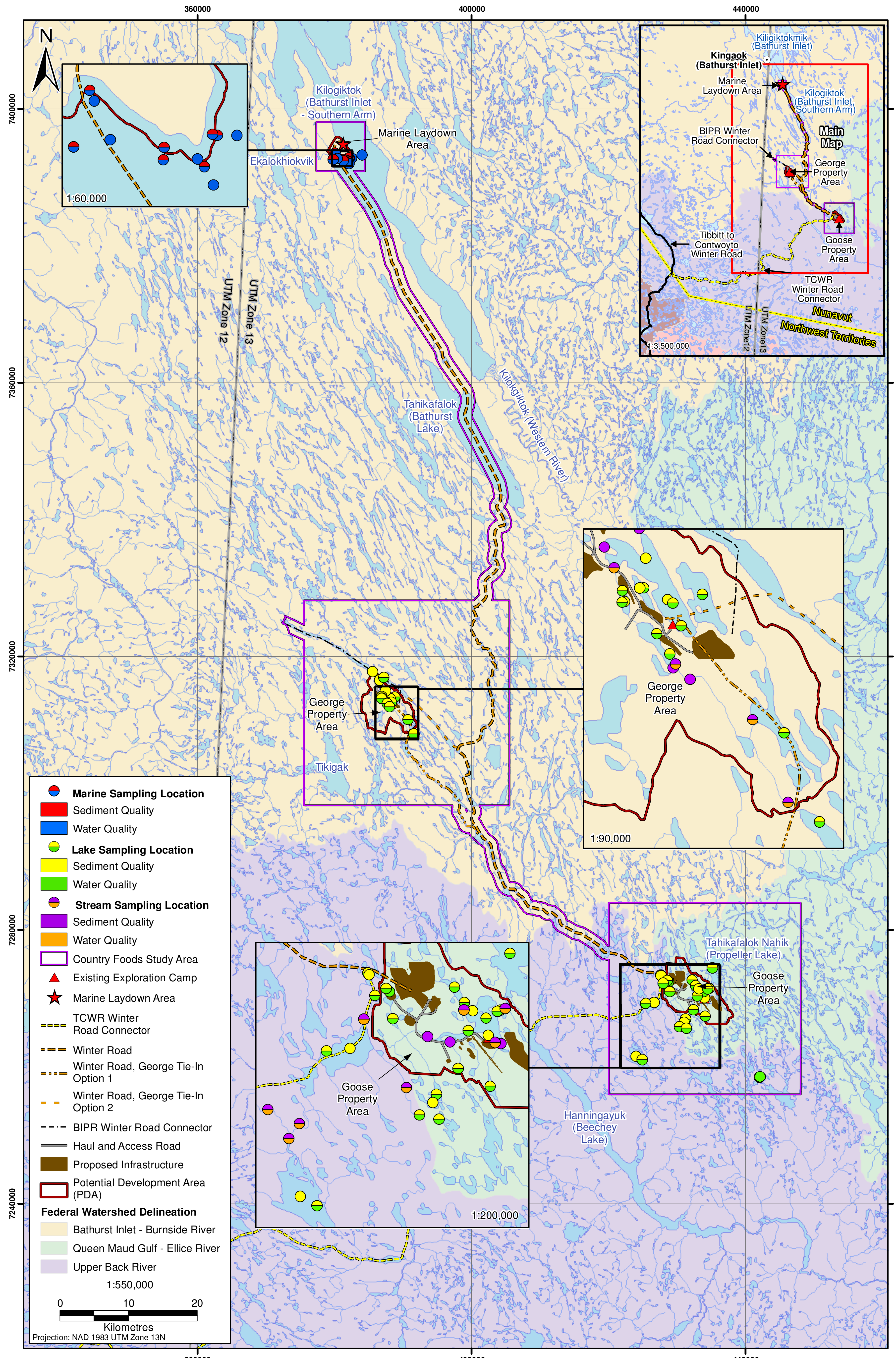

Figure 3.3-2

Water and Sediment Quality Sampling Locations within the Country Foods Study Area, Back River Project

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Figure 3.3-2

Table 3.3-1. Metals Evaluated as Contaminants of Potential Concern

COPC Evaluated	Rationale for Inclusion as COPC						
	Maximum Soil Concentrations Exceeded CCME Guideline[1]	Maximum Water Concentrations Exceeded CCME Guideline (Freshwater)[2]	Maximum Water Concentrations Exceeded CCME Guideline (Marine)[1]	Maximum Sediment Concentrations Exceeded Interim CCME Guideline (Freshwater)[2]	Maximum Sediment Concentration Exceeded Interim CCME Guideline (Marine)[1]	Bio-accumulation or Bio-magnification Potential	Inclusion
Aluminum	No Guideline	**Yes**	No Guideline	No Guideline	No Guideline	Low	**Yes**
Antimony	No Guideline	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Arsenic	**Yes**	No	No	**Yes**	**Yes**	Variable	**Yes**
Barium	No	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Beryllium	No	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Bismuth	No Guideline	No	No Guideline	No Guideline	No Guideline	Low	No
Boron	Not Determined	No	No Guideline	No Guideline	No Guideline	Low	No
Cadmium	No	**Yes**	**Yes**	**Yes** (Lakes only)	No	Moderate to high	**Yes**
Calcium	No Guideline	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Chromium	No	No	No	**Yes**	No	Low	**Yes**
Cobalt	No	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Copper	**Yes**	**Yes**	No Guideline	**Yes**	**Yes**	Low	**Yes**
Iron	No Guideline	**Yes**	No Guideline	No Guideline	No Guideline	Low	No
Lead	No	**Yes**	No Guideline	No	No	Low to High (plants)	**Yes**
Lithium	No Guideline	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Magnesium	No Guideline	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Manganese	No Guideline	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Mercury	No	No	No	No	No	High as methylmercury	**Yes**
Molybdenum	No	No	No Guideline	No Guideline	No Guideline	Low	No
Nickel	No	**Yes**	No Guideline	No Guideline	No Guideline	Low to moderate	**Yes**
Potassium	No Guideline	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Selenium	No	No	No Guideline	No Guideline	No Guideline	Moderate to high	**Yes**
Silicon	Not Determined	No Guideline	No Guideline	No Guideline	No Guideline	Low	No

(continued)

Table 3.3-1. Metals Evaluated as Contaminants of Potential Concern (completed)

COPC Evaluated	Rationale for Inclusion as COPC						
	Maximum Soil Concentrations Exceeded CCME Guideline[1]	Maximum Water Concentrations Exceeded CCME Guideline (Freshwater)[2]	Maximum Water Concentrations Exceeded CCME Guideline (Marine)[1]	Maximum Sediment Concentrations Exceeded Interim CCME Guideline (Freshwater)[2]	Maximum Sediment Concentration Exceeded Interim CCME Guideline (Marine)[1]	Bio-accumulation or Bio-magnification Potential	Inclusion
Silver	No	No	No Guideline	No Guideline	No Guideline	Low	No
Sodium	No Guideline	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Strontium	No Guideline	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Thallium	No	No	No Guideline	No Guideline	No Guideline	Moderate	**Yes**
Tin	No	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Titanium	No Guideline	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Uranium	No	No	No Guideline	No Guideline	No Guideline	Low	No
Vanadium	No	No Guideline	No Guideline	No Guideline	No Guideline	Low	No
Zinc	No	No	No Guideline	**Yes** (Lakes only)	No	High	**Yes**

Notes:
COPC: Contaminant of Potential Concern
CCME: Canadian Council of Ministers of the Environment
[1] Years screened: 2012.
[2] Year screened: 2010-2012.

Toddlers are considered the most susceptible life stage for chemical exposures because of their higher relative ingestion rates per unit body weight and their rapid absorption and metabolic rates during this important growth period, compared to adults.

3.5 HUMAN EXPOSURE PATHWAYS

Human exposure pathways are the routes by which people are exposed to chemicals. Food-related exposure pathways were selected for the country foods assessment based on the ingestion of:

- terrestrial animals that have taken up metals through the ingestion of soil, vegetation, and surface water;
- aquatic species that have taken up metals from their diet, sediments, and surrounding water; and
- plants that have taken up metals from the soil and water.

The human exposure pathways are presented in Figure 3.5-1. This figure presents the sources of COPCs, residency media (e.g., terrestrial animals, fish and vegetation), and exposure routes to human receptors. The conceptual model for this assessment is presented in Figure 3.5-2, which shows how metals in the environment move into the food chain and subsequently into humans through their diet.

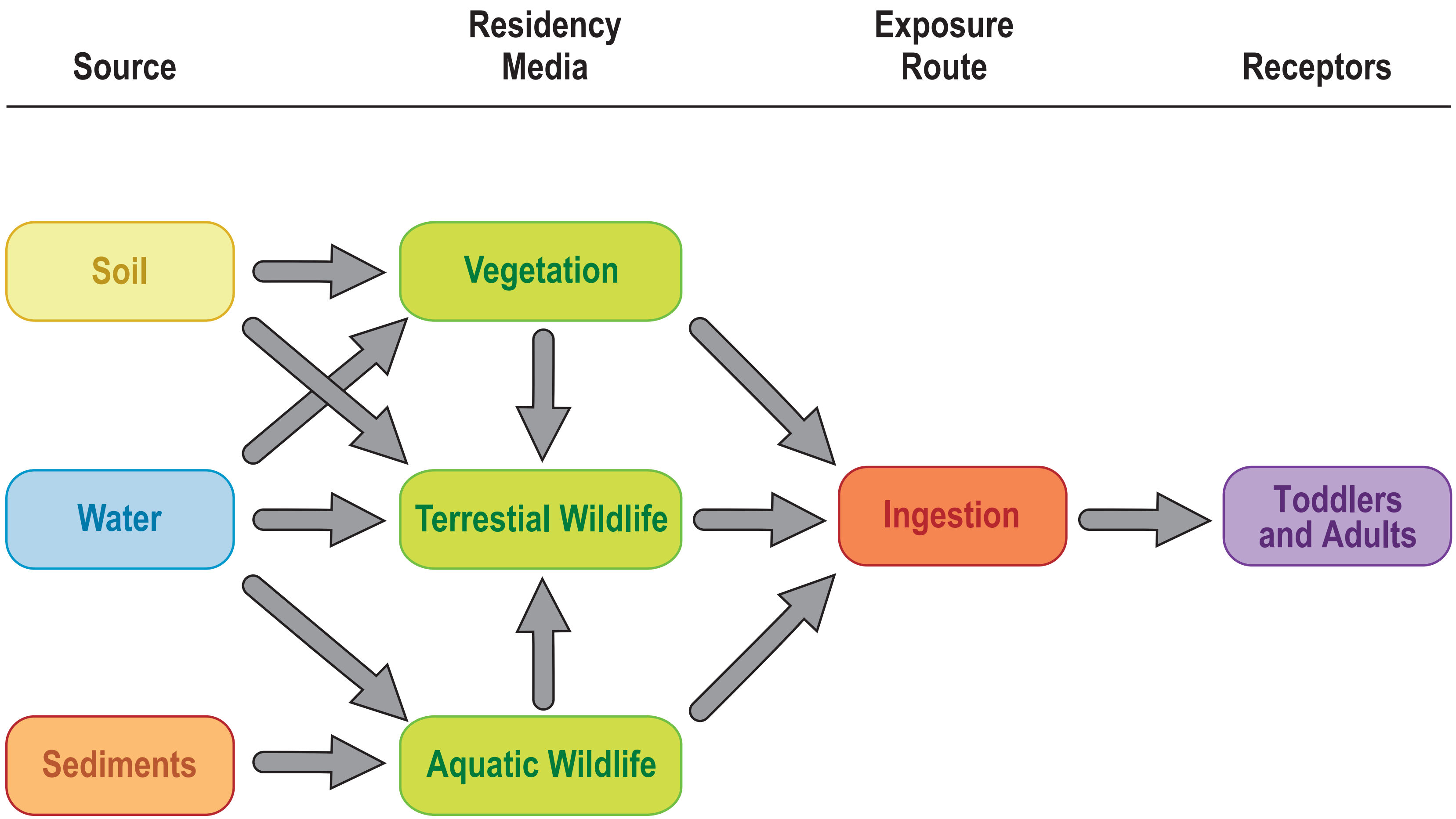

Figure 3.5-1

Human Exposure Pathways

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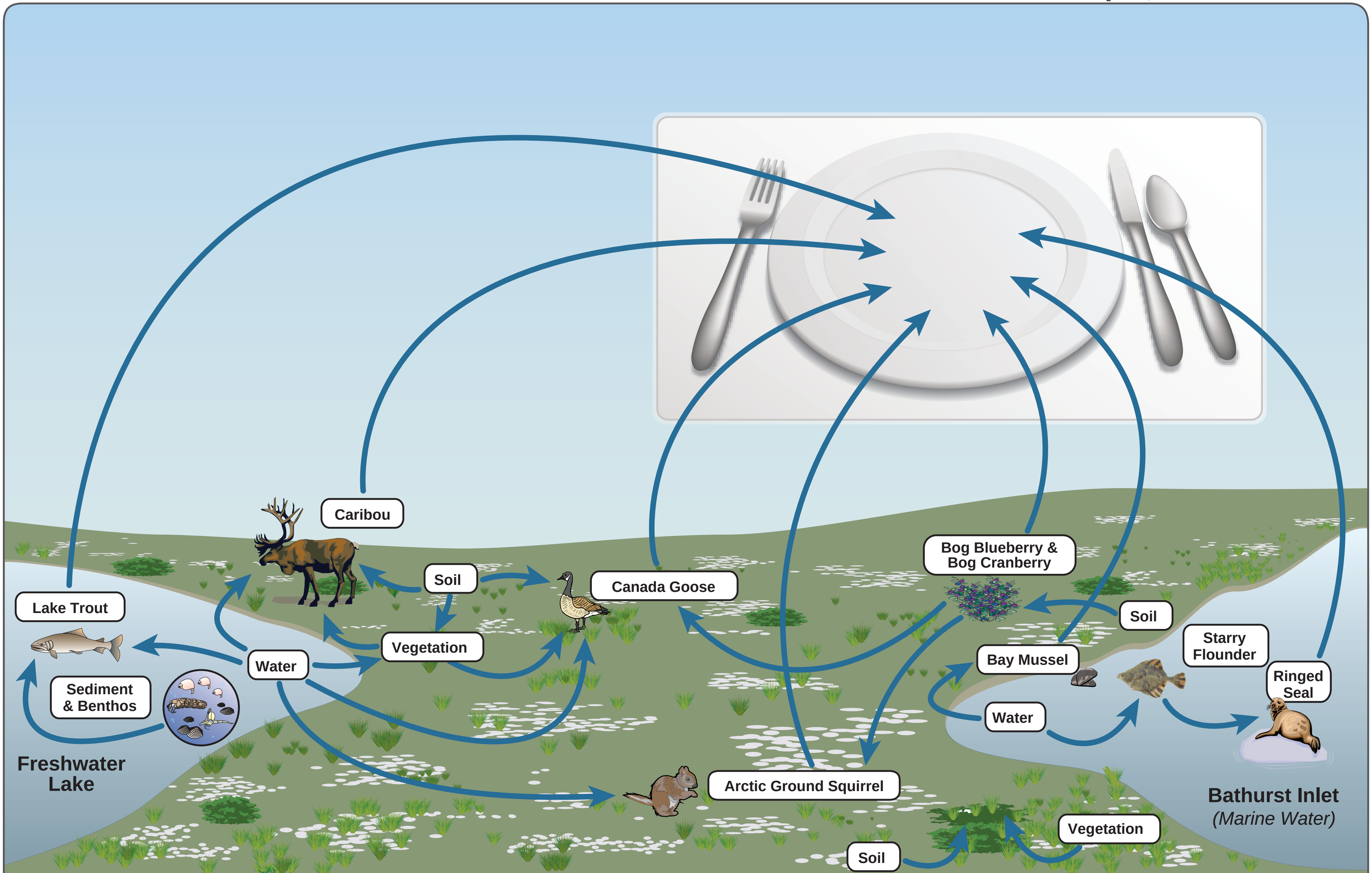

Figure 3.5-2

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Country Foods Conceptual Model

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4. Exposure Assessment

4. Exposure Assessment

4.1 INTRODUCTION

The amount of COPCs that people are exposed to from consuming country foods depends on several factors including:

- the concentration of metals in terrestrial wildlife resulting from their ingestion of environmental media (e.g., vegetation, water, and soil);
- the concentration of metals in aquatic species resulting from their uptake of metals from water, sediment, and their diet;
- the concentration of metals in vegetation resulting from their uptake of metals from environmental media; and
- human receptor characteristics (e.g., consumption amount, frequency, body weight).

These parameters are included in the exposure estimate equations to determine the estimated daily intake (EDI) of each metal through the consumption of the selected country food. EDIs are based on the background measured metal concentrations in country foods, or modelled estimates based on metal concentrations in the environmental media.

4.2 TERRESTRIAL WILDLIFE TISSUE CONCENTRATIONS

No terrestrial wildlife species were sacrificed to obtain tissue samples for metal analysis from the country foods study area. Rather, caribou, Arctic ground squirrel, and Canada goose tissue concentrations were estimated using a food chain model described in Golder (2005). Details of the model can be found in Appendix B. The model used mean baseline metal concentrations in soil, water, berries, lichens, and sedges, animal-specific ingestion rates, and metal-specific biotransfer factors (BTFs; Appendix B, Table B-2, Table B-4, and Table B-5). Each terrestrial wildlife species was assumed to take up metals from every environmental medium (soil, water, and vegetation). For terrestrial wildlife specific diet assumptions refer to Appendix B, Section 2.1.1.

The model generally over-predicts the concentrations in animal tissue and is considered a conservative approach (Golder 2005). Table 4.2-1 presents the modelled caribou, Arctic ground squirrel, and Canada goose muscle tissue concentrations for each of the COPCs.

Table 4.2-1. Predicted Mean Metal Concentrations in Terrestrial Wildlife from Exposure to Soil, Surface Water, Lichens and Berries

COPC	Caribou Meat (mg/kg wet weight)	Arctic Ground Squirrel Meat (mg/kg wet weight)	Canada Goose Meat (mg/kg wet weight)
Aluminum	5.61	0.0133	83.6
Arsenic	0.00874	0.0000234	0.152
Cadmium	0.0000884	0.000000430	0.00702
Chromium	0.0489	0.000114	0.0703
Copper	0.139	0.000849	0.680
Lead	0.00155	0.00000431	0.0424

(continued)

Table 4.2-1. Predicted Mean Metal Concentrations in Terrestrial Wildlife from Exposure to Soil, Surface Water, Lichens and Berries (completed)

COPC	Caribou Meat (mg/kg wet weight)	Arctic Ground Squirrel Meat (mg/kg wet weight)	Canada Goose Meat (mg/kg wet weight)
Mercury	0.0477	0.000147	0.0000294
Nickel	0.107	0.000464	0.000912
Selenium	0.0211	0.000101	0.0679
Thallium	0.00336	0.0000151	0.00300
Zinc	6.12	0.0422	0.0487

COPC: Contaminants of potential concern

4.3 AQUATIC BIOTA TISSUE CONCENTRATIONS

Metal concentrations were analyzed in 19 lake trout collected in 2011 and 30 lake trout collected in 2012; sampling locations are shown in Figure 3.2-1. Lake trout were collected from both George and Goose properties (Rescan 2012a, 2012c). In 2011, mean fork length of lake trout was 430 mm and was similar to the 432 mm value measured in 2012; therefore, the data was pooled for 2011 and 2012. Table 4.3-1 presents the mean metal concentrations of COPCs from the 2011 to 2012 lake trout tissue sampling and a summary for lake trout tissue metal concentrations is presented in Appendix A4-1.

Table 4.3-1. Mean Metal Concentrations Measured in Lake Trout Tissue

	Mean Lake Trout Tissue Concentration (mg/kg wet weight)		
COPC	2011 (n = 19)	2012 (n = 30)	Pooled (n = 49)
Aluminum	<2.0	1.36	1.22
Arsenic	0.0198	0.0411	0.0328
Cadmium	<0.0050	<0.0050	<0.0050
Chromium	0.110	<0.1	0.0733
Copper	0.297	0.271	0.281
Lead	0.0591	0.0371	0.0459
Mercury	0.278	0.179	0.215
Nickel	0.0568	<0.1	0.0527
Selenium	0.382	0.367	0.374
Thallium	0.00568	0.00753	0.00682
Zinc	4.26	3.88	4.03

COPC: Contaminants of potential concern

Bay mussels (*M. trossulus*) were collected from southern Bathurst Inlet in 2012 (Rescan 2013a) from the sampling locations shown in Figure 3.2-1. Table 4.3-2 presents the mean metal concentrations of COPCs from the 2012 bay mussel tissue sampling and a summary for bay mussel metal tissue concentrations is presented in Appendix A4-2.

Table 4.3-3 provides the predicted mean metal concentrations of COPCs in ringed seals, modelled based on starry flounder tissue metal concentrations (Appendix B, Section 2.1.2).

Table 4.3-2. Mean Metal Concentrations Measured in Bay Mussel Tissue

COPC	Mean Bay Mussel Concentration (mg/kg wet weight) (n = 20)
Aluminum	226
Arsenic	2.18
Cadmium	2.09
Chromium	0.585
Copper	2.0
Lead	0.339
Mercury	0.025
Nickel	0.623
Selenium	1.0
Thallium	0.00190
Zinc	17.3

COPC: Contaminants of potential concern

Table 4.3-3. Mean Metal Concentrations Predicted in Ringed Seal Tissue

COPC	Seal Tissue Concentration (mg/kg wet weight)
Aluminum	0.0303
Arsenic	0.00912
Cadmium	0.00000424
Chromium	0.000618
Copper	0.00832
Lead	0.0000194
Mercury	0.0298
Nickel	0.000674
Selenium	0.0134
Thallium	0.000270
Zinc	1.48

COPC: Contaminants of potential concern

4.4 PLANT TISSUE CONCENTRATIONS

Berries were collected within the country foods study area in the summer of 2012. In total, 25 berry samples (*V. uliginosum and V. vitis-idaea*) were collected from the country foods study area and analyzed for metal concentrations (Rescan 2013d). Table 4.4-1 provides a summary of the available berry data for the assessment. Figure 3.2-2 includes the locations of the berry samples within the country foods study area. Appendix A5 summarizes the analytical results for all metals analyzed in the berry samples. The berry data were used to calculate the COPC exposure for people who consume local berries.

Table 4.4-1. Mean Metal Concentrations Measured in Berry Tissue

COPC	Mean Berry[1] Concentration (mg/kg wet weight) (n = 25)
Aluminum	5.91
Arsenic	0.00812
Cadmium	0.0153
Chromium	0.0523
Copper	0.949
Lead	<0.020
Mercury	0.000536
Nickel	0.343
Selenium	<0.20
Thallium	<0.010
Zinc	5.23

COPC: Contaminants of potential concern
[1] Berry samples were bog blueberry *(V. uliginosum)* and bog cranberry *(V. vitis-idaea)*.

4.5 HUMAN RECEPTOR CHARACTERISTICS

The human receptor characteristics used to calculate the estimated daily intake (EDI) were body weight (kg), consumption amount (serving size), and consumption frequency (number of servings per year or per week of highest exposure) of the selected country foods. Table 4.5-1 presents a summary of the human receptor characteristics. The body weights and consumption amounts for adults and toddlers were based on guidance provided by Health Canada (Health Canada 2010a, 2010c).

Table 4.5-1. Human Receptor Characteristics

Parameter	Toddler[1] Consumption Rate (kg/day)	Adult[2] Consumption Rate (kg/day)	# Times Consumed per Year	Data Source
Caribou	0.12	0.27	365	Nancarrow (2007)
Arctic ground squirrel[3]	0.023	0.053	104[4]	Coad (1994)
Canada goose	0.085	0.20	5.0	Nancarrow (2007)
Lake trout	0.11	0.25	5.0	Nancarrow (2007)
Bay mussel[4]	0.0013	0.0030	48[5]	Innis, Kuhnlein, and Kinloch (1988)
Ringed seal muscle	0.10	0.25	10	Nancarrow (2007)
Ringed seal blubber	0.037	0.087	82	Nancarrow (2007)
Berries	0.0056	0.013	152	Egeland (2010)

[1] *Toddler body weight is 16.5 kg*
[2] *Adult body weight is 70.0 kg*
[3] *Arctic ground squirrel consumption rate was assumed to be twice a week throughout the year*
[4] *Bay mussel consumption rates was assumed to be three time a week, for four months of the year*

Human receptor consumption characteristics are based on studies on the Inuit (Innis, Kuhnlein, and Kinloch 1988; Coad 1994; Nancarrow 2007; Egeland 2010) as well as general human characteristics outlined by Health Canada (Health Canada 2010a, 2010c). The majority of data for country food daily intake estimates for this report was obtained from results of extensive and relatively recent surveys of portion sizes and consumption frequencies conducted for 25% of the adults from Repulse Bay and Kugaaruk communities between 2003 to 2005 (Nancarrow 2007). Portion size and consumption frequency for seal muscle, seal blubber, caribou, lake trout, and Canada goose were based on the results of these surveys.

In addition to the muscle, different organs of country foods may be a part of a stable diet of Inuit (Nancarrow 2007). For example muscle, fat, bone marrow, and organs such as tongue, kidneys, liver, stomach, and intestine of caribou, and muscle, blubber, kidneys, liver, heart, flippers, and blood of ringed seals are included in the Inuit diet and provide a valuable nutritional source (Nancarrow 2007). Although this assessment does not estimate the risk of consumption of individual organs, consumption frequencies and portion sizes related to caribou and ringed seals were selected to reflect the risk from consumption of these country foods as a whole.

For Canada goose and lake trout it was assumed that the entire country foods were consumed as the report only referred to meat of birds and fish and did not specify consumption of various organs in these country foods (Nancarrow 2007). Mussel's tissue and berries were assumed to be consumed as a whole, due to the absence of contradicting data.

Consumption quantities used for Arctic ground squirrel were based on small game estimated consumption value gathered by Coad (1994) from literature (1986-1990). Estimates of daily intake of bay mussel were collected from commercial, private, and government databases from 1986 to 1996 (Innis, Kuhnlein, and Kinloch 1988).

Vegetation is not considered a staple of the Inuit diet. Subsequently, most country food surveys of the Inuit in the Canadian Arctic do not address locally harvested vegetation as a food. A country foods 24-hour recall survey of 1,092 individuals in Nunavut showed that only five people (< 0.5% of total participants) indicated that they consume blueberries (Kuhnlein et al. 2002). Although fruits and vegetables are increasingly consumed, many are imported and purchased from markets. Berry portion size was based on data from the Inuit Health Survey 2007 - 2008 (Egeland 2010).

Although the Inuit are the primary harvesters of country foods in the study area, less than half (6 to 40%) of their total food consumed comes from country foods, depending on the degree of urbanization or remoteness of the community (INAC 2003). These estimates are based on 24-hour recall data of the Inuit that show the mean country food consumption for adult males between the ages of 20 and 40 years to be 245 g/day, and adult males over 40 years of age to be 440 g/day during the entire year (INAC 2003). Generally, older individuals had a higher consumption rate of traditional country foods (Kuhnlein and Receveur 2001). It is recognized that younger generations of Inuit are more urbanized and rely less on country foods; therefore, these consumption rates are likely to overestimate the true consumption for toddlers and younger adults (18 to 40 years old). No data were collected on the serving sizes of toddlers, it was assumed that a toddler would eat the country foods at the same frequency as adults; toddler's serving size was assumed to be 43% of the adult's serving size (Richardson 1997). It is anticipated that this assumption overestimates the actual toddler serving size.

4.6 ESTIMATED DAILY INTAKE

The EDI of each COPC for toddlers and adults was based on the predicted (caribou, Canada goose, Arctic ground squirrel, ringed seal) and measured (fish, berries) tissue concentrations and the human receptor characteristics. The following equation was used to estimate the EDI of COPCs from the consumption of country foods:

$$EDI_{food} = \frac{IR \times C_{food} \times F_s}{BW}$$

where:

EDI_{food} = estimated daily intake of COPCs from country food (mg COPC/kg BW/day)
IR = ingestion rate (kg/day)
C_{food} = mean concentration of COPCs in food (mg/kg)
F_s = fraction of year consuming country food (unitless)
BW = body weight (kg BW)

The EDI of each COPC for toddler and adult receptors is presented in Table 4.6-1. For this baseline, it was assumed that 100% of the country foods were harvested from the country foods study area and that 100% of the COPCs were bioavailable; assumptions that are not entirely possible, and therefore provide a highly conservative estimate. Appendix C presents a sample calculation of the EDI of arsenic for toddlers consuming caribou tissue. An assessment of the EDIs in country foods shows that humans had the highest EDI of aluminum, chromium, copper, lead, mercury, nickel, selenium, thallium and zinc from consuming caribou, the highest EDI of cadmium from consuming mussels, and the highest EDI of arsenic from consuming berries. The lowest EDIs of COPCs were associated with the consumption of ground squirrels and ringed seals blubber.

Table 4.6-1. Estimated Daily Intake of Contaminants of Potential Concern by Human Receptors

COPC	Caribou (mg/kg body weight/day)		Arctic Ground Squirrel (mg/kg body weight/day)		Canada Goose (mg/kg body weight/day)		Lake Trout (mg/kg body weight/day)	
	Toddler	Adult	Toddler	Adult	Toddler	Adult	Toddler	Adult
Aluminum	0.039	0.021	<0.00001	<0.00001	0.0059	0.0032	0.00011	0.000060
Arsenic	<0.00001	<0.00001	<0.0001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Cadmium	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chromium	0.00034	0.00019	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Copper	0.00098	0.00053	<0.00001	<0.00001	0.000048	0.000026	0.000026	0.000014
Lead	0.000011	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Mercury	0.00034	0.00018	<0.00001	<0.00001	<0.00001	<0.00001	0.000019	0.000011
Nickel	0.00075	0.00041	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Selenium	0.00015	0.000081	<0.00001	<0.00001	<0.00001	<0.00001	0.000034	0.000018
Thallium	0.000024	0.000013	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Zinc	0.0431	0.0234	<0.00001	<0.00001	<0.00001	<0.00001	0.00037	0.00020

COPC	Bay Mussel (mg/kg body weight/day)		Ringed Seal Meat (mg/kg body weight/day)		Ringed Seal Blubber (mg/kg body weight/day)		Bog Blueberry & Bog Cranberry (mg/kg body weight/day)	
	Toddler	Adult	Toddler	Adult	Toddler	Adult	Toddler	Adult
Aluminum	0.0023	0.0013	0.000043	0.000023	<0.00001	<0.00001	0.00083	0.00045
Arsenic	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00000055	0.00000030
Cadmium	0.000022	0.000012	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chromium	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001
Copper	0.000021	0.000011	0.000012	<0.00001	<0.00001	<0.00001	0.00013	0.000073
Lead	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Mercury	<0.00001	<0.00001	0.000042	0.000023	<0.00001	<0.00001	<0.00001	<0.00001
Nickel	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.000048	0.000026
Selenium	0.000010	<0.00001	0.000019	0.000010	<0.00001	<0.00001	0.000014	<0.00001
Thallium	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.0001	<0.00001
Zinc	0.00018	0.000096	0.00208	0.00113	0.0000459	0.0000249	0.00074	0.00040

COPC: Contaminants of potential concern
Highlighted numbers denote country food with highest estimated daily intake for a toddler or adult of a particular COPC.

5. Toxicity Reference Value Assessment

5. Toxicity Reference Value Assessment

5.1 INTRODUCTION

The TRV assessment involves determining the amount of a COPC that can be taken into the human body without experiencing adverse health effects. Toxicity information is typically derived from laboratory studies, where dose-response information is extrapolated from animal test subjects to humans by applying uncertainty or safety factors. In most cases, uncertainty factors of 100 to 1,000 are applied to the laboratory-derived no observed adverse effect levels (NOAELs). NOAELs are the highest concentration used in a toxicity test that results in no chronic health effects are observed or measured. These factors account for interspecies extrapolation and the protection of the most susceptible portion of the population (i.e., children and the elderly). Therefore, TRVs based on animal studies generally have large margins of safety to ensure that the toxicity or risk of a substance to people is not underestimated. Lowest observed adverse effect levels (LOAEL) from human studies have smaller uncertainty factors because no extrapolation from animals to humans is required.

The TRVs in this assessment are presented as Tolerable Daily Intakes (TDIs) or Provisional Tolerable Daily Intakes (PTDIs). The TDI is defined as the amount of metal per unit body weight (BW) that can be taken into the body each day (e.g., mg/kg BW/day) with no risk of adverse health effects. The term tolerable is used because it signifies permissibility rather than acceptability for the intake of contaminants unavoidably associated with the consumption of otherwise wholesome and nutritious country foods (Herrman and Younes 1999). Use of the term provisional expresses the tentative nature of the evaluation, in view of the paucity of reliable data on the consequences of human exposure at levels approaching those indicated.

Health Canada guidelines were used preferentially (i.e., Health Canada's Bureau of Chemical Safety, Chemical Health Hazard Division [CHHAD]) unless they were not available for certain COPCs, in which case alternative sources of guidelines were used. Other sources of guidelines included: United States Environmental Protection Agency's (US EPA) Integrated Risk Information System (IRIS) guidelines, Food and Agriculture Organization of the United Nations (FAO)/World Health Organization (WHO) Joint Expert Committee on Food Additives and Contaminants (JECFA) guidelines, and toxicological profiles for metals from Agency for Toxic Substances and Disease Registry (ASTDR). The TRVs used in this baseline assessment are presented in Table 5.1-1. It is noted that US EPA uses the term reference dose (RfD) rather than TDI, but for consistency within the report, RfDs will be reported as TDIs. Toxicity studies on which the TDIs were based on and the rationale for their selection are briefly summarized in Section 5.2. Health Canada guidelines were used preferentially unless they were not available for certain COPCs, in which case EPA guidelines were used.

5.2 TOXICITY REFERENCE VALUES

5.2.1 Aluminum

Health Canada (2011) provides a PTDI of 300 µg/kg BW/day for aluminum. No rationale is provided for the derivation of this PTDI. In 2006, JECFA re-evaluated the toxicology of aluminum and revised the provisional tolerable weekly intake (PTWI) from 7.0 mg/kg BW/week (1,000 µg/kg BW/day) to 1.0 mg/kg BW/week (143 µg/kg BW/day) (JECFA 2007). JECFA concluded that aluminum compounds have the potential to affect the reproductive system and the developing nervous system at doses lower than those used in establishing the previous PTWI. Health Canada is currently reviewing the dietary exposure to aluminum in Canada. The Health Canada PTDI of 300 µg/kg BW/day is used in this report.

Table 5.1-1. Toxicity Reference Values for Contaminants of Potential Concern

COPC	Tolerable Daily Intake (TDI): Health Canada, Contaminated Sites Program (2010)	Tolerable Daily Intake (TDI): U.S. EPA, Integrated Risk Information System (IRIS)	Tolerable Daily Intake (TDI): Joint FAO/WHO Expert Committee on Food Additives	Tolerable Daily Intake (TDI)
Aluminum	300[1]	-	143[2]	300
Arsenic	1,800 (Oral cancer slope factor; µg/kg BW/day)	0.3	Under review	0.3[3], 1,800[3]
Cadmium	1	1	0.8	1
Chromium (trivalent)	-	1,500	-	1,500
Chromium (total)	1	-	-	1
Copper	91 to 141 depending on age group	-	500	91 (toddler), 141 (adult)
Lead	Under review	under discussion	3.6	3.6
Mercury, total	0.3	-	0.47[4]	0.3
Mercury, methyl	0.47	0.1	0.23[7]	0.23[5] , 0.47[6]
Nickel	11	20	-	11
Selenium	5.5 to 6.3 depending on age group	5	-	6.2 (toddler), 5.7 (adult)
Thallium	0.07[1]	under discussion	-	0.07
Zinc	480 to 570 depending on age group	300	300 to 1,000[8]	480 (toddler), 570 (adult)

Notes: COPC = Contaminant of potential concern
All units in µg/kg BW/day, unless otherwise stated.
[1] Based on Health Canada, Chemical Health Hazard Assessment Division (2011) "in house" reference source.
[2] Based on a PTWI of 1,000 µg/kg BW/week.
[3] Arsenic TDI of 0.3 is used for calculation of non-cancer risk while slope factor of 1,800 (µg/kg BW/day) is used for cancer risk calculations.
[4] Based on a PTWI of 3.3 µg/kg BW/week.
[5] For children and women of child-bearing age and pregnant women.
[6] General public.
[7] Based on a PTWI for adults of 1.6 µg/kg BW/week.
[8] Provisional daily dietary requirement/maximum tolerable daily intake.

5.2.2 Arsenic

For assessment of non-cancer risks from arsenic, IRIS (US EPA 2013) provides 0.3 µg/kg BW/day for a chronic oral TDI, while JECFA recommends a PTWI of 15 µg/kg BW/week for oral exposures (JECFA 2010). The JECFA PTWI is based on the incidence of lung cancer from epidemiological studies that used a range of assumptions to estimate total dietary exposure to inorganic arsenic via drinking water and food (JECFA 2010).

Arsenic is the only metal in this study that is considered carcinogenic via the ingestion pathway. For carcinogens, slope factors are used as the TRVs (Health Canada 2010b, 2010a). A slope factor is a measurement of carcinogenic potency; it relates the dose of arsenic (in this case) to the expected probability of developing cancer and quantifies the number of predicted cancer per unit dose of arsenic (Health Canada 2010c). A slope factor is the upper bound estimate of the probability of a response-per-unit intake of a material of concern over an average human lifetime. It is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of arsenic. Upper-bound estimates conservatively exaggerate the risk to ensure that the risk is not underestimated if the underlying model is incorrect and is based on one affected population in Taiwan concerning non-fatal skin cancer incidence, age, and level of exposure to arsenic via drinking water (not food). The confidence in the oral slope factor is overall low.

Animal studies have not associated arsenic exposure via ingestion with cancer, the mechanism of action in causing human cancer is not known, and studies on mutagenicity are inconclusive (US EPA 2000a). The oral slope factor for arsenic cancer risk is 1,800 per µg/kg BW/day (Health Canada 2010b), based on the tumourigenic dose (TD_{05}). Of the various species of arsenic that exist, inorganic arsenic has been identified as the primary carcinogenic form, while organic arsenic compounds have relatively low carcinogenic activity, but a higher bioaccumulation potential (Roy and Saha 2002).

To account for the low proportion of inorganic arsenic in food, it was assumed that 10% of the total detected arsenic in the fish is inorganic based on the estimate from Slejkovec, Bajc, and Doganoc (2004). Based on a market basket survey with chicken breasts, the proportion of inorganic to total arsenic in chicken was estimated to be 0.0104, or 1.04% (Schoof et al. 1999), which was used to estimate the concentration of inorganic arsenic in Canada goose. Similarly, the proportion of inorganic to total organic arsenic in beef (used as a surrogate for caribou and Arctic ground squirrel) was estimated to be 0.0078, or less than 0.78% (Schoof et al. 1999).

A study surveyed the inorganic arsenic concentration in marine organisms including several shellfish species, such as horse mussel (*Modilous modiolus*), oyster (*Ostrea edulis*) and scallop muscle (*Pecten maximus*), as well as several marine mammals including mink whale (*Balaenoptera acutorostrata*), harp seal (*Pagophilus groenlandicus*), and hooded seal (*Cystophora cristata*; Jens, Larsen, and Julshamn 2005). The proportion of inorganic to total arsenic concentrations in horse mussel and scallop mussel were 0.00035 and 0.0026, respectively. Among shellfish examined, oysters had the highest proportion of inorganic arsenic to total arsenic concentration of 0.0078, or 0.78% (Jens, Larsen, and Julshamn 2005). Therefore, to account for the inorganic arsenic, it was assumed that 0.78% of the total arsenic measured in bay mussels was in its inorganic form.

The proportion of inorganic to organic arsenic concentrations in harp seals, mink whale, and hooded seal were 0.00067, 0.00098, and 0.0027, respectively (Jens, Larsen, and Julshamn 2005). The highest proportion of inorganic arsenic to total arsenic concentrations of 0.0027, or 0.27%, was used to calculate the proportion of inorganic arsenic concentration in ringed seals.

Berries were not analyzed in the food market study (Schoof et al. 1999) or the study by Jen and colleagues (2005); however, a variety of fruits including apples, bananas, grapes, oranges, peaches, and watermelons were included in the food market study. The average inorganic to total arsenic proportion in fruits analyzed by Schoof et al. (1999) was calculated be 0.48. Therefore, for this assessment, it was assumed that 48% of the total arsenic concentration in berries was in the inorganic form.

5.2.3 Cadmium

Health Canada (2010b) provides a PTDI of 1 µg/kg BW/day for cadmium, which was used in this assessment. This PTDI is similar to JECFA’s PTMI of 25 µg/kg BW/month (JECFA 2011), which accounts for the long half-life of cadmium in the body. The JECFA TDI of 0.8 µg/kg BW/day will ensure cadmium concentrations in the renal cortex do not exceed 50 mg/kg; this level is thought to protect normal kidney function. Health Canada (2011) and IRIS (US EPA 2013) provide a TDI of 1 µg/kg BW/day for oral exposures to cadmium based on recommendations by the JECFA (1972a, 2005).

5.2.4 Chromium

Health Canada (2011) provides a TDI of 1,500 μg/kg BW/day for trivalent (III) chromium. The TDI for chromium III was selected for use because hexavalent (VI) chromium is generally not present in animal or plant tissue. After its absorption, hexavalent chromium is rapidly reduced to the trivalent form that is the main form found in biological material (Leonard and Lauwerys 1980; Kerger et al. 1996; Shrivastava, Upreti, and Chaturvedi 2003). The TDI for chromium III is based on the IRIS TDI (US EPA 2013), which was derived from a chronic toxicity study conducted by Ivankovic and Preussman (1975). Groups of rats (12 to 19 per group) were exposed to 0%, 2%, or 5% chromic oxide in bread for five days per week over 18 weeks and monitored for food consumption and body weight. Toxicological endpoints (measures of effect) included serum protein, urine analysis, organ weights, and microscopic examination. The only effects observed were reductions (12% to 37%) in liver and spleen weights of animals in the high-dose group. The NOAEL was 1,468 mg/kg BW/day. An uncertainty factor of 1,000 was applied to the NOAEL: 10 for interspecies extrapolation, 10 for protection of the most susceptible receptor, and 10 for a lack of chronic and reproductive toxicity studies.

5.2.5 Copper

Health Canada (2010b) reports a TDI of 91 to 141 μg/kg BW/day for copper based on specific age groups. Copper is an essential nutrient. JECFA recommends a provisional value of maximum tolerable daily intake of 500 μg/kg BW. However, recommendations were made for further collection of information on copper with considerations of epidemiological surveys to study the evidence of copper-induced ill-health. A TDI of 91 μg/kg BW/day and 141 μg/kg BW/day was used for toddlers and adults, respectively, in this report.

5.2.6 Lead

Health Canada (2010b) is revising the TDI for lead based on PTWI of 25 μg/kg BW/week recommended by the JECFA (2000b). However, JECFA withdrew this PTWI in 2011 (JECFA 2011) because the intake value was associated with a decrease of at least 3 Intelligence Quotient (IQ) points in children and an increase in systolic blood pressure of approximately 3 mmHg (0.4 kPa) in adults. Because the dose–response analysis done by JECFA does not provide any indication of a threshold for the key effects of lead, the JECFA Committee concluded that it was not possible to establish a new PTWI that would be considered to be health protective. The Ontario Ministry of the Environment and Energy recommends a more protective TDI of 1.85 μg/kg BW/day for lead, which is used for this assessment (Fleming and Ursitti 1994).

5.2.7 Mercury

Health Canada (2010b) provides a PTDI of 0.3 μg/kg BW/day for inorganic mercury exposure for the general public, based on CCME soil quality guidelines and supporting documentation on health-based guidelines prepared by Health Canada. As data are not available on the mercury speciation in the local vegetation and terrestrial animals, it was assumed that for caribou, Arctic ground squirrel, Canada goose, and berries the mercury was present as inorganic mercury. Therefore, total mercury was compared to the Health Canada (2010b) inorganic mercury PTDI as a TRV.

For fish and shellfish, mercury was assumed to be present 100% as methylmercury (Health Canada 2007). Based on a study on marine mammals and speciation of mercury, methymercury in western Arctic belugas, eastern Arctic belugas, eastern Arctic narwhale, western Arctic ringed seals, and eastern Arctic ringed seals constituted between 92 to 97% of total mercury concentrations (Wagemann et al. 1998). Therefore, mercury concentrations in ringed seals was also assumed to be present 100% as methylmercury. For methylmercury, JECFA recommends a PTDI of 0.47 μg/kg BW/day for the general public, and 0.23 μg/kg BW/day for sensitive groups (i.e., children and women who are pregnant or who are of child-bearing age). This was also adopted by Health Canada (2010b).

5.2.8 Nickel

Health Canada (2010b) provides a TDI of 11 μg/kg BW/day for nickel that is based on a reproductive toxicity study in rats that administered drinking water with a range of nickel concentrations and determined a NOAEL of 1,100 μg/kg BW/day. US EPA IRIS provides a TDI of 20 μg/kg BW/day (nickel soluble salts). Health Canada (2011) provides a TDI of 25 μg/kg BW/day for nickel. This TDI for total nickel was based on a dietary study in rats that found a NOAEL of 5,000 μg/kg BW/day for altered organ to body weight ratios. An uncertainty factor of 200 was applied to the NOAEL: 10 for interspecies variation and 10 to protect sensitive populations. A modifying factor of two was also applied to account for the inadequacies of the reproductive studies. While the TDIs for nickel are comparable, the more conservative TDI of 11 μg/kg BW/day (Health Canada 2010b) was used in this assessment.

5.2.9 Selenium

Health Canada (2011) provides a TDI of 750 μg/person/day for selenium. As the recommended maximum intake of selenium is not presented as being proportional to an individual's weight, the value was divided by the average adult weight (70.7 kg) to produce a proportional value of 11 μg/kg BW/day. Health Canada does not provide a rationale for the derivation of this TDI. IRIS (US EPA 2013) provides an oral TDI of 5 μg/kg BW/day for selenium based on a NOAEL of 15 μg/kg/day. Health Canada (2010b) provides a range of TDIs between 5.5 and 6.3 μg/kg/day specific to age groups as selenium is an essential element. Selenium has been demonstrated to be a cofactor of glutathione peroxidase, a hydrogen and lipid peroxide reducing enzyme. Elevated levels of selenium can induce selenium toxicity and varying forms of selenosis. A TDI of 6.2 and 5.7 μg/kg/day was adopted for toddlers and adults, respectively, for this assessment.

5.2.10 Thallium

Health Canada (2011) provides a PTDI of 0.07 μg/kg BW/day for thallium. Health Canada does not provide a rationale for the derivation of this TDI, but states that this PTDI is considered temporary as it was derived from an incomplete data set. The PTDI of 0.07 μg/kg BW/day for thallium was used for this assessment.

5.2.11 Zinc

Health Canada (2011) provides a TDI of 700 g/kg BW/day for zinc, while Health Canada (2010b) provides a more conservative range of TDIs based on age groups between 480 and 570 μg/kg BW/day. Listing different TDIs for specific age groups acknowledges the fact that zinc is an essential element in the nutrition of humans, animals and plants, thus those age group values were used in this assessment. JECFA (1982a) provides an estimate for a provisional maximum tolerable daily intake of 300 to 1,000 g/kg BW/day; this acknowledges the wide margin between nutritionally-required amounts of zinc for numerous enzymatic functions and toxic levels.

6. Risk Characterization

6. Risk Characterization

6.1 INTRODUCTION

Health effects from chemicals are generally divided into two categories: threshold (i.e., non-carcinogenic) and non-threshold (i.e., carcinogenic) dose response relationships. Chemicals in the threshold and non-threshold dose response relationships are evaluated differently. Therefore, when selecting the human receptors for assessment, the category of COPCs was considered.

Both adults (older than 19 years of age) and toddlers (six months to four years of age) were evaluated for their susceptibility to threshold chemicals. Toddlers are generally considered the most susceptible life stage for threshold chemicals because of their higher relative ingestion rates per unit body weight and their rapid absorption during this important growth period, compared to adults. When assessing the risk from intake of methylmercury in fish, shellfish, and ringed seal an additional sensitive receptor group (women of childbearing age) was also considered

For carcinogenic risk, all life stages are susceptible. However, adults are used to evaluate carcinogenic risk because this is calculated over an adult lifespan, as recommended by Health Canada (2010a, 2010c).

Using the results of the exposure and TRV assessments, human health risks from the consumption of country foods were quantified using exposure ratios (ER). The ER is the ratio between the EDI and the TDI and provides a measure of the risk associated with exposure to a COPC through the consumption of country foods.

In addition, the RMWIs and ILCRs were calculated for each country food evaluated. The RMWIs were compared to current weekly consumption rates of the country foods.

6.2 ESTIMATION OF NON-CANCER RISK

Human health risk estimates were quantified using exposure ratios, and were calculated as:

$$\textit{Exposure Ratio (ER)} = \frac{\textit{Estimated Daily Intake (EDI)}}{\textit{Tolerable Daily Intake (TDI)}}$$

For non-carcinogenic metals, an exposure ratio (ER) of less than 0.2 represents exposure that does not pose a significant health risk to human receptors (Health Canada 2010a). Health Canada considers an ER value of 0.2 appropriate because only one exposure pathway is evaluated for human health and it is assumed that people are exposed to COPCs from multiple sources such as other food groups, soil, air, water, cigarette smoke, and cigarette second-hand smoke.

ER values greater than 0.2 do not necessarily indicate that adverse health effects will occur since the TRVs are conservative and protect human health based on the application of uncertainty factors. ERs are not a measure of the magnitude of risk; rather they are measures of level of concern (Tannenbaum, Johnson, and Bazar 2003). ER values of greater than 0.2 suggest potential risks that may require a more detailed evaluation. For instance, when evaluating country foods where the country food comprises the main component of the diet (e.g., caribou meat) an ER of 0.2 may be over protective because exposure from other food groups (e.g., berries) would be minimal; as along as the sum of all ERs from all pathways is less than 1 then the exposure is acceptable.

Table 6.2-1 presents the calculated ERs based on the predicted wildlife concentrations and measured fish, mussel, and berry concentrations. Calculated ERs for Arctic ground squirrel, ringed seal blubber, and berry (bog blueberry and bog cranberry) consumption were all below 0.2. Thus, the estimation of risk based on the predicted and measured metal tissue concentrations is acceptable for all human life stages and all meals evaluated for these country foods.

The ERs for (inorganic) mercury for toddlers and adults consuming caribou were above the threshold ratio of 0.2 (1.12 and 0.607, respectively). Other studies have found high levels of mercury in Canadian arctic caribou (Gamberg et al. 2005). The ERs for chromium and thallium for toddlers consuming caribou were also above 0.2 (0.344 and 0.338, respectively). Given the conservative nature of the risk estimate due to the assumptions and inputs into the model, the risk associated with consumption of caribou is likely over-estimated and it is unlikely that health effects will occur since the ERs are only slightly elevated over a highly protective benchmark. It is noted that there is uncertainty (see Uncertainty analysis in Section 7) with this risk level, and that this report examines country foods under baseline conditions, prior to initiation of the Project.

6.2.1 Recommended Maximum Weekly Intake

The RMWIs were calculated as described by Health Canada (Health Canada 2010a, 2010d, 2010c), using the following equation:

$$RMWI = \frac{(TRV \times BW \times 7)}{C_{food}}$$

where:

RMWI = recommended maximum weekly intake of food (kg/week)
TRV = toxicological reference value (mg/kg BW/day)
BW = receptor body weight (kg BW)
7 = days/week
C_{food} = mean metal concentration in food (mg/kg)

This equation was applied to each metal and receptor scenario (Appendix E). The metal that had the lowest RMWI for each receptor was selected as the overall RMWI for that receptor because the lowest metal-specific RMWI is the driver of potential risk. The RMWI was converted to the recommended maximum number of servings per week by dividing by the estimated serving size. Table 6.2-2 presents the RMWIs, as well as the recommended number of servings per week, that would be protective against potential effects to human health due to naturally-occurring metals present in the foods.

The majority of the recommended weekly number of servings were greater than the current consumption rates used in this report (Table 6.2-2) for the country foods evaluated. Toddler and adult recommended weekly number of servings for Arctic ground squirrel, Canada goose, Lake trout, bay mussel, ringed seal meat and blubber, and berries, as well as adults recommended weekly number of serving for caribou were greater than the estimated consumption rates (Table 6.2-2); therefore, local harvesters can continue to consume these foods at the amounts and frequencies used in this report that were assumed to reflect current consumption patterns.

The only exception was caribou recommended maximum weekly consumption for toddlers, which was slightly lower than the current assumed seven servings per week. Mercury was responsible for the lowest RMWI in caribou (Appendix E).

Table 6.2-1. Human Exposure Ratios Based on Predicted and Measured Tissue Concentrations

COPC	Caribou		Arctic Ground Squirrel		Canada Goose		Lake Trout		
	Toddler	Adult	Toddler	Adult	Toddler	Adult	Toddler	Adult (General Public)	Adult (Women of Childbearing Age)[1]
Aluminum	0.0395	0.0214	<0.0001	<0.0001	0.00588	0.00319	0.000111	<0.0001	-
Arsenic	0.00159	0.000864	<0.0001	<0.0001	0.00372	0.000202	0.000993	0.000539	-
Cadmium	0.000622	0.000338	<0.0001	<0.0001	0.000494	0.000268	0.000227	0.000123	-
Chromium	**0.344**	0.187	<0.0001	<0.0001	0.00494	0.00268	0.00664	0.00326	-
Copper	0.0107	0.00379	<0.0001	<0.0001	0.000525	0.000184	0.000281	<0.0001	-
Lead	0.00303	0.00164	<0.0001	<0.0001	0.000828	0.000449	0.00116	0.000627	-
Mercury	**1.12**	**0.607**	<0.0001	<0.0001	<0.0001	<0.0001	0.0847	0.0225	0.0459
Nickel	0.030	0.0163	<0.0001	<0.0001	<0.0001	<0.0001	0.0000191	0.000104	-
Selenium	0.0240	0.00142	<0.0001	<0.0001	0.000770	0.000455	0.00547	0.00323	-
Thallium	**0.338**	0.183	<0.0001	<0.0001	0.00301	0.00163	0.00883	0.00479	-
Zinc	0.0755	0.00410	<0.0001	<0.0001	<0.0001	<0.0001	0.000642	0.000348	-

COPC	Bay Mussel			Ringed Seal Meat			Ringed Seal Blubber			Bog Blueberry & Bog Cranberry	
	Toddler	Adult (General Public)	Adult (Women of Childbearing Age)[1]	Toddler	Adult (General Public)	Adult (Women of Childbearing Age)[1]	Toddler	Adult (General Public)	Adult (Women of Childbearing Age)[1]	Toddler	Adult
Aluminum	0.000232	0.00126	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	0.000835	0.000453
Arsenic	0.0583	0.0316	-	0.00012	<0.0001	-	<0.0001	<0.0001	-	0.00183	0.000995
Cadmium	0.0215	0.0117	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	0.00217	0.00118
Chromium	0.00106	0.00326	-	0.000868	0.000471	-	<0.0001	<0.0001	-	0.00751	0.00408
Copper	0.000226	<0.0001	-	0.000128	<0.0001	-	<0.0001	<0.0001	-	0.00147	0.000516
Lead	0.000967	0.000525	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	0.000392	0.000213
Mercury	0.00110	0.000292	0.000596	0.182	0.0484	0.0989	0.00403	0.00107	0.00219	0.000252	0.000137
Nickel	0.000256	0.000139	-	<0.0001	<0.0001	-	<0.0001	<0.0001	-	0.00194	0.00105
Selenium	0.00166	0.000980	-	0.00305	0.00180	-	<0.0001	<0.0001	-	0.00228	0.00134
Thallium	0.000279	0.000152	-	0.00541	0.00294	-	0.000120	<0.0001	-	0.0101	0.00547
Zinc	0.000311	0.000169	-	0.00365	0.00198	-	<0.0001	<0.0001	-	0.00130	0.000703

COPC = Contaminant of Potential Concern
ER values above 0.2 are bold and shaded in gray.
[1] ERs for lake trout, mussels, and ringed seal meat and blubber are based on methylmercury concentrations rather than inorganic mercury (see Section 5.2.7). Therefore, a sensitive group of adult women of childbearing age were considered separately as a human receptor group for these country foods.

Table 6.2-2. Recommended Maximum Weekly Intake and Number of Servings of Country Food

Country Food	Human Receptor	Recommended Maximum Weekly Intake (kg/week)	Serving Size (kg/serving)	Recommended Maximum Weekly Number of Servings (servings/week)	Consumption Rate Used in this Assessment (servings/week)
Caribou	Toddler	0.726	0.116	6.3	7.0
	Adult	3.11	0.270	12	7.0
Arctic ground squirrel	Toddler	235	0.023	10,322	2.0
	Adult	1,008	0.053	19,018	2.0
Canada goose	Toddler	1.38	0.085	16	0.096
	Adult	5.92	0.197	30	0.096
Lake trout[1]	Toddler	0.124	0.109	1.1	0.096
	Adult (general public)	1.08	0.254	4.3	0.096
	Adult (women of child bearing age)	0.530	0.254	2.1	0.096
Bay mussel[2]	Toddler	0.0553	0.0013	43	0.92
	Adult	0.237	0.0030	79	0.92
Ringed seal meat[1]	Toddler	0.890	0.103	8.6	1.6
	Adult (general public)	7.80	0.240	32	1.6
	Adult (women of child bearing age)	3.81	0.240	15.9	1.6
Ringed seal blubber[1]	Toddler	0.890	0.037	24	0.096
	Adult (general public)	7.80	0.087	90	0.096
	Adult (women of child bearing age)	3.81	0.087	44	0.096
Bog Blueberry and Bog Cranberry	Toddler	1.62	0.0056	289	2.9
	Adult	6.93	0.013	533	2.9

[1] Recommended Maximum Weekly Intake for lake trout, and ringed seal meat and blubber is based on the lowest RMWI due to methylmercury concentrations. Therefore, a sensitive group of adult women of childbearing age were considered separately as a human receptor group.
[2] Recommended Maximum Weekly Intake for mussels is based on the lowest RMWI due to cadmium. Therefore unlike lake trout and ringed seal, a sensitive group was not considered separately as a human receptor.
Shaded and bolded numbers are recommended maximum number of servings that are smaller than the consumption rate used in this report.

It is important to understand the assumptions used in calculation of the maximum recommended weekly number of servings of country foods. The maximum recommended weekly number of servings of country foods calculation is based on a series of conservative assumptions (e.g., assumptions inherent in modelling of tissue residues and bioavailablity of metals in the food, and use of literature values for consumption rates and serving sizes), and therefore is a conservative measure. In the case of caribou, it is also possible that the consumption rate has been overestimated since it was based on a sum of consumption of various tissues of caribou (e.g., meat, liver, etc.) reported by Nancarrow (2007); it is unlikely that the full serving size used in this assessment (116 g/day for toddlers, 270 g/day for adults) of caribou meat would be consumed on a daily basis. Generally, it is probable that the ER values, RMWIs, and maximum recommended weekly number of servings overestimate the true risk associated with the consumption of these country foods and this is discussed further in Chapter 7 (Uncertainty Analysis). To ensure a more accurate and reasonable estimate of non-carcinogenic risk to toddlers consuming caribou based on mercury, the conservative assumptions used in the calculation of the ER, RMWI, and recommended weekly number of servings were re-evaluated in the following section.

6.2.1.1 Re-evaluation of Assumptions Used in the Recommended Maximum Weekly Intake Calculations for Caribou by Toddlers

Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013b). Since the calculated maximum recommended weekly number of servings for toddlers based on mercury levels in caribou (6.3 servings per week) is below the consumption rate used in this assessment (7 servings per week), the data and assumptions used in the assessment were reconsidered to ensure that a more accurate estimate of the risk to toddler consumers is presented. This reassessment was conducted because, while it is important to identify true risks to human health, it is equally important to avoid creating unnecessary concern about the quality of country foods due to overestimation of the risk to consumers.

The recommended maximum weekly number of servings calculation is based on a several parameters that have the potential to be overestimated through the use of conservative assumptions: modelled tissue metal residues in the food, consumption frequency of caribou, and the serving size for toddlers consuming caribou.

To determine if the food chain model predicted mercury concentrations that are consistent with measured tissue metal residues in caribou, a literature search was conducted to locate studies in which caribou tissue mercury concentrations were measured in caribou from the Kitikmeot Region. The food chain model used in this country foods baseline screening level risk assessment predicted mercury concentrations in caribou to be 0.0478 mg/kg ww (Appendix B), and this was considered to be representative of the average mercury content in caribou. Based on a study by Tian et al. (2011) of toddler exposure to mercury through consumption of country foods in Nunavut, the mercury concentration measured in the caribou consumed by toddlers in Nunavut, including the Kitikmeot region, ranges from not detected (caribou fat) to 0.51 mg/kg ww (raw caribou kidneys). Mercury concentrations measured in caribou meat, tongue, stomach, and heart ranged between 0.01 to 0.07 mg/kg ww. Caribou liver concentrations were reported as 0.16 mg/kg ww in Nunavut. The mercury concentration in caribou predicted by the food chain model is within the range of reported mercury concentrations in Nunavut and represents a reasonable estimate of mercury levels that may be present in caribou consumed by Inuit toddlers from the region.

Another possible source of recommended maximum weekly number of servings underestimation could be the consumption frequency of caribou by toddlers. In this assessment, it was assumed that toddlers consume country at the same frequency of adults. For caribou, it was assumed that toddlers consumed caribou on a daily basis. This assumption was based on a study conducted by Nancarrow (2007), who had looked at consumption of caribou (cooked/fresh/frozen). To validate this assumption, Sabina staff communicated with a number of community advisory group members and Hunter and Trappers Organizations in the Bathurst Inlet area (Sabina, pers. comm.). Based on these communications, caribou consumption was reported to range from three times a week to every day, although it was noted that consumption of country foods by youth/teenagers was generally low. Therefore, the use of a daily consumption rate in this country foods baseline assessment was considered to be realistic for the highest consumer group, although this may still overestimate the consumption rate for toddlers.

Recommended maximum weekly number of servings could also be underestimated if the serving size used in the estimate is too large. Based on guidelines provided by Richardson (1997), toddler serving size was estimated to be 43% of the adult serving size. A toddler serving size of 116 g/serving was used based on 43% of the adult serving size of 270 g/serving (Nancarrow 2007). However, Tian et al. (2011) reported a toddler (aged 3 to 5 years) serving size of 31.14 g/serving of caribou meat, which was based on responses by 132 participants from Nunavut in a 24-hour recall survey who were asked about serving sizes of caribou meat consumed on the previous day (Tian et al. 2011). Based on the findings by Tian et al. (2011), the serving size used in the current assessment was too large and the toddler recommended maximum weekly number of caribou for toddlers based on mercury presented in Table 6.2-2 is most likely an underestimation. Therefore, recalculation of recommended maximum weekly number of servings for toddlers consuming caribou using the serving size provided by Tian et al. (2011) was done to provide a more realistic measure of potential risk to toddlers associated with consumption of caribou from within the country foods study area (Table 6.2-3).

Table 6.2-3. Re-calculated Recommended Maximum Weekly Intake and Number of Servings of Caribou for Toddlers

Country Food	Human Receptor	Exposure Ratio	Recommended Maximum Weekly Intake (kg/week)	Serving Size (kg/serving)	Recommended Maximum Weekly Number of Servings (servings/week)	Consumption Rate Used in this Assessment (servings/week)
Caribou	Toddler	0.0106	0.726	0.0311	23.3	7.0

Using the more realistic toddler serving size of 31.14 g/serving, the recalculated recommended maximum weekly number or servings due to consumption of caribou for toddlers was 23.3 servings per week, which is larger than the current number of servings used in this assessment (7 servings/week; Table 6.2-3). Therefore, toddlers are not expected to experience health risks related to consumption of caribou based on the consumption rates and frequencies used in this assessment.

6.3 ESTIMATION OF CANCER RISKS

Of the metals evaluated, only arsenic is considered carcinogenic through ingestion. Carcinogenic risks were estimated as an ILCR according to the following formula (Health Canada 2010a):

$$ILCR = Estimated\ Lifetime\ Daily\ Exposure\ in\ \left(\frac{mg}{\mathrm{kg}_{BW}day}\right) \times Oral\ Cancer\ Slope\ Factor\ in\ \left(\frac{mg}{\mathrm{kg}_{BW}day}\right)^{-1}$$

The oral slope factor for arsenic cancer risk is 1.8 $(\text{mg/kg BW/day})^{-1}$ as described by Health Canada (2010b). The following equation was used to calculate the estimated lifetime daily exposure (ELDE; Health Canada 2010a):

$$ELDE_{country\ food} = \frac{IR \times F_s \times C_{country\ food} \times P_{as} \times YE}{BW \times LE}$$

Where:

$ELDE_{country\ food}$	= estimated lifetime daily exposure of country food (mg COPC/kg BW/day)
IR	= ingestion rate (kg/day)
F_s	= fraction of year consuming country food (unitless)
$C_{country\ food}$	= concentration of COPC in country food (mg/kg)
P_{as}	= proportion of inorganic arsenic relative to total arsenic concentration
YE	= years exposed (yr)
BW	= body weight (kg BW)
LE	= life expectancy (yr)

For the ELDE, measured and predicted arsenic concentrations in tissue were used in the exposure calculations and results are presented in Table 6.3-1. Appendix D provides a sample calculation for the ELDE for an adult consuming lake trout. An ILCR estimate that is less than $1{\times}10^{-5}$ is normally considered acceptable (Health Canada 2010a).

Table 6.3-1. Estimated Daily Lifetime Exposure and Incremental Lifetime Cancer Risk for Human Receptors Exposed to Arsenic in Country Foods

Country food	ELDE (mg/kg BW/day)	ILCR (unitless)
Caribou	2.50×10^{-7}	4.67×10^{-7}
Arctic ground squirrel	3.89×10^{-11}	7.00×10^{-11}
Canada goose	6.06×10^{-8}	1.09×10^{-7}
Lake trout	1.62×10^{-7}	2.91×10^{-7}
Bay mussel	9.49×10^{-8}	1.71×10^{-7}
Ringed seal muscle	1.90×10^{-8}	3.41×10^{-8}
Ringed seal blubber	4.19×10^{-10}	7.55×10^{-10}
Berries	2.99×10^{-7}	5.38×10^{-7}

ILCR = incremental lifetime cancer risk
ELDE = estimated lifetime daily exposure
The oral slope factor for arsenic is 1.8 $(mg/kg\ BW/day)^{-1}$ (Health Canada 2010b)
An ILCR of less than 1×10^{-5} is considered acceptable (Health Canada 2010a)

The results of the ILCR calculation from exposure to inorganic arsenic in country foods are presented in Table 6.3-1. The calculated ILCRs for arsenic from caribou, Arctic ground squirrel, Canada goose, lake trout, bay mussels, ringed seal, and berry consumption were less than $1{\times}10^{-5}$, the acceptable risk level. These country foods can be considered safe for consumption at the assumed local consumption rates and the foods do not pose a significant elevated cancer risk. Uncertainties associated with this risk estimate are discussed in Chapter 7 (Uncertainty Analysis).

7. Uncertainty Analysis

7. Uncertainty Analysis

7.1 INTRODUCTION

The process of evaluating human health risks from exposure to environmental media involves multiple steps, each containing inherent uncertainties that ultimately affect the final risk estimates. These uncertainties exist in numerous areas, including the collection of samples, laboratory analysis, estimation of potential exposures, and derivation of toxicity reference values, potentially resulting in either an over- or under-estimation of risk. However, for the present study, where uncertainties existed, an appropriate conservative approach was taken to overestimate rather than underestimate potential risks.

Some of the uncertainties have been mentioned in the preceding report sections. The following uncertainty analysis is a qualitative discussion of the key sources of uncertainty in this study. There may be sources of uncertainty other than those evaluated here; however, their effect on the estimated risks and RMWIs are considered to be less significant.

7.2 CONTAMINANTS OF POTENTIAL CONCERN

The COPCs selected for this assessment were metals due to the proposed development of gold deposits. As metals naturally occur in environmental media (i.e., soil, water, and plant and animal tissue), there is a high probability that all relevant metals have been selected as COPCs and subsequently assessed in baseline studies. However, there exists a possibility that other COPCs (other metals, organic chemicals, etc.) may be associated with the Project operations, but do not occur under baseline conditions. Any such COPCs that are identified would be evaluated as part of future Project monitoring and mitigation measures.

7.3 TISSUE CONCENTRATIONS

There are some uncertainties associated with the tissue concentrations used in this assessment. A description of these uncertainties is provided for wildlife, aquatic species, and plants.

7.3.1 Terrestrial Wildlife Species

Concentrations in the tissue of caribou, Arctic ground squirrel, and Canada goose were predicted using an uptake food chain model. As with all modelled data, the results are highly dependent on the accuracy of literature-based input parameters and the quality of the model itself. However, standard guidance and models have been used and clearly described throughout this report and appendices.

The main uncertainty in the employed model was the biotransfer factors (BTFs) used. For all animal exposure routes, BTFs from food-to-tissue were used. However, it is unlikely that the BTFs from soil-to-tissue and water-to-tissue are the same as food-to-tissue. In addition, the caribou and Arctic ground squirrel BTFs were based on values for beef, as BTFs are not available specifically for caribou and Arctic ground squirrels. Similarly, values for the Canada goose were based on available avian species, which was the domesticated chicken (*Gallus gallus domesticus*). Notwithstanding, this method is the accepted method to model the uptake of COPCs into animals when empirical data are not available or samples sizes are too small to make conclusions about population tissue concentrations (Golder and Associates 2005; Health Canada 2010d).

Other uncertainties associated with the predicted animal tissue concentrations include the assumption that the diet of caribou is only composed of 90% lichens, and 10% water sedge and berries combined, that Arctic ground squirrel only consume an even mix of water sedge and berries, while Canada goose consume an even mix of lichens, water sedge, and berries that were collected in the field. Although selected for their prevalence, the lichen, sedges, and berries may not have been representative of the actual foods consumed by the evaluated terrestrial mammals and birds. For instance, geese feed on grass seeds and sprouts, and some aquatic vegetation and may prefer some food items over others. The Arctic ground squirrel eats a wide variety of plants including seeds, berries, willow leaves, mushrooms, grasses and flowers. However, the conservative nature of the food chain model is expected to provide adequate protection against these violations.

The predicted animal tissue concentrations were one of the largest sources of uncertainty in this assessment. Overall, empirical tissue data would be preferred as it could increase the certainty of the assessment for caribou, ground squirrel, and Canada goose.

The migratory nature of caribou and Canada geese introduces another level of uncertainty. Metals in their tissues were modelled; however, any measured increase in tissue metal concentrations would not necessarily be indicative of a Project effect. As both species utilize a wide area (caribou have ranges covering thousands of square kilometres and Canada geese extend as far as Mexico for winter feeding grounds), they consume food and water outside of the country foods study area. Therefore, increased metal loads could result from effects unrelated to the Project. Regardless, both species were included due to their importance in the Inuit diet. Therefore, any increase in measured metal concentrations would provide information to local people to reduce their consumption of these food sources. This would serve as a public health service rather than a Project monitoring tool. Use of localized plant (lichens, berries, others), animal (Arctic ground squirrels), and fish and shellfish species (lake trout and mussels) provide better monitoring tools for potential ecological (and human health) effects from the Project.

7.3.2 Aquatic Species

Lake trout tissue was collected from the George and Goose Properties in 2011 and 2012. The dataset available for lake trout (n = 49) is considered large enough to provide a good indication of the metal concentrations in these tissues in the country foods study area.

However, no tissue concentration data was available for marine mammals (such as seals), and thus human exposure to metals from the consumption of the ringed seal could only be predicted based on a food chain model. Marine mammals take up metals primarily thought ingestion (Wagemann and Stewart 1994) and flounders are a common prey item for seal (Rahman, Haseqawa, and Lim 2012). Therefore, the model assumed that starry flounder, which was sampled for tissue metal analysis for the nearby Bathurst Inlet Port and Road (BIPR) Project, constitute 100% of a ringed seal's diet. Metal concentrations in flounder tissue result from living in marine habitats as demersal (bottom feeding) fish. Flounders have high site fidelity and therefore are good indicators of local conditions. Although the starry flounder tissue metal data were collected from relatively close proximity to the proposed Project Marine Laydown Area.

However, the dataset for starry flounder tissue metal concentrations resulted from one year of data collection and is comparatively small (n = 15). The dataset may not provide an accurate estimate of metal concentrations in starry flounder tissues in the marine portion of the country foods study area. The data was collected in 2001 and therefore the starry flounder metal tissue concentrations may not be reflective of the more recent metal concentrations in these organisms. In addition, there have been changes in collection methods, analytical procedures, and detection limits for measuring metals in biota in more recent years. Therefore, there are uncertainties associated with the modelled ringed seal metal tissue concentrations.

Input parameters to the food chain model (i.e., quality and quantity of the seal diet, food ingestion rates, etc.) were obtained from the US EPA Wildlife Exposure Handbook (1993) for harbour seals and were assumed to be similar to ringed seals. Because there is no BTF available for COPCs in seals, the beef BTF was used for the model. However, it is unlikely that the BTFs from plant-to-tissue (in beef) are the same as fish-to-tissue (in seals) and there are no BTFs available for any marine mammals in the literature. These assumptions have significant uncertainties associated with them, similar to those discussed for the terrestrial food chain model. As a result, the modelled seal tissue COPC concentrations had a very high level of uncertainty.

Bay mussel tissues were collected from southern Bathurst Inlet in 2012. It was assumed that 1.29 and 3.00 grams of mussels were consumed by toddlers and adults, three times a week, during the summer season for four months. These assumptions have significant uncertainties since there is very little information available on the amount and frequency of consumption for mussels collected from southern Bathurst Inlet.

7.3.3 Plant Species

A total of 95 plant samples were collected from the country foods study area for analysis of tissue metal concentrations. It is felt that the number of species and samples (sedges, n = 30; berries, n = 25; lichen, n = 20) are a good representation of the plant species consumed by wildlife. Lichen, sedge, and berries data were used in the modeling of wildlife tissue concentrations while berries were assessed as country foods consumed (Appendix B). There is a high degree of variation in metal concentrations between the plant species, likely due to species-specific physiological characteristics. Therefore, it is important to collect different plant species and not rely on surrogates.

Plants are likely rarely harvested in the country foods study area by people due to the distance away from any community. The impact of vegetation, especially berries, on total consumed metals is likely to be insignificant compared to animal consumption.

7.3.4 Arsenic Speciation and Carcinogenicity

The percent of inorganic arsenic in caribou, Arctic ground squirrel, Canada goose, and berries were based on a food basket survey study conducted in the Unites States (Schoof et al. 1999). In this study, total and inorganic concentrations were measured in variety of food samples collected during October from various supermarkets, restaurants, and a hotel in two towns in Texas (Schoof et al. 1999). There may be uncertainty introduced by extrapolating the finding of this study to this assessment due to intra- and interspecies variation in arsenic speciation, since the foods items included in the food basket survey did not include caribou, Arctic ground squirrel, Canada goose, berries. Instead, the beef ratio of inorganic to total arsenic concentrations was applied for caribou and Arctic ground squirrel, while chicken ratios were used for Canada goose.

The food basket survey study did not include any berries; however, it included a variety of fruits and fruit juices, such as raw apple, apple juice, banana, grapes, grape juice, orange, orange juice, peaches, and watermelon (Schoof et al. 1999). An average of proportion of inorganic to total arsenic concentrations for fruits and fruit juices were used to represent the proportion of inorganic to total arsenic concentrations in berries. Therefore, there is uncertainty associated with the percentage of inorganic arsenic concentrations in berries used in this assessment.

The largest uncertainties associated with the risk assessment of arsenic carcinogenicity to human health are the uncertainty in the cancer slope factor, local consumption patterns, and spatial boundaries. The cancer slope factor was used to estimate an upper-bound probability of an individual developing cancer from a lifetime of exposure to a particular level of arsenic. Upper-bound estimates conservatively exaggerate the risk to ensure that the risk is not underestimated if the underlying model is incorrect. The slope factor is based on one affected population in Taiwan concerning non-fatal skin cancer incidence, age, and level of exposure to arsenic via drinking water (not food). The confidence in the oral slope factor is low. Animal studies have not associated arsenic exposure via ingestion with cancer, the mechanism of action in causing human cancers is not known, and studies on mutagenicity are inconclusive (US EPA 2000b).

7.3.5 Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) methodologies were followed during the sampling of the soil, water, vegetation, fish, and metal tissues. All persons collecting the tissue samples were trained on appropriate tissue sampling techniques. This minimized the potential for cross-contamination and ensured that the sample sizes were adequate for chemical analyses. Additional details on the QA/QC of the environmental media sampling are presented in the respective soil, vegetation, freshwater, marine, and fish baseline reports.

All chemistry samples were analyzed by ALS Environmental in Burnaby, BC. ALS is certified by the Canadian Association of Environmental Analytical Laboratories. Chain of custody forms were completed and transported with all water, soil, and tissue samples that were sent to ALS.

7.4 LOCATIONS OF COUNTRY FOODS HARVESTED

For all of the country foods evaluated, it was assumed that 100% of the country foods consumed by people each year came from the country foods study area. This was an overestimate given the vast area available for harvesting and the distance from the communities to the study area. This overestimation provides additional conservatism in the risk predictions.

7.5 CONSUMPTION AMOUNTS AND FREQUENCY

Human receptor consumption characteristics are based on studies of the Inuit (Innis, Kuhnlein, and Kinloch 1988; Coad 1994; Nancarrow 2007; Egeland 2010), as well as general human characteristics outlined by Health Canada (Health Canada 2010a, 2010c). Responses to food consumption surveys are known to vary considerably depending on when foods are assessed. For example, blueberry harvesting occurs during the short summer months. A 24-hour recall interview in the summer, during blueberry harvesting could yield higher reported consumption frequencies compared to the same interview during winter months.

Uncertainties also exist for foods such as Arctic ground squirrel, starry flounder, and lake trout, which may be available through the year, but not harvested as often. The consumption frequencies were estimated based on the migration patterns of some of these animals and likely availability of the food within the country foods study area and best professional judgement. For example, Canada goose is unavailable through the year and migrates into the area in the summer only. Shellfish are only available during the ice-free season. Accurate reporting would be dependent on the ability of an individual to recollect past consumption patterns.

Literature data (Innis, Kuhnlein, and Kinloch 1988; Coad 1994; Nancarrow 2007; Egeland 2010) were used for the exposure calculations. Where more than one consumption estimate was available, the higher and therefore more conservative estimate was used. Higher estimates probably occur due to intrinsic methodological differences between studies. Harvest studies (likely consumed weight equals the harvested weight minus the assumed weight of waste, bait, dog food) often over-estimate the consumption rates when compared to a 24-hour recall surveys. Harvest studies conducted in different regions among Inuit communities indicate that the apparent country food consumption pattern and consumption rates vary considerably on regional basis (Coad 1994). Therefore, consumption rates for the Kitikmeot region provided by Coad (1994) and Nancarow (2007) were used as highly conservative and region-specific estimate of country food intake rates, but may not represent actual intake rates for the assessed species. Overall, food consumption surveys often lead to overestimation of actual intake (Institute for Risk Research 1999). Therefore, any uncertainties associated with consumption quantities and frequencies provide conservatism in the risk evaluation and RMWIs.

Consumption of organ meat was not explicitly taken into account in the country foods food chain model; however, the frequency of consumption of muscle meat was increased to account for organ consumption for caribou in particular. Considering that muscle meat usually has lower concentrations of metals compared to organs like the kidney and liver (Wren 1986; Świergosz et al. 1993; Jarzyńska and Falandysz 2011), the food chain model may somewhat underestimate metal exposure from meat consumption. However, the food chain model was very conservative and the inflated consumption rate for muscle meat likely resolved this issue.

Generally, older individuals have a higher consumption rate of traditional country foods (Kuhnlein and Receveur 2001). It is recognized that younger generations of Inuit are more urbanized and rely less on country foods, therefore, these consumption rates are likely to overestimate the true consumption for toddlers and younger adults (18 to 40 years old). No data was collected on the serving sizes of toddlers; it was assumed that a toddler would eat the country foods at the same frequency as adults, with a serving size of 43% of the adult serving size, as described by Richardson (1997). It is anticipated that this assumption overestimates the actual toddler serving size. Interviews with local consumers about consumption frequencies and portion sizes of these country foods is preferred and would reduce the uncertainties associated with these values.

Related to the uncertainty surrounding consumption frequency, the ERs for the eight country foods were not summed together to represent total health risk to individuals. This would have been an overly conservative measure since the consumption frequencies were already considered inflated.

7.6 TOXICITY REFERENCE VALUES

There is uncertainty associated with estimating toxicity benchmarks by extrapolating potential effects on humans from animal studies in the laboratory. Thus, for human health risk assessments, it is a standard practice to assume that people are more sensitive to the toxic effects of a substance than laboratory animals. Therefore, the toxicity benchmarks for human health are set at much lower levels than the animal benchmarks (typically 100 to 1,000 times lower). This large margin ensures that doses less than the toxicity benchmarks are safe and that minor exceedance of these benchmarks are unlikely to cause adverse health effects.

The TRVs are derived for individual contaminants. However, it is recognized that multiple chemicals may be present within a food item and interactions between compounds may result in additivity (overall effect is the sum of the individual effects), antagonism (overall effect less than the sum of the individual effects), synergism (overall effect is greater than the sum of the individual effects), or potentiation (presence of one chemical results in toxicity of another chemical that otherwise would have been safe). Many of these interactions are poorly understood or remain unknown by modern science. Furthermore, in natural systems numerous physical variables (e.g., media temperature, pH, salinity, hardness, etc.) can accelerate or impede these chemical interactions. Because of these environmental variables, as well as poorly understood interactions among different compounds, assessments were only conducted for the individuals COPC levels and not for overall health effects.

7.7 DEFINITION OF HEALTH

This country foods assessment is a science-based approach recommended by Health Canada to protect human receptors from adverse health effects caused by exposure to the selected COPCs (metals). Community health and well-being is being addressed as a separate baseline study for the Project (Rescan 2013b). However, it is recognized that health is defined by more than just physical well-being as social, cultural, nutritional, and economic factors also play a role in a person's overall health status.

8. Conclusions

8. Conclusions

This country foods baseline risk assessment integrated the results of the environmental media baseline data, human receptor characteristics, and regulatory-based TRVs. In total, the quality of seven country foods from seven different groups was estimated prior to development of the potential Project, and thus was reflective of baseline levels risk associated with country foods consumption. The country foods evaluated included: a large terrestrial mammal (caribou, *R. tarandus*), a small terrestrial mammal (Arctic ground squirrel, *S. parryii*), a bird species (Canada goose, *B. canadensis*), a fish species (lake trout, *S. namaycush*), a shellfish species (bay mussel, *M. trossulus*), a marine mammal (ringed seal, *P. hispida),* and berries (bog cranberry, *V. vitis-idaea* and bog blueberry, *V. uliginosum* combined).

A calculated Incremental Lifetime Cancer Risk (ILCR) below 1×10^{-5} is considered acceptable for metals that are potentially carcinogenic. The only carcinogenic metal in this assessment was arsenic. The Recommended Maximum Weekly Intakes (RMWIs) were calculated for non-carcinogenic effects from metal exposure and are representative of the highest intake rates of country foods that are safe for consumption at an acceptable risk level. Based on calculated ILCRs and RMWIs, caribou, Arctic ground squirrels, Canada geese, lake trout, ringed seals (both muscle and blubber tissue), bay mussels, and berries (bog blueberry and bog cranberry) were shown to not present health risks from metals to local human consumers. People in the area can continue to eat these foods at the consumption rates used in this report.

The duration for which the animals were assumed to be present within the country foods study area, consumption frequencies of country foods, and portion size of country foods consumed were conservative in nature. In addition, the highest measured or modelled country food tissue metal concentration was used in the calculation of RMWIs and ILCRs. Therefore, the current assessment provides a conservative measure of risk and may overestimate the true risk and the level of concern associated with the consumption of these country foods in most cases.

References

References

Adriano, D. C. 2001. *Trace Elements in terrestrial environments: biogeochemistry, bioavailability, and risk of metals*. Second ed ed. New York: Springer-Verlag.

Cambridge Bay Hunter focus Group. 2012. *Hunter, Trapper Focus Group, Cambridge Bay, December 30, 2012*. Rescan: Cambridge Bay, Nunavut.

CCME. 2012a. *Canadian Sediment Quality Guidelines for Protection of Aquatic Life: Summary Table*. Environment Canada. Canadian Council of Ministers of the Environment. http://ceqg-rcqe.ccme.ca (accessed December 2012).

CCME. 2012b. *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (Agricultral Land): Summary Table*. Environment Canada. Canadian Council of Ministers of the Environment. http://ceqg-rcqe.ccme.ca (accessed December 2012).

CCME. 2012c. *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (residential/parkland): Summary Table*. Environment Canada. Canadian Council of Ministers of the Environment. http://ceqg-rcqe.ccme.ca (accessed December 2012).

CCME. 2012d. *Canadian Water Quality Guidelines for Protection of Aquatic Life: Summary Table*. Environment Canada. Canadian Council of Ministers of the Environment. http://ceqg-rcqe.ccme.ca (accessed December 2012).

Chan, H. M. and A. Ing. 1998. A database for environmental contaminants in traditional food in northern Canada. *International Journal of Circumpolar Health*, 57 (Suppl. 1): 567-71.

Coad, S. 1994. *Consumption of Fish and Wildlife by Canadian Native Peoples: A Quantitative Assessment from the Published and Unpublished Literature*. Contract Report prepared for the Hazardous Waste Section, Environmental Health Directorate, Health and Welfare Canada:

Egeland, G. M. 2010. *Inuit Health Survey 2007-2008: Nunavut. International Polar Year Inuit Health Survey: Health in Transition and Resiliency*. McGill School of Environment: Anne de Bellevue, Quebec.

Fleming, S. and F. Ursitti. 1994. *Scientific criteria document for multimedia environmental standards development — lead*. Standards Development Branch, Ontario Ministry of the Environment and Energy: Toronto, Ontario.

Ford, J. and L. Hasselbach. 2001. *Heavy metals in mosses and soils on six transects along the Red Dog Mine haul road*. http://dec.alaska.gov/spar/csp/docs/reddog/reddogrpt2.pdf (accessed March 2013).

Gamberg, M., B. Braune, E. Davey, B. Elkin, P. F. Hoekstra, D. Kennedy, C. Macdonald, D. Muir, A. Nirwal, M. Wayland, and B. Zeeb. 2005. Spatial and temporal trends of contaminants in terrestrial biota from the Canadian arctic. *Science of the Total Environment*, 351-352: 148-64.

Gartner Lee Limited. 2008. *Field Report - Back River Project: Freshwater Aquatic Resources 2007*. GLL 71707, 72709, 72712. Dundee Precious Metals Inc: Toronto, On.

Golder and Associates. 2005. *Guidance Document for Country Foods Surveys for the Purpose of Human Health Risk Assessment*. Prepared for Health Canada.

Golder and Associates. 2007. *Back River Project: Environmental Baseline Studies, September 2006*. Prepared for Dundee Precious Metals Inc. by Golder Associates LTD: Edmonton, AB.

Health Canada. 2003. *Toxic substances in the Arctic and associated effects – human health. Northern contaminants program. Northern contaminants program. Canadian Arctic contaminants assessment report II*. Health Canada: Ottawa, ON.

Health Canada. 2007. *Human health risk assessment of mercury in fish and health benefits of fish consumption*. November 20, 2011. Bureau of Chemical Safety, Food Directorate, Health Products and Food Branch: Ottawa, ON.

Health Canada. 2010a. *Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0. Revised 2012.* Ottawa, ON.

Health Canada. 2010b. *Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0.* Health Canada: Ottawa, ON.

Health Canada. 2010c. *Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRA chem)*. Health Canada: Ottawa, ON.

Health Canada. 2010d. *Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRA foods)*. Health Canada: Ottawa, ON.

Health Canada. 2011. *Toxicological reference values, estimated daily intakes or dietary reference values for trace elements. Obtained from Chemical Health Hazard* Revised March 2011, unpublished: Ottawa, ON.

Heide-Jørgensen, M. P., B. S. Stewart, and S. Leatherwood. 1992. Satellite tracking of ringed seals Phoca hispida off northwest Greenland. *Ecography*, 15: 56-61.

Herrman, J. and M. Younes. 1999. Background to the ADI/TDI/PTWI. *Regul Toxicol Pharmacol*, 30: S109-S13.

INAC. 2003. *Nutrition and Food Security in Kugaaruk, Nunavut Baseline Survey for the Food Mail Pilot Project*. Indian and Northern Affairs Canada: Ottawa, ON.

Innis, S. M., H. V. Kuhnlein, and D. Kinloch. 1988. The composition of red cell membrane phospholipids in Canadian Inuit consuming a diet high in marine mammals. *Lipids*, 23: 1064-68.

Institute for Risk Research. 1999. Country Foods: Benefits and Risks, A Resource Document for Nunavut and Labrador. In Waterloo, Ontario.

Intrinsik. 2010. *Evaluation of exposure potential from ore dusting events in selected VECS: Caribou and blueberry*. Prepared for Baffin Island Mines Corporation by Intrinsik Environmental Sciences Inc.: Halifax, NS.

Ivankovic, S. and R. Preussman. 1975. Absence of toxic and carcinogenic effects after administration of high doses of chromic oxide pigment in subacute and long-term feeding experiments in rats. *Food Cosmet Toxicol*, 13 (3): 347-51.

Jarzyńska, G. and J. Falandysz. 2011. Selenium and 17 other largely essential and toxic metals in muscle and organ meats of Red Deer (Cervus elaphus) — Consequences to human health. *Environment International*, 37 (5): 882-88.

JECFA. 1972a. *Cadmium*. Joint FAO/WHO Expert Committee on Food Additives (JECFA). http://www.inchem.org/documents/jecfa/jecmono/v004je04.htm (accessed March 2013).

JECFA. 1972b. *Cadmium*. Presented at Joint FAO/WHO Expert Committee on Food Additives (JECFA),

JECFA. 1982a. *Zinc*. Joint FAO/WHO Expert Committee on Food Additives (JECFA). http://www.inchem.org/documents/jecfa/jeceval/jec_2411.htm (accessed March 2013).

JECFA. 1982b. *Zinc*. Presented at Joint FAO/WHO Expert Committee on Food Additives (JECFA),

JECFA. 2000a. *Lead*. Joint FAO/WHO Expert Committee on Food Additives (JECFA). http://www.inchem.org/documents/jecfa/jecmono/v44jec12.htm (accessed January 2013).

JECFA. 2000b. *Lead. In: Safety Evaluation of Certain Food Additives and Contaminants.* Prepared by the Fifty-third meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA). http://www.inchem.org/documents/jecfa/jecmono/v44jec12.htm (accessed March 2013).

JECFA. 2005. *Cadmium. In: Summary of Evaluations Performed by the Join FAO/WHO Expert Committe on Food Additives.* Joint FAO/WHO Expert Committee on Food Additives (JECFA). http://www.inchem.org/documents/jecfa/jeceval/jec_297.htm (accessed March 2013).

JECFA. 2007. *Aluminum. In: Safety evaluation of certain food additives.* Prepared by the sixty-seventh meeting of the Joint FAO/WHO Expert Committee on Food Additives (JEFCA). (accessed March 2013).

JECFA. 2010. *Arsenic.* Joint FAO/WHO Expert Committee on Food Additives (JECFA). http://apps.who.int/ipsc/database/evaluations/chemical.aspx?chemID=1863 (accessed March 2013).

JECFA. 2011. *Safety evaluation of certain food additives and contaminants.* Prepared by the seventy-third meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA). (accessed March 2013).

Jens, J. S., E. H. Larsen, and K. Julshamn. 2005. Survey of Inorganic Arsenic in Marine Animals and Marine Certified Reference Materials by Anion Exchange High-Performance Liquid Chromatography-Inductively Coupled Plasma Mass Spectrometry. *Journal of Agricultural and Food Chemistry,* 53: 6011-18.

Kapel, F. O., J. , J. Christiansen, M. P. Heide-Jørgensen, T. Härkönen, E. W. Born, L. O. Knutsen, F. Riget, and J. Teilmann. 1998. *Netting and conventional tagging used to study movements of ringed seals (Phoca hispida) in Greenland.* NAMMCO Scientific Publications, Vol. 1. N. Atl. Mar. Mamm. Comm: Tromsø, Norway.

Kelly, B. P., O. H. Badajos, M. Kunnasranta, J. R. Moran, M. Martinez-Bakker, D. Warkzok, and P. Boveng. 2010. Seasonal home ranges and fidelity to breeding sites among ringed seals. *Polar Biology,* 33: 1095-109.

Kerger, B. D., D. H. Paustenbach, G. E. Corbetter, and B. L. Finely. 1996. Absorption and elimination of trivalent and hexavalent chromium in humans following ingestion of a bolus dose in drinking water. *Toxicol Appl Pharmacol*, 141: 145–58.

KIA. 2012. *Inuit Traditional Knowlege of Sabina Gold and Silver Corporation's Back River (Hannigayok) Project* . Kitikmeot Inuit Association: Kugluktuk, Nunavut. December 7 2012.

Kugluktuk Hunter Focus Group. 2012. *Hunter, Trapper Focus Group, Kuglukuk November 27, 2012.* Rescan: Kugluktuk, Nunavut.

Kuhnlein, H. V., H. M. Chan, D. Leggee, and V. Barthet. 2002. Macronutrient, mineral and fatty acid composition of Canadian Arctic traditional foods. *Journal of Food Composition and Analysis* 15: 5445-566.

Kuhnlein, H. V. and O. Receveur. 2001. *Personal Cmmunication.* Center for Indigenous People's Nutrition and Environmnet (CINE): ste-Anne-deBellevue, Quebec.

Leonard, A. and R. R. Lauwerys. 1980. Carcinogenicity and mutagenicity of chromium. *Mutat Res,* 76: 227–39.

MHBL. 2005. *Final environmental impact statement for Doris North Project.*

Nagpal, N. K. and K. Howell. 2001. *Water Quality Guidelines for Selenium. Technical Appendix. Water Protection Branch, Water, Lands, and Air Protection.* http://www.env.gov,bc.ca/wat/wq/BCguidelines/selenium/index.html#TopOfPage (accessed January 2013).

Nancarrow, T. L. 2007. Climiate Change Impacts on Dietary Nutrient Status of Inuit in Nanavut, Canada. Master of Science diss., School of Dietetics and Human Nutrition, McGill University.

Omingmaktok Hunter Focus Group. 2012. *Hunter, Trapper Focus Group, Omingmaktok/Bathurst Inlet, December 1, 2012*. Rescan: Cambridge Bay, Nunavut.

Pacific States Marine Fisheries Commission. 1996. http://www.psmfc.org/habitat/edu_flounder_fact.html (accessed July 2012).

Priest, H. and P. J. Usher. 2004. *Nunavut Wildlife Harvest Study. Final Report*. Prepared for Nunavut Wildlife Management Board (NWMB):

Rahman, M. A., H. Haseqawa, and R. P. Lim. 2012. Bioaccumulation, biotransformation and trophic transfer of arsenic in the aquatic food chain. *Environmental Research*, 116: 118-35.

Rescan. 2007. *Bathurst Inlet Port and Road Project: Draft Environmental Impact Statement*. Vancouver, British Columbia.

Rescan. 2010. *2010 Back River Project: 2010 Fish and Fish Habitat Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2011. *2010 Back River and Hackett River Projects: 2010 Caribou and Muskox Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2012a. *Back River Project: 2011 Fish and Fish Habitat Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. April 2012: Vancouver, British Columbia.

Rescan. 2012b. *Back River Project: 2011 Freshwater Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. June 2012: Vancouver, British Columbia.

Rescan. 2012c. *Back River Project: 2012 Fish and Fish Habitat Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. December 2012: Vancouver, British Columbia.

Rescan. 2012d. *Back River Project: 2012 Freshwater Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. 2013: Vancouver, British Columbia.

Rescan. 2012e. *Back River Project: Project Description*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. June 2012: Vancouver, British Columbia.

Rescan. 2012f. *Back River Project: Wildlife Baseline Report 2011*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2013a. *Back River Project: 2012 Marine Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. 2013: Vancouver, British Columbia.

Rescan. 2013b. *Back River Project: 2012 Socio-Economic and Land Use Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Rescan. 2013c. *Back River Project: 2012 Soil and Terrain Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Rescan. 2013d. *Back River Project: 2012 Vegetation and Wetlands Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Rescan. 2013e. *Back River Project: 2012 Wildlife Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Richardson, G. M. 1997. *Compendium for Canadian Human Exposure Factors for Risk Assessment*. Ottawa, ON: O'Conner Associates Environmental Inc.

Roy, P. and A. Saha. 2002. Metabolism and toxicity of arsenic: A human carcinogen. *Current Science*, 82 (1): 38-45.

Schoof, R. A., L. J. Yost, J. Eickhoff, E. A. Crecelius, D. W. Cragin, D. M. Meacher, and D. B. Menzel. 1999. A Marker Basket Survey of Inorganic Arsenic in Food. *Food and Chemical Toxicology*, 37: 839-46.

Shrivastava, R., R. K. Upreti, and U. C. Chaturvedi. 2003. Various cells of the immune system and intestine differ in their capacity to reduce hexavalent chromium. *FEMS Immunol Med Microbiol*, 38 (65–70):

Slejkovec, Z., Z. Bajc, and D. Z. Doganoc. 2004. Arsenic speciation patterns in freshwater fish. *Talanta*, 62 (5): 931–36.

Solomon, G. M. and P. M. Weiss. 2002. Chemical Contaminants in Breast Milk: Time trends and regional variability. *Environmental Health Perspectives*, 110 (6): A339-A3347.

Statistics Canada. 2008. *Inuit Health, Education and Country Food Harvesting*. http://www.statcan.gc.ca/pub/89-637-x/89-637-x2008004-eng.pdf (accessed January 2012).

Świergosz, R., K. Perzanowski, U. Makosz, and I. Biłek. 1993. The incidence of heavy metals and other toxic elements in big game tissues. *Science of The Total Environment*, 1 (0): 225-31.

Tannenbaum, L. V., M. S. Johnson, and M. Bazar. 2003. Application of the hazard quotient method in remedial decisions: A comparison of human and ecological risk assessments. *Human and Ecological Risk Assessment*, 9 (1): 387-401.

Teilmann, J., E. W. Born, and M. Acquarone. 1999. Behaviour of ringed seals tagged with satellite transmitters in the North Water polynya during fast-ice formation. *Journal of Zoology*, 77: 1934-46.

Tenenbein, M. 2005. Unit-dose packaging of iron supplements and reduction of iron poisoning in young children. *Archives of Paediatrics, and Adolescent Medicine*, 159 (6): 557-60.

Thorpe, N. L. 2000. Contributions of Inuit ecological knowledge to understanding the impacts of climate change on the Bathurst caribou herd in the Kitikmeot region, Nunavut. Ph.D. diss., Simon Fraser University.

Tian, W., G. M. Egeland, I. Sobol, and H. M. Chan. 2011. Mercury hair concentrations and dietary exposure among Inuit preschool children in Nunavut, Canada. *Environment International*, 37: 42-48.

US EPA. 1993. Wildlife Exposure Factors Handbook.

US EPA. 1997. *Mercury Study Report to Congress. Vol. III: Fate and transport of mercury in the environment*.

US EPA. 2000a. *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 2: Risk Assessment and Fish Consumption Limits*. EPA 823-B00-008. US EPA: Washington, DC.

US EPA. 2000b. *Risk Assessment and Fish Consumption Limits*. In Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Washington, DC: Office of Science and Technology, Office of Water. (accessed December 2012).

US EPA. 2013. *Integrated Risk Information System (IRIS)*. US Environmental Protection Agency. http://www.epa.gov/IRIS/ (accessed May 2013).

Wagemann, R. and R. E. A. Stewart. 1994. Concentrations of heavy metals and selenium in tissues and some foods of walrus (Odobenus rosmarus rosmarus) from the eastern Canadian Arctic and sub-Arctic, and associations between metals, age, and gender. *Canadian Journal of Fisheries and Aquatic Sciences*, 50: 426-36.

Wagemann, R., E. Trebacz, G. Boila, and W. L. Lockhart. 1998. Methylmercury and Total Mercury in Tissues of Arctic Marine Mammals. *The Science of the Total Environment*, 218: 19-31.

WHO. 1991. *Environmental Health Criteria 108-Nickel*. http://www.inchem.org/documents/ehc/ehc/ehc108.htm#SectionNumber:4.2 (accessed March 2013).

WKRLUP. 2005. *West Kitikmeot Regional Land Use Plan: Preliminary Draft*. Nunavut Planning Commision: Cambridge Bay, UN.

Wren, D. C. 1986. A review of metal accumulation and toxicity in wild mammals: I. Mercury. *Environmental Research*, 40 (1): 210-44.

Appendix A

Measured Metal Concentrations in Environmental Media

Appendix A1. Summary of Metal Concentrations in Soil Samples Collected in 2012

Metals	George (n = 8)		Goose (n = 21)		Marine (n = 2)		All Sites (n=31)		CCME Guideline Limits	
	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Agricultural Criteria	Industrial Criteria
Aluminum	11,288	31,800	4,630	7,070	1,122	1,570	6,122	31,800	-	-
Antimony	0.120	0.520	0.050	0.050	0.050	0.050	0.0681	0.520	20	40
Arsenic	20.6	55.4	4.10	8.76	0.611	0.870	8.17	55.4	12	12
Barium	32.6	149.0	25.4	62.4	15.3	25.2	26.6	149	750	2,000
Beryllium	0.408	2.32	0.160	0.220	0.10	0.10	0.184	2.32	4	8
Bismuth	0.181	0.75	0.10	0.10	0.10	0.10	0.121	0.750	-	-
Cadmium	0.0394	0.112	0.0264	0.0540	0.0250	0.0250	0.0296	0.112	1.4	22
Calcium	1,515	4,070	1,563	2,290	122	144	1,458	4,070	-	-
Chromium	30.9	44.2	15.3	24.8	1.94	2.61	18.5	44.2	64	87
Cobalt	9.54	22.4	3.87	6.42	0.50	0.750	5.12	22.4	40	300
Copper	24.6	86.7	10.0	17.2	0.40	0.550	13.2	86.7	63	91
Iron	18,200	36,300	9,313	13,600	2,485	3,650	11,166	36,300	-	-
Lead	3.99	7.18	2.33	4.06	0.580	0.910	2.65	7.18	70	600
Lithium	19.7	39.4	7.76	12.2	2.50	2.50	10.5	39.4	-	-
Magnesium	6,413	14,300	2,784	4,620	395	535	3,566	14,300	-	-
Manganese	227	696	75.0	125	17.1	28.5	110	696	-	-
Mercury	0.0210	0.0553	0.00532	0.0278	0.00410	0.00570	0.00917	0.0553	6.6	50
Molybdenum	0.445	0.70	0.250	0.250	0.250	0.250	0.30	0.70	5	40
Nickel	23.6	47.5	9.98	15.7	0.910	1.30	12.9	47.5	50	50
Phosphorus	364	724	384	571	67.0	109	358	724	-	-
Potassium	1,005	5,290	427	730	370	520	572	5,290	-	-
Selenium	0.124	0.290	0.10	0.10	0.10	0.10	0.106	0.290	1	2.9
Silver	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	20	40
Sodium	50.0	50.0	83.8	180	50.0	50.0	72.9	180	-	-
Strontium	6.92	17.2	9.59	36.0	42.6	73.4	11.0	73.4	-	-
Thallium	0.0665	0.231	0.0280	0.0580	0.0250	0.0250	0.0377	0.231	1	1
Tin	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	5	300
Titanium	257	481	331	507	27.8	28.0	293	507	-	-
Uranium	0.850	3.06	0.40	0.826	0.205	0.276	0.503	3.06	23	300
Vanadium	24.4	38.2	21.7	39.0	2.58	3.36	21.2	39.0	130	130
Zinc	33.7	72.7	13.5	22.5	2.25	3.20	18.0	72.7	200	360

All values expressed in mg/kg dry weight.

Shaded values indicate an exceedance of the CCME guideline.

CCME = Canadian Council of Ministers of the Environment.

Appendix A2-1. Summary of Metal Concentrations in Water Samples collected from Lakes in 2010-2012

Lake	Samples	Collection Years	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron	
			Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum
Goose Area														
Gander Lake	2	2012	0.0230	0.0304	0.000547	0.000711	0.000019	0.000033	0.00030	0.00045	0.00231	0.00296	0.269	0.498
Chair Lake	2	2010	0.0114	0.0114	0.000150	0.000150	0.000005	0.000005	0.00025	0.00025	0.00155	0.00166	0.043	0.043
Mam Lake	1	2010	0.0152	0.0152	0.000150	0.000150	0.000005	0.000005	0.00025	0.00025	0.00164	0.00164	0.175	0.175
Pond 19	1	2012	0.0067	0.0067	0.000413	0.000413	0.000005	0.000005	0.00005	0.00005	0.00230	0.00230	0.063	0.063
Llama Lake	6	2010, 2011	0.0165	0.0273	0.000267	0.000318	0.000005	0.000005	0.00026	0.00072	0.00172	0.00286	0.024	0.041
Big Lake	2	2012	0.0194	0.0207	0.000406	0.000452	0.000005	0.000005	0.00021	0.00026	0.00183	0.00192	0.058	0.088
Fox Lake	2	2012	0.0084	0.0099	0.000287	0.000355	0.000005	0.000005	0.00012	0.00020	0.00135	0.00180	0.028	0.042
Echo Lake	1	2012	0.0353	0.0353	0.001560	0.001560	0.000005	0.000005	0.00031	0.00031	0.00252	0.00252	0.592	0.592
Umwelt Lake	3	2010, 2011	0.0132	0.0164	0.000361	0.000634	0.000007	0.000012	0.00067	0.00167	0.00262	0.00349	0.092	0.106
Rabbit Lake	1	2012	0.0149	0.0149	0.000227	0.000227	0.000005	0.000005	0.00011	0.00011	0.00313	0.00313	0.056	0.056
Rascal Lake	2	2012	0.0221	0.0248	0.000335	0.000468	0.000008	0.000010	0.00027	0.00038	0.00295	0.00298	0.133	0.202
Giraffe Lake	9	2011, 2012	0.0245	0.0325	0.000256	0.000370	0.000010	0.000018	0.00019	0.00037	0.00279	0.00407	0.039	0.050
Goose Lake	13	2011, 2012	0.0232	0.0703	0.000245	0.000326	0.000008	0.000015	0.00018	0.00030	0.00221	0.00402	0.032	0.062
Propellor Lake	8	2011, 2012	0.0122	0.0142	0.000152	0.000203	0.000006	0.000012	0.00022	0.00080	0.00112	0.00167	0.021	0.064
Reference B	5	2010, 2011	0.0079	0.0117	0.000152	0.000213	0.000005	0.000005	0.00015	0.00025	0.00093	0.00124	0.046	0.070
George Area														
Lower Long Lake	2	2012	0.0040	0.0046	0.000425	0.000436	0.000005	0.000005	0.00011	0.00016	0.00119	0.00131	0.013	0.018
Fold Lake	4	2012	0.0030	0.0043	0.000481	0.000531	0.000005	0.000005	0.00008	0.00013	0.00122	0.00136	0.012	0.018
George Lake	5	2012	0.0100	0.0140	0.000446	0.000499	0.000006	0.000008	0.00008	0.00013	0.00157	0.00200	0.016	0.037
Lytle Lake	1	2012	0.0093	0.0093	0.000514	0.000514	0.000005	0.000005	0.00005	0.00005	0.00231	0.00231	0.021	0.021
Occurrence Lake	1	2012	0.0328	0.0328	0.000653	0.000653	0.000011	0.000011	0.00015	0.00015	0.00313	0.00313	0.043	0.043
Sleigh Lake	1	2012	0.0117	0.0117	0.000588	0.000588	0.000005	0.000005	0.00011	0.00011	0.00236	0.00236	0.057	0.057
Dragon Lake	2	2012	0.0031	0.0047	0.000997	0.001140	0.000005	0.000005	0.00010	0.00014	0.00200	0.00244	0.020	0.035
Komatic Lake	4	2012	0.0064	0.0076	0.000853	0.000988	0.000007	0.000011	0.00010	0.00017	0.00253	0.00310	0.048	0.074
Overall Lake Water Quality														
All Lake Sites	78	2010, 2011, 2012	0.0153	0.0703	0.00036	0.00156	0.000007	0.000033	0.00019	0.00167	0.00195	0.00407	0.052	0.592
CCME Guideline for the Protection of Freshwater Aquatic Life[a]			0.005-0.1[b]		0.005		equation[c,d]		Cr(VI): 0.001 ; Cr(III): 0.0089[d]		0.002-0.004[e]		0.3	

Lake	Samples	Collection Years	Lead		Mercury		Nickel		Selenium		Thallium		Zinc	
			Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum
Goose Area														
Gander Lake	2	2012	0.000085	0.000144	0.000005	0.000005	0.01656	0.02780	0.00005	0.00005	0.00003	0.00003	0.00450	0.00750
Chair Lake	2	2010	0.000025	0.000025	0.000005	0.000005	0.00171	0.00171	0.00010	0.00010	0.00005	0.00005	0.00050	0.00050
Mam Lake	1	2010	0.000136	0.000136	0.000005	0.000005	0.00185	0.00185	0.00010	0.00010	0.00005	0.00005	0.00050	0.00050
Pond 19	1	2012	0.000025	0.000025	0.000005	0.000005	0.00594	0.00594	0.00005	0.00005	0.00003	0.00003	0.00150	0.00150
Llama Lake	6	2010, 2011	0.000070	0.000202	0.000005	0.000005	0.00247	0.00502	0.00007	0.00010	0.00004	0.00005	0.00158	0.00320
Big Lake	2	2012	0.000025	0.000025	0.000005	0.000005	0.00313	0.00467	0.00005	0.00005	0.00003	0.00003	0.00205	0.00260
Fox Lake	2	2012	0.002572	0.005106	0.000005	0.000005	0.00264	0.00417	0.00005	0.00005	0.00003	0.00003	0.00150	0.00150
Echo Lake	1	2012	0.000025	0.000025	0.000005	0.000005	0.00273	0.00273	0.00005	0.00005	0.00003	0.00003	0.00150	0.00150
Umwelt Lake	3	2010, 2011	0.000123	0.000219	0.000005	0.000005	0.00570	0.00828	0.00007	0.00010	0.00004	0.00005	0.00242	0.00335
Rabbit Lake	1	2012	0.000025	0.000025	0.000005	0.000005	0.00183	0.00183	0.00005	0.00005	0.00003	0.00003	0.00150	0.00150
Rascal Lake	2	2012	0.000435	0.000780	0.000005	0.000005	0.00589	0.01010	0.00005	0.00005	0.00003	0.00003	0.00360	0.00570
Giraffe Lake	9	2011, 2012	0.000074	0.000320	0.000005	0.000005	0.00911	0.01580	0.00005	0.00005	0.00003	0.00005	0.00303	0.00530
Goose Lake	13	2011, 2012	0.000139	0.000547	0.000005	0.000005	0.00512	0.00864	0.00005	0.00005	0.00003	0.00005	0.00219	0.00440
Propellor Lake	8	2011, 2012	0.000169	0.000573	0.000005	0.000005	0.00218	0.00254	0.00005	0.00005	0.00003	0.00005	0.00190	0.00390
Reference B	5	2010, 2011	0.000078	0.000199	0.000005	0.000005	0.00111	0.00164	0.00007	0.00010	0.00005	0.00005	0.00110	0.00150
George Area														
Lower Long Lake	2	2012	0.000025	0.000025	0.000005	0.000005	0.00048	0.00065	0.00005	0.00005	0.00003	0.00003	0.00150	0.00150
Fold Lake	4	2012	0.000346	0.000758	0.000005	0.000005	0.00154	0.00212	0.00005	0.00005	0.00003	0.00003	0.00216	0.00330
George Lake	5	2012	0.000570	0.001980	0.000005	0.000005	0.00440	0.00787	0.00005	0.00005	0.00003	0.00003	0.00423	0.00730
Lytle Lake	1	2012	0.000025	0.000025	0.000005	0.000005	0.00532	0.00532	0.00005	0.00005	0.00003	0.00003	0.00150	0.00150
Occurrence Lake	1	2012	0.000061	0.000061	0.000005	0.000005	0.00540	0.00540	0.00005	0.00005	0.00003	0.00003	0.00150	0.00150
Sleigh Lake	1	2012	0.000025	0.000025	0.000005	0.000005	0.00373	0.00373	0.00005	0.00005	0.00003	0.00003	0.00150	0.00150
Dragon Lake	2	2012	0.000180	0.000335	0.000005	0.000005	0.00288	0.00440	0.00005	0.00005	0.00003	0.00003	0.00245	0.00340
Komatic Lake	4	2012	0.000025	0.000025	0.000005	0.000005	0.00733	0.01170	0.00005	0.00005	0.00003	0.00003	0.00348	0.00550
Overall Lake Water Quality														
All Lake Sites	78	2010, 2011, 2012	0.000214	0.005106	0.000005	0.000005	0.00454	0.02780	0.000055	0.00010	0.00003	0.00005	0.00228	0.00750
CCME Guideline for the Protection of Freshwater Aquatic Life[a]			0.001-0.007[f]		Inorganic Mercury: 0.000026 Methylmercury: 0.000004[b]		0.025-0.150[g]		0.001		0.0008		0.03	

All concentrations are expressed in mg/L.

Shaded cells indicate values that exceed CCME guidelines.

[a] *Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment (CCME 2011).*

[b] *0.005 mg/L at pH <6.5; 0.1 mg/L at pH ≥ 6.5.*

[c] *Equation for correcting the guideline value for hardness = 10{0.86[log(hardness)] - 3.2} .*

[d] *Interim guideline.*

[e] *0.002 mg/L at [$CaCO_3$] = 0-120 mg/L; 0.003 mg/L at [$CaCO_3$] = 120-180 mg/L; 0.004 mg/L at [$CaCO_3$] = >180 mg/L.*

[f] *0.001 mg/L at [$CaCO_3$] = 0-60 mg/L; 0.002 mg/L at [$CaCO_3$] = 60-120 mg/L; 0.004 mg/L at [$CaCO_3$] = 120-180 mg/L; 0.007 mg/L at [$CaCO_3$] = >180 mg/L.*

[g] *0.025 mg/L at [$CaCO_3$] = 0-60 mg/L; 0.065 mg/L at [$CaCO_3$] = 60-120 mg/L; 0.110 mg/L at [$CaCO_3$] = 120-180 mg/L; 0.150 mg/L at [$CaCO_3$] = >180 mg/L.*

Appendix A2-2. Summary of Metal Concentrations in Water Samples Collected from Streams in 2011-2012

		Collection	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Lead		Mercury		Nickel		Selenium		Thallium		Zinc	
Stream	**Samples**	**Years**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**m**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**
Goose Area																										
Moby OF	6	2012	0.06525	0.0742	0.00034	0.000544	3.91667E-05	0.000064	0.00032833	0.00053	0.003495	0.0040	0.21783	0.391	4.2333E-05	0.000065	0.000005	0.000005	0.03683333	0.0568	0.00005	0.00005	0.00005	0.00005	0.01088333	0.018
Gander IF	6	2012	0.04478	0.06580	0.00040	0.00048	0.000010	0.000021	0.000303	0.000410	0.0020	0.0034	0.153	0.226	0.000073	0.000262	0.000005	0.000005	0.010103	0.018400	0.00005	0.00005	0.000025	0.000025	0.003733	0.008300
Gander US	6	2012	0.02667	0.05260	0.00038	0.00045	0.000005	0.000005	0.000232	0.000290	0.0016	0.0019	0.107	0.126	0.000025	0.000025	0.000005	0.000005	0.003828	0.005170	0.00005	0.00005	0.000025	0.000025	0.001917	0.004000
Pond 19 OF	6	2012	0.03452	0.04290	0.00041	0.00058	0.000012	0.000016	0.000283	0.000340	0.0030	0.0040	0.106	0.207	0.000025	0.000025	0.000005	0.000005	0.008245	0.009850	0.00005	0.00005	0.000025	0.000025	0.002483	0.003900
Chair OF	12	2011-2012	0.05524	0.11200	0.00074	0.00141	0.000006	0.000022	0.000325	0.000590	0.0019	0.0024	0.279	0.500	0.000035	0.000058	0.000005	0.000005	0.003500	0.004740	0.00005	0.00005	0.000029	0.000050	0.001800	0.003400
Llama OF	12	2011-2012	0.03309	0.06020	0.00020	0.00025	0.000117	0.000216	0.000187	0.000320	0.0020	0.0030	0.012	0.022	0.000025	0.000025	0.000005	0.000005	0.026053	0.047000	0.00005	0.00005	0.000029	0.000050	0.011992	0.023900
Echo OF	8	2011-2012	0.12410	0.16300	0.00033	0.00042	0.000032	0.000054	0.000551	0.000750	0.0022	0.0027	0.128	0.158	0.000025	0.000025	0.000005	0.000005	0.006258	0.008190	0.00005	0.00005	0.000031	0.000050	0.005700	0.008300
Giraffe OF	12	2011-2012	0.02408	0.03820	0.00020	0.00024	0.000006	0.000011	0.000162	0.000260	0.0020	0.0023	0.061	0.082	0.000028	0.000056	0.000005	0.000005	0.005408	0.008160	0.00005	0.00005	0.000029	0.000050	0.001500	0.001500
Wolf OF	12	2011-2012	0.01918	0.02810	0.00021	0.00026	0.000005	0.000005	0.000226	0.000360	0.0013	0.0015	0.136	0.228	0.000025	0.000025	0.000005	0.000005	0.002479	0.003100	0.00005	0.00005	0.000029	0.000050	0.001500	0.001500
Goose OF	12	2011-2012	0.01948	0.03520	0.00020	0.00023	0.000006	0.000014	0.000186	0.000320	0.0014	0.0016	0.072	0.167	0.000038	0.000134	0.000005	0.000005	0.003185	0.005350	0.00005	0.00005	0.000029	0.000050	0.001633	0.003100
Propellor OF	12	2011-2012	0.01156	0.02200	0.00017	0.00030	0.000005	0.000005	0.000155	0.000210	0.0011	0.0012	0.025	0.040	0.000025	0.000025	0.000005	0.000005	0.001992	0.003170	0.00005	0.00005	0.000029	0.000050	0.001500	0.001500
Propellor Downstream	6	2011	0.01442	0.02300	0.00015	0.00020	0.000005	0.000005	0.000167	0.000260	0.0012	0.0013	0.032	0.038	0.000025	0.000025	0.000005	0.000005	0.001385	0.001900	0.00005	0.00005	0.000033	0.000050	0.001500	0.001500
Reference B OF	12	2011-2012	0.03737	0.07490	0.00027	0.00048	0.000005	0.000005	0.000353	0.000710	0.0010	0.0018	0.674	2.040	0.000029	0.000053	0.000005	0.000005	0.001937	0.003370	0.00005	0.00005	0.000029	0.000050	0.001708	0.004000
George Area																										
George OF	6	2012	0.01755	0.02360	0.00048	0.00058	0.000011	0.000016	0.000143	0.000270	0.0018	0.0020	0.064	0.082	0.000025	0.000025	0.000005	0.000005	0.005862	0.008150	0.00005	0.00005	0.000025	0.000025	0.004033	0.005800
Sleigh OF	6	2012	0.02423	0.03830	0.00057	0.00077	0.000012	0.000021	0.000140	0.000200	0.0026	0.0029	0.077	0.089	0.000025	0.000025	0.000005	0.000005	0.006317	0.008890	0.00005	0.00005	0.000025	0.000025	0.003533	0.005400
Dragon OF	6	2012	0.00993	0.01430	0.00099	0.00138	0.000005	0.000005	0.000107	0.000200	0.0018	0.0018	0.070	0.109	0.000025	0.000025	0.000005	0.000005	0.003363	0.004630	0.00005	0.00005	0.000025	0.000025	0.002100	0.003400
Komatic IF	6	2012	0.04947	0.09360	0.00106	0.00146	0.000009	0.000019	0.000260	0.000340	0.0028	0.0032	0.178	0.283	0.000042	0.00008	0.000005	0.000005	0.008037	0.014600	0.00005	0.00005	0.000025	0.000025	0.003983	0.007500
Overall Lake Water Quality																										
All Stream Sites	146	2011-2012	0.03502	0.16300	0.00038	0.00146	0.000019	0.000216	0.000242	0.000750	0.0018	0.0040	0.152	2.040	0.000031	0.000262	0.000005	0.000005	0.007456	0.056800	0.00005	0.00005	0.000029	0.000050	0.003495	0.023900
CCME Guideline for the Protection of Freshwater Aquatic Life[a]			0.005-0.1[b]		0.005		0.000017[c,d]		Cr(VI): 0.001 Cr(III): 0.0089[d]		0.002-0.004[e]		0.3		0.001-0.007[f]		Inorganic Mercury: 0.000026 Methylmercury: 0.000004[d]		0.025-0.150[g]		0.001		0.0008		0.03	

All concentrations are expressed in mg/L.

Shaded cells indicate values that exceed CCME guidelines.

[a] *Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment (CCME 2011).*

[b] *0.005 mg/L at pH <6.5; 0.1 mg/L at pH ≥ 6.5.*

[c] *Equation for correcting the guideline value for hardness = 10{0.86[log(hardness)] - 3.2} .*

[d] *Interim guideline.*

[e] *0.002 mg/L at [$CaCO_3$] = 0-120 mg/L; 0.003 mg/L at [$CaCO_3$] = 120-180 mg/L; 0.004 mg/L at [$CaCO_3$] = >180 mg/L.*

[f] *0.001 mg/L at [$CaCO_3$] = 0-60 mg/L; 0.002 mg/L at [$CaCO_3$] = 60-120 mg/L; 0.004 mg/L at [$CaCO_3$] = 120-180 mg/L; 0.007 mg/L at [$CaCO_3$] = >180 mg/L.*

[g] *0.025 mg/L at [$CaCO_3$] = 0-60 mg/L; 0.065 mg/L at [$CaCO_3$] = 60-120 mg/L; 0.110 mg/L at [$CaCO_3$] = 120-180 mg/L; 0.150 mg/L at [$CaCO_3$] = >180 mg/L.*

Appendix A2-3. Summary of Metal Concentrations in Water Samples Collected from the Project Lakes and Streams in 2010-2012

Metal	Average	Maximum
Aluminum	0.0281	0.163
Arsenic	0.000372	0.00156
Cadmium	0.0000144	0.000216
Chromium	0.000225	0.00167
Copper	0.00188	0.00407
Iron	0.117	2.04
Lead	0.0000946	0.00511
Mercury	0.0000050	0.0000050
Nickel	0.00644	0.0568
Selenium	0.0000518	0.00010
Thallium	0.0000298	0.000050
Zinc	0.00307	0.0239

Notes:

Concentrations in mg/L based on average and maximum of total stream and lake concentrations from 2010 to 2012; n=224.

Appendix A2-4. Summary of Metal Concentrations in Water Samples Collected from Bathurst Inlet in 2012

Marine Location[a]	Number of Samples	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Lead		Mercury		Nickel		Selenium		Thallium		Zinc	
		Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum
BI-4-SF	1	0.00250	0.00250	0.0010	0.0010	0.0000250	0.0000250	0.000250	0.000250	0.00060	0.00060	0.0050	0.0050	0.000150	0.000150	0.0000050	0.0000050	0.000730	0.000730	0.0010	0.0010	0.0000250	0.0000250	0.00150	0.00150
BI-4-AP	2	0.00250	0.00250	0.0010	0.0010	0.0000395	0.0000540	0.000250	0.000250	0.000725	0.000810	0.0105	0.0160	0.000150	0.000150	0.0000050	0.0000050	0.00101	0.00111	0.0010	0.0010	0.0000250	0.0000250	0.00150	0.00150
BI-4-BP	1	0.00250	0.00250	0.0010	0.0010	0.0000250	0.0000250	0.000250	0.000250	0.000250	0.000250	0.0050	0.0050	0.000150	0.000150	0.0000050	0.0000050	0.000540	0.000540	0.0010	0.0010	0.0000250	0.0000250	0.00150	0.00150
BI-4-DP	1	0.00250	0.00250	0.0010	0.0010	0.0000860	0.0000860	0.000250	0.000250	0.000250	0.000250	0.0050	0.0050	0.000150	0.000150	0.0000050	0.0000050	0.000640	0.000640	0.0010	0.0010	0.0000250	0.0000250	0.00150	0.00150
06-10-SF	2	0.0490	0.0493	0.0010	0.0010	0.0000945	0.000120	0.000250	0.000250	0.00108	0.00126	0.0675	0.0720	0.000150	0.000150	0.0000050	0.0000050	0.001015	0.00104	0.0010	0.0010	0.0000250	0.0000250	0.00525	0.00540
06-20-SF	1	0.239	0.239	0.0010	0.0010	0.0000680	0.0000680	0.000860	0.000860	0.00132	0.00132	0.298	0.298	0.000150	0.000150	0.0000050	0.0000050	0.00136	0.00136	0.0010	0.0010	0.0000250	0.0000250	0.00540	0.00540
06-22-SF	1	0.187	0.187	0.0010	0.0010	0.0000250	0.0000250	0.000580	0.000580	0.00090	0.00090	0.185	0.185	0.000150	0.000150	0.0000050	0.0000050	0.00103	0.00103	0.0010	0.0010	0.0000250	0.0000250	0.00630	0.00630
06-24-AP	2	0.0965	0.098	0.0010	0.0010	0.0000710	0.0000740	0.000250	0.000250	0.000665	0.000680	0.116	0.118	0.000150	0.000150	0.0000050	0.0000050	0.000970	0.00104	0.0010	0.0010	0.0000250	0.0000250	0.00465	0.00540
06-24-BP	1	0.0225	0.0225	0.0010	0.0010	0.0000910	0.0000910	0.000250	0.000250	0.000530	0.000530	0.0450	0.0450	0.000150	0.000150	0.0000050	0.0000050	0.000830	0.000830	0.0010	0.0010	0.0000570	0.0000570	0.00550	0.00550
06-24-DP	1	0.0255	0.0255	0.0010	0.0010	0.000128	0.000128	0.000250	0.000250	0.00136	0.00136	0.0860	0.0860	0.000150	0.000150	0.0000050	0.0000050	0.00183	0.00183	0.0010	0.0010	0.0000250	0.0000250	0.00910	0.00910
06-24-SF	1	0.0798	0.0798	0.0010	0.0010	0.0000760	0.0000760	0.000250	0.000250	0.00080	0.00080	0.120	0.120	0.000150	0.000150	0.0000050	0.0000050	0.00105	0.00105	0.0010	0.0010	0.0000250	0.0000250	0.00430	0.00430
06-30-SF	1	0.0856	0.0856	0.0010	0.0010	0.0000640	0.0000640	0.000250	0.000250	0.000850	0.000850	0.109	0.109	0.000150	0.000150	0.0000050	0.0000050	0.00105	0.00105	0.0010	0.0010	0.0000250	0.0000250	0.00590	0.00590
06-32-SF	1	0.0218	0.0218	0.0010	0.0010	0.0000790	0.0000790	0.000250	0.000250	0.0010	0.0010	0.0230	0.0230	0.000150	0.000150	0.0000050	0.0000050	0.000930	0.000930	0.0010	0.0010	0.0000250	0.0000250	0.00630	0.00630
06-40-SF	1	0.0373	0.0373	0.0010	0.0010	0.000070	0.000070	0.000250	0.000250	0.00070	0.00070	0.040	0.040	0.000150	0.000150	0.0000050	0.0000050	0.000940	0.000940	0.0010	0.0010	0.0000250	0.0000250	0.00620	0.00620
06-42-SF	1	0.0167	0.0167	0.0010	0.0010	0.0000910	0.0000910	0.000250	0.000250	0.00131	0.00131	0.0270	0.0270	0.000150	0.000150	0.0000050	0.0000050	0.000910	0.000910	0.0010	0.0010	0.0000250	0.0000250	0.00560	0.00560
06-44-AP	1	0.00780	0.00780	0.0010	0.0010	0.0000750	0.0000750	0.000250	0.000250	0.000650	0.000650	0.0130	0.0130	0.000150	0.000150	0.0000050	0.0000050	0.00090	0.00090	0.0010	0.0010	0.0000250	0.0000250	0.00560	0.00560
06-44-DP	1	0.0203	0.0203	0.0010	0.0010	0.000132	0.000132	0.000250	0.000250	0.000780	0.000780	0.0330	0.0330	0.000150	0.000150	0.0000050	0.0000050	0.00116	0.00116	0.0010	0.0010	0.0000250	0.0000250	0.00910	0.00910
06-44-SF	1	0.0114	0.0114	0.0010	0.0010	0.0000660	0.0000660	0.000250	0.000250	0.000630	0.000630	0.0160	0.0160	0.000150	0.000150	0.0000050	0.0000050	0.000970	0.000970	0.0010	0.0010	0.0000250	0.0000250	0.00930	0.00930
06-50-SF	1	0.0990	0.0990	0.0010	0.0010	0.000050	0.000050	0.000250	0.000250	0.000590	0.000590	0.106	0.106	0.000150	0.000150	0.0000050	0.0000050	0.00090	0.00090	0.0010	0.0010	0.0000690	0.0000690	0.00150	0.00150
06-52-SF	2	0.0169	0.0228	0.0010	0.0010	0.0000250	0.0000250	0.000250	0.000250	0.000445	0.000640	0.0185	0.020	0.000150	0.000150	0.0000050	0.0000050	0.000820	0.000840	0.0010	0.0010	0.0000725	0.0000730	0.00150	0.00150
06-54-AP	1	0.0105	0.0105	0.0010	0.0010	0.0000680	0.0000680	0.000250	0.000250	0.00108	0.00108	0.0160	0.0160	0.000150	0.000150	0.0000050	0.0000050	0.000980	0.000980	0.0010	0.0010	0.0000570	0.0000570	0.00420	0.00420
06-54-BP	1	0.0172	0.0172	0.0010	0.0010	0.000128	0.000128	0.000630	0.000630	0.00124	0.00124	0.214	0.214	0.000330	0.000330	0.0000050	0.0000050	0.0010	0.0010	0.0010	0.0010	0.0000520	0.0000520	0.00410	0.00410
06-54-DP	1	0.00250	0.00250	0.0010	0.0010	0.000101	0.000101	0.000250	0.000250	0.000250	0.000250	0.0050	0.0050	0.000150	0.000150	0.0000050	0.0000050	0.00070	0.00070	0.0010	0.0010	0.0000250	0.0000250	0.00410	0.00410
06-54-SF	2	0.03115	0.0495	0.0010	0.0010	0.000060	0.0000650	0.000250	0.000250	0.000840	0.000850	0.0180	0.0190	0.000150	0.000150	0.0000050	0.0000050	0.00104	0.00116	0.0010	0.0010	0.0000575	0.0000610	0.00265	0.00380
Grand Total	29	0.0443	0.239	0.0010	0.0010	0.0000699	0.000132	0.000296	0.000860	0.00077897	0.00136	0.0624	0.298	0.000156	0.000330	0.0000050	0.0000050	0.00097103	0.00183	0.0010	0.0010	0.0000352	0.0000730	0.00442	0.00930
CCME Guideline [b]		-		0.01250[c]		0.00012		Cr(VI): 0.0015 Cr(III): 0.056[c]		-		-		-		0.000016[c,d]		-		-		-		-	

Notes:

All concentrations are expressed in mg/L.

Values below detection limits were replaced with half the detection limit to calculate the mean.

[a] *Data excludes winter samples obtained from Bathurst Inlet for conservative measures since the samples were taken far from the shore and none of the sample exceeded any of the available guidelines.*

[b] *Canadian Water quality guidelines for the projection of marine aquatic life, Canadian Council of Ministers of the Environment (CCME 2011).*

[c] *Interim guidelines.*

[d] *Guideline refers to inorganic mercury.*

Appendix A3-1. Summary of Metal Concentrations in Sediment Samples Collected from Lakes in 2010-2012

		Collection	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Lead		Mercury		Nickel		Selenium		Thallium		Zinc	
Lake	Samples	Years	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum
Goose Area																										
Gander Lake	3	2012	12,367	12,600	9.11	9.57	0.173	0.182	41.2	41.7	34.3	34.8	18,133	18,400	5.99	6.15	0.0258	0.0263	68.9	71.3	0.2	0.2	0.127	0.133	70.1	71.1
Chair Lake	6	2010	16,933	19,500	59.6	96.4	0.472	1.180	48.3	56.1	142.3	170.0	56,100	85,800	8.91	10.70	0.0612	0.0679	113	242	0.7	1.1	0.207	0.599	136	201
Mam Lake	3	2010	10,817	11,400	23.6	37.5	0.313	0.420	35.8	37.8	79.0	92.1	28,533	35,100	5.92	6.33	0.0667	0.0729	64.8	75.5	0.4	0.5	0.111	0.132	74.3	102
Pond 19 Lake	3	2012	5,990	6,550	3.48	3.83	0.131	0.149	19.7	21.5	30.1	30.7	9,940	10,800	2.02	2.11	0.0141	0.0161	57.5	61.0	0.1	0.1	0.037	0.062	47.9	52.1
Llama Lake	15	2010, 2011	10,951	13,900	34.4	141.0	0.311	0.470	33.5	40.4	89.8	150.0	29,713	82,100	5.66	7.15	0.0640	0.1010	57.9	78.8	0.5	0.8	0.102	0.133	65.8	90.4
Echo Lake	3	2012	6,413	7,200	16.1	23.4	0.227	0.270	27.4	29.6	40.3	48.9	19,433	28,100	3.70	4.04	0.0367	0.0433	41.7	44.9	0.3	0.4	0.078	0.091	52.5	56.6
Big Lake	3	2012	9,550	9,560	27.9	29.4	0.271	0.290	29.8	30.4	74.1	75.0	22,100	23,800	5.73	5.94	0.0643	0.0699	60.7	61.2	0.5	0.5	0.087	0.090	63.0	64.3
Fox Lake	3	2012	7,377	7,910	17.6	19.5	0.291	0.331	22.0	23.9	77.9	87.5	24,100	26,200	5.91	6.27	0.0682	0.0719	74.9	84.2	0.6	0.6	0.068	0.074	57.4	64.2
Umwelt Lake	6	2010, 2011	6,668	8,570	12.5	22.5	0.267	0.732	19.9	29.0	45.1	73.9	13,902	22,900	3.81	5.10	0.0402	0.0720	35.7	55.1	0.3	0.4	0.068	0.165	54.9	120
Rabbit Lake	3	2012	7,300	7,540	17.2	24.9	0.456	0.516	24.9	26.9	71.1	86.0	13,900	16,900	4.95	5.26	0.0272	0.0428	96.5	106	0.5	0.7	0.130	0.140	87.3	101
Rascal Lake	3	2012	3,870	4,110	3.39	3.61	0.163	0.182	12.3	13.0	36.3	38.3	7,083	7,510	2.83	3.00	0.0414	0.0439	31.3	33.4	0.2	0.3	0.025	0.025	35.4	40.2
Giraffe Lake	12	2011, 2012	8,677	11,000	11.3	14.1	0.374	0.638	22.1	28.3	90.0	128.0	15,575	32,000	4.32	5.60	0.0705	0.1030	95.7	135.0	0.5	0.7	0.080	0.115	78.4	115
Goose Lake	18	2011, 2012	8,499	11,500	11.7	30.2	0.345	1.430	23.3	33.2	74.0	166.0	16,983	35,200	4.65	6.63	0.0590	0.1010	54.6	97.6	0.4	0.8	0.070	0.177	66.2	142
Propellor Lake	6	2011, 2012	7,717	8,500	4.66	6.69	0.293	0.364	23.9	25.8	43.7	50.7	11,600	15,000	4.71	5.16	0.0414	0.0575	33.4	40.2	0.3	0.4	0.083	0.100	53.5	66.5
Reference B Lake	9	2010, 2011	4,077	6,770	7.35	14.8	0.126	0.250	12.0	21.3	27.4	62.9	19,787	40,300	2.99	7.06	0.0205	0.0508	23.8	48.1	0.2	0.5	0.042	0.106	28.6	66.9
George Area																										
Lower Long Lake	3	2012	13,000	13,100	27.7	28.9	0.452	0.593	39.6	42.2	90.8	108.0	20,800	22,000	9.34	9.77	0.0652	0.0922	51.7	60.2	0.5	0.6	0.066	0.067	81.1	92.2
Fold Lake	3	2012	11,167	11,700	281	542	0.367	0.467	39.1	41.0	80.4	101.0	50,467	86,600	6.28	6.72	0.0377	0.0492	65.4	72.3	0.4	0.6	0.134	0.189	97.7	116
George Lake	6	2012	11,582	15,900	29.3	55.6	0.093	0.203	43.7	62.0	21.8	34.5	23,233	27,800	1.93	2.38	0.0044	0.0084	55.6	70.5	0.1	0.1	0.038	0.073	62.5	69.7
Lytle Lake	3	2012	17,500	17,700	43.3	51.0	0.208	0.234	65.2	66.0	46.6	48.3	30,833	32,700	7.17	7.26	0.0142	0.0150	93.6	102	0.1	0.1	0.101	0.105	148	156
Occurrence Lake	3	2012	33,267	34,000	52.6	55.1	0.296	0.326	123.3	125.0	111.3	112.0	49,033	49,200	11.9	12.1	0.0208	0.0219	136	142	0.3	0.3	0.210	0.212	261	267
Sleigh Lake	3	2012	9,510	10,600	13.9	15.7	0.025	0.025	35.5	40.0	17.3	18.3	17,033	18,600	3.05	3.31	0.0025	0.0025	24.1	26.4	0.1	0.1	0.025	0.025	36.0	39.1
Dragon Lake	3	2012	12,300	15,200	64.0	82.4	0.427	0.472	41.1	50.7	90.1	107.0	23,333	25,400	6.57	6.91	0.0232	0.0281	105	121	0.4	0.4	0.118	0.141	125	143
Komatic Lake	3	2012	14,933	15,200	345	391	0.691	0.735	52.5	53.4	132.0	135.0	65,033	69,500	9.53	10.20	0.0695	0.0736	149	156	0.7	0.8	0.129	0.130	176	178
Overall Lake Water Quality																										
All Lake Sites	123		14,982	34,000	98.4	542	0.299	1.430	32.0	125.0	69.6	170.0	23,940	86,600	5.17	12.1	0.0461	0.1030	60.4	242	0.4	1.1	0.088	0.599	76.9	267
CCME Guideline for the Protection of Freshwater Aquatic Life[a]			-		5.9		0.6		37.3		35.7		-		35		0.17		-		-		-		123	

Shaded cells indicate values that exceed CCME guidelines.

[a] *CCME Interim Sediment Quality Guidelines for the Protection of Freshwater Aquatic Life.*

All concentrations are expressed in mg/kg dry weight.

Appendix A3-2. Summary of Metal Concentrations in Sediment Samples Collected from Streams in 2011-2012

		Collection	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Lead		Mercury		Nickel		Selenium		Thallium		Zinc	
Stream	**Samples**	**Years**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**m**	**Mean**	**Maximum**	**Mean**	**m**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**	**Mean**	**Maximum**
Goose Area																										
Moby OF	3	2012	4,990.00000	6,480.00000	3.95333	5.02000	0.025000	0.025000	15.933333	21.500000	5.4833	5.7400	8,980.000	11,800.000	1.500000	1.71	0.0025	0.0025	13.566667	15.600000	0.10000	0.10000	0.025	0.025	19.533333	24.100000
Gander IF	3	2012	4,343.33333	4,750.00000	3.68667	4.23000	0.025000	0.025000	13.600000	14.900000	4.6533	4.8600	7,733.333	8,670.000	1.190000	1.32	0.0025	0.0025	10.800000	11.400000	0.10000	0.10000	0.025	0.025	16.766667	17.800000
Gander US	3	2012	6,390.00000	6,920.00000	8.47667	8.89000	0.025000	0.025000	21.533333	22.900000	6.4900	7.4000	12,366.667	12,900.000	1.590000	1.9	0.0025	0.0025	13.733333	13.900000	0.10000	0.10000	0.025	0.025	23.933333	24.900000
Pond 19 OF	3	2012	9,090.00000	9,780.00000	2.91667	3.23000	0.025000	0.025000	30.366667	32.100000	10.0500	10.9000	14,300.000	15,800.000	1.843333	2.11	0.0053	0.0068	20.900000	20.900000	0.10000	0.10000	0.025	0.025	32.866667	34.500000
Chair OF	6	2011, 2012	10,078.33333	12,800.00000	12.90500	18.10000	0.080000	0.187000	33.116667	42.800000	21.1733	46.2000	16,331.667	22,100.000	3.056667	5.23	0.01498333	0.0421	24.650000	40.600000	0.15333	0.27000	0.043833	0.092000	35.616667	44.100000
Giraffe OF	6	2011, 2012	7,921.66667	9,380.00000	7.84333	16.20000	0.062167	0.248000	26.033333	31.500000	20.5967	44.5000	17,350.000	26,400.000	2.798333	3.83	0.01081667	0.046	29.066667	54.300000	0.13667	0.32000	0.030167	0.056000	33.583333	40.500000
Wolf OF	6	2011, 2012	2,750.00000	3,020.00000	1.85000	3.03000	0.029667	0.053000	6.915000	8.060000	5.3983	7.6900	5,816.667	8,660.000	1.308333	2.08	0.00543333	0.0126	7.835000	11.400000	0.10000	0.10000	0.025000	0.025000	11.616667	16.000000
Goose OF	6	2011, 2012	4,771.66667	7,190.00000	8.06333	21.90000	0.209833	0.711000	14.083333	20.600000	21.9083	54.4000	16,670.000	29,700.000	3.621667	9.08	0.0354	0.111	41.923333	122.000000	0.24500	0.66000	0.054000	0.168000	29.783333	60.400000
Propellor OF	3	2012	19,800.00000	23,700.00000	25.10000	27.50000	0.086333	0.209000	60.833333	75.300000	21.4400	36.2000	38,800.000	45,400.000	6.696667	11.4	0.00366667	0.006	54.000000	81.000000	0.10000	0.10000	0.046333	0.089000	75.166667	86.700000
Propellor Downstream	1	2011	5,280.00000	5,280.00000	5.63000	5.63000	0.116000	0.116000	23.200000	23.200000	20.2000	20.2000	23,600.000	23,600.000	6.270000	6.27	0.0292	0.0292	28.000000	28.000000	0.10000	0.10000	0.054000	0.054000	56.400000	56.400000
Reference B OF	6	2011, 2012	3,701.66667	4,570.00000	2.75333	3.96000	0.132333	0.296000	11.740000	13.100000	25.7667	62.2000	9,013.333	12,900.000	2.461667	6.74	0.03058333	0.0824	14.556667	26.500000	0.30000	0.87000	0.025000	0.025000	14.816667	19.800000
George Area																										
George OF	3	2012	11,500.00000	12,500.00000	57.20000	96.60000	0.224333	0.263000	33.466667	36.600000	105.0667	122.0000	22,500.000	28,300.000	8.72	10.5	0.05623333	0.0702	76.866667	84.700000	0.87333	1.21000	0.085	0.109	92.533333	101.000000
Sleigh OF	3	2012	15,733.33333	17,100.00000	8.48000	8.72000	0.025000	0.025000	58.000000	62.800000	11.8333	12.0000	25,633.333	28,000.000	2.48	2.58	0.0025	0.0025	38.700000	42.600000	0.10000	0.10000	0.025	0.025	53.000000	56.900000
Dragon OF	3	2012	14,866.66667	16,000.00000	36.00000	39.30000	0.039000	0.067000	53.166667	55.400000	15.7333	18.2000	36,800.000	39,200.000	2.9033333	3.11	0.0044	0.0054	36.733333	38.800000	0.10000	0.10000	0.025	0.025	49.566667	51.000000
Komatic IF	3	2012	13,866.66667	16,700.00000	10.76000	14.90000	0.025000	0.025000	53.300000	66.600000	9.1267	9.8500	23,766.667	29,300.000	1.82	2.07	0.0025	0.0025	33.233333	40.900000	0.10000	0.10000	0.025	0.025	45.633333	54.400000
Overall Lake Water Quality																										
All Stream Sites	**58**	**2011, 2012**	8,316.55172	23,700.00000	11.65241	96.60000	0.081017	0.711000	27.502241	75.300000	19.9809	122.0000	17,022.931	45,400.000	2.965172	11.4	0.014807	0.111	28.134310	122.000000	0.18500	1.21000	0.035190	0.168000	35.101724	101.000000
CCME Guideline for the Protection of Freshwater Aquatic Life[a]			-		5.9		0.6		37.3		35.7		-		35		0.17		-		-		-		123	

Shaded cells indicate values that exceed CCME guidelines

[a] *CCME Interim Sediment Quality Guidelines for the Protection of Freshwater Aquatic Life*

All concentrations are expressed in mg/kg dry weight

Appendix A3-3. Summary of Metal Concentrations in Samples Collected from the Project Lakes and Streams Sediments in 2010-2012

Metal	Average	Maximum
Aluminum	9,524	34,000
Arsenic	28.1	542
Cadmium	0.0250	1.43
Chromium	30.6	125
Copper	69.6	170
Iron	21,724	86,600
Lead	4.46	12.1
Mercury	0.0361	0.111
Nickel	53.230	242
Selenium	0.315	1.21
Thallium	0.0712	0.599
Zinc	63.5	267

Concentrations in mg/kg dry weight based on average and maximum of total stream and lake sediment concentrations from 2010 to 2012; n=181.

Shaded cells indicate values that exceed CCME Interim Sediment Quality Guidelines for the Protection of Freshwater Aquatic Life.

Appendix A3-4. Summary of Metal Concentrations in Sediment Samples Collected from Bathurst Inlet in 2012

Marine Location[a]	Number of Samples	Collection Years	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Lead		Mercury		Nickel		Selenium		Thallium		Zinc	
			Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum
06-10	3	2012	3,683	3,970	1.57	1.73	0.025	0.025	9.06	10.2	3.09	3.47	6,160	6,770	2.08	2.20	0.0025	0.0025	6.40	6.93	0.1	0.1	0.025	0.025	9.13	10.1
06-20	3	2012	1,017	1,020	1.00	1.07	0.025	0.025	2.19	2.24	1.12	1.23	1,803	1,830	0.91	0.97	0.0025	0.0025	1.46	1.50	0.1	0.1	0.025	0.025	2.9	3.6
06-22	3	2012	15,867	16,200	8.45	9.13	0.025	0.025	42.97	43.2	20.1	20.4	24,200	24,700	8.27	8.37	0.0081	0.0085	23.70	23.80	0.1	0.1	0.148	0.149	47.1	47.8
06-30	3	2012	8,337	9,250	4.47	5.05	0.025	0.025	23.93	27.8	12.93	14.9	13,500	15,000	6.03	6.60	0.0025	0.0025	14.27	16.60	0.1	0.1	0.084	0.095	25.2	28.7
06-32	3	2012	17,200	17,700	10.5	11.1	0.03566667	0.057	45.13	45.9	19.33	19.6	25,900	26,600	9.23	9.35	0.0132	0.0156	24.73	25.30	0.22666667	0.24	0.151	0.153	50.4	51.2
06-42	3	2012	12,000	12,200	5.13	5.37	0.025	0.025	31.67	31.9	14.33	14.5	17,333	17,500	6.69	6.73	0.0097	0.0100	17.50	17.60	0.1	0.1	0.107	0.111	35.8	37.1
06-50	3	2012	6,287	6,710	3.49	4.06	0.025	0.025	18.07	20.3	9.83	11.1	10,430	11,300	3.72	4.03	0.0025	0.0025	10.35	11.40	0.1	0.1	0.049	0.062	19.9	22.2
06-52	3	2012	11,433	11,500	5.18	5.51	0.025	0.025	29.93	30.5	13.97	14.5	16,867	17,000	6.15	6.18	0.0084	0.0087	16.63	16.70	0.1	0.1	0.103	0.105	33.8	35
Grand Total	24	2012	9,478	17,700	4.97	11.1	0.02633333	0.057	25.4	45.9	11.84	20.4	14,524	26,600	5.39	9.35	0.0062	0.0156	14.38	25.30	0.11583333	0.24	0.086	0.153	28.0	51.2
CCME Guideline [b]			-		7.24		0.7		52.3		18.7		-		30.2		0.13		-		-		-		124	

All concentrations expressed in mg/kg dry weight.

Values below detection limits were replaced with half the detection limit to calculate the mean.

Light shaded cells indicate values that exceed CCME guidelines for the protection of aquatic life, which at least one sample above detection limit.

[a] *Data excludes winter samples obtained from Bathurst Inlet for conservative measures since the samples were taken far from the shore and none of the sample exceeded any of the available guidelines.*

[b] *Canadian Water quality guidelines for the projection of marine aquatic life, Canadian Council of Ministers of the Environment (CCME 2011).*

Appendix A3-5. Summary of Metal Concentrations in Sediment Samples Collected from Wetlands in 2012

	Concentrations (n=11)	
Metal	**Mean**	**Maximum**
Aluminum	4027	10600
Arsenic	10.9	37.7
Cadmium	0.297	0.420
Chromium	10.0	30.6
Copper	36.5	72.5
Iron	7465	14000
Lead	2.38	8.10
Mercury	0.0917	0.133
Nickel	37.8	145
Selenium	0.375	0.670
Thallium	0.0447	0.168
Zinc	21.8	43.0

All concentrations expressed in mg/kg dry weight.

Shaded cells indicate values that exceed CCME Interim Sediment Quality Guidelines

Appendix A3-6. Metal Concentrations in Sediment Samples Collected from Wetlands in 2012

RESULTS OF ANALYSIS													
Sample ID		W026	W052	W067	W073	W075	W077	W051	W080	W083	W128	W134	W135
Date Sampled		09-JUL-12	12-JUL-12	13-JUL-12	14-JUL-12	15-JUL-12	15-JUL-12	15-JUL-12	16-JUL-12	16-JUL-12	22-JUL-12	23-JUL-12	24-JUL-12
ALS Sample ID		L1184194-1	L1184194-2	L1184194-3	L1184194-4	L1184194-5	L1184194-6	L1184194-7	L1184194-8	L1184194-9	L1184194-10	L1184194-11	L1184194-12
Matrix		Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Sediment	Soil	Sediment	Sediment
Physical Tests	**Units**												
Moisture	%	80.6	73.5	82.0	80.0	86.2	92.0	89.4	75.9	71.8	82.3	82.8	75.4
Organic / Inorganic Carbon													
$CaCO_3$ Equivalent	%	9.97	4.02	1.60	1.59	1.69	1.57	2.62	<0.80	1.98	1.13	1.39	2.13
Inorganic Carbon	%	1.20	0.48	0.19	0.19	0.20	0.19	0.31	<0.10	0.24	0.14	0.17	0.26
Total Carbon by Combustion	%	19.9	27.8	39.7	43.1	38.1	38.5	27.7	19.3	38.9	29.5	36.6	30.5
Total Organic Carbon	%	18.7	27.3	39.5	42.9	37.9	38.3	27.4	19.3	38.6	29.3	36.4	30.2
Metals													
Aluminum (Al)	mg/kg	10600	5070	2140	2410	859	3970	797	2350	6060	2790	2170	7870
Antimony (Sb)	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.27
Arsenic (As)	mg/kg	23.1	2.05	1.73	1.50	1.65	37.7	18.7	5.39	8.65	7.44	4.19	15.3
Barium (Ba)	mg/kg	83.6	106	130	60.1	68.5	46.9	32.5	80.0	87.7	36.7	11.8	20.6
Beryllium (Be)	mg/kg	0.41	<0.20	<0.20	<0.20	<0.20	0.53	<0.20	0.23	0.34	<0.20	<0.20	0.57
Bismuth (Bi)	mg/kg	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	mg/kg	0.400	0.420	0.244	0.252	0.180	0.368	0.122	0.408	0.255	0.066	0.266	0.357
Calcium (Ca)	mg/kg	1790	3200	4560	2740	2060	5340	6460	4490	2420	6280	4450	551
Chromium (Cr)	mg/kg	30.6	17.6	4.68	11.6	0.88	2.64	1.67	2.54	18.6	8.97	6.24	13.2
Cobalt (Co)	mg/kg	9.04	4.13	6.54	4.93	5.11	64.0	14.0	7.66	7.32	5.64	6.47	3.63
Copper (Cu)	mg/kg	63.0	41.9	26.7	37.0	12.6	72.5	9.77	28.5	71.9	7.51	5.78	32.0
Iron (Fe)	mg/kg	14000	8130	4460	5320	4670	10900	3980	3190	11300	14900	4070	12100
Lead (Pb)	mg/kg	8.10	1.44	0.94	0.98	0.78	4.42	2.19	0.91	3.39	1.79	1.35	1.70
Lithium (Li)	mg/kg	10.9	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.9
Magnesium (Mg)	mg/kg	3420	1070	892	471	653	1670	1730	1010	1350	1680	1300	2320
Manganese (Mn)	mg/kg	57.8	25.9	12.1	8.1	15.3	281	25.9	7.8	25.2	33.5	17.9	26.4
Mercury (Hg)	mg/kg	0.113	0.0545	0.125	0.0557	0.0748	0.0977	0.114	0.119	0.0642	0.0513	0.133	0.0573
Molybdenum (Mo)	mg/kg	1.73	0.66	<0.50	<0.50	0.53	0.64	<0.50	<0.50	<0.50	<0.50	0.96	0.75
Nickel (Ni)	mg/kg	38.9	27.9	17.1	21.3	10.4	145	28.7	75.8	28.4	12.2	6.35	16.0
Phosphorus (P)	mg/kg	913	398	1340	805	931	636	517	362	1080	582	407	696
Potassium (K)	mg/kg	930	220	490	320	420	380	490	290	300	260	410	420
Selenium (Se)	mg/kg	0.52	0.67	0.28	0.57	<0.20	0.47	<0.20	0.21	0.65	<0.20	<0.20	0.45
Silver (Ag)	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	0.27	<0.10	<0.10	0.15	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg	120	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Strontium (Sr)	mg/kg	26.3	15.2	27.7	11.0	17.9	32.9	32.0	32.9	11.5	28.8	18.1	3.00
Thallium (Tl)	mg/kg	0.168	<0.050	0.070	<0.050	<0.050	0.054	<0.050	<0.050	<0.050	0.108	<0.050	<0.050
Tin (Sn)	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	mg/kg	246	149	43.7	48.2	17.4	27.7	22.8	35.2	215	72.9	102	52.3
Uranium (U)	mg/kg	1.71	0.704	0.411	0.825	0.269	1.57	0.099	0.359	3.78	0.333	0.121	1.22
Vanadium (V)	mg/kg	54.6	27.5	6.14	17.4	1.63	3.30	1.82	2.89	31.4	7.70	5.79	19.7
Zinc (Zn)	mg/kg	30.5	39.8	8.7	5.3	21.6	30.6	27.4	15.3	8.8	12.4	43.0	9.0

All concentrations expressed in mg/kg dry weight.

Shaded cells indicate values that exceed CCME Interim Sediment Quality Guidelines

Appendix A4-1. Summary of Metal Concentrations in Lake Trout *(Salvelinus namaycush)* Muscle Sampled in 2011 and 2012

Metal	Lake Trout Tissue Metal Concentrations, 2011 and 2012 (n = 49)	
	Mean	Maximum
Aluminum	1.22	7.1
Antimony	0.005	0.005
Arsenic	0.0328	0.156
Barium	0.0245	0.114
Beryllium	0.05	0.05
Bismuth	0.015	0.015
Cadmium	0.0025	0.0025
Calcium	101.2	434
Chromium	0.0733	0.27
Cobalt	0.0226	0.139
Copper	0.282	0.503
Lead	0.046	0.31
Lithium	0.05	0.05
Magnesium	274.9	312
Manganese	0.119	0.378
Mercury	0.215	0.549
Molybdenum	0.0054	0.014
Nickel	0.053	0.12
Selenium	0.37	0.54
Strontium	0.106	0.566
Thallium	0.007	0.019
Tin	0.025	0.025
Uranium	0.001	0.001
Vanadium	0.05	0.05
Zinc	4.03	6.77

All concentrations expressed in mg/kg wet weight.

Only Lake trout tissue metal concentrations were used in this assessment.

Appendix A4-2. Summary of Metal Concentrations in Bay Mussels *(Mytilus trossulus)* Tissue Sampled in 2012

Metal	Mussel Metal Concentrations (n=20)	
	Mean	Maximum
Aluminum	226	484
Arsenic	2.18	2.86
Cadmium	2.09	3.64
Chromium	0.585	1.10
Copper	2.00	2.61
Iron	195	370
Lead	0.339	0.520
Mercury	0.0246	0.0327
Nickel	0.623	0.908
Selenium	1.00	1.23
Thallium	0.00190	0.00487
Zinc	17.3	34.5

All concentrations expressed in mg/kg wet weight.

Appendix A5. Summary of Metal Concentrations in Lichens (*C. Stygia* and *S. Paschale*) Collected in 2012

Metal	Lichen Metal Concentrations (n=20)	
	Mean	Maximum
Aluminum (Al)	370	1,340
Antimony (Sb)	**0.020**	**0.020**
Arsenic (As)	0.299	0.83
Barium (Ba)	13.40	29.1
Beryllium (Be)	**0.20**	**0.20**
Bismuth (Bi)	**0.060**	**0.060**
Cadmium (Cd)	0.043	0.072
Calcium (Ca)	1,043	1,940
Chromium (Cr)	0.389	1.01
Cobalt (Co)	1.267	9.22
Copper (Cu)	2.36	7.8
Iron (Fe)	358	1,020
Lead (Pb)	0.838	2.76
Lithium (Li)	0.21	0.48
Magnesium (Mg)	389	921
Manganese (Mn)	53.5	107
Mercury (Hg)	0.056	0.156
Molybdenum (Mo)	0.028	0.088
Nickel (Ni)	3.63	35.7
Phosphorus (P)	343	475
Potassium (K)	920	1,380
Selenium (Se)	**0.40**	**0.40**
Silver (Ag)	0.022	0.053
Sodium (Na)	45.35	147
Strontium (Sr)	4.75	12
Thallium (Tl)	**0.020**	**0.02**
Tin (Sn)	**0.10**	**0.10**
Titanium (Ti)	10.45	24.7
Uranium (U)	0.0323	0.0977
Vanadium (V)	0.50	1.16
Zinc (Zn)	15.2	22.1

Values below detection limits were replaced with half the detection limit to calculate the mean.
If all samples had metal concentrations below the detection limit, the half detection value is shaded.
All concentrations expressed in mg/kg wet weight.

Appendix A6. Summary of Metal Concentrations in Bog Blueberries and Bog Cranberry (*V. Vitis-idaea and V. uliginosum*) Collected in 2012

	Berry Metal Concentrations (n=25)	
Metal	**Mean**	**Maximum**
Aluminum (Al)	5.91	46.3
Antimony (Sb)	0.0050	0.0050
Arsenic (As)	0.0081	0.0490
Barium (Ba)	3.32	7.77
Beryllium (Be)	0.050	0.050
Bismuth (Bi)	0.0150	0.0150
Cadmium (Cd)	0.0153	0.0357
Calcium (Ca)	276	581
Chromium (Cr)	0.0532	0.130
Cobalt (Co)	0.0278	0.0990
Copper (Cu)	0.949	1.75
Iron (Fe)	6.48	75.3
Lead (Pb)	0.010	0.010
Lithium (Li)	0.052	0.10
Magnesium (Mg)	124	225
Manganese (Mn)	27.7	124
Mercury (Hg)	0.000536	0.00140
Molybdenum (Mo)	0.0144	0.050
Nickel (Ni)	0.343	1.11
Phosphorus (P)	229	409
Potassium (K)	1362	2500
Selenium (Se)	0.10	0.10
Silver (Ag)	0.0050	0.0050
Sodium (Na)	100	100
Strontium (Sr)	0.705	2.07
Thallium (Tl)	0.0050	0.0050
Tin (Sn)	0.161	0.417
Titanium (Ti)	0.560	2.0
Uranium (U)	0.00136	0.010
Vanadium (V)	0.0544	0.160
Zinc (Zn)	5.23	23.3

All concentrations expressed in mg/kg wet weight.

Appendix A7. Summary of Metal Concentrations in Water Sedges (*C. Aquatilis*) Collected in 2012

Metal	Sedge Metal Concentrations (n=30)	
	Mean	Maximum
Aluminum (Al)	**1.0**	**1.0**
Antimony (Sb)	**0.005**	**0.005**
Arsenic (As)	0.118	0.903
Barium (Ba)	2.55	7.31
Beryllium (Be)	**0.05**	**0.05**
Bismuth (Bi)	**0.015**	**0.015**
Cadmium (Cd)	0.00944	0.0506
Calcium (Ca)	559	998
Chromium (Cr)	**0.05**	**0.05**
Cobalt (Co)	0.0514	0.169
Copper (Cu)	2.63	4.23
Lead (Pb)	0.0117	0.0620
Lithium (Li)	0.0577	0.210
Magnesium (Mg)	471	764
Manganese (Mn)	39.1	102
Mercury (Hg)	0.00139	0.0020
Molybdenum (Mo)	0.267	1.90
Nickel (Ni)	1.77	4.11
Selenium (Se)	**0.1**	**0.1**
Strontium (Sr)	1.51	2.90
Thallium (Tl)	0.00570	0.0260
Tin (Sn)	**0.025**	**0.025**
Uranium (U)	**0.001**	**0.001**
Vanadium (V)	**0.05**	**0.05**
Zinc (Zn)	13.1	24.3

If all samples had metal concentrations below the detection limit, the half detection value is shaded.

All concentrations expressed in mg/kg wet weight.

Appendix B

Food Chain Model and Predicted Caribou, Arctic Ground Squirrel, Canada Goose, and Ringed Seal Concentrations

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Appendix B. Food Chain Model and Predicted Caribou, Arctic Ground Squirrel, Canada Goose, and Ringed Seal Concentrations

1. INTRODUCTION

Tissue concentrations for caribou, Arctic ground squirrel, Canada goose, and seal were estimated using a food chain model. The food chain model predicts metal concentrations in animal tissue by estimating the fraction of metals that are retained in the tissues when wildlife ingest environmental media such as vegetation, soil and surface water. The food chain model followed the methodology described in Golder (2005).

This appendix provides details on the methodology of the food chain model and the modelled metal concentrations in the tissues of the terrestrial and marine mammal country foods. The modelled metal concentrations were used in the country foods baseline study to assess the potential for health risks in human consumers.

2. METHODS

The following equation was used to predict terrestrial animal tissue concentrations:

$$C_{meat}\ (mg/kg) = C_{msoil} + C_{mwater} + C_{mveg}$$

where:
C_{msoil} = *Concentration in meat from the animal's exposure to metals in soil.*
C_{mwater} = *Concentration in meat from the animal's exposure to metals in water.*
C_{mveg} = *Concentration in meat from the animal's exposure to metals in vegetation.*

The terrestrial wildlife uptake equations used to obtain the concentrations in animal tissue (meat) from exposure to soil, vegetation and water are presented in Table B-1.

Table B-1. Terrestrial Wildlife Uptake Equations

Pathway	Equation and Equation Parameters
Soil ingestion	$C_{msoil} = BTF_{tissue\text{-}food} \times C_{soil} \times IR_{soil} \times fw \times fp$
Water ingestion	$C_{mwater} = BTF_{tissue\text{-}food} \times C_{water} \times IR_{water} \times fw \times fp$
Vegetation ingestion	$C_{mveg} = BTF_{tissue\text{-}food} \times C_{veg} \times IR_{veg} \times fw \times fp$
where: BTF = biotransfer Factor (day/kg) IR = ingestion rate for caribou, arctic ground squirrel and Canada goose (kg/day or L/day) C = concentration (mg/kg) fw = fraction of daily consumption (assumed 1; unitless) fp = fraction of the year the animal is onsite (unitless)	

For caribou, it was assumed that 90% of their diet was lichen, and 10% was composed of an even mix of sedge and berries. For Canada goose, it was assumed that 100% of their diet was an even mix of sedge and berries, while for Arctic ground squirrel, it was assumed that 100% of their diet was an even mix of sedge, berries, and lichen. For mean metal concentrations in these vegetation groups see Table B-2.

Since Canada goose may ingest soil from both the terrestrial environment and wetland sediment, the mean COPC concentration from soil and wetland sediment were included in the model to estimate the Canada goose tissue concentration as a result of ingestion of these materials.

The seal tissue metal concentration, C_{mseal}, was predicted using tissue concentrations in starry flounder (*Platichthys stellatus*) based on the following equation:

$$C_{mseal} = BTF_{tissue\text{-}food}\ (day/kg) \times C_{fish}\ (mg/kg) \times IR_{fish}\ (kg/day) \times fw \times fp$$

2.1 Environmental Metal Concentrations Used in the Food Chain Model

2.1.1 Terrestrial Wildlife

Rescan conducted several field studies to determine the current metal concentrations in two lichen and two berry species (2013b), soil (2013a), and freshwater (2012a, 2012b). Lichen (*Cladina stygia* and *Stereocaulon paschale*) and water sedge (*Carex aquatilis*) samples were collected from within the country foods study area in 2012 and analyzed for metal concentrations (Rescan 2013b).

Figure B-1 presents the lichens and water sedge sampling locations within the country foods study area. Berry sampling locations within the country foods study area is presented in Figure 3.2-2 of the main report.

A summary of the metal concentration data collected is presented in Table B-2. These concentrations were used as inputs into the food chain model to predict the metal concentrations in caribou, Arctic ground squirrel and Canada goose tissue.

Table B-2. Summary of Mean Metal Concentrations in Lichen, Berry, and Sedge Tissue, Soil, and Surface Freshwater Samples

Metal	Lichen Tissues (mg/kg wet weight)[1]	Berry Tissues (mg/kg wet weight)[1]	Sedge Tissues (mg/kg wet weight)[1]	Wetland Sediment (mg/kg)[2]	Soil (mg/kg)[3]	Surface Freshwater (mg/L)[4,5,6]
Aluminum	370	5.91	1.0	852	6122	0.0281
Arsenic	0.299	0.00812	0.118	1.87	8.17	0.000372
Cadmium	0.0433	0.0153	0.00944	0.0875	0.0296	0.0000144
Chromium	0.389	0.0523	0.050	3.40	18.5	0.000225
Copper	2.36	0.949	2.63	10.1	13.1	0.00188
Lead	0.838	<0.020	0.0117	0.536	2.65	0.0000946
Mercury	0.0562	0.000536	0.00139	0.0204	0.00917	<0.000010
Nickel	3.63	0.343	1.77	8.20	12.9	0.00644
Selenium	<0.80	<0.20	0.10	0.124	0.106	0.0000518
Thallium	<0.040	<0.010	0.00570	0.00992	0.0377	0.0000298
Zinc	15.2	5.23	13.1	6.59	18.0	0.00307

[1] *Source: Rescan (2013b); total of 20 lichen samples, 25 berry samples, and 30 sedge samples.*
[2] *Source: Appendices A3-5 and A3-6; total of 11 wetland sediment samples.*
[3] *Source: Rescan (2013a); total of 31 soil samples.*
[4] *Source: Rescan (Rescan 2012a).*
[5] *Source: Rescan (Rescan 2012b).*
[6] *Data pooled from both 2010, 2011, and 2012 lakes and stream sites; a total of 224 water samples were collected and used in this assessment. List of the streams and lakes used in the assessments are provided in Appendices A2-1 and A2-2.*

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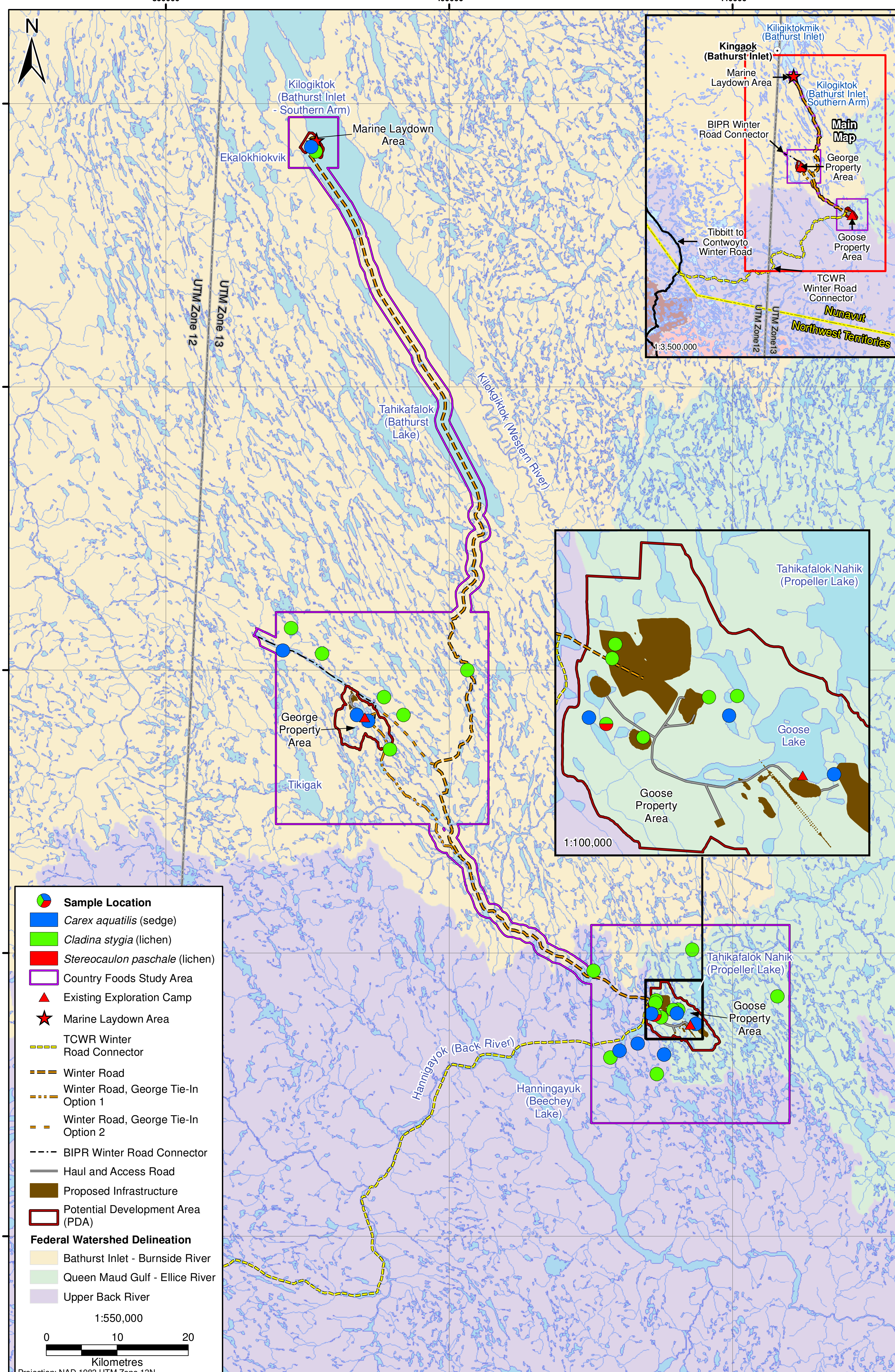

Figure B-1

Sabina GOLD & SILVER CORP.

Lichen and Water Sedge Sampling Locations within the Country Foods Study Area, Back River Project

Figure B-1

Rescan Engineers & Scientists

Data used from the soil sampling program included 31 soil samples collected from depths ranging from 0 to 5 cm below ground surface. The data used from the freshwater sampling program included surface water samples from lakes and streams within the country foods study area collected between 2010 and 2012. Data for wetland sediment metal concentrations were collected from wetlands within the country foods study area in 2012 and the raw data is present in Appendix A3-6.

Plant tissue samples included 20 lichen samples and 25 berry samples, comprised of bog blueberries and bog cranberries (*Vaccinium uliginosum* and *Vaccinium vitis-idaea*). In addition, 30 water sedge samples were collected from the country foods study area. Appendices A5, A6, and A7 summarize the analytical results of these samples. For berry producing plants, the berries were submitted for analysis. The entire lichen plant and the above ground, water portion of the water sedge plant were collected and analyzed.

2.1.2 Marine Wildlife

The diet of seals is made up primarily of fish and for the purpose of this assessment it was assumed that starry flounder make up 100% of their diet. COPC concentrations in starry flounder were measured as a part of baseline studies for the nearby Bathurst Inlet Road and Port Project (Rescan 2007) and these data were used to model ringed seal COPC concentrations. The mean starry flounder COPC concentrations used in the modelling of COPCs in ringed seals are presented in Table B-3.

Table B-3. Mean Metal Concentrations Measured in Starry Flounder Muscle Tissue

COPC	Starry Flounder Tissue Metal Concentration (mg/kg wet weight) (n = 15)
Aluminum	8.89
Arsenic	2.01
Cadmium	0.00339
Chromium	0.0494
Copper	0.366
Lead	0.0213
Mercury	0.0525
Nickel	0.0494
Selenium	0.394
Thallium	0.00296
Zinc	6.50

There are some uncertainties associated with the modelled ringed seal metal tissue concentrations based on the starry flounder collected in 2001. For example, cadmium, chromium, lead, nickel, and thallium COPCs were measured below the method detection limit and were replaced with a value of half of the detection limit to calculate the mean metal tissue concentrations. This likely over-estimated the actual concentrations of metals in the tissues due to the high method detection limits and resulted in a highly conservative estimate of human health exposure ratios. The model assumed that all exposure resulted from starry flounder as food source of the ringed seal and not from uptake of water or sediment.

2.2 Wildlife Characteristics

Terrestrial wildlife characteristics with respect to body weight and ingestion rates were based on values provided in guidance from the Oakridge National Laboratory (ORNL 1997), and MacDonald and Gunn (2004). Characteristics of seals and their diet were based on values provided in the *Wildlife Exposure Handbook* (US EPA 1993). Water intake by seals is considered negligible (US EPA 1993). Table B-4 presents the species specific characteristics that were used as inputs in the food chain model to predict tissue concentrations in terrestrial wildlife and ringed seals.

Table B-4. Terrestrial and Marine Wildlife Characteristics

Receptor	Body Weight (kg)	Food Ingestion Rate (kg wet weight/day)	Vegetation Ingestion Rate (kg wet weight/day)	Soil Ingestion Rate (kg/day)	Water Ingestion Rate (L/day)	Fraction of Year at Site
Caribou	169	8.2	7.38	0.82	10	0.5
Ground squirrel	1.4	0.09	0.088	0.002	0.13	0.42
Canada goose	3.2	1.4	1.35	0.07	0.06	0.42
Ringed seal	90	2.274	not applicable	not applicable	negligible	1

Estimation of the occurrence of caribou in the country foods study area is based on survey data from the *2010 Caribou and Muskox Baseline Report* which included data from 2007 to 2010 (Rescan 2011), the *Wildlife Baseline Report 2011* which included data from 2011 (Rescan 2012c), and the *2012 Wildlife Baseline Report* which included data from 2012 (Rescan 2013c).

The country foods study area lies within the seasonal ranges of the Ahiak, Bathurst, and Dophin and Union caribou herds. Collared Bathurst caribou did not overwinter near the country foods study area between 2007 to 2010 (Rescan 2011). No collared Bathurst caribou were observed to migrate through the country foods study area from 2007 to 2010 (Rescan 2011), while the spring migration route for collared Ahiak caribou passes to the east of Bathurst Inlet in a generally northerly direction from wintering grounds (Rescan 2011). Collared Ahiak caribou have been observed to overwinter within and in areas surrounding the country foods study area in more than one year. The Marine Laydown Area portion of the country foods study area also overlaps with the Dophin and Union Herd annual range, as they overwinter on the tundra, principally in the area surrounding Bathurst Inlet (Rescan 2011)

The calving range of the Ahiak herd and Bathurst herd, based on the fixed kernel utilization distribution, is mainly outside of the country foods study area, although a 95% kennel utilization distribution overlapped with the Goose Property area during 2008. Interestingly, a few females from Ahiak herd appeared to have wintered and migrated along with the Bathurst herd in 2007 and 2010 and in doing so, passed through the country foods study area in the last stages of their migration to calving grounds east of Bathurst Inlet.

Fixed kernel utilization distributions during the post-calving period shows that the collard Bathurst caribou use habitat in the country foods study area, while collared Ahiak caribou are generally found far from the country foods study area. During summer, collared Bathurst and Ahiak caribou shift southwest from the areas occupied during post-calving and therefore collared Bathurst caribou move away from the country foods study area while collared Ahiak caribou move towards the country foods study area. The Ahiak herd is also present near or within the country foods study area during fall.

For 2012, the first caribou observation was captured by the wildlife cameras in the field in late May 2012 and the last observation was an incidental observation in September 2012 (Rescan 2013c). Based on the above observations and the information on the seasonal ranges of the caribou herds between 2007 and 2010, it is unlikely that any caribou would spend all year in the country foods study area. However, although unlikely, based on collective presence of caribou from both Bathurst and Ahialk herds within or near the country foods study area, a single caribou may potentially be present at the country foods study area from May to end of October. Thus, for the purposes of this assessment it was assumed that caribou have an exposure period of six months in the study area. This is considered to be a conservative estimate of time spent in the study area.

Canada geese arrive on the central Canadian Arctic barrens in early to mid-May and generally depart by mid-September. If a pair of geese were to nest and raise young in the country foods study area, it is conceivable that residency in area would be for the entire time that they are in the Arctic. Therefore, residency time in the study area is, at most, five months.

The country foods study area is large enough that it could overlap with the entire home range of the Arctic ground squirrel (Hubbs and Boonstra 1998). However, this species hibernates over winter from early September to late April. Thus, residency time in the study area is five months.

Based on a report using satellite tracking indices, ringed seals typically feed within 100 km of their breeding habitat (National Marine Fisheries Service 2012). However, they can cover hundreds or thousands of kilometers to get to areas that have abundant food resources (National Marine Fisheries Service 2012). Ringed seals have been observed in Bathurst Inlet (Rescan 2013c), including the portion that is part of the country foods study area. The foraging area for ringed seals in southern Bathurst Inlet is much smaller than the habitat range of these animals which may be up to 1000s of km in summer (Heide-Jørgensen, Stewart, and Leatherwood 1992; Kapel et al. 1998; Teilmann, Born, and Acquarone 1999); however, it was conservatively assumed that seals spend all year eating within the country foods area. Therefore, the seal tissue concentrations modelled in this assessment is highly conservative in nature.

2.3 Biotransfer Factors

Tissue uptake calculations were based on metal-specific biotransfer factors (BTF), which are rates at which metals are taken up and absorbed into wildlife tissue from their food. Food-to-tissue BTFs were used for water-to-tissue and soil-to-tissue transfer calculations in the absence of specific BTFs for these media. This methodology is based on a document prepared for Health Canada (Golder and Associates 2005).

No species-specific BTFs for caribou, Arctic ground squirrel, or seals were available, therefore beef BTFs were used. The use of beef BTFs for wild mammals is considered to be a conservative approach (RAIS 2010).

There were no BTFs specifically for the Canada goose, and beef BTFs are inappropriate, therefore chicken BTFs were used (RAIS 2010). The chicken BTFs were obtained from the Pacific Northwest National Laboratory's (PNNL) report (Staven et al. 2003). The metal specific food-to-tissue chicken BTFs were used for all exposure pathways for Canada goose, since media-specific BTFs were not available (Table B-5).

3. SAMPLE CALCULATION AND COMPLETE MODEL RESULTS

Table B-6 provides a sample calculation for the concentration of thallium in Canada goose tissue. Tables B-7 to B-9 present the estimated tissue concentrations in caribou, arctic ground squirrel and Canada goose from the food chain modelling of metal uptake from soil, surface water and vegetation. Table B-10 presents the estimated tissue COPC concentrations in ringed seals from consumption of starry flounder.

Table B-5. Biotransfer Factors Used to Predict Metal Uptake into Terrestrial and Marine Wildlife Tissue

Metal	BTF_{beef} (day/kg)[1]	$BTF_{chicken}$ (day/kg)	$BTF_{chicken}$ Reference
Aluminum	0.0015	0.8	Staven et al.(2003)[2]
Arsenic	0.002	0.83	Staven et al.(2003)
Cadmium	0.00055	0.8	Staven et al.(2003)
Chromium	0.0055	0.2	Staven et al.(2003)
Copper	0.01	0.5	Staven et al.(2003)
Lead	0.0004	0.8	Staven et al.(2003)
Mercury	0.25	0.03	Staven et al.(2003)
Nickel	0.006	0.001	Staven et al.(2003)
Selenium	0.0150	1.12	US EPA (2005)
Thallium	0.040	0.8	Staven et al.(2003)
Zinc	0.10	0.009	US EPA (2005)

[1] *RAIS (2010).*
[2] *No Avian BTF; used BTF for fluorine.*

Table B-6. Sample Calculation of Thallium Concentration in Canada Goose Tissue from Exposure to Soil, Surface Water, and Vegetation

$$C_{meat} = C_{msoil} + C_{mveg} + C_{mwater}$$

and:

$$C_{msoil} = BTF_{tissue\text{-}food} \times [(C_{soil} + C_{wetland\ sediment})/2] \times IR_{soil} \times fw \times fp$$

$$C_{mveg} = BTF_{tissue\text{-}food} \times [(C_{berry} + C_{water\ sedge})/2] \times IR_{veg} \times fw \times fp$$

$$C_{mwater} = BTF_{tissue\text{-}food} \times C_{water} \times IR_{water} \times fw \times fp$$

where:

C_{meat} = total concentration of COPC in meat tissue from soil, vegetation and water consumption (mg/kg)
C_{msoil} = concentration of COPC in meat tissue from soil and wetland sediment consumption (mg/kg)
C_{mveg} = concentration of COPC in meat tissue from vegetation consumption (mg/kg)
C_{mwater} = concentration of COPC in meat tissue from water consumption (mg/kg)
C_{soil} = concentration of COPC in soil (mg/kg)
$C_{wetland\ sediment}$ = concentration of COPC in wetland sediment (mg/kg)
C_{berry} = concentration of COPC in berries (mg/kg)
$C_{water\ sedge}$ = concentration of COPC in water sedge (mg/kg)
C_{water} = concentration of COPC in water (mg/L)
$BTF_{tissue\text{-}food}$ = bio-transfer factor from food consumption to tissues for a selected metal (day/kg)
C = average concentration of metal in media (mg/kg)
IR = ingestion rate of media (kg/day)
Fw = fraction of daily consumption (assumed 1; unitless)
Fp = fraction of the year the animal is onsite (unitless)

Calculation:

C_{msoil} = 0.8 day/kg x [(0.00992 mg/kg +0.0377 mg/kg)/2] x 0.07 kg/day x 1 x 0.42 = 0.000560 mg/kg
C_{mveg} = 0.8 day/kg x [(0.005 mg/kg + 0.0057 mg/kg)/2] x 1.355 kg/day x 1 x 0.42= 0.00244 mg/kg
C_{mwater} = 0.8 day/kg x 0.0000298 mg/L x 0.161 L/day x 1 x 0.42 = 0.00000161 mg/kg
C_{meat} = 0.0030 mg/kg wet weight

Table B-7. Estimated Concentrations in Caribou Meat

Metal	C_{soil}	C_{water}	C_{veg}	C_{total}
Aluminum	$3.77x10^{+00}$	$2.11x10^{-04}$	$1.85x10^{+00}$	$5.61x10^{+00}$
Arsenic	$6.70x10^{-03}$	$3.72x10^{-06}$	$2.03x10^{-03}$	$8.74x10^{-03}$
Cadmium	$6.68x10^{-06}$	$3.97x10^{-08}$	$8.17x10^{-05}$	$8.84x10^{-05}$
Chromium	$4.17x10^{-02}$	$6.18x10^{-06}$	$7.20x10^{-03}$	$4.89x10^{-02}$
Copper	$5.39x10^{-02}$	$9.38x10^{-05}$	$8.49x10^{-02}$	$1.39x10^{-01}$
Lead	$4.34x10^{-04}$	$1.89x10^{-07}$	$1.11x10^{-03}$	$1.55x10^{-03}$
Mercury	$9.40x10^{-04}$	$6.25x10^{-06}$	$4.68x10^{-02}$	$4.77x10^{-02}$
Nickel	$3.18x10^{-02}$	$1.93x10^{-04}$	$7.47x10^{-02}$	$1.07x10^{-01}$
Selenium	$6.53x10^{-04}$	$3.88x10^{-06}$	$2.05x10^{-02}$	$2.11x10^{-02}$
Thallium	$6.18x10^{-04}$	$5.96x10^{-06}$	$2.74x10^{-03}$	$3.36x10^{-03}$
Zinc	$7.37x10^{-01}$	$1.54x10^{-03}$	$5.38x10^{+00}$	$6.12x10^{+00}$

All units are in mg/kg wet weight

Table B-8. Estimated Concentrations in Arctic Ground Squirrel Meat

Metal	C_{soil}	C_{water}	C_{veg}	C_{total}
Aluminum	$7.71x10^{-03}$	$2.31x10^{-06}$	$5.60x10^{-03}$	$1.33x10^{-02}$
Arsenic	$1.37x10^{-05}$	$4.06x10^{-08}$	$9.59x10^{-06}$	$2.34x10^{-05}$
Cadmium	$1.37x10^{-08}$	$4.33x10^{-10}$	$4.16x10^{-07}$	$4.30x10^{-07}$
Chromium	$8.55x10^{-05}$	$6.75x10^{-08}$	$2.87x10^{-05}$	$1.14x10^{-04}$
Copper	$1.10x10^{-04}$	$1.02x10^{-06}$	$7.38x10^{-04}$	$8.49x10^{-04}$
Lead	$8.89x10^{-07}$	$2.07x10^{-09}$	$3.42x10^{-06}$	$4.31x10^{-06}$
Mercury	$1.93x10^{-06}$	$6.83x10^{-08}$	$1.45x10^{-04}$	$1.47x10^{-04}$
Nickel	$6.51x10^{-05}$	$2.11x10^{-06}$	$3.97x10^{-04}$	$4.64x10^{-04}$
Selenium	$1.34x10^{-06}$	$4.24x10^{-08}$	$9.98x10^{-05}$	$1.01x10^{-04}$
Thallium	$1.27x10^{-06}$	$6.51x10^{-08}$	$1.37x10^{-05}$	$1.51x10^{-05}$
Zinc	$1.51x10^{-03}$	$1.68x10^{-05}$	$4.07x10^{-02}$	$4.22x10^{-02}$

All units are in mg/kg wet weight

Table B-9. Estimated Concentrations in Canada Goose Meat (mg/kg wet weight)

Metal	C_{soil}	C_{water}	C_{veg}	C_{total}
Aluminum	$8.20x10^{+01}$	$1.52x10^{-03}$	$1.57x10^{+00}$	$8.36x10^{+01}$
Arsenic	$1.23x10^{-01}$	$2.09x10^{-05}$	$2.98x10^{-02}$	$1.52x10^{-01}$
Cadmium	$1.38x10^{-03}$	$7.81x10^{-07}$	$5.64x10^{-03}$	$7.02x10^{-03}$
Chromium	$6.44x10^{-02}$	$3.04x10^{-06}$	$5.87x10^{-03}$	$7.03x10^{-02}$
Copper	$1.71x10^{-01}$	$6.34x10^{-05}$	$5.09x10^{-01}$	$6.80x10^{-01}$
Lead	$3.74x10^{-02}$	$5.12x10^{-06}$	$4.95x10^{-03}$	$4.24x10^{-02}$
Mercury	$1.30x10^{-05}$	$1.01x10^{-08}$	$1.64x10^{-05}$	$2.94x10^{-05}$
Nickel	$3.10x10^{-04}$	$4.36x10^{-07}$	$6.02x10^{-04}$	$9.12x10^{-04}$
Selenium	$3.80x10^{-03}$	$3.94x10^{-06}$	$6.41x10^{-02}$	$6.79x10^{-02}$
Thallium	$5.60x10^{-04}$	$1.61x10^{-06}$	$2.44x10^{-03}$	$3.00x10^{-03}$
Zinc	$3.16x10^{-03}$	$1.82x10^{-06}$	$4.55x10^{-02}$	$4.87x10^{-02}$

All units are in mg/kg wet weight

Table B-10. Estimated Concentrations in Ringed Seal

Metal	C_{total}
Aluminum	3.03×10^{-02}
Arsenic	9.12×10^{-03}
Cadmium	4.24×10^{-06}
Chromium	6.18×10^{-04}
Copper	8.32×10^{-03}
Lead	1.94×10^{-05}
Mercury	2.98×10^{-02}
Nickel	6.74×10^{-04}
Selenium	1.34×10^{-02}
Thallium	2.70×10^{-04}
Zinc	$1.48 \times 10^{+00}$

All units are in mg/kg wet weight

REFERENCES

Golder and Associates. 2005. *Guidance Document for Country Foods Surveys for the Purpose of Human Health Risk Assessment*. Prepared for Health Canada.

Heide-Jørgensen, M. P., B. S. Stewart, and S. Leatherwood. 1992. Satellite tracking of ringed seals Phoca hispida off northwest Greenland. *Ecography*, 15: 56-61.

Hubbs, A. H. and R. Boonstra. 1998. Effects of food and predators on the home-range sizes of Arctic ground squirrels (Spermophilus parryii). *Canadian Journal of Zoology*:

Kapel, F. O., J. , J. Christiansen, M. P. Heide-Jørgensen, T. Härkönen, E. W. Born, L. O. Knutsen, F. Riget, and J. Teilmann. 1998. *Netting and conventional tagging used to study movements of ringed seals (Phoca hispida) in Greenland*. NAMMCO Scientific Publications, Vol. 1. N. Atl. Mar. Mamm. Comm: Tromsø, Norway.

MacDonald, C. R. and A. Gunn. 2004. *Analysis of the ash weight and elemental composition of caribou (Rangifer tarandus) faecal pellets collected at Colomac and other sites in the NWT*. Manuscript Report No. 159. Department of Resources, Wildlife and Economic Development: Yellowknife, NWT.

National Marine Fisheries Service. 2012. *Endangered Species Act-Section 7 Consultation: Biological Opinion and Conference Report*. Prepared by National Fisheries Service: Alaska Region, AK.

ORNL. 1997. *Methods and Tools for Estimation of the Exposure of Terrestrial Wildlife to Contaminants*. Oak Ridge, Tennessee, ORNL/TM-13391:

PNNL. 2003. *A Compendium of Transfer Factors for Agricultural and Animal Products*. Prepared for the U.S. Department of Energy, PNNL-13421.

RAIS. 2010. *Chemical Factors*. http://rais.ornl.gov/index.html (accessed January 2012).

Rescan. 2007. *Bathurst Inlet Port and Road Project: Draft Environmental Impact Statement*. Vancouver, British Columbia.

Rescan. 2011. *2010 Back River and Hackett River Projects: 2010 Caribou and Muskox Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2012a. *Back River Project: 2011 Freshwater Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. June 2012: Vancouver, British Columbia.

Rescan. 2012b. *Back River Project: 2012 Freshwater Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. 2013: Vancouver, British Columbia.

Rescan. 2012c. *Back River Project: Wildlife Baseline Report 2011*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2013a. *Back River Project: 2012 Soil and Terrain Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Rescan. 2013b. *Back River Project: 2012 Vegetation and Wetlands Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Rescan. 2013c. *Back River Project: 2012 Wildlife Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Staven, L. H., K. Rhoads, B. A. Napier, and D. L. Strenge. 2003. *A Compendium of Transfer Factors for Agricultural and Animal Products*. PNNL-13421. Pacific Northwest National Laboratory US Department of Energy: Richland, WA.

Teilmann, J., E. W. Born, and M. Acquarone. 1999. Behaviour of ringed seals tagged with satellite transmitters in the North Water polynya during fast-ice formation. *Journal of Zoology*, 77: 1934-46.

US EPA. 1993. Wildlife Exposure Factors Handbook.

US EPA. 2005. *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. Multimedia Planning and Permitting Division Office of Solid Waste Center for Combustion Science and Engineering, Report number: EPA530-R-05-006.

Appendix C

Sample Calculation of Estimated Daily Intake of Arsenic for a Toddler Consuming Caribou Tissue

Appendix C. Sample Calculation of Estimated Daily Intake of Arsenic for a Toddler Consuming Caribou Tissue

$$EDI_{countryfood} = \frac{IR \times F_s \times C_{countryfood} \times P_{as}}{BW}$$

$EDI_{countryfood}$ = estimated daily intake of country food (mg/kg body weight-day)
IR = ingestion rate (kg/day)
$C_{countryfood}$ = mean metal concentration in country food (mg/kg ww)
F_s = fraction of year/week consuming country foods
BW = receptor body weight (kg)
P_{as} (in caribou) = proportion of inorganic arsenic relative to total arsenic concentration

Parameter	Value
IR	0.116 kg/day
$C_{countryfood}$	0.00874 mg/kg ww
F_s	1
BW	16.5 kg/day
P_{as}	0.0078 (from Schoof et al 1999)

$$EDI_{countryfood} = \frac{0.116 \times 1 \times 0.00874 \times 0.0078}{16.5}$$

$$EDI_{countryfood} = 4.8 \times 10^{-7} \left(\frac{mg}{kg_{BW} day} \right)$$

Appendix D

Sample Calculation of Estimated Daily Lifetime Exposure to Arsenic for an Adult Consuming Lake Trout Tissue

Appendix D. Sample Calculation of Estimated Daily Lifetime Exposure to Arsenic for an Adult Consuming Lake Trout Tissue

$$ELDE_{countryfood} = \frac{IR \times F_s \times C_{countryfood} \times P_{as} \times YE}{BW \times LE}$$

$ELDE_{countryfood}$	= estimated lifetime daily intake of country food (mg/kg bw/day)
IR	= ingestion rate (kg/day)
F_s	= fraction of year consuming country foods (unitless)
P_{as} (in lake trout)	= proportion of inorganic arsenic relative to total arsenic concentration
$C_{countryfood}$	= metal concentration in country food (mg/kg)
YE	= years exposed (yr)
BW	= receptor body weight (kg)
LE	= life expectancy (yr)

Parameter	Value
IR	0.254 kg/day
Fs	0.0137
$C_{countryfood}$	0.0328 mg/kg ww
P_{as} (in lake trout)	0.1[1]
YE=LE	80 years
BW	70.7 kg

$$ELDE_{countryfood} = \frac{0.254 \times 0.0137 \times 0.0328 \times 0.1 \times 80}{70.7 \times 80}$$

$$ELDE_{countryfood} = 1.62 \times 10^{-7} \left(\frac{mg}{kg_{BW}\, day} \right)$$

[1] assuming 10% of the total $C_{countryfood}$ is in the form of inorganic arsenic. Source: Zdenka et al. (2004).

Appendix E

Recommended Maximum Weekly Intake Rates for Country Foods

Appendix E. Recommended Maximum Weekly Intake Rates for Country Foods

Country Food	Human Receptor	Recommended Maximum Weekly Intake of Food (RMWI; kg/week)											Lowest MetalRMWI (kg/Week)	Serving Size (kg/Serving)	Recommended Number of Servings/Week	Current Number of Servings/Week
		Aluminum	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Thallium	Zinc				
Caribou	Toddler	20.6	511	1,306	2.36	76	268	0.726	27.1	33.9	2.41	10.8	0.726	0.116	6.3	7.0
	Adult	88.2	2,187	5,597	10.1	502	1,150	3.11	116	134	10.3	46.1	3.11	0.270	12	7.0
Arctic Ground Squirrel	Toddler	8,673	190,956	268,728	1,011	12,375	96,404	235	6,223	7,078	537	1,559	235	0.0228	10,322	2.0
	Adult	37,162	818,217	1,151,458	4,331	82,163	413,077	1,008	26,662	27,883	2,302	6,679	1,008	0.0530	19,018	2.0
Canada Goose	Toddler	1.38	22.0	16.5	1.64	15.5	9.81	1,177	3,165	10.60	2.70	1,352	1.38	0.0847	16	0.10
	Adult	5.92	94	70.5	7.04	103	42.0	5,042	13,561	41.5	11.6	5,794	5.92	0.197	30	0.10
Lake Trout	Toddler	94.6	10.6	46.2	1.58	37.3	9.06	0.124	54.8	1.92	1.19	16.3	0.124	0.109	1.1	0.10
	Adult	406	45.2	198.0	6.75	248	38.8	1.08	235	7.55	5.08	70.0	1.08	0.254	4.3	0.10
	Sensitive Groups*							0.530					0.530	0.254	2.1	0.10
Mussels	Toddler	0.512	0.0204	0.0553	0.198	5.26	1.23	1.08	4.64	0.716	4.25	3.82	0.0553	0.00129	43	0.92
	Adult	2.19	0.0873	0.237	0.847	34.9	5.26	9.47	19.9	2.82	18.2	16.3	0.2370	0.0030	79	0.92
Ringed Seal Meat	Toddler	3,810	1,393	27,215	187	1,263	21,471	0.890	4,284	53.3	30.0	44.5	0.890	0.103	33	0.19
	Adult	16,326	5,970	116,611	801	8,386	92,001	7.80	18,357	210	129	191	7.80	0.240	8.6	0.19
	Sensitive Groups*							3.81					3.81	0.240	15.9	0.19
Ringed Seal Blubber	Toddler	3,810	1,393	27,215	187	1,263	21,471	0.890	4,284	53.3	30.0	44.5	0.890	0.037	24	1.57
	Adult	16,326	5,970	116,611	801	8,386	92,001	7.80	18,357	210	129	191	7.80	0.087	90	1.57
	Sensitive Groups*							3.81					3.81	0.087	44	1.57
Berries	Toddler	19.5	8.89	7.53	2.17	11.1	41.6	64.6	8.41	7.16	1.62	12.6	1.62	0.00559	290	2.9
	Adult	83.7	38.1	32.3	9.30	73.5	178	277	36.1	28.2	6.93	53.9	6.93	0.0130	533	2.9

Values are RMWI in g/week (unless stated otherwise).

** protective of sensitive groups (women with child-bearing age) for the lowest metal RMWI is based on mercury concentrations.*

$$RMWI = \frac{(TRV \times BW \times 7)}{C_{food}}$$

where:

RMWI = Recommended Maximum Weekly Intake of food (g/week)
TRV = toxicological reference value (µg/kg body weight/day)
BW = receptor body weight (kg) (toddler 16.5 kg; adult 70.7 kg)
7 = number of days/week
C_{food} = concentration of each meal (µg/g)

Appendix V8-5B

Addendum to the Proposed Back River Project Country Foods Baseline Screening Level Risk Assessment

Sabina
GOLD & SILVER CORP.

SCIENCE INTEGRITY KNOWLEDGE

ADDENDUM TO THE PROPOSED BACK RIVER PROJECT COUNTRY FOODS BASELINE SCREENING LEVEL RISK ASSESSMENT

APPENDIX V8-5B

Final Report

October 16, 2015

Prepared For: **Sabina Gold & Silver Corp.**

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ADDENDUM TO THE PROPOSED BACK RIVER PROJECT COUNTRY FOODS BASELINE SCREENING LEVEL RISK ASSESSMENT

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GLOSSARY AND ABBREVIATIONS

BTF	biotransfer factor
CCME	Canadian Council of Ministers of the Environment
COPC	contaminant of potential concern
EDI	estimated daily intake
FAO	Food and Agriculture Organization of the United Nations
ILCR	Incremental Lifetime Cancer Risk
IQ	intelligence quotient
IRIS	Integrated Risk Information System
JECFA	Joint FAO/WHO Expert Committee on Food Additives
KIA	Kitikmeot Inuit Association
LOAEL	lowest observable adverse effect level
LSA	Local Study Area
NOAEL	no observed adverse effect level
NWMB	Nunavut Wildlife Management Board
PTWI	provisional tolerable weekly intake
RDL	realized detection limit
RfD	reference dose
RMWI	Recommended Maximum Weekly Intake
TDI	tolerable daily intake
the Project	Back River Project
TRV	toxicity reference value
U.S. EPA	United States Environmental Protection Agency
WHO	World Health Organization

EXECUTIVE SUMMARY

As summarized in Vol 8-5A, The Back River Project (the Project) is an exploration gold project owned by Sabina Gold and Silver Corp. (Sabina) located in the West Kitikmeot region of Nunavut. In 2012, Sabina contracted Rescan Environmental Services (Rescan, now known as ERM) to conduct a comprehensive baseline program that covered the geographical area of the Goose Property, the George Exploration Camp, and a Marine Laydown Area located on the southern part of Bathurst Inlet. Volume 8-5A of the FEIS presents the results of the country foods baseline portion of the overall program, and this report provides an addendum to that report.

The country foods baseline risk assessment integrated the results of the environmental media baseline data, human receptor characteristics, and regulatory-based Toxicity Reference Values (TRVs) to predict potential risks associated with consumption of country foods in the Local Study Area (LSA) of the proposed Project, associated with baseline (pre-Project implementation) concentrations. In total, the quality of seven country foods from seven different groups was estimated prior to development of the potential Project, and these results are considered to reflect the baseline risk associated with country foods consumption. The country foods evaluated included: a large terrestrial mammal (caribou, *Rangifer tarandus*), a small terrestrial mammal (Arctic ground squirrel, *Spermophilus parryii*), a bird species (Canada goose, *Branta canadensis*), a fish species (lake trout, *Salvelinus namaycush*), a shellfish species (bay mussel, *Mytilus trossulus*), a marine mammal (ringed seal, *Phoca hispida),* and berries (bog cranberry, *Vaccinium vitis-idaea* and bog blueberry, *Vaccinium uliginosum* combined).

This addendum updated certain aspects of the baseline country food study presented in Appendix Vol 8-5A. In particular, the baseline media concentrations were re-calculated to reflect the fact that the George Property is now going to remain an Exploration Camp, rather than undergo full development; selected TRVs were updated due largely to the passage of time since the DEIS; selected consumption rates were updated to include organ meat consumption for selected country foods, and other slight modifications. As a result, the Estimated Daily Intakes (EDI) and Risk Quotients presented in this report supersede those presented in Appendix V8-5A.

The results of the baseline country food study indicate that consumption of country foods at the rates assumed in the current project are not expected to result in adverse health effects to toddler or adults. Some Risk Quotients marginally greater than 1 were predicted for toddler consumption of caribou organ meats and freshwater fish, as well as for pregnant women consuming seal meat. These exceedances were considered to be a result of conservative assumptions in the assessment. Consideration of these factors, in conjunction with the nutritional benefits of these foods, clearly indicates that consumption of these foods at the rates indicated in this assessment is unlikely to be associated with any adverse health effects.

The Recommended Maximum Weekly Intakes (RMWIs) were calculated for non-carcinogenic effects from metal exposure and are representative of the highest intake rates of country foods that are safe for consumption at an acceptable risk level. Based on calculated RMWIs, caribou, Arctic ground squirrels, Canada geese, lake trout, ringed seals (both muscle, liver and blubber tissue), bay mussels, and berries (bog blueberry and bog cranberry) were shown to not present health risks from metals to local human consumers. People in the area can continue to eat these foods at the consumption rates used in this report. With respect to the lifetime cancer risk (LCR) predictions associated with arsenic in country foods, the predicted LCR was 8.6 in 100,000, and the Estimated Daily Intake predicted in this assessment is within the range predicted for typical Canadian or American background exposures to inorganic arsenic from food and water. This provides some assurance that predicted background exposures to inorganic arsenic related to local harvesting of foods, consumption of surface waters and incidental ingestion of soils in the LSA are similar to those found in other populations in North America.

The duration for which the animals were assumed to be present within the country foods study area, consumption frequencies of country foods, and portion size of country foods consumed were conservative in nature. In addition, the highest measured or modelled country food tissue metal concentration was used in the calculation of RMWIs and LCRs. The current assessment is therefore considered to provide a conservative assessment of risk. The current assessment does not account for the cultural and nutritional benefits associated with the harvesting activities and consumption of country foods. There has been an increase in the literature over the past 15 years stressing the cultural, social, nutritional, and economic benefits of traditional food hunting, gathering and consumption, and weighing these benefits with potential risk related to contaminants in food (e.g., Chan 2011; Kuhnlein and Chan 2000; Kuhnlein et al 2000; Van Oostdam et al,1999). Country foods are healthy food choices (with the exception of any food advisories, which should be respected), relative to many store bought food choices, and are high in protein, nutrients and vitamins. The results of the current assessment supports the consumption of these foods at the rates assumed in the current project.

1.0 INTRODUCTION

In 2012, Sabina contracted ERM/Rescan Environmental Services Ltd. (ERM) to conduct a comprehensive baseline program that covered the geographical area of the Goose Property, the George Property, and a Marine Laydown Area located on the southern part of Bathurst Inlet. In addition, ERM completed a country foods baseline screening level assessment for the Project as part of the Draft Environmental Impact Statement (DEIS)(See Volume 8-5A). Since the release of the DEIS, several changes to the Project have been proposed including that the George Property will not be immediately developed, but rather will be an exploration camp which may be developed at a later date. In addition, several mine design changes have been implemented at the Goose Property since the DEIS, which require consideration for the FEIS. As such, the country foods baseline screening level risk assessment presented in Appendix Volume 8-5A of the DEIS required revision to incorporate these and other changes.

Intrinsik Environmental Sciences Inc. (Intrinsik) was contracted by Sabina to update the country foods baseline screening level risk assessment. In addition to consideration of the changes to the Project, key input parameters to the baseline country food assessment also were reviewed to ensure that they were up to date (e.g., approaches, guidelines, etc.) in light of the passage of time since the DEIS was completed. This addendum provides the update to Appendix V8-5A. This addendum only provides updates for sections wherein changes were made, relative to Appendix V8-5A, since many aspects of the detailed approach to conduct the baseline country foods assessment were left unchanged. To provide some context in this addendum, some text from Appendix V8-5A has been copied verbatim and included in sections of this addendum, with approval by Sabina. Therefore, while this is published as an Intrinsik Addendum, ERM is an important contributor to this report, through the use of methodology and text as provided in Appendix V8-5A.

To summarize changes between the DEIS Baseline Country Foods Assessment and this addendum, the following should be noted:

- Problem Formulation: The Problem Formulation largely remains the same as in Appendix V8-5A. Differences are identified in Section 3.0 of this Addendum.
- Exposure Assessment: Due to exclusion of the George Property (now known as the George Exploration Camp) from the FEIS, the baseline data required re-calculation, and hence, the Exposure Assessment presented in this Addendum (Section 4.0) supersedes that presented in Appendix V8-5A. In addition, in response to comments received at Technical Hearings associated with the DEIS, game meat consumption rates were revised to include organ meat consumption for selected country foods.
- Toxicity Assessment: Some minor updates to Toxicity Reference Values (TRVs) used in the DEIS were undertaken, and all changes are summarized in Section 5.0 of this Addendum.
- Risk Characterization: Due to changes to both the Exposure Assessment and Toxicity Assessment, the Risk Characterization presented in this Addendum (Section 6.0) supersedes that presented in Appendix V8-5A.

1.1 Scope and Objectives

This report is an addendum to the country foods baseline screening level risk assessment (Appendix V8-5A) which provides the baseline concentrations of Contaminants of Potential Concern (COPC), the estimated consumption rates of country foods by the harvesters, as well as estimated daily intakes (based on baseline concentrations of metals in various media, and the estimated consumption rates), and estimated health risks associated with consumption of country foods. Calculations of the current Recommended Maximum Weekly Intakes (RMWIs) of country foods are also presented following Health Canada's guidance on health impact assessments (Health Canada 2012; 2010a, b).

2.0 APPROACH AND STUDY AREA

2.1 Approach of the Country Foods Assessment

As stated in Appendix V8-5A, Section 2.1, the approach for the country foods study was based on Health Canada's guidance on methods for conducting human health risk assessment in environmental impact assessments (Health Canada 2012, 2010a) and is divided into the following five stages:

- Problem Formulation;
- Exposure Assessment;
- Toxicity Assessment;
- Risk Characterization; and
- Uncertainty Analysis and Data Gaps.

2.2 Study Area

The study area for the country foods baseline assessment encompassed the Goose Property, the Marine Laydown Area and winter road access corridors (See Figure 2.2-1). A description of the study area is provided in Appendix V8-5A, Section 2.2. As discussed in Appendix V8-5A, the closest communities to the Project are Kingaok, located approximately 160 km to the north of the Goose Property, and Omingmaktok, located approximately 250 km to the northeast of the Goose Property. Both of these communities are populated by small groups for short portions of the year. Currently there are no prominent residents. While the George Property was included as part of the study area in Appendix V8-5A, it has been excluded for this addendum since the George Property is no longer being proposed for initial development, and is now an exploration camp only. The Local Study Area (LSA) for the country foods assessment is identified as the area around potential Project infrastructure, as far as 10 km from the Goose Property, and 3.5 km from the Marine Laydown Area in a northerly, westerly, southerly and easterly direction. In addition, a 1-km buffer zone was included along winter road access corridors. These distances correspond to the Atmospheric LSA areas, as air dispersion of emissions from the Project is considered one of the key potential Project Interactions with the existing environment. The LSA represents the area within the Regional Study Area (RSA) where the Project is predicted to have the greatest emissions and hence greatest potential risks.

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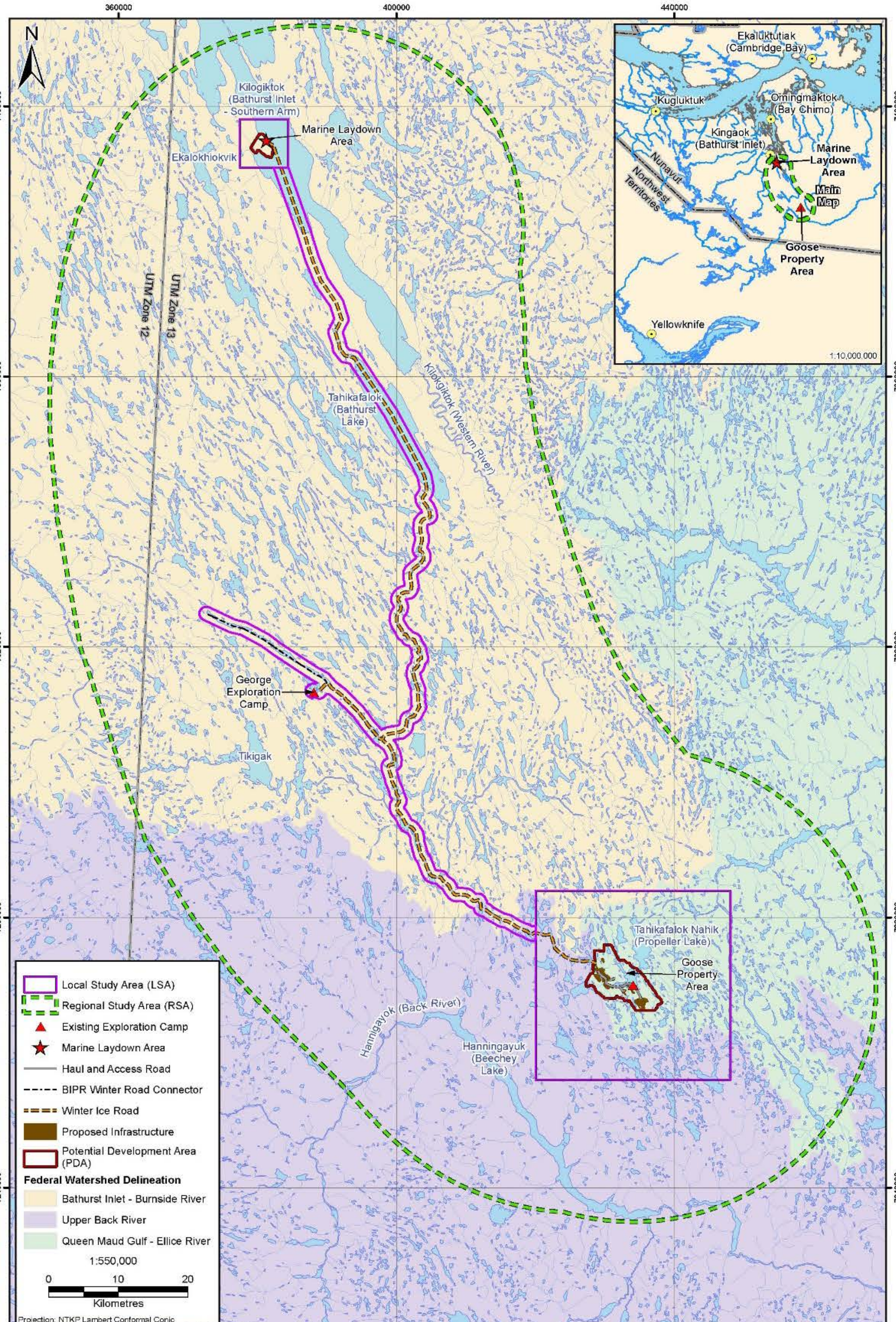

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Figure 2.2-1

Country Foods Local and Regional Study Areas

3.0 PROBLEM FORMULATION

3.1 Introduction

The objectives of the problem formulation stage are to:

- identify the most relevant country foods harvested;
- identify the COPCs in the country foods;
- identify the human receptors and the relevant life stages (e.g., adults and toddlers) that
- harvest and consume the foods; and
- identify the relevant human exposure pathways.

The output of the problem formulation is a conceptual model for the country foods baseline assessment, which identifies the critical issues being assessed. The various aspects of the Problem Formulation which have been updated compared to Appendix V8-5A are presented in the sections which follow.

3.2 Country Foods Selected For Evaluation

The country foods selected for evaluation are provided in Table 3.2-1. Further rationale and justification for the country foods selected for the assessment is provided in Section 3.2, Appendix V8-5A. Based on comments received at the Technical Meetings associated with the DEIS hearings, the KIA had expressed an interest in having organ meat consumption included in the baseline country foods assessment. Organ meat consumption had been accounted for in the DEIS, through increasing consumption rates for caribou muscle. The approach used in the DEIS has been revised such that organ meats are assessed separately from muscle consumption for caribou and ringed seal. Specifics of the consumption rates used in the baseline country foods assessment are discussed further in Section 4.6.

Table 3.2-1 Country Foods Selected for Evaluation

Category	Country Food	Species Name	Parts Consumed
Terrestrial Wildlife	caribou	*Rangifer tarandus*	muscle, liver, kidneys, tongue, stomach, intestine, blubber
	Arctic ground squirrel	*Spermophilus parryii*	muscle
	Canada goose	*Branta canadensis*	muscle
Fish	lake trout	*Salvelinus namaycush*	muscle
Marine Shellfish	Bay mussel	*Mytilus trassulus*	tissue
Marine Mammal	ringed seal	*Phoca hispida*	muscle, blubber, liver
Vegetation	bog blueberry	*Vaccinium uliginosum*	fruit
	bog cranberry	*Vaccinium vitis-idaea*	fruit

3.3 Contaminants of Potential Concern Selected for Evaluation

The screening process used by ERM to select metals as COPCs is described in Appendix V8-5A, Section 3.3 and summarized below. A metal was selected as a COPC if one of the following four criteria were met:

- The maximum metal concentration in soil measured during the soils baseline study exceeded CCME soil quality guidelines for residential and park land land-use.
- The maximum total metal concentration in surface waters measured during the freshwater and marine baseline studies and exceeded its CCME water quality guideline for the protection of aquatic life.

- The maximum metal concentration in sediment measured during the freshwater, marine, and wetland baseline studies exceeded the CCME sediment quality guideline for the protection of aquatic life.
- The metal has a potential to bioaccumulate in organisms or biomagnify in food webs (as identified by ERM).

Based on the above criteria, ERM selected the following metals for inclusion in the country foods baseline assessment:

- aluminum
- arsenic
- cadmium
- chromium
- copper
- lead
- mercury
- nickel
- selenium
- thallium; and
- zinc.

In addition to the COPCs identified above, emissions from future development of the mine were also evaluated to determine which, if any, merited further assessment. By including these COPCs in the Baseline Country Foods Assessment, it enables comparisons to future exposures as a result of the Project and their potential influence on country foods.

The primary pathways by which the Project could influence country foods is through either dust deposition onto area soils, vegetation and water courses, or through effluent discharge onto land or water courses. These pathways were evaluated in detail in Volume 8, Chapter 6 (Human and Ecological Risk Assessment), and it was determined that metals in mine dusts during operations merited further study, due to the potential for metals to accumulate in soils, vegetation, and area lakes, which could result in exposures to country foods consumed by humans. Non-metal emissions, such as volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and dioxins and furans were considered as possible COPCs but were excluded based on mitigation measures that will be put in place to manage these substances. This is discussed further in Chapter 6, Section 6.4.2.6.1 (Vol 8). Therefore, metals associated with mine dusts that could result in increases to country food concentrations were also screened. Based on the results of the air dispersion analysis conducted at Goose Property and the MLA, dust deposition was highest at Goose Property. Therefore, the focus of the COPC screening was on Goose Property dusts. At Goose Property, waste rock was identified as the predominant form of dust associated with the dust deposition (See Volume 4; RWDI, 2015, Appendix V4-1B and 1C). As such, metals in dusts which could be deposited in the LSA where country foods were assumed to be harvested were assessed using a relative toxic potency screen to determine the constituents within the geochemistry which imparted the greatest toxicity potential, based on their relative percent within the waste rock, and their potency. Those metals which represented > 99% of the cumulative toxic potency were considered to require further evaluation in the country foods assessment, and were added as COPCs in the baseline country food assessment. The screening process is described in detail in Appendix A. Based on the toxic potency screening of metals in dusts, arsenic, aluminum, and iron were found to represent > 99% of the cumulative toxic potency of dusts. Iron was added to the COPC list identified in Appendix V8-5A, while aluminum and arsenic were already identified as COPCs.

With respect to the potential for effluent discharge to influence country foods in the future, treated sewage effluent will be discharged onto land only during the Construction phase of the Project. This was considered to have a negligible potential to influence country foods, based on the small size of areas potentially affected by effluent discharge and the large home range of many terrestrial species. In addition, because hunting will be prohibited for employees residing at the camps near Project infrastructure, it is unlikely that wildlife with small home ranges residing in close proximity to Project infrastructure (e.g., Arctic ground squirrels) would be harvested from areas where treated effluent is discharged (See Chapter 5, Section 5.5.4.1.2). Effluent discharge into Goose Lake as a result of operations could potentially influence country foods in the instance that wildlife forage in Goose Lake, and are subsequently consumed by humans. Since the specific COPCs of concern related to this scenario would be bioaccumulative metals, and since these metals were already captured in the screening process, no further COPC additions were required to address this issue. Fish present within Goose Lake could also be influenced by bioaccumulative metals, they were not considered to be accessible for human consumption during Operations, since there will be a no hunting policy for lakes (and terrestrial areas) near Project infrastructure within the PDA (Chapter 5, Section 5.5.3.5). Fish consumption in the future (post Closure) could occur, and as stated above, this issue is addressed through the inclusion of bioaccumulative metals which are already listed as COPCs.

Based on the screening criteria presented by ERM and in this addendum, the following COPCs were selected for evaluation in the baseline country food assessment:

- aluminum
- arsenic
- cadmium
- chromium
- copper
- iron
- lead
- mercury (total mercury and methyl mercury)
- nickel
- selenium
- thallium; and
- zinc.

3.4 Human Receptors

As discussed in Appendix V8-5A, Section 3.4, the human receptors selected for the assessment included both toddlers (six months to four years of age) and adults (older than 19 years of age). Toddlers are often considered the most susceptible life stage for effects due to chemical exposures because of their higher relative ingestion rates per unit body weight and their rapid adsorption and metabolic rates during this important growth period, compared to adults. For adults, the most sensitive subgroup is pregnant women and/or those women of child-bearing age, due to the inherent sensitivities of this group to methyl mercury (Health Canada 2010c).

3.5 Human Exposure Pathways

Human exposure pathways for the baseline country foods presented in Appendix V8-5A were modified to also include direct soil and drinking water ingestion. These pathways, although minor, are plausible as hunters and their families travelling in the area, they could incur incidental soil ingestion and consume drinking water from area lakes and water courses. While soil and water are not considered “country foods” per se, since the baseline assessment must be compared to predicted future exposures which could be incurred as a result of Project-related emissions, and since predicted future exposures should include soil and drinking water, these pathways were captured in this baseline assessment for COPCs associated with county foods consumption to ensure a valid comparison between existing baseline and project alone exposures. Figure 3.5-1 and Figure 3.5-2 in Appendix V8-5A provide the human country foods exposure pathways, and the Country Foods Conceptual Model. While soil ingestion and drinking water ingestion are not included in these figures, all relevant country food pathways are included in these figures and were assessed.

4.0 EXPOSURE ASSESSMENT

4.1 Introduction

The primary objective of the exposure assessment is to estimate, using a series of conservative assumptions, the concentration of the COPCs in various foods eaten by local receptors, and ultimately the rate of exposure (expressed in µg/kg body weight/day) of human receptors to COPCs through the exposure scenarios and pathways identified in the problem formulation. The degree of exposure of human receptors to chemicals in the environment depends on the interactions of major assumptions used in the assessment, including:

- The concentrations of COPCs in various terrestrial wildlife species (such as caribou, Arctic ground squirrel and Canada geese), as a result of their exposures through their diet, waters, and soils.
- The concentrations of COPCs in various aquatic wildlife species (such as freshwater fish, ringed seals, and bay mussels), as a result of their exposures through their diet, waters, and sediments;
- The concentrations of COPCs in various vegetation species (such as berries), as a result of uptake through soils;
- The physical-chemical characteristics of the COPC which affect their environmental fate and transport and determine such factors as efficiency of absorption into the body of a given external exposure; and,
- The behavioural characteristics of the human receptors (*e.g.*, ingestion rates of specific foods, soils, drinking water), as well as body weight, *etc*.

The tissue concentrations of COPCs in various food types and media in this study are based on either measured data or estimated concentrations. Where concentrations were estimated, standardized equations from the published literature were used. The sections which follow provide summaries of the measured environmental concentrations, as well as predictive methods for estimating tissue concentrations. In addition, the predictive approach to estimating the daily intake of each COPCs through consumption of country foods is provided.

4.2 Terrestrial Wildlife Tissue Concentrations

As stated in Appendix V8-5A, no terrestrial wildlife species were sacrificed to obtain tissue samples for metal analysis from the country foods study area. Rather, caribou, Arctic ground squirrel, and Canada goose tissue concentrations were estimated using a food chain model described in Golder (2005). Details of the model can be found in Appendix B. A 95 percent Upper Confidence Limit of the arithmetic mean (95UCLM) baseline metal concentrations in soil, water, sediment, berries, lichens, and sedges (Table B-2.1-1), in addition to animal-specific ingestion rates (Table B-2.2-1), and metal-specific biotransfer factors (BTFs; Table B-2.3-1) were used (in the model) to predict tissue concentrations. To predict caribou and seal organ tissues, a concentration ratio approach was used, based on reported literature values of selected COPCs in caribou muscle to caribou liver. Further details are provided in Appendix B, Section B-2.3.

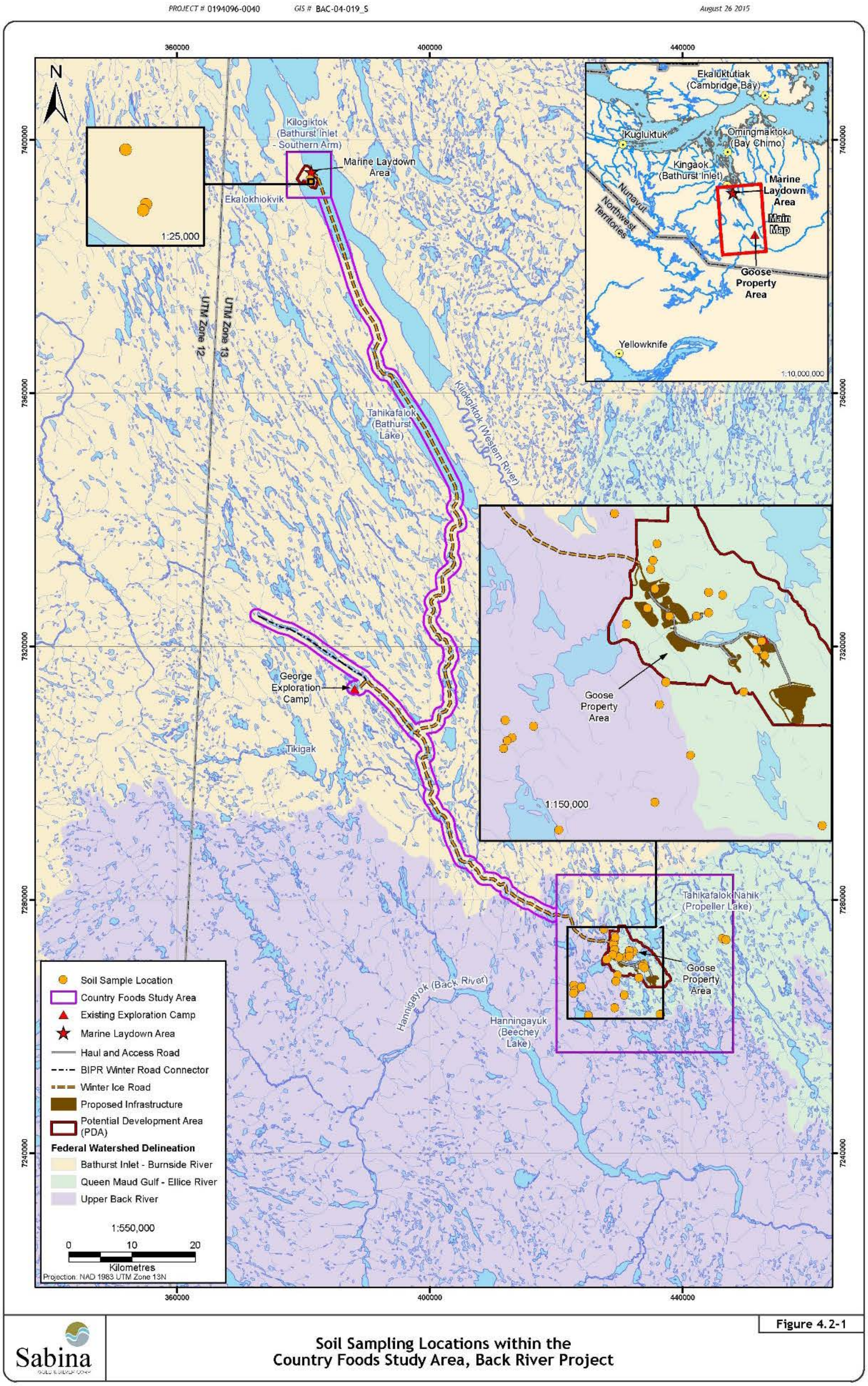
Statistical summaries of the baseline soil, water, berry, lichen and sedge data used in the food chain model had to be revised from those used in the DEIS due to the removal of the George Exploration Camp baseline data, and the use of a differing Exposure Point Concentration (EPC) (a mean value was used in the DEIS versus 95UCLM in the current assessment). The summaries of data used in the current assessment can be found in Appendix C, and sampling locations of the various environmental media are outlined in Figures 4.2-1 (soil sampling locations), Figure 4.2-2 (water and sediment sampling locations), Figure 4.2-3 (berry sampling locations), and Figure 4.2-4 (lichen and sedge sampling locations). Each terrestrial wildlife species consumed in the baseline country foods risk assessment was assumed to be exposed to metal concentrations in the LSA from every environmental medium (i.e., soil, water, and vegetation). For terrestrial wildlife specific diet assumptions refer to Appendix B, Section B-2.2.

Table 4.2-1 presents the predicted Exposure Point Concentrations (EPC) for caribou, Arctic ground squirrel, and Canada goose muscle tissue for each of the COPCs. These predicted concentrations were used as EPCs for the baseline country foods assessment. The modelling approach taken to predict animal tissue concentrations was based on reasonable assumptions (e.g., 95UCLM concentration assumed for EPC, exposed to media in LSA only) and considered acceptable for risk assessment purposes (Golder 2005).

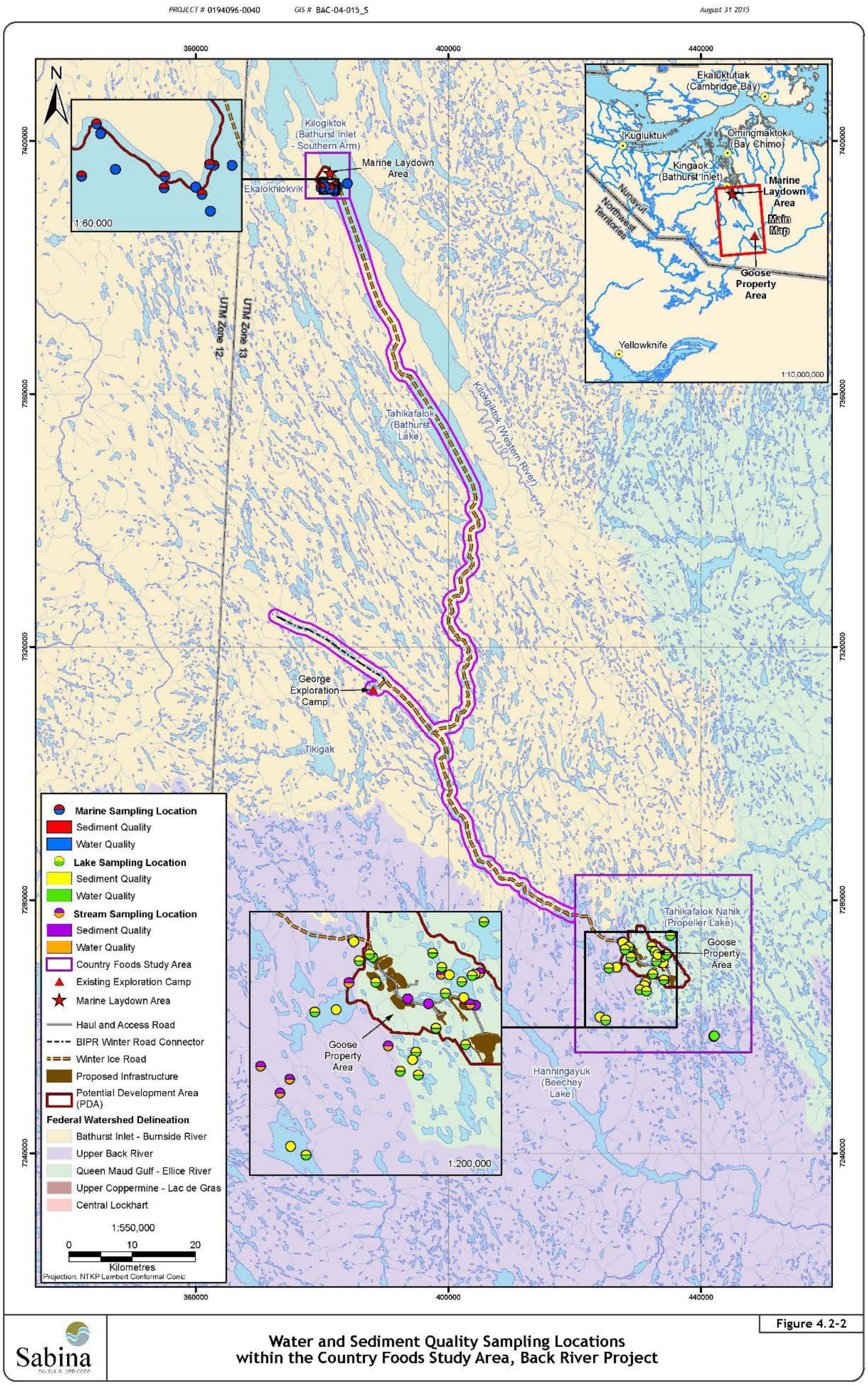
Table 4.2-1 Exposure Point Concentrations Predicted in Terrestrial Wildlife from Exposure to Soil, Surface Water, Lichens and Berries (mg/kg-ww)

COPC	Caribou Muscle Meat (mg/kg)	Caribou Liver [a] (mg/kg)	Arctic Ground Squirrel Meat (mg/kg)	Canada Goose Meat (mg/kg)
Aluminum	6.96	6.96	0.0470	0.797
Arsenic	0.00788	0.00788	0.0000632	0.737
Cadmium	0.000138	0.0236	0.00000161	0.0351
Chromium	0.052	0.052	0.00032	0.33
Copper	0.229	0.229	0.003120	3.59
Iron	130	130	1.08	29.6
Lead	0.0024	0.0024	0.000019	0.25
Mercury [b]	0.0588	0.588	0.000493	0.000136
Nickel	0.314	0.314	0.00306	0.00520
Selenium	0.00093	0.00093	0.000010	0.031
Thallium	0.0011	0.0011	0.000019	0.00054
Zinc	8.23	8.23	0.129	0.172

***Notes**:*
COPC: contaminants of potential concern
ww = wet weight
a Caribou liver concentrations were assumed to equal caribou muscle concentrations except where a metal-specific concentration factor was available; See Appendix B, Section B-2.3 for details.
b methyl mercury is not predicted in terrestrial wildlife, as it is not present in species foraging in terrestrial environments



Soil Sampling Locations within the Country Foods Study Area, Back River Project



Water and Sediment Quality Sampling Locations within the Country Foods Study Area, Back River Project

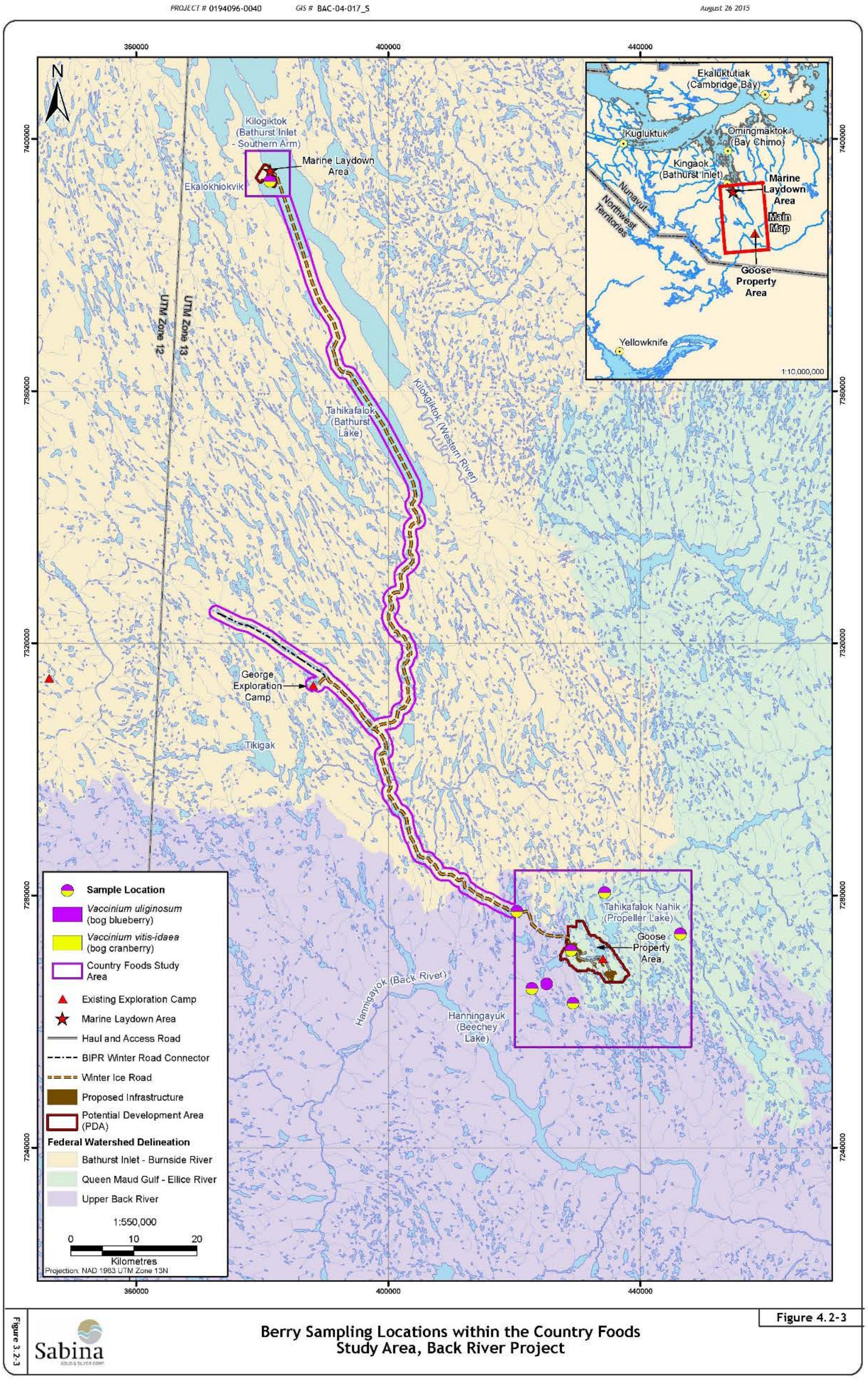


Figure 4.2-3

Berry Sampling Locations within the Country Foods Study Area, Back River Project

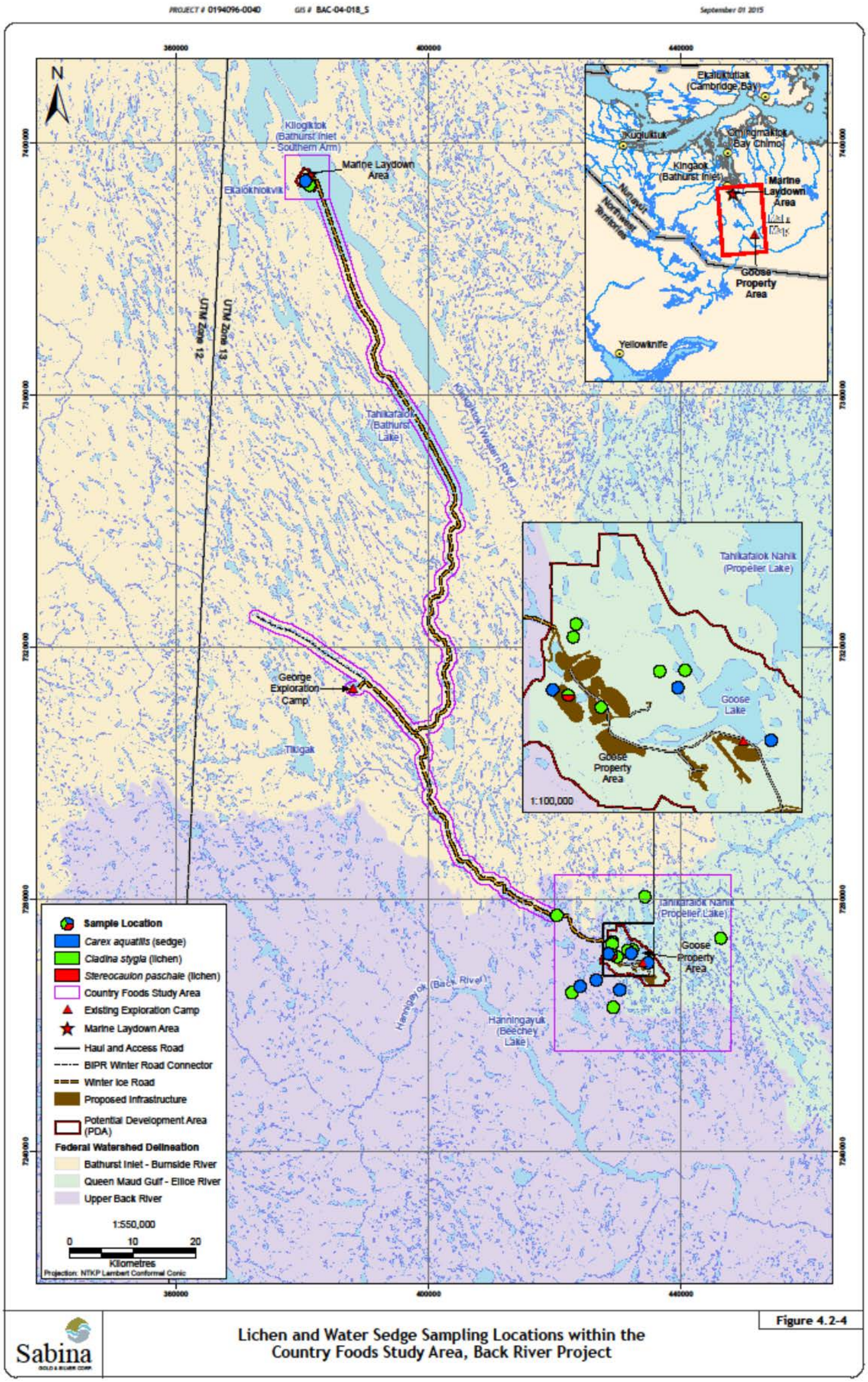


Figure 4.2-4

Lichen and Water Sedge Sampling Locations within the Country Foods Study Area, Back River Project

4.3 Aquatic Biota Tissue Concentrations

For aquatic biota, metal concentrations were analyzed in 22 lake trout (*Salvelinus namaycush*) collected in 2011 and 2012 from the Goose Property LSA. Figure 4.3-1 provides an overview of fish sampling locations within the LSA. Bay mussels (*M. trossulus*) were collected from southern Bathurst Inlet in 2012 (Rescan 2013) from the sampling locations shown in Figure 4.3-1. Statistical summaries of metal concentrations in the lake trout and bay mussel are presented in Appendix C.

The statistical summaries of environmental data (Appendix C), and the EPCs used in the food chain model (Table 4.3-1), differ from those used in the DEIS, as data associated with the George Exploration Camp area were removed. As previously indicated, the DEIS used a mean value as an EPC, whereas the FEIS used the 95UCLM as the EPC, where data allowed, otherwise the maximum was used. Table 4.3-1 provides the EPCs for lake trout and bay mussels used in modelling of baseline country food exposures.

Table 4.3-1 Exposure Point Concentrations for Lake Trout Tissue (mg/kg -ww) and Bay Mussel Tissue (mg/kg -ww) from the Goose Property and Marine Laydown Area

COPC	Lake Trout Tissue (N=22)[a]	Bay Mussel Tissue (N=20)[a]
Aluminum (Al)	1.9	293
Arsenic (As)	0.036	2.32
Cadmium (Cd)	0.0025	2.38
Chromium (Cr)	0.13	0.705
Copper (Cu)	0.307	2.15
Iron (Fe)	Not analyzed	240
Lead (Pb)	0.089	0.387
Mercury (Hg)	0.301	0.0264
Nickel (Ni)	0.06	0.708
Selenium (Se)	0.4	1.062
Thallium (Tl)	0.007	0.0025
Zinc (Zn)	4.84	19.9

Notes:
ww = wet weight
[a] *Exposure Point Concentration (EPC) is represented by the 95UCLM*

For ringed seal, measured data were not available, and hence, metal concentrations were predicted using the food chain model. For estimating ringed seal tissue concentrations, seal were assumed to eat a diet of 100% fish. Baseline data collected by ERM in 2001 for starry flounder were used to characterize fish tissue concentrations. These data are presented in Table B-2.1.2 (Section B-2.1.2 of Appendix B). Estimated muscle and blubber EPCs of metals in ringed seal used in the model are provided in Table 4.3-2.

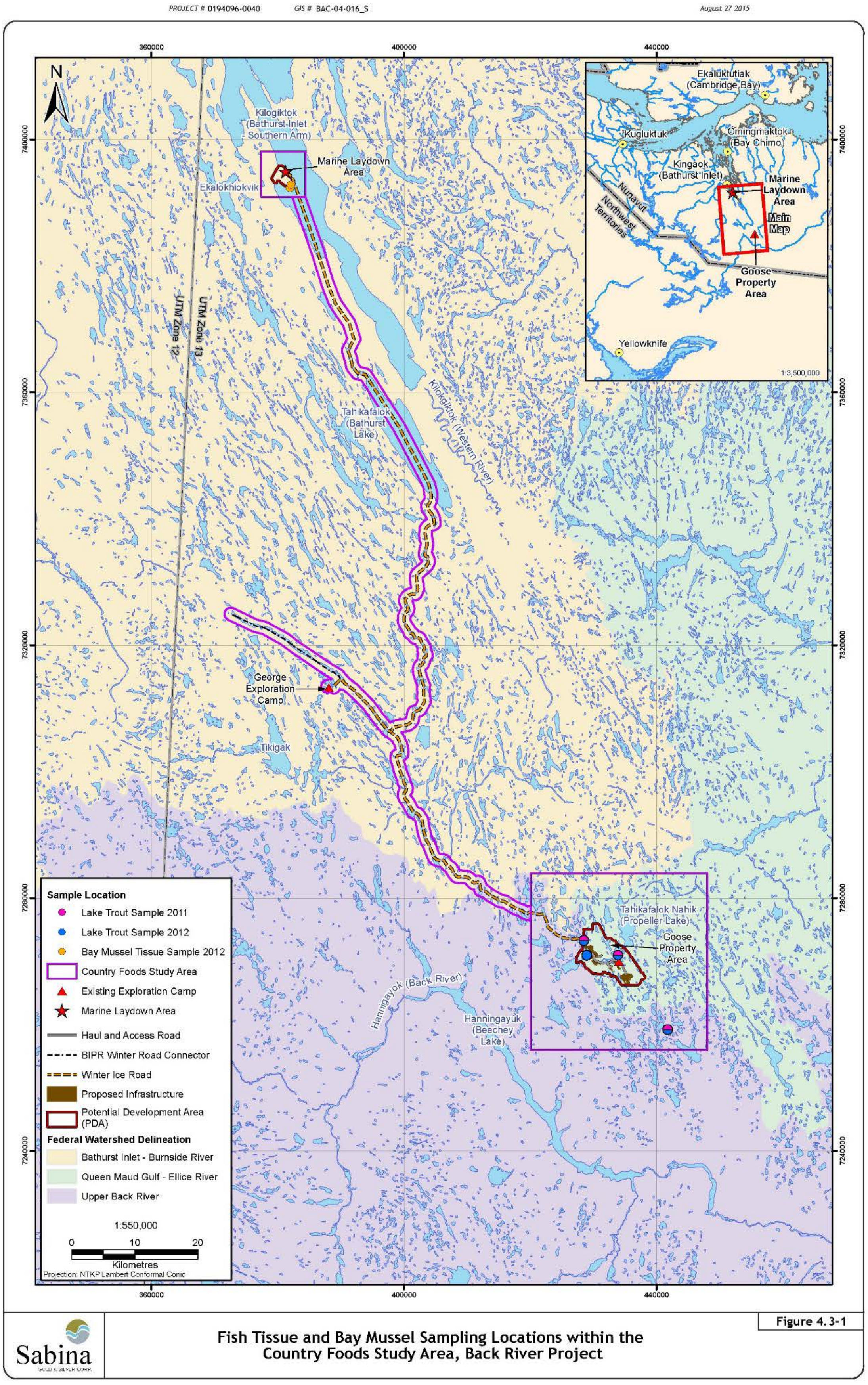


Figure 4.3-1

Fish Tissue and Bay Mussel Sampling Locations within the Country Foods Study Area, Back River Project

Table 4.3-2 Exposure Point Concentrations Predicted in Ringed Seal Tissue (Muscle; Organ Meats; Blubber)

COPC	Seal Muscle Concentration (mg/kg-ww)	Seal Liver Concentration [a] (mg/kg-ww)	Seal Blubber Concentration [b] (mg/kg-ww)
Aluminum	0.0303	0.0303	0.0303
Arsenic	0.00914	0.00914	0.00914
Cadmium	0.00000424	0.0000187	0.00000424
Chromium	0.00062	0.00062	0.00062
Copper	0.00832	0.00832	0.00832
Iron	12.1	12.1	12.1
Lead	0.000019	0.000019	0.000019
Mercury	0.0015	0.15	0.0015
Methyl Mercury	0.30	0.60	0
Nickel	0.000674	0.000674	0.000674
Selenium	0.013	0.013	0.013
Thallium	0.00027	0.00027	0.00027
Zinc	1.48	1.48	1.48

Notes:
COPC: Contaminants of potential concern; ww = wet weight
a Seal liver concentrations were assumed to equal seal muscle concentrations except where a metal-specific concentration factor was available; See Section B-2.3 for details.
b Seal blubber concentrations were assumed to equal seal muscle concentrations.

4.4 Vegetation Tissue Concentrations

Berries were collected within the country foods study area in the summer of 2012. In total, 15 samples of bog blueberry and bog cranberry (i.e., *V. uliginosum and V. vitis-idaea*) were collected from the country foods study area and analyzed for metal concentrations (13 samples from the Goose Property Area, and two samples from the MLA). Appendix C presents statistical summaries of the berry data, and Figure 4.2-3 provides the locations of samples within the country foods study area. The EPCs used in the baseline country food assessment were the 95UCLM of berry data from Goose Property, unless otherwise noted.

Table 4.4-1 Exposure Point Concentrations for Bog Blueberry (*V. ugliginosum*) and Bog Cranberry (*V. vitis-idaea*) in Goose Property Area

COPC	Bog Blueberry and Bog Cranberry Metals Concentrations (mg/kg-ww) (N=13)[a]
Aluminum (Al)	14.5
Arsenic (As)	0.05 [c]
Cadmium (Cd)	0.02
Chromium (Cr)	0.13 [c]
Copper (Cu)	1.22
Iron (Fe)	19.98
Lead (Pb)	0.01 [b]
Mercury (Hg)	0.0005 [b]
Nickel (Ni)	0.051
Selenium (Se)	0.1 [b]
Thallium (Tl)	0.005 [b]
Zinc (Zn)	5.27

***Notes**:*
ww = wet weight
a Exposure Point Concentration (EPC) is based on the 95 UCLM, unless otherwise stated
b All samples had non-detectable concentrations; EPC provided represents half the analytical method of detection
c A 95 UCLM could not be calculated due to insufficient number of detectable concentrations; as such, the maximum detected concentration was selected as the EPC.

4.5 Soil and Drinking Water Concentrations

As discussed in Section 3.5, since the FEIS ultimately requires the evaluation of baseline exposures relative to future exposures associated with potential impacts of the proposed mine, additional exposure pathways were added into the baseline country food assessment. These pathways included incidental ingestion of soils and drinking water (from study area lakes) for COPCs associated with country foods, since human receptors using the Country Foods LSA for hunting purposes have a potential to be exposed to these media while travelling, camping and hunting in the area. Soil samples were collected from the Country Food LSA, and sampling locations are presented in Figure 4.2-1. Similarly, lake water samples were taken in various years, and sampling locations within the LSA are provided in Figure 4.2-2. Appendix C provides statistical summaries of these data, and the EPC used in the food chain model are provided in Table 4.5-1.

Table 4.5-1 Exposure Point Concentrations for Baseline Soil and Lake Surface Water Used in the Baseline Country Food Assessment

COPC	Baseline Soil Concentrations (mg/kg) (N = 21)[a]	Baseline Lake Surface Water Concentrations (mg/L) (N= 53)[a]
Aluminum (Al)	5110	0.0216
Arsenic (As)	5.17	0.00034
Cadmium (Cd)	0.054 [b]	0.00001
Chromium (Cr)	17.1	0.00030
Copper (Cu)	11.7	0.00232
Iron (Fe)	10100	0.0902
Lead (Pb)	2.58	0.00040
Mercury (Hg)	0.0080	0.000005
Nickel (Ni)	11.4	0.00642
Selenium (Se)	0.1 [c]	0.0001
Thallium (Tl)	0.058 [b]	0.00005 [b]
Zinc (Zn)	15.2	0.00261

Notes:
COPC: Contaminants of potential concern
a Exposure Point Concentration (EPC) is based on the 95 UCLM, unless otherwise stated
b A 95UCLM could not be calculated due to insufficient number of detectable concentrations; maximum value is provided
c All samples had non-detectable concentrations; EPC provided represents half the analytical method of detection

4.6 Human Receptor Characteristics

4.6.1 Country Food Consumption Rates and Frequencies

As discussed in Appendix V8-5A, the human receptor characteristics used to calculate the estimated daily intake (EDI) were body weight (kg), consumption amount (serving size), and consumption frequency (number of servings per year or per week of highest exposure) of the selected country foods. Table 4.5-1 presents a summary of the human receptor characteristics, related to consumption rates. The body weights and consumption amounts for adults and toddlers were based on guidance provided by Health Canada (Health Canada 2012, 2010a). Both adults (older than 19 years of age) and toddlers (six months to four years of age) were evaluated for susceptibility to selected COPCs. Among adults, pregnant women and breastfeeding mothers are considered to be a sensitive group for exposure to some metals, particularly mercury (methyl mercury). Toddlers are often considered the most susceptible life stage because of their higher relative ingestion rates per unit body weight and their rapid adsorption and metabolic rates during this important growth period, compared to adults.

The consumptions rates used in the DEIS were reviewed and confirmed through examination of the cited reference and cross referencing other publications from the same region. Consumption rates and frequencies were updated as appropriate to reflect additional information identified in the most recent literature review. In addition, interest from the Inuit Association related to organ meat consumption had been raised in Technical Meetings associated with the DEIS hearings. In response to this, Sabina committed to re-examining consumption rates, and hence, the revised rates include organ meat consumption for selected organs and traditional foods. Two different types of consumption data were used in the update:

1. Chronic daily consumption rates (kg/day) – these rates were obtained from food frequency questionnaire results presented as annualized values (Egeland 2010; Chan 2011)
2. Portion size and consumption frequency rates (kg/serving and servings/year) - these rates are obtained directly from the food frequency questionnaire results as grams per person per day (g/day) reported for each food item on the survey and the frequency (days/year) that each food item was consumed by the sample population (Nancarrow 2007, Solomon 2005, Kuhnlein 2000,

Coad 1993 and Wein 1995). As detailed in Nancarrow (2007) the servings and frequency are combined in order to calculate an annualized total (food/person/year) which can then be divided by 365 in order to calculate a chronic daily consumption rate.

In the DEIS caribou consumption included muscle tissue only, but at a consumption rate to account for potential organ meat consumption (adult consumption rate in the DEIS was 270 g/day based on Nancarrow 2007 which included consumption of all caribou parts [(reported g/serving)*(servings/year)/365 days/year]). For the FEIS, in response to comments received from the Inuit Association, muscle and organ meats were assessed separately to reflect the difference in potential tissue metal concentrations. Therefore, the caribou consumption rate used in the DEIS was revised in the current assessment to reflect muscle consumption only and to account for the addition of organ meat consumption as a unique exposure pathway, based on data presented in additional sources. Based on a review of the literature, the caribou muscle meat consumption rate for selected adults in the current assessment was 208 g/day which was obtained from the Inuit Health Survey (IHS) (Egeland 2010; Chan 2011). An organ consumption rate for caribou liver and kidney of 14 g/day was calculated from an assessment of consumption of country food and nutrient intake in Repulse Bay completed by Nancarrow (2007). Cadmium concentrations are typically higher in kidney tissue than in liver tissue; however in the literature reviewed, liver was identified as being consumed more frequently than kidney (Nancarrow 2007, Solomon 2005, Kuhnlein 2000). Therefore, the organ consumption rate of 14 g/day reflects the sum of the mean liver and kidney consumption rates as identified in Nancarrow (2007), Solomon (2005) and Kuhnlein (2000). For the FEIS the metal concentrations in organ tissue were predicted for liver (due to the more frequent consumption of this tissue, relative to kidney).

The consumption rate for the Arctic ground squirrel is consistent between the DEIS and FEIS assessments as identified in Coad (1994). Coad (1994) uses the sum of all small animal consumption rates as a surrogate for the consumption of the squirrel. This value is consistent with the mean consumption rate identified for a Yukon First Nation (mean 5.5 times/year, 100 g portion per serving) (Wein 1995).

The consumption rate of Canada goose was updated in the FEIS, relative to the DEIS value used, based on information in the IHS (Egeland 2010; Chan 2011). The IHS identified the average consumption rate for Canada goose in the 12 months previous to the completion of survey as 23 g/day (23 g/d x 365 d/year = 8,395 g/year). This value was selected over the value used in the DEIS which was based on the consumption of swan meat (Nancarrow 2007 Table 4.4). The consumption rate in the DEIS for swan meat was 200 g/day, five times per year (200 g/d x 5 d/year = 1,000 g/year). The revised value represents a more conservative consumption rate.

The specific consumption of lake trout was not uniquely identified in the FEIS. Rather, the consumption of lake trout was included as part of the overall consumption of freshwater fish. The consumption rate of 113 g/day identified in Egeland (2010) and Chan (2011) was used. The annualized consumption was adjusted to represent seasonal fish consumption from the country food LSA (113 g/d for 90 days of the year = 10,170 g/year), based on the remote location of this area, relative to communities.

The consumption rate for bay mussels used in the DEIS was 3 g/day and is consistent between the DEIS and the FEIS (Innis et al. 1988). The consumption frequency in the DEIS was 3 times/week for 4 months/year. The rate of 3g/day is an annualized value; the frequency of consumption in the FEIS was updated to 365 days per year (3 g/d x 365 d/year = 1,095 g/year). This value represents a more conservative consumption rate, and is realistic considering bay mussels could be collected from the area, frozen, and consumed at a later date.

The ringed seal muscle consumption rate of 250 g/day as presented in the DEIS remains consistent in the FEIS. Nancarrow (2007) identifies 87 consumption occasions of ringed seal annually (muscle 10 times per year cooked, meat 10 times per year raw, intestines 16 times/year, blood 16 times/year, soup or broth 10 times/year, heart 10 times/year, flippers 10 times/year and cartilage 5 times per year). The consumption frequency was adjusted to reflect this information. The DEIS assessed the consumption of seal muscle and blubber. Some metal can accumulate in the organ tissues of seal (such as liver and kidney), whereas organic constituents would be more predominant in the blubber. While seal liver consumption was listed in both Nancarrow (2007) and Egeland (2010) a consumption advisory issued by the Nunavut Health and Social Services Department in June 2012 recommended that women who may become pregnant, are planning to get pregnant, or who are pregnant should not eat ringed seal liver due to elevated levels of mercury. Due to the current advisory, seal liver consumption was only modelled in the assessment for adult men. This reflects the fact that seal liver was identified as the seventh most popular traditional food in the Inuit Health Survey (Egeland 2010). The consumption rate and portion size for seal organs were obtained from Nancarrow (2007) and are 130 g/serving, 5 times per year for liver and 74 g/serving, 5 times per year for kidney). The seal organ consumption rate was modelled in the FEIS as liver at a consumption rate of 102 g/serving for 10 servings/year for adult men (this reflects the average serving size between liver and kidney). The consumption rates and frequency for seal blubber (87 g/serving, 5 times per year) as listed in Appendix V8-5A; Table 5.1-2 in the DEIS were retained in the FEIS.

The consumption rate for berries used in the DEIS was 13 g/day is consistent between the DEIS and the FEIS (Egeland 2010). The consumption frequency in the DEIS was 13g/day daily for 5 months/year. The rate of 13 g/day is an annualized value; the consumption frequency in the FEIS was updated to 365 days per year. This update is based on the assumption that berries from the area could be collected, frozen, and consumed at a later date.

Toddlers (body weight 16.5 kg as defined by Health Canada (2010)) were assumed to eat country foods at the same frequency as adults (body weight 70.7 kg as defined by Health Canada (2010)). A factor of 0.43 was used in the DEIS to determine toddler serving size based on adult portions, based on Table 5.3 in Richardson (1997) (for the consumption of meat and eggs for male eaters only). The factor of 0.43 was carried forward to the FEIS with two exceptions (caribou muscle and ringed seal muscle). Based on the findings by Tian et al. (2011), applying a 43% amortization of adult consumption rates for toddlers with respect to these tissues may result in elevated consumption rates, which could unnecessarily predict health risks. In order to provide a more realistic measure of potential risk to toddlers associated with consumption of caribou and ringed seal, the consumption rates were updated in the FEIS using region specific rates collected in the Tian et al. (2011) study. This study collected consumption data using a 24-hour recall survey (for consumption on the previous day) conducted with 132 participants in Nunavut to establish country food consumption patterns of children. Tian et al. (2011) reported a daily intake of 31.14 g of caribou meat and 5.75 g of ringed seal meat for toddlers (aged 3 to 5 years; mean weight 20.1±4.1 kg). These values were used in the baseline country foods assessment.

Based on the updated information the daily consumption quantity of traditional or country foods is estimated to be 368 g/day for an adult, which is within the range of 250 to 440 g/day referenced in the DEIS. The selected consumption rates are summarized in Table 4.6-1.

Table 4.6-1 Human Receptor Characteristics (Consumption of Country Foods)

Parameter	Daily Toddler Consumption Rate (kg/day)	Daily Adult Consumption Rate (kg/day)	Toddler serving size (kg/portion)	Adult serving size (kg/portion)	# Times Consumed per Year	Data Source
Caribou Muscle	0.031	0.208			365[a]	Tian et al (2011); Inuit Health Survey; Egeland (2010); Chan (2011)
Caribou liver	0.006	0.014			365	Nancarrow (2007)
Arctic ground squirrel			0.023	0.053	104[b]	Coad (1994)
Canada goose	0.010	0.023			365	Inuit Health Survey; Egeland (2010); Chan (2011)
Fish - fresh water			0.049	0.113	90[c]	Inuit Health Survey: Egeland (2010); Chan 2011
Bay mussel	0.001	0.003			365[d]	Innis Kuhnlein and Kinloch (1988)
Ringed seal muscle	0.00575			0.25	87	Tian et al (2011); Nancarrow (2007)
Ringed seal liver			0[e]	0.102[e]	10	Nancarrow (2007)
Ringed seal blubber			0.037	0.087	5	Nancarrow (2007)
Berries	0.006	0.013			365	Egeland (2010); Chan (2011)

Notes:

a. Data obtained from communications of Sabina staff with members of community advisory group members and Hunter and Trappers Organizations in the Bathurst Inlet Area (Sabina, pers. comm.)

b. Arctic ground squirrel consumption rate was assumed to be twice a week throughout the year

c. Fish consumption from the Study area was assumed to occur 3 months of the year

d. Bay mussel and berry consumption rates assumed that these foods could be collected in Study area, frozen and consumed at various times through the year.

e. Consumption of ringed seal liver for the toddler and for pregnant women and women of child-bearing age was assumed to be zero, due to a consumption advisory for this organ related to methyl mercury exposure focused on pregnant women and women of child-bearing age. While children are not specifically mentioned in the consumption advisory, the Toxicity Reference Value for methyl mercury is set to protect the female receptors, as well as children, and hence, it was assumed that consumption of this organ would be zero. Adult male and adult females outside of child-bearing age were assumed to consume ringed seal liver at the consumption rate provided

4.6.2 Soil and Water Ingestion Rates

While travelling, hunting or camping within the LSA, land users could incur additional exposures through consumption of surface waters in the LSA, and through incidental soil ingestion. In order to provide a more complete estimate of exposures, these additional media were added into the risk assessment. The soil and water ingestion rates used in the assessment are provided in Table 4.6-2, and follow standard recommendations from Health Canada (2012). For water ingestion, 50% of water ingestion was assumed to come from the LSA, whereas all soil ingestion came from the LSA.

Table 4.6-2 Soil and Water Ingestion Rates Used in Baseline Country Foods Assessment

Variable	Receptor	Abbreviation	Value	Units	Comment
Soil Ingestion Rate	Adult	SIR_Adult	0.02	g/d	Health Canada (2012); soil ingestion rate
	Toddler	SIR_Toddler	0.08	g/d	Health Canada (2012); soil ingestion rate
Water Ingestion Rate	Adult	WIR_Adult	0.75	L/d	Health Canada (2012); 50% of the drinking water ingestion rate
	Toddler	WIR_Toddler	0.3	L/d	Health Canada (2012); 50% of the drinking water ingestion rate

Notes:

Assumptions are based on Health Canada 2012

4.7 Estimated Daily Intake Calculation

The EDI of each COPC for toddlers and adults was based on the modelled (i.e., caribou, caribou organ, Canada goose, Arctic ground squirrel, and ringed seal meat, blubber and organ) and measured (i.e., fish, mussel, berries) tissue metal concentrations and the human receptor characteristics, as outlined in earlier sections of this report. The following equation was used to calculate the EDI of COPCs from the consumption of country foods

$$EDI_{food} = \frac{\sum_{i=1}^{n} IR_i * C_i * CA * F_i}{BW}$$

where:

EDI_{food} = estimated daily intake of COPCs from country food (mg COPC/kg BW/day)
IR_i = ingestion rate for i^{th} food item (kg/day)
C_i = measured or predicted concentration of COPCs for i^{th} food (mg/kg)
CA = Chemical apportionment due to speciation for COPC (unitless)
F_i = fraction of year consuming i^{th} country food item (unitless)

The EDI of each COPC for adult receptors is presented in Table 4.7-1, with the relative contribution of each exposure media to total exposure for adults presented in Table 4.7-2. The EDI for each COPCs for the toddler is presented in Table 4.7-3, with the relative contribution of each exposure media to total exposure in toddlers in Table 4.7-4. For baseline, it was conservatively assumed that 100% of the country foods harvested were from the LSA, and that all foods (as well as exposures from drinking water and soils) were 100% bioavailable. Appendix D and E provides sample calculations for EDI of arsenic in the toddler and adult.

Based on the modelled predictions presented in Table 4.7-1, the consumption of caribou results in the highest EDIs of aluminum, chromium, iron, mercury, nickel, thallium and zinc in the adult. Consumption of goose resulted in the highest EDIs for arsenic, copper and lead, whereas consumption of mussels resulted in the highest EDI for cadmium. Consumption of freshwater fish resulted in the highest EDI for selenium and ringed seal muscle consumption was highest for methyl mercury (Table 4.7-1). Table 4.7-2 illustrates the relative contributions of each media based on percentage of the total EDI. For the toddler, soil exposures resulted in the highest EDI for aluminum and arsenic (Table 4.7-3). Caribou consumption had the highest EDIs of iron, nickel and zinc, whereas caribou organ meat had the highest EDI for mercury. Goose consumption resulted in the highest EDIs for chromium, copper and lead, whereas mussel consumption had the most elevated EDI for cadmium. Freshwater fish consumption was the driving media for methyl mercury, selenium and thallium (Table 4.7-3). Table 4.7-4 illustrates the relative contributions of each media based on percentage of the total EDI.

Table 4.7-1 Estimated Daily Intake of COPCs by Adults

Chemical	Estimated Daily Intake (EDI)														
	Soil	Drinking Water	Dust	Berries	Freshwater Fish	Mussels	Caribou Muscle	Caribou Organ	Squirrel	Goose	Ringed Seal Blubber	Ringed Seal Muscle	Ringed Seal Organ	Total EDI	Total EDI[a]
	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/kg/day
Aluminum	102	16.2	0.064	189	52.9	879	1447	97.4	0.71	18.3	0.036	1.81	0.085	2804	39.7
Arsenic	0.10	0.26	0.000065	0.40	0.10	0.70	0.082	0.0055	0.000048	0.85	0.00054	0.027	0.0013	2.52	0.036
Cadmium	0.0011	0.0075	0.00000068	0.26	0.070	7.14	0.029	0.33	0.000024	0.81	0.0000051	0.00025	0.000052	8.64	0.12
Chromium	0.34	0.23	0.00022	1.69	3.62	2.12	10.8	0.72	0.0049	7.66	0.00074	0.037	0.0017	27.2	0.38
Copper	0.23	1.74	0.00015	15.86	8.55	6.45	47.6	3.20	0.047	82.5	0.0099	0.50	0.023	167	2.36
Iron	202	67.7	0.13	260	503	720	26979	1816	16.4	680	14.5	724	33.9	32015	453
Lead	0.052	0.30	0.000033	0.13	2.48	1.16	0.50	0.034	0.00028	5.65	0.000023	0.0012	0.000054	10.31	0.15
Mercury	0.00016	0.0038	0.00000010	0.0065	0.021	0.00020	12.2	8.23	0.0074	0.0031	0.0018	0.089	0.42	21.0	0.30
Methyl Mercury	0	0.00022	0	0	8.39	0.079	0	0	0	0	0	17.9	1.68	28.1	0.40
Nickel	0.23	4.82	0.00014	0.66	1.67	2.12	65.2	4.39	0.046	0.12	0.00080	0.040	0.0019	79.3	1.12
Selenium	0.002	0.075	0.0000013	0.065	11.15	3.19	0.19	0.013	0.00015	0.72	0.016	0.80	0.038	16.26	0.23
Thallium	0.0012	0.038	0.00000073	0.00030	0.20	0.0075	0.22	0.015	0.00029	0.012	0.00032	0.016	0.00075	0.51	0.0072
Zinc	0.30	1.96	0.00019	68.5	135	59.7	1712	115	1.94	3.96	1.76	88.1	4.13	2192	31.0

Notes:
Shading indicates the highest Estimated Daily Intake per COPC
[a] *total EDI on a µg/kg bw/d basis is calculated by dividing the EDI (µg/day) by the adult body weight of 70.7 kg*

Table 4.7-2 Percent Contribution of Each Media to Total Estimated Daily Intake of COPCs (Adult)

Chemical	Percent Contribution													
	Soil	Drinking Water	Dust	Berries	Freshwater Fish	Mussels	Caribou Muscle	Caribou Organ	Squirrel	Goose	Ringed Seal Blubber	Ringed Seal Muscle	Ringed Seal Organ	Total
Aluminum	3.64%	0.58%	0.0023%	6.73%	1.89%	31.35%	51.59%	3.47%	0.025%	0.65%	0.0013%	0.064%	0.0030%	100.0%
Arsenic	4.1%	10.1%	0.0026%	15.8%	4.0%	27.7%	3.3%	0.22%	0.0019%	33.7%	0.022%	1.1%	0.051%	100.0%
Cadmium	0.012%	0.087%	0.0000079%	3.01%	0.81%	82.6%	0.33%	3.82%	0.00028%	9.33%	0.000058%	0.0029%	0.00060%	100.0%
Chromium	1.26%	0.83%	0.00079%	6.22%	13.32%	7.78%	39.6%	2.67%	0.018%	28.16%	0.0027%	0.14%	0.0064%	100.0%
Copper	0.14%	1.04%	0.000089%	9.51%	5.13%	3.87%	28.54%	1.92%	0.028%	49.5%	0.0059%	0.30%	0.014%	100.0%
Iron	0.63%	0.21%	0.0004%	0.81%	1.57%	2.25%	84.3%	5.67%	0.051%	2.12%	0.045%	2.26%	0.11%	100.0%
Lead	0.50%	2.91%	0.00032%	1.26%	24.06%	11.26%	4.85%	0.33%	0.0027%	54.8%	0.00022%	0.011%	0.00053%	100.0%
Mercury	0.00076%	0.018%	0.00000048%	0.031%	0.10%	0.0010%	58.2%	39.2%	0.035%	0.015%	0.0085%	0.42%	1.98%	100.0%
Methyl Mercury [a]	0	0.00079%	0	0	29.9%	0.28%	0	0	0	0	0	63.9%	5.99%	100.0%
Nickel	0.29%	6.07%	0.00018%	0.84%	2.11%	2.68%	82.2%	5.53%	0.058%	0.15%	0.0010%	0.051%	0.0024%	100.0%
Selenium	0.012%	0.46%	0.0000078%	0.40%	68.6%	19.60%	1.19%	0.080%	0.00092%	4.45%	0.10%	4.93%	0.23%	100.0%
Thallium	0.23%	7.39%	0.00014%	0.059%	38.44%	1.48%	43.6%	2.93%	0.058%	2.46%	0.063%	3.16%	0.15%	100.0%
Zinc	0.014%	0.089%	0.0000087%	3.13%	6.15%	2.72%	78.1%	5.26%	0.089%	0.18%	0.080%	4.02%	0.19%	100.0%

Notes:
Shading indicates the highest estimated percent contribution to Estimated Daily Intake per COPC
a. These percentages are for the general population; the women of child bearing age and pregnant women ringed seal muscle is 67.9% and seal organs are 0%.

Table 4.7-3 Estimated Daily Intake of COPCs by Toddler

Chemical	Estimated Daily Intake (EDI)														
	Soil	Drinking Water	Dust	Berries	Freshwater Fish	Mussels	Caribou Muscle	Caribou Organ	Squirrel	Goose	Ringed Seal Blubber	Ringed Seal Muscle	Ringed Seal Organ	Total EDI	Total EDI[a]
	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/day	µg/kg/day
Aluminum	409	6.48	0.032	92.49	22.76	378	216	41.9	0.31	7.88	0.016	0.17	0.036	1174	71.17
Arsenic	0.41	0.10	0.000033	0.19	0.043	0.30	0.012	0.0024	0.000021	0.36	0.00023	0.0026	0.00055	1.43	0.087
Cadmium	0.0043	0.0030	0.00000034	0.13	0.030	3.07	0.0043	0.14	0.000010	0.35	0.0000022	0.000024	0.000022	3.73	0.23
Chromium	1.37	0.090	0.00011	0.83	1.56	0.91	1.60	0.31	0.0021	3.29	0.00032	0.0035	0.00074	9.97	0.60
Copper	0.94	0.70	0.000074	7.77	3.68	2.77	7.09	1.38	0.020	35.49	0.0043	0.047	0.010	59.87	3.63
Iron	808	27.1	0.064	127	216	310	4021	781	7.03	292	6.22	68.7	14.6	6679	405
Lead	0.21	0.12	0.000016	0.064	1.07	0.50	0.075	0.014	0.00012	2.43	0.000010	0.00011	0.000023	4.47	0.27
Mercury	0.00064	0.0015	0.000000050	0.0032	0.0090	0.000085	1.82	3.54	0.0032	0.0013	0.00076	0.0084	0	5.38	0.33
Methyl Mercury	0	0.000089	0	0	3.61	0.034	0	0	0	0	0	1.70	0	5.34	0.33
Nickel	0.911	1.93	0.000072	0.32	0.72	0.91	9.72	1.89	0.020	0.051	0.00035	0.0038	0.00081	16.48	0.999
Selenium	0.0080	0.030	0.00000063	0.032	4.79	1.37	0.029	0.0056	0.00006	0.31	0.0069	0.076	0.016	6.62	0.40
Thallium	0.0046	0.015	0.00000037	0.00015	0.084	0.0032	0.033	0.0064	0.00013	0.0054	0.00014	0.0015	0.00032	0.15	0.0092
Zinc	1.2	0.78	0.000096	33.57	57.99	25.67	255	49.54	0.84	1.70	0.76	8.37	1.78	437	26.5

Notes:
Shading indicates the highest Estimated Daily Intake per COPC
a. total EDI on a µg/kg bw/d basis is calculated by dividing the EDI (µg/day) by the adult body weight of 16.5 kg

Table 4.7-4 Percent Contribution of Each Media to Total Estimated Daily Intake of COPCs (Toddler)

Chemical	Percent Contribution													
	Soil	Drinking Water	Dust	Berries	Freshwater Fish	Mussels	Caribou Muscle	Caribou Organ	Squirrel	Goose	Ringed Seal Blubber	Ringed Seal Muscle	Ringed Seal Organ	Total
Aluminum	34.8%	0.55%	0.0027%	7.9%	1.9%	32.2%	18.4%	3.6%	0.026%	0.67%	0.001%	0.015%	0.0031%	100.0%
Arsenic	28.9%	7.12%	0.0023%	13.6%	3.01%	20.9%	0.85%	0.17%	0.0014%	25.4%	0.016%	0.18%	0.038%	100.0%
Cadmium	0.12%	0.08%	0.0000091%	3.4%	0.80%	82.4%	0.11%	3.8%	0.0003%	9.3%	0.000058%	0.00064%	0.00060%	100.0%
Chromium	13.7%	0.90%	0.0011%	8.3%	15.6%	9.1%	16.1%	3.1%	0.021%	33.0%	0.0032%	0.035%	0.0075%	100.0%
Copper	1.6%	1.2%	0.00012%	13.0%	6.1%	4.6%	11.8%	2.3%	0.034%	59.3%	0.0071%	0.079%	0.017%	100.0%
Iron	12.2%	0.41%	0.0010%	1.9%	3.3%	4.6%	60.2%	11.8%	0.11%	4.4%	0.094%	1.03%	0.22%	100.0%
Lead	4.6%	2.7%	0.00036%	1.4%	23.8%	11.2%	1.7%	0.32%	0.0027%	54.3%	0.00022%	0.0025%	0.00052%	100.0%
Mercury	0.012%	0.028%	0.00000094%	0.06%	0.17%	0.0016%	33.9%	65.7%	0.06%	0.025%	0.014%	0.16%	0%	100.0%
Methyl Mercury	0%	0.0022%	0%	0%	67.5%	0.63%	0%	0%	0%	0%	0%	31.9%	0%	100.0%
Nickel	5.5%	11.7%	0.00044%	2.0%	4.4%	5.5%	59.0%	11.5%	0.12%	0.31%	0.0021%	0.023%	0.0049%	100.0%
Selenium	0.12%	0.45%	0.000010%	0.48%	71.8%	20.5%	0.44%	0.08%	0.0010%	4.7%	0.10%	1.14%	0.24%	100.0%
Thallium	3.0%	9.8%	0.00024%	0.10%	54.6%	2.1%	21.4%	4.2%	0.082%	3.5%	0.09%	0.99%	0.21%	100.0%
Zinc	0.28%	0.18%	0.000022%	7.7%	13.3%	5.9%	58.3%	11.3%	0.19%	0.39%	0.18%	1.91%	0.41%	100.0%

Notes:
Shading indicates the highest estimated percent contribution to Estimated Daily Intake per COPC

5.0 TOXICITY REFERENCE VALUE ASSESSMENT

5.1 Introduction

Toxicity Reference Values (TRVs; also known as Tolerable Daily Intakes, or TDIs) used in the DEIS were reviewed to examine whether any values required updating. Table 5.1-1 provides a summary of changes to TRVs used in the DEIS, and descriptions of the revised TRVs are provided in Section 5.2.

Table 5.1-1 Changes to Oral TDIs for Assessment of Baseline Country Food COPCs in the FEIS (µg/kg/day)[1]

COPC	TDI Used in the DEIS (Table 5.1-1 in DEIS)	TDI Used in the FEIS	Comment
Aluminum	300 (Health Canada – unpublished reference)	143 (WHO 2014, 2010 a,b)	Unable to verify unpublished Health Canada reference, therefore published value from WHO was selected (2014, 2010 a,b)
Arsenic	0.3 (TDI non-cancer)(US EPA 1993) / 1800 (µg/kg/day)$^{-1}$ (oral slope factor) (Health Canada 2010c)	No change	
Cadmium	1 (Health Canada 2010c)	No change	
Chromium (trivalent)	1500 (U.S. EPA 1998)	No change	
Chromium (total)	1 (Health Canada 2010c)	No change	
Copper	91 to 141 (depending on age; Health Canada 2010c)	No change	
Iron	Not a COPC	700 (U.S. EPA 2006)	New COPC
Lead	3.6 (JEFCA)	0.6 children; 1.3 adults (JECFA 2011)	Health Canada lead TRV still under review; JEFCA TRV updated; used JEFCA provisional RSD
Mercury, total (inorganic)	0.3 (Health Canada 2010c)	No change	
Mercury, methyl	0.47 (general adult population); 0.2 (children <12 years and women of child bearing age); Health Canada 2010c)	No change	
Nickel	11 (Health Canada 2010c)	No change	
Selenium	5.5 to 6.3 (depending upon age; Health Canada 2010c)	6.2 toddler; 5.7 adult (Health Canada 2010c)	
Thallium	0.07 (Health Canada – unpublished reference)	0.02 U.S. EPA (2012a) provisional peer reviewed toxicity value for thallium sulphate	Unable to verify unpublished Health Canada reference; therefore published value from U.S. EPA was selected (2012a)
Zinc	480 to 570 (depending on age; Health Canada 2010c)	No change	

Notes:
Shaded cell indicates TDI in DEIS was changed for FEIS
µg/kg/day unless otherwise noted

5.2 Toxicity Reference Value Summaries

The basis of TRVs which were updated for the FEIS are provided below. For toxicity summaries of other TRVs, please refer to Section 5.2 of Appendix V8-5A.

5.2.1 Aluminum

No Health Canada TRV for aluminum was identified in the literature reviewed. The WHO Food and Agriculture Organisation (FAO) (WHO 2010a,b, 2014; WHO/FAO 2007) derived a provisional tolerable weekly intake (PTWI) of 1,000 µg/kg bw (equivalent to a TDI of 143 µg/kg bw per day) based on a comprehensive review of several rodent and human studies involving the administration of aluminum in diet, drinking water and intravenous injection. This PTWI is discussed in the supporting documentation for the WHO water quality guideline (WHO 2010a,b) for aluminum, based on WHO/FAO (2007). The previous WHO PTWI of 0 to 7 mg/kg was re-evaluated by WHO/FAO (2007), and it was determined that there is potential for adverse reproductive and developmental effects in association with aluminum exposure at doses less than the 7 mg/kg per week. In addition, the previous WHO PTWI did not take epidemiological studies into account, and background exposures to aluminum were not considered as a result. A range of LOAELs was identified by the WHO/FAO (2007) from human dietary studies as 50 to 75 mg/kg for reproductive, neurological effects, liver and kidney effects. Based on the lowest LOAEL in this range of 50 mg/kg and various uncertainty factors (the latter are not well described), the WHO/FAO (2007) derived a PTWI of 1,000 µg/kg bw (equivalent to 143 µg/kg bw per day). As this value is based on a recent, comprehensive review of the scientific literature and includes consideration of background exposures to aluminum, the WHO TDI of 143 µg/kg bw per day was selected for use in the assessment. The basis of this value includes potential reproductive and developmental effects, neurological effects, as well as kidney and liver effects.

5.2.2 Iron

No Health Canada TRV for iron was identified in the literature reviewed. The U.S. EPA (2006) derived a provisional peer reviewed toxicity value for iron of 0.7 mg/kg/day from a study by Frykman et al. (1994). Frykman et al. (1994) reported an LOAEL of 60 mg/day for gastrointestinal effects of minor severity in Swedish men and women based on daily supplementation of elemental iron. To determine the LOAEL for total daily iron intake, the Frykman et al (1994) LOAEL of 60 mg/day was added to the estimated mean dietary iron intake for six European countries of 11 mg elemental iron/day (NAS 2001) for a total daily iron intake of 71 mg elemental iron/day. Using a body weight of 70 kg the U.S. EPA calculated a LOAEL for gastrointestinal effects for total daily iron intake of 1 mg elemental iron/kg/day. An uncertainty factor of 1.5 was applied to this value by the U.S. EPA (2006), resulting in a provisional TRV of 0.7 mg/kg/day.

5.2.3 Lead

Health Canada has rescinded the lead TRV published in its guidance document, and lead is currently under review. In light of an increasing body of scientific research demonstrating a broad spectrum of health outcomes associated with lead exposure, most notably neurological effects among children at low blood lead levels, various regulatory agencies have updated their respective health-based policies and guidelines concerning lead. Most agencies have concluded that lead should be considered a non-threshold substance (e.g., Health Canada 2013; U.S. EPA 2012b; JECFA 2011).

The most comprehensive analysis of neurodevelopmental toxicity was conducted by Lanphear *et al*. (2005) who found an inverse relationship between concurrent blood lead levels and IQ score. In the most recent and comprehensive published review of the Lanphear et al. (2005) dataset, JECFA (2011) concluded that a dose of 0.6 µg/kg/day (5^{th} to 95^{th} percentile 0.2 to 7.2 µg/kg/day) results in a one IQ point decrement in children (the level considered *de minimus* by JECFA). This dose, considered a risk specific dose protective of a one IQ point decrement in infants, toddlers and children, was selected as the TRV for the purposes of estimating risks to youths.

For the evaluation of adults, systolic blood pressure is selected as the endpoint on which to assess the effects of lead exposure. Increased blood pressure, particularly systolic blood pressure, is the endpoint with the greatest weight of evidence for a causal relationship between lead exposure and an effect (JECFA 2011). In the most recent and comprehensive published review of systolic blood pressure effects, JECFA (2011) averaged the linear slope estimates relating increases in systolic blood pressure as a function of blood lead from four studies. A median slope estimate of 0.28 mm Hg per 1 µg/dL was derived. Blood lead levels were then converted to dose levels associated with a 1 mm Hg increase in systolic blood pressure, considered the *de minimus* risk level. A dose level of 80 µg/day or 1.3 µg/kg/day (5^{th} to 95^{th} percentile 0.6 to 28 µg/kg/day) was estimated and was selected as the adult TRV for this endpoint.

5.2.4 Thallium

No Health Canada TRV for thallium was identified in the literature reviewed. The U.S. EPA (2012b) derived a provisional peer reviewed toxicity value for thallium of 0.00002 mg/kg/day. This TRV was based on an estimated NOAEL for hair follicle atrophy in rats of 0.05 mg/kg-day thallium (I) sulfate (Tl_2SO_4) or 0.04 mg/kg-day soluble thallium (MRI, 1988). The U.S. EPA (2012a) applied a 3000-fold uncertainty factor to this NOAEL to derive a provisional toxicity reference value of 0.00002 mg/kg/day.

6.0 RISK CHARACTERIZATION

The approach taken to characterize risks associated with exposure varies, depending upon whether the COPC in question has a threshold dose-response relationship (such as for non-carcinogenic substances), or a non-threshold dose-response relationship (such as for carcinogens, or substances such as lead). Each of these types of calculations with respect to the current assessment is described in the sections which follow.

6.1 Estimation of Non-Cancer Risk and Recommended Maximum Weekly Intakes

6.1.1 Non-Cancer Risk Estimates

Risk characterization for chemicals with a threshold-type dose-response (e.g., non-carcinogens) consists of a comparison between the toxicological criteria (*i.e.*, the rate of exposure that would not produce adverse effects) against the total EDI. For these COPCs, a Risk Quotient (RQ) was calculated. These ratios are calculated by dividing the predicted exposure (from the exposure model) by the toxicological criterion, as indicated in the following equations:

$$\text{Risk Quotient} = \frac{\text{Estimated Exposure } (ug/kg/day)}{\text{TRV } (ug/kg/day)}$$

If the total exposure to a chemical is equal to or less than the toxicological criterion, then the RQ would be 1.0 or less, and no adverse health effects would be expected. For human exposures to non-carcinogens, the toxicological criteria represents the level of total exposure derived from multi-source and multimedia exposures, which would not result in adverse health effects, regardless of the source or route of exposure. In cases where total exposure has been estimated from both a number of exposure pathways, it would be valid to compare the estimated exposure to the entire TRV, and an acceptable RQ level would be 1.0 (Health Canada, 2010a).

If the HHRA addresses risks associated with a single source (such as food alone, or soil exposure alone), the selection of an RQ of 1.0 as a benchmark to indicate that exposure does not exceed the toxicological criterion is not valid. In an attempt to address this problem, Health Canada has apportioned 20% of the total exposure to any one environmental medium (food; soil; drinking water; etc.) (Health Canada, 2012a). For the current assessment, while the focus of the assessment was on food exposures, additional pathways have been included (such as soil and water). As a result, it was considered appropriate to use a Risk Quotient of 1.0 as the benchmark of comparison for the assessment. This approach differs from Appendix V8-5A, wherein each food type was assessed against a RQ of 0.2. Where RQs>1, it does not necessarily suggest there is a health risk associated with the scenario, but rather, it means risk estimates require a more detailed evaluation.

Table 6.1-1 presents the calculated RQs for the toddler and adult, based on the predicted and measured country food tissue levels, as well as exposure to soil and surface water within the LSA. The results of the baseline assessment indicate that RQs for the toddler were less than 1.0 for all COPCs with the exception of inorganic mercury (RQ = 1.1) and methyl mercury (RQ = 1.4). Based on Table 4.7-4, the most predominant pathways were caribou organ meats for inorganic mercury (which comprised 65.7% of total estimated exposure), and freshwater fish for methyl mercury (67.5% of total estimated exposure). For the adult, all RQs were less than 1.0 for all COPCs, with the exception of methyl mercury (RQ = 1.6), for the sensitive sub group of pregnant women and women of child-bearing age (Table 6.1-1). The predominant exposure for this group was identified as consumption of ringed seal muscle (63.9%; Table 4.7-2), but consumption of freshwater fish also is a contributing factor (29.9%; Table 4.7-2).The risks predicted as a result of the assumptions used in this assessment are marginal and it is unlikely that adverse health effects would occur, based on the marginal exceedance over the RQ of 1.0 in these cases. The seal muscle consumption rate used in this assessment of 250g/day, 87 times per year (Nancarrow,

2007) is based on a sample size of 103 (49 women and 54 men), with a median portion size for the sample population being reported. The IHS (Egeland 2010) reports that women of child-bearing age eat 141 g/week (N = 637) compared to all participants who reported an average of 181 g/week. (N=1564). Based on this information, modelled consumption rate is elevated relative to women of child-bearing age, and hence risk is considered to be overestimated by a factor of 1.8, and hence risks are considered low and within acceptable levels.

The toddler and adult methyl mercury risks were predicted based on a concentration of 0.301 mg/kg in fish (measured) and 0.30 mg/kg (predicted) in seal muscle. The predicted value of 0.30 mg/kg methyl mercury in muscle tissue of ringed seal agrees well with reported values from the literature (Eastern Arctic ringed seal muscle: mean value of 0.43 mg/kg MeHg mg/kg ww +/- 0.31; N = 100; range of 0.05 – 1.80 mg/kg; Wagemann et al. 1998). The assessment assumed that 100% of this mercury concentration was in the form of methyl mercury for both fish and seal muscle, as recommended by Health Canada (2007), and these concentrations are below the commercial fishery limit for mercury (total mercury) in fish (0.5 mg/kg). They slightly exceed a limit of 0.2 mg/kg, which is frequently used for subsistence fish populations, although this value is not officially sanctioned by Health Canada. No fish consumption advisories could be found for Nunavut (Environment Canada, 2015), nor is there an advisory on ringed seal muscle tissue. There is however, an advisory currently in place on ringed seal liver for pregnant women, and women of child-bearing age. Ringed seal muscle tissue is considered a nutritious and safe choice for consumption, even for pregnant woman and women of childbearing age (Egeland, 2010; Chan 2011). Health Canada (2007) notes that fish is a high-quality source of dietary protein, and also contains fatty-acids and vitamin D. Regular fish consumption has been associated with the prevention of various diseases and conditions (Health Canada 2007; Ginsberg and Toal 2009). The health advantages related to eating fish is well-documented and are actively re-enforced in the IHS (Egeland, 2010; Chan, 2011). It is important to note that any nutritional benefits associated with eating fish, seal meat, or other country foods from areas within the LSA were not accounted for in the characterization of the potential health risks.

Table 6.1-1 Human Risk Quotient Ratios Based on Predicted and Measured Tissue and Media Concentrations within the LSA

COPC	Type	Toddler			Adult			Max RQ	
		RQ Value	% Exposure	Dominant Exposure Source	RQ Value	% Exposure	Dominant Exposure Source	RQ Value	Maximum Receptor
Aluminum	RfD	0.50	34.8%	Soil	0.28	51.6%	Caribou Muscle	0.50	Toddler
Arsenic	RfD	0.29	28.9%	Soil	0.12	33.7%	Goose	0.29	Toddler
Cadmium	RfD	0.23	82.4%	Mussels	0.12	82.6%	Mussels	0.23	Toddler
Chromium	RfD	0.60	33.0%	Goose	0.38	39.6%	Caribou Muscle	0.60	Toddler
Copper	RfD	0.04	59.3%	Goose	0.03	49.5%	Goose	0.04	Toddler
Iron	RfD	0.58	60.2%	Caribou Muscle	0.65	84.3%	Caribou Muscle	0.65	Adult
Lead	RfD	0.45	54.3%	Goose	0.24	54.8%	Goose	0.45	Toddler
Mercury	RfD	1.1	65.7%	Caribou Organ	0.99	58.2%	Caribou Muscle	1.1	Toddler
Methyl Mercury[a]	RfD	NA	NA	NA	0.85	63.9%	Ringed Seal Muscle	0.85	Adult
Methyl Mercury[b]	RfD	1.4	67.5%	Freshwater Fish	1.6	63.9%	Ringed Seal Muscle	1.6	Adult
Nickel	RfD	0.09	59.0%	Caribou Muscle	0.10	82.2%	Caribou Muscle	0.10	Adult
Selenium	RfD	0.07	71.8%	Freshwater Fish	0.04	68.6%	Freshwater Fish	0.07	Toddler
Thallium	RfD	0.47	54.6%	Freshwater Fish	0.36	43.6%	Caribou Muscle	0.47	Toddler
Zinc	RfD	0.06	58.3%	Caribou Muscle	0.06	78.1%	Caribou Muscle	0.06	Adult

Notes: NA= Not Applicable
a. General Population; RQ calculated with TRV for the general population

b. Children and pregnant woman and woman of child bearing age; RQ calculated with TRV for pregnant women and women of child bearing age

6.1.2 Recommended Maximum Weekly Intake Calculations

The RMWI were calculated based on considerations of Health Canada guidance (Health Canada 2012; 2010a, b). The following equation was used to calculate the allowable week intake:

$RMWI = TRV \times BW \times EF / C_m$

Where

RMWI	= Recommended maximum weakly intake rate (kg/week)
TRV	= Toxicity reference value (mg/kg/day)
BW	= Body weight (kg)
EF	= Exposure frequency (7days / week)
C_m	= Concentration of COPC in tissue (mg/kg wet weight)

This equation was applied to each metal, game meat and receptor life stage. The metal that had the lowest RMWI for each receptor was selected as the overall RMWI for that receptor because the lowest metal-specific RMWI is the driver of potential risk. Table 6.1-2 presents the RMWIs that would be protective against potential effects to human health due to naturally-occurring metals present in the foods. These RMWIs can be compared to the consumption rates used in the risk assessment, and only ringed seal muscle was identified as having a RMWI lower than that assumed in the assessment. This is related to the marginal exceedance for methyl mercury over the TRV for the sensitive subpopulation of pregnant women and women of childbearing age, which was previously discussed as being over estimated (See Section 6.1.1). All other RMWI were greater than the current consumption rates assumed in the assessment (Table 6.1-2) for the country foods evaluated. Toddler and adult recommended weekly number of servings for caribou, caribou liver, Arctic ground squirrel, Canada goose, Lake trout, bay mussel, ringed seal blubber, and liver, as well as berries. Therefore, local harvesters can continue to consume these foods at the amounts and frequencies used in this report that were assumed to reflect current consumption patterns.

For the toddler, slightly elevated RQs were reported related to mercury in caribou organ, and methyl mercury in freshwater fish and ringed seal muscle (Table 6.1-1). As noted in Table 6.1-2, no reduction in RMWI is evident for these tissues, relative to the assumptions used in the assessment. This is due to the fact that the RMWI are based on consideration of each game meat in isolation; whereas, the RQ values presented in Table 6.1-1 account for multiple pathways of exposure (e.g., consumption of fish tissue and ringed seal muscle combined).

Table 6.1-2 Recommended Maximum Weekly Intake(RMWI) Values Compared to Assumptions Used in the Risk Assessment

Food	Overall Maximum RMWI by Food [kg/week]		Consumption Rates Used in the HHRA [kg/week]	
	Toddler	Adult	Toddler	Adult
Berries	0.30	1.29	0.045	0.091
Caribou Muscle	0.59	2.53	0.22	1.46
Caribou Organ	0.059	0.25	0.042	0.10
Freshwater Fish	0.088	0.38	0.084	0.20
Goose	0.28	1.21	0.069	0.16
Mussels	0.049	0.21	0.0090	0.021
Ringed Seal Blubber	8.6	36.8	0.0036	0.0083
Ringed Seal Muscle	0.088	0.38	0.04	0.42
Ringed Seal Organ	0.04	0.19	0.0084	0.020
Squirrel	70.3	301.4	0.045	0.11

Notes:
Shading indicates the overall maximum RWMI by food was lower than the consumption rate used in the HHRA

6.2 Estimation of Cancer Risks

Of the COPCs included in this assessment, only arsenic was considered carcinogenic via the oral route of exposure. Arsenic, as a carcinogen, was assumed to have a non-threshold dose-response curve, meaning any amount of exposure has the potential to cause damage. As a result, it is necessary to define an "acceptable" level of risk associated with these types of exposures. The acceptable level of risk is an issue of policy rather than a scientific decision (CCME, 2006), and is set by regulatory agencies as opposed to risk assessors. Regulatory agencies have typically employed acceptable incremental lifetime cancer risk (ILCR) levels (*i.e.*, over and above baseline) between 1-in-100,000 and 1-in-1,000,000. An ILCR represents the incremental risk of an individual within a given population developing cancer over his or her lifetime due to exposures from a specific carcinogenic compound. Health Canada has specified an ILCR of 1-in-100,000, which is considered "essentially negligible" (Health Canada, 2012). By way of example, an ILCR of 1-in-100,000 increases a person's lifetime cancer risk from 0.40000 (based on the existing 40% lifetime probability of developing cancer in Canada) to 0.40001.

ILCR estimates generally consider risks related to a particular Project (the Project alone, excluding any contribution from other background or pre-existing sources) in that the cancer risks are expressed on an incremental or additional basis as compared to cancer risks related to all sources. Similar to an ILCR, the lifetime cancer risk (LCR) is an additional measure used to assess cancer. Unlike ILCRs, LCRs include the consideration of cancer risks from all sources including existing baseline conditions. As such, LCRs are expressed on a total or all sources basis. There are no acceptable LCR levels for exposure to carcinogens associated with background or existing baseline conditions and, therefore, the LCR values (for baseline and all sources) are typically provided for reference only.

Similar to the methods used to predict an ILCR, the following equation provides the general methods used to develop a LCR:

$$LCR = Estimated\ Exposure\ (ug\ /\ kg\ /\ day) * q_1(ug\ /\ kg\ /\ day)^{-1}$$

The predicted LCR estimate as a result of predicted exposures to inorganic arsenic under existing baseline conditions was 8.6 in 100,000 or 0.000086.

The predicted LCR estimate for inorganic arsenic (under existing baseline conditions) was developed using exposure estimates for a toddler and adult of 1.4 to 2.5 µg/day, respectively (Table 4.7-1 and 4.7-3). In an effort to provide some perspective on how these exposures compare to the typical levels of background inorganic arsenic exposure found throughout North America, published data on estimated daily intakes of inorganic arsenic within Canada and the U.S. were identified. These data are summarised in Table 6.2-2, along with the estimated daily intakes of inorganic arsenic determined in the HHRA for the Inuit harvesters in the LSA.

Health Canada (1995) estimated the average daily intake of inorganic arsenic for a non-smoking adult male to be 13 µg/day. An earlier Health Canada document estimated inorganic arsenic intake to be 3.9 to 31 µg/day for children aged 0.5 to 4 years and 7 to 49 µg/day for adults (CEPA, 1995). These estimates were based on concentrations of total arsenic in various food groups from Canadian supermarkets (Dabeka et al., 1987; 1993) and an estimate that 37% of the arsenic content of food is inorganic. Yost et al. (1998) reported values on percent inorganic content in food to estimate inorganic arsenic intake in Canadians and Americans using total arsenic data from the U.S. FDA and a Canadian market basket study by Dabeka et al. (1993). The estimated daily dietary intake of inorganic arsenic was calculated to be from 4.8 to 13 µg/day for various age groups in Canada and 8.3 to 14 µg/day for various age groups in the U.S.

More recently, Tsuji *et al*. (2007) estimated background inorganic arsenic intake from diet and water for children in the U.S. aged 1 to 6 years and adults. They modeled the data stochastically using USDA consumption data, published data on inorganic arsenic in foods and EPA data on arsenic in drinking water.

Mean and 90th percentile intakes were calculated to be 5.6 and 10.5 µg/day for adults and 3.5 and 5.9 µg/day for children (Tsuji *et al*., 2007).

It is apparent that the EDIs of inorganic arsenic determined in the current assessment are within the range of EDIs published for typical Canadian or American background exposure to arsenic from food and water. This provides some assurance that the local population harvesting foods and drinking water in the LSA is not at excess risk of developing cancer from arsenic exposure when compared to the general population.

Table 6.2-1 Estimated Daily Intake of Arsenic for Human Receptors in the LSA Compared to General Population Estimates

Receptor Group / Population	Estimated Daily Intake (µg/day)	
	Toddler	**Adult**
Predicted Inuit Receptor Exposure[a]	1.4	2.5
Canadian population		
CEPA, 1995	3.9 to 31	7 to 49
Health Canada, 1995	8.6	13, 15[b]
Yost *et al*., 1998	4.8	13
Alberta Health and Wellness, 2006		50
Alberta Health and Wellness, 2007	0.6	6.8
U.S. population		
Yost *et al*., 1998	8.3	14
Yost *et al*., 2004	3.2, 1.6 to 6.2[c]	
Tsuji *et al*., 2007	3.5, 5.9[d]	5.6, 11[d]

[a] *Based on 95UCLM concentration in all media (i.e., water and food)*
[b] *Non-smoking and smoking adult*
[c] *Mean, 5th to 95th percentile intakes for children 1 to 6 years*
[d] *Mean and 90th percentile intakes*

7.0 UNCERTAINTY ANALYSIS

A detailed uncertainty analysis is presented in Section 7, Appendix V8-5A. The uncertainties stated in that section apply to the current assessment, in that the updated assessment presented in this addendum uses the many of the same assumptions and approaches. The following updates to uncertainties are provided, based on changes made to the current assessment:

- The approach to calculating site-specific Bioconcentration Factors (BCFs) for soil-to-lichen; soil-to-sedge; soil-to-berries differed in the current assessment, relative to that used in Appendix V8-5A. In Appendix V8-5A, site-specific BCFs were used wherein BCFs were calculated on each paired soil and vegetation sample (N = 13 for soil to lichen; N = 1 for soil to sedge; N = 12 for soil to berry). With the removal of George Property baseline data from the assessment, the number of relevant paired soil and vegetation samples was reduced (N = 9 for soil to lichen; N = 1 for soil to sedge; N = 7 for soil to berry), such that an alternative approach was taken. To calculate BCFs in this assessment, a ratio was calculated between the Exposure Point Concentrations (EPCs) used in the baseline modelling for each media, as the number of non-paired samples of soils, lichens, sedge and berries (soils: N = 21; lichen: N = 13; sedge; N = 6; berry; N = 13) were greater than those available for paired samples. Where concentrations in a particular media were not detected, a site-specific BCF was not calculated and a literature-based BCF was selected instead. While the use of paired, site-specific data for a BCF would be preferred, the paucity of relevant paired data in the revised dataset (i.e., George data removed) required that a different approach to be implemented. Differences between the BCFs in Appendix V8-5A and those used in this addendum were minimal, in the vast majority of cases, and hence would not have had a significant impact on assessment outcomes.

- As per Appendix V8-5A, the Biotransfer Factors (BTF) used to convert wildlife intakes to game meat concentrations were based on values derived from literature. There is considerable uncertainty in the application of these values to predict game meat concentrations, as no BTFs specific to game meat being evaluated in this assessment (i.e., caribou, seal, squirrel, goose) were available. As such, literature based BTFs for beef and chicken were used. This is discussed in detail in Appendix V8-5A.

- In order to predict possible organ meat concentrations in caribou liver and seal liver, a Concentration Ratio (CR) approach was used. CRs were developed from published literature where both muscle and liver tissue concentrations were provided. These literature-based CRs were then applied to the predicted muscle concentrations in caribou and seal from this assessment. The literature related to measured concentrations of metals in organ meats is focused on a select number of organs and metals only, and therefore CRs could not be developed for all COPCs. Where a ratio could not be developed, organ meat concentrations were assumed to equal the predicted muscle tissue concentrations in this report, which may underestimate some organ concentrations. CRs could be developed for cadmium and mercury, since published data on muscle and liver tissue concentrations in caribou and seal were available for these two metals. While there is uncertainty associated with the application of a literature based CR due to a number of factors (e.g., number of samples and studies the ratios are based on; age of datasets), since the CRs are based on measured data in the literature were from caribou and ringed seal, the degree of uncertainty is likely small.

- While squirrel hibernate for approximately 7 months of the year, and Canada goose migrate south during the winter, they were assumed to be in LSA 100% of time. These assumptions will overestimate the contribution of the area geology to total exposure to these species; however since no metals were elevated in baseline soils, relative to ecological health-based soil quality guidelines (see Chapter 6, Vol 8), the LSA was not considered overly enriched with metals. These assumptions were made in an attempt to not underestimate baseline metal exposures in these species.

- All wildlife exposures and game meat concentrations were based on aquatic (i.e., drinking water and sediment) and terrestrial (i.e., soil, lichen berries and sedge) environmental media concentrations derived from the LSA. The LSA is a pristine area, with limited to no previous development. The use of baseline data to characterize exposures in these species therefore should provide a reasonable estimation of intakes and tissue residues, barring uncertainties cited previously with the BTF values (literature based).

- Several Toxicity Reference Values (TRVs) were updated since the DEIS (Appendix V8-5A), and hence reflect more recent literature. These TRVs have undergone extensive review by the regulatory agencies from where they were identified (i.e., JECFA; WHO; US EPA) and therefore are considered to be adequately conservative and protective of health.

- The assessment assumed that 100% of metal concentrations in media and game meat were 100% bio-accessible via consumption in the HHRA. This assumption will likely bias exposures, and risks, high, rather than low, as there is ample literature supporting the reasonably low bioavailability of metals in soils.

- Methyl mercury levels used in the assessment to predict risks from methyl mercury in seal muscle and organ meat are within the range of values reported in northern contaminant studies, which measured mercury levels in various traditional foods. In addition, the predicted seal inorganic mercury level in muscle is very low in comparison to methyl mercury, which is also in agreement with literature values. The predicted inorganic mercury levels in seal organ (i.e., 0.15 mg/kg-WW) are predicted below the average reported in literature but within the range of measured values. Measured total mercury levels in ringed seal organ range from 0.09 to 150 mg/kg-ww in a study conducted by Wagemann et al. (1998) and averaged 9.5 +/- 7.4 mg/kg-ww in a study by Laird et al. (2013). The predicted inorganic mercury levels are lower than what is measured on average, but within the range of expected values.

- There is uncertainty with predicted baseline tissue concentrations for COPCs in seal, caribou, Canada geese, and Arctic ground squirrel due to the use of a model (rather than measured data). Since changes in the marine environment as a result of the Project are not anticipated, the Project is not expected to alter the quality of country foods in the marine environment. With respect to the terrestrial environment, an under prediction of baseline tissue concentrations would not be expected to change conclusions of the assessment, given the negligible increases predicted related to the Project.

8.0 CONCLUSIONS

The results of the baseline country food study indicate that consumption of country foods at the rates assumed in the current project are not expected to result in adverse health effects to toddler or adults. Some Risk Quotients marginally greater than 1 were predicted for toddler consumption of caribou organ meats and freshwater fish, as well as for pregnant women consuming seal meat. These exceedances were considered to be a result of conservative assumptions in the assessment. Consideration of these factors, in conjunction with the nutritional benefits of these foods, clearly indicates that consumption of these foods at the rates indicated in this assessment is unlikely to be associated with any adverse health effects.

The Recommended Maximum Weekly Intakes (RMWIs) were calculated for non-carcinogenic effects from metal exposure and are representative of the highest intake rates of country foods that are safe for consumption at an acceptable risk level. Based on calculated RMWIs, caribou, Arctic ground squirrels, Canada geese, lake trout, ringed seals (both muscle, liver and blubber tissue), bay mussels, and berries (bog blueberry and bog cranberry) were shown to not present unacceptable health risks from metals to local human consumers. People in the area can continue to eat these foods at the consumption rates used in this report. With respect to the lifetime cancer risk (LCR) predictions associated with arsenic in country foods, the predicted LCR was 8.6 in 100,000, and the Estimated Daily Intake predicted in this assessment is within the range predicted for typical Canadian or American background exposures to inorganic arsenic from food and water. This provides some assurance that predicted background exposures to inorganic arsenic related to local harvesting of foods, consumption of surface waters and incidental ingestion of soils in the LSA are similar to those found in other populations in North America.

The duration for which the animals were assumed to be present within the country foods study area, consumption frequencies of country foods, and portion size of country foods consumed were conservative in nature. In addition, the highest measured or modelled country food tissue metal concentration was used in the calculation of RMWIs and LCRs. The current assessment is therefore considered to provide a conservative assessment of baseline health risks. The current assessment does not account for the cultural and nutritional benefits associated with the harvesting activities and consumption of country foods. There has been an increase in the literature over the past 15 years stressing the cultural, social, nutritional, and economic benefits of traditional food hunting, gathering and consumption, and weighing these benefits with potential risk related to contaminants in food (e.g., Chan 2011; Kuhnlein and Chan 2000; Kuhnlein et al 2000; Van Oostdam et al,1999). Country foods are healthy food choices (with the exception of any food advisories, which should be respected), relative to many store bought food choices, and are high in protein, nutrients and vitamins. The results of the current assessment supports the consumption of these foods at the rates assumed in the current project.

9.0 REFERENCES

Alberta Health and Wellness, 2007. Assessment of the Potential Lifetime Cancer Risks Associated with Exposure to Inorganic Arsenic among Indigenous People living in the Wood Buffalo Region of Alberta. Public Health Surveillance and Environmental Health. March 2007.

CEPA. 1995. Arsenic and its Compounds. Priority Substances List Assessment Report. Canadian Environmental Protection Agency.

Chan 2011 Inuit Health Survey 2007-2008. Contaminant Assessment in Nunavut. Nunavut Steering Committee Member Organizations.

CCME (Canadian Council for Ministers of the Environment). 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. Canadian Council for Ministers of the Environment. ISBN – 10 1-896997-45-7 PDF.

Coad, S. 1994. Consumption of Fish and Wildlife by Canadian Native Peoples: A Quantitative Assessment from the Published and Unpublished Literature. Hazardous Waste Section, Environmental Health Directorate, Health and Welfare Canada

Dabeka, RW., McKenzie AD, Lacroix GMA. 1987. Dietary intakes of lead, cadmium, arsenic and fluoride by Canadian adults: a 24-hour duplicate diet study. Food Additives and Contaminants, 4(1), 89-102.

Dabeka, R. W. and A. D. McKenzie. 1993. "Survey of Arsenic in Total Diet Food Composites and Estimation of the Dietary Intake of Arsenic by Canadian Adults and Children". Journal of AOAC International, 76(1): 14-25.

Environment Canada, 2015. https://ec.gc.ca/mercure-mercury/default.asp?lang=En&n=DCBE5083-1#NV

Egeland et. al. 2010. Inuit Health Survey 2007-2008. Contaminant Assessment in Nunavut. Nunavut Steering Committee Member Organizations.

Frykman, E., M. Bystrom, U. Jansson, A. Edberg and T. Hansen. 1994. Side effects of iron supplements in blood donors: Superior tolerance of heme iron. J Lab Clin Med. 123(4):561-4. Cited In: U.S. EPA 2006.

Ginsberg, GL and BF Toal 2009. Quantitative approach for incorporating methylmercury risks and omega-3 fatty acid benefits in developing species-specific fish consumption advice. Environmental Health Perspectives, 117: 267-275.

Golder and Associates. 2005. *Guidance Document for Country Foods Surveys for the Purpose of Human Health Risk Assessment*. Prepared for Health Canada.

Health Canada, 1995. Canadian Soil Quality Guidelines for Contaminated Sites Human Health Effects: INORGANIC ARSENIC Final Report: The National Contaminated Sites Remediation Program. February 1995

Health Canada. 2007. Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption. Bureau of Chemical Safety Food Directorate Health Products and Food Branch. http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/nutrition/merc_fish_poisson_e.pdf

Health Canada. 2013. Final Human Health State of the Science Report on Lead. Ottawa, Canada. Her Majesty the Queen in Right of Canada, represented by the Minister of Health, 2013. ISBN: 978--1-100-21-304-0. Available on Internet at the following address: http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/dhhssrl-rpecscepsh/index-eng.php

Health Canada. 2012. *Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0. Revised 2012*. Ottawa, ON.

Health Canada. 2010a. *Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRA chem)*. Health Canada: Ottawa, ON.

Health Canada. 2010b. *Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRA foods)*. Health Canada: Ottawa, ON.

Health Canada. 2010c. *Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0*. Health Canada: Ottawa, ON.

Innis, S. M., H. V. Kuhnlein, and D. Kinloch. 1988. The composition of red cell membrane phospholipids in Canadian Inuit consuming a diet high in marine mammals. Lipids, 23: 1064-68.

JECFA. 2011. WHO Food Additive Series: 64. Safety Evaluation of Certain Food Additives and Contaminants. Prepared by the sevety-third meeting of JECFA, Joint FAO/WHO Expert Committee on Food Additives. ISBBN 978 924 166064 8.

Kuhnlein, H.V., Receveur, O., Chan, H.M. and Loring, E. 2000. Assessment of Dietary Benefit/Risk in Inuit Communities. ISBN: 0-7717-0558-1.

Kuhnlein, H.V. and Chan, H.M. 2000. Environment and contaminants in traditional food systems of northern indigenous peoples. Annual Reviews of Nutrition 20:595-626.

Laird, D.; Goncharob, B.A.; Egeland, G.M.; Chan, H.M. 2013. Dietary Advice on Inuit Traditional Food Use Needs to Balance Benefits and Risks of Mercury, Selenium, and n3 Fatty Acids. *Nutrition*.1-8.

Lanphear, B.P., R. Hornung, J. Khoury, K. Yolton, P. Baghurst, D.C. Bellinger, R.L. Canfield, K.N. Dietrich, R. Bornschein, T. Greene, S.J. Rothenberg, H.L. Needleman, L. Schnaas, G. Wasserman, J. Graziano, and R. Roberts. 2005. Low-level environmental lead exposure and children's intellectual function: an international pooled analysis. EHP 113(7): 894-899.

MRI (Midwest Research Institute). 1988. Toxicity of thallium (I) sulfate (CAS No. 7446-18-6) in Sprague-Dawley rats. Vol. 2. Subchronic (90-day) study. Rockville, MD: Dynamac Corporation. Cited In: U.S. EPA 2012b.

Nancarrow, T. 2007. Climate Change Impacts on Dietary Nutrient Status of Inuit in Nunavut, Canada. A thesis submitted to McGill University in partial fulfillment of the requirements for the degree of Master of Science. File Reference: ISBN: 978-0-494-51313-2. Accessed at http://digitool.library.mcgill.ca/R/?func=dbin-jump-full&object_id=112545&local_base=GEN01-MCG02

NAS. 2001. Iron. In: Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. National Academy of Sciences. Institues of Medicine, Food and Nutrition Board. National Academy Press, Washington, DC. P. 233-310. Cited In: U.S. EPA, 2006.

Rescan. 2013. *Back River Project: 2012 Marine Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. 2013: Vancouver, British Columbia.

Richardson, G.M. 1997. Compendium for Canadian Human Exposure Factors for Risk Assessment. Ottawa, ON: O'Conner Associates Environmental Inc.

Solomon, P.A. 2005. Managing the Issue of Mercury Exposure in Nunavut. A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Masters of Science. File Reference: ISBN: 978-0-494-24803-4. Accessed at: http://www.collectionscanada.gc.ca/obj/thesescanada/vol2/QMM/TC-QMM-98802.pdf

Tian W, Egeland GM, Sobol I, Chan HM. 2011. Mercury hair concentrations and dietary exposure among Inuit preschool children in Nunavut, Canada. Environment International. 37:42-8.

Tsuji, J.S., Yost, L.J., Barraj, L.M., Scraffrd, C.G., and Mink, P.J. 2007. Use of background inorganic arsenic exposures to provide perspective on risk assessment results. Regulatory Toxicology and Pharmacology. 48:59-68.

U.S. EPA. 2012a. Provisional Peer-Reviewed Toxicity Values for Thallium and Compounds. Final. Superfund Health Risk Technical Support Center, National Center for Environmental Assessment, Office of Research and Development Cincinnati, OH 45268 U.S. Environmental Protection Agency http://hhpprtv.ornl.gov/issue_papers/ThalliumSolubleSalts.pdf

U.S. EPA. 2012b. Integrated Science Assessment for Lead. United States Environmental Protection Agency. Second External Review Draft. EPA/600/R-10/075B. February, 2012.

U.S. EPA. 2006. Provisional Peer Reviewed Toxicity Values for Iron (CASRN 7439-89-6) and Compounds. Derivation of Subchronic and Chronic Oral RfDs. United States Environmental Protection Agency. http://hhpprtv.ornl.gov/issue_papers/IronandCompounds.pdf

U.S. EPA (United States Environmental Protection Agency). 1998. Oral RfD for Chromium 3+ http://www.epa.gov/ncea/iris/toxreviews/0028tr.pdf

U.S. EPA. 1993. IRIS Integrated Risk Information System (IRIS). Inorganic Arsenic. Oral RfD. http://www.epa.gov/iris/subst/0278.htm

Van Oostdam, J., Donaldson, S.G., Feeley, M., Arnold, D., Ayotte, P., Bondy, G., Chan, L., Dewailly, E., Furgal, C.M. et. al. 2005. Human health implications of environmental contaminants in Arctic Canada: A review. Science of the total Environment. 351-352:165-246.

Wagemann, R., Trebacz,E.; Boila, G.; Lockhart, W.L.1998. Methylmercury and total mercury in tissues of arctic marine mammals. Science of the Total Environment (218). 19-31.

Wein, E.E. and Freeman, M.M.R. 1995. Frequency of traditional food use by three Yukon First Nations living in four communities. Arctic 48(2):161-171.

WHO (World Health Organization). 2010a. Aluminum in Drinking Water. Background Document for Development of WHO Guidelines for Drinking-water Quality.

WHO (World Health Organization). 2010b. Aluminum Summary Statement. Available at: http://www.who.int/water_sanitation_health/dwq/chemicals/aluminium_summary_statement.doc

WHO (World Health Organization). 2014. Guidelines for Drinking-water Quality – Review Documents. Available at: http://www.who.int/water_sanitation_health/dwq/chemicals/en/index.html

WHO/FAO (World Health Organization and the Food and Agriculture Organization of the United Nations). 2007. Evaluation of Certain Food Additives and Contaminants. Sixty-seventh report of the Joint FAO WHO Expert Committee on Food Additives. WHO Technical Report Series 940. Geneva. Available at: http://whqlibdoc.who.int/trs/WHO_TRS_940_eng.pdf

Yost, L.J., Schoof, R.A., and Aucoin, R. 1998. Intake of Inorganic Arsenic in the North American Diet. Human and Ecological Risk Assessment. 4(1), 137-152.

APPENDIX A

HHRA CHEMICALS OF POTENTIAL CONCERN SCREENING FOR THE PROJECT

A-1.0 INTRODUCTION

This appendix describes the approach used to screen the chemicals of potential concern (COPCs) in the human health risk assessments for the Project.

The HHRA COPC screening consisted of two main steps as follows:

- **Baseline Screening and Bioaccumulation Check (Section A-2.0):** Chemicals which were initially identified by ERM (formerly Rescan) as COPCs using a baseline screening approach and bioaccumulation check, were also carried forward as COPCs in this assessment. The ERM baseline screening approach consisted of selecting chemicals as COPCs that had baseline concentrations which exceeded soil, water and / or sediment quality guidelines. In addition, chemicals which were identified as bioaccumulative were selected as COPCs. COPCs selected by ERM are discussed in Section A-2.0, while full details of the baseline screening and bioaccumulation check are provided in Volume 8-5A.

- **Oral Toxic Potency Screening (Section A-3.0):** An oral toxic potency screening was conducted to determine any additional COPCs that would require assessment related to dust deposition associated with future emissions. Screening based on the toxic potency of a chemical is a method used to differentiate chemicals that have a high toxic potential and those that do not. Chemicals which represented >99% of the cumulative toxic potency in the human screening were carried forward for assessment (See Section A-3.0).

A-2.0 BASELINE SCREENING AND BIOACCUMULATION CHECK

COPCs for the baseline country food assessment of the Project were selected by ERA based on comparisons of maximum baseline soil, water and sediment data to available CCME (Canadian Council of Ministers of the Environment) guidelines, in addition to consideration of the chemical's bioaccumulation potential (See Table 3.3-1 of Country Food report Volume 8-5A). ERM indicated they used sediment quality guidelines (SedQG) and surface water quality guidelines (WQG) as a screening method for country foods as it was assumed if the metal exceeded a guideline in the baseline media, then country foods may have accumulated this metal. If a chemical exceeded a guideline in baseline media and / or was considered to bioaccumulate, it was carried forward as a COPC. Iron was identified as exceeding the freshwater WQG but not carried forward for further assessment.

The chemicals selected as COPCs via the baseline screening and bioaccumulation check and the reason they were carried forward are provided below:

- Aluminum (over CCME freshwater WQG)
- Arsenic (over CCME SQG (soil quality guideline) and freshwater and marine SedQGs; variable bioaccumulation potential)
- Cadmium (over freshwater WQG, freshwater and marine SedQG, moderate to high bioaccumulative potential)
- Chromium (over freshwater SedQG)
- Copper (over SQG, freshwater WQG and freshwater and marine SedQG)
- Lead (over freshwater WQG; low to high bioaccumulation potential in vegetation)
- Mercury (high bioaccumulative potential as CH_3Hg)
- Nickel (over freshwater WQG; low to moderate bioaccumulation potential)
- Selenium (moderate to high bioaccumulative potential)
- Thallium (moderate bioaccumulative potential)
- Zinc (over freshwater SedQG in lakes only; high bioaccumulation potential)

A-3.0 ORAL TOXIC POTENCY SCREENING

A chemical screening process, often referred to as toxic potency screening, was conducted to identify metals of potential concern for the HHRA related to dust deposition. Toxic potency screening is essentially a relative ranking system for chemicals that ranks chemicals based on the combination of toxic potency and an indicator of exposure potential, which can be emission rates, percent chemical composition of raw materials, environmental media concentrations etc. It is based on a screening procedure developed by the U.S. EPA (1989) and used by other regulatory agencies to determine COPCs in environmental impact statements (e.g., Alberta Health and Wellness 2011).

The toxic potency of a chemical is the dose or quantity of that chemical which is necessary to produce adverse health effects (i.e., toxic effects). For example, the toxic potency of chemical A would be greater than that of chemical B if toxic effects are produced at a lower concentration of chemical A than chemical B. It is important to consider the toxic potency of chemicals when selecting the chemicals of concern for a risk assessment, as chemicals present at low concentrations with a high toxic potency may pose a greater risk potential to human receptors than chemicals which are present at higher concentrations, but with a lower toxic potency.

The toxic potency screening was based on the overall weighted average of the geochemistry of the combined waste rock datasets of Umwelt, Llama, Echo and Main derived by SRK Consulting (2015)(Table A-3-1). Based on the air dispersion analysis conducted, the waste rock was predicted to be the dominant form of dust within the PDA (Mike Lepage RWDI, Pers Comm). Dust deposition at the MLA and winter road corridors are much lower than predicted for the Goose Property and hence the focus of the toxic potency screen was on Goose Property.

For the oral toxic potency screening, the weighted average percent metal composition data for waste rock were compared to regulatory oral toxicity reference values (TRVs) developed for human receptors (e.g., Health Canada, U.S. Environmental Protection Agency, World Health Organization). TRVs are doses of chemicals that individuals can be exposed to on a daily basis without developing adverse health effects, or where the risk of incurring adverse health effects is considered to be at an acceptable level. Human TRVs are selected based on the most sensitive endpoints in individuals (i.e., cancer, neurological effects, reproductive effects, etc.). In a toxic potency screen, human health TRVs are typically expressed as either reference doses (RfD) (used for non-carcinogens), or risk-specific doses (RsD), where the risk of incurring adverse carcinogenic health effects is considered to be at a predefined acceptable level (the RsD is typically only used for carcinogens). RsDs are calculated by dividing the acceptable risk level (e.g., 1 in 100,000 to 1 in 1,000,000) by the cancer slope factor. A risk level of 1 in 100,000 was selected as an acceptable risk level based on Canadian regulatory guidance (Health Canada 2010a).

In the toxic potency screening, the elemental weight percent values of each element were divided by the corresponding TRV for that element to yield a value that represents the individual toxic potency of that element. It must be recognized that this value is simply an expression of toxic potency that relates the amount of chemical present in the concentrate to its exposure limit. Thus, the units do not need to cancel out. Individual toxic potency for each chemical parameter was then expressed as a per cent of the total summed individual toxic potency of all chemical parameters considered. Following this, the chemicals were ranked in descending order of contribution to total individual toxic potency. Cumulative toxic potency was then calculated by adding the per cent individual toxic potency of the chemical with the highest individual toxic potency to that of the chemical with the next highest individual toxic potency, until the cut-off value for cumulative toxic potency is reached (99% in this case). The choice of cut-off for the cumulative toxic potency is an arbitrary decision. In many HHRAs, cut-off values of 99% or 95% are used. There is no regulatory guidance on this issue; rather, professional toxicological judgment is important in defining a reasonable and protective cut-off value. For the current toxic potency screen of concentrate, 99% cumulative toxic potency was considered a reasonable and conservative cutoff value, as it is very unlikely that chemicals contributing less than 1% of the cumulative toxic potency would pose a risk in the HHRA

Results of the oral toxic potency screening for the HHRA related to dust deposition associated with facility emissions are presented in Table A-3-2.

Table A-3-1 Weight Averages of the Geochemistry for Goose Property Area Based on the Combined Rock Dataset for Umwelt, Llama, Echo, and Main

Group (Tonnes by Rock)	Statistic	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	Hg	K	La	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Sc	Se	Sr	Te	Th	Ti	Tl	U	V	W	Zn
		ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppb	%	ppm	%	ppm	ppm	%	ppm	%	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
GABwaste (2,681,125)	Average	0.11	3.21	11.49	20.79	105.91	0.05	1.52	0.12	36.53	49.47	165.79	6.27	7.77	5.84	0.56	8.18	2.10	775.48	0.55	0.21	48.76	0.12	3.85	0.18	0.07	10.27	0.34	38.31	0.02	0.87	0.37	0.21	0.13	144.73	0.20	70.21
	Min	0.04	1.82	0.20	3.00	2.80	0.02	0.30	0.01	22.70	22.00	68.11	3.48	4.80	5.00	0.03	3.00	0.87	429.00	0.22	0.00	29.60	0.05	0.43	0.05	0.02	1.60	0.10	8.60	0.01	0.20	0.01	0.02	0.05	54.00	0.10	38.50
	5th % ile	0.05	2.02	0.80	8.50	14.61	0.02	0.55	0.01	25.77	30.87	103.10	3.94	5.08	5.00	0.09	3.50	1.12	487.10	0.27	0.02	32.96	0.05	0.81	0.06	0.02	2.71	0.10	11.44	0.02	0.21	0.15	0.02	0.10	67.10	0.10	41.95
	25th % ile	0.07	2.35	2.03	20.00	45.18	0.02	0.80	0.06	30.50	36.08	118.25	4.69	5.98	5.00	0.30	4.85	1.41	605.00	0.36	0.03	40.05	0.06	1.35	0.10	0.02	3.60	0.20	16.25	0.02	0.40	0.25	0.10	0.10	93.50	0.10	54.60
	Median	0.10	2.71	4.10	20.00	103.50	0.02	1.00	0.10	33.75	46.50	146.50	5.69	6.85	5.00	0.55	8.55	1.70	689.00	0.50	0.04	48.00	0.08	2.08	0.13	0.02	5.55	0.30	18.65	0.02	0.85	0.32	0.20	0.10	112.00	0.10	64.75
	75th % ile	0.12	3.52	9.98	20.00	158.75	0.04	1.33	0.14	40.90	58.85	214.25	7.97	8.79	5.00	0.74	10.38	2.45	779.50	0.63	0.07	55.90	0.11	3.32	0.14	0.10	9.93	0.43	25.25	0.02	1.10	0.38	0.27	0.10	162.50	0.20	80.85
	95th % ile	0.20	6.68	26.08	37.50	207.70	0.12	5.73	0.30	53.28	77.80	242.90	10.09	13.35	10.00	1.13	12.70	4.27	1689.50	0.95	1.36	71.19	0.13	8.58	0.38	0.30	44.95	0.70	202.45	0.03	1.59	0.89	0.41	0.30	348.70	0.60	116.87
	Max	0.53	7.03	222.60	51.00	277.00	0.39	6.89	0.35	54.00	114.00	326.00	12.45	16.30	20.00	1.31	24.00	5.51	1740.00	1.64	2.66	78.60	1.15	61.56	2.84	0.40	47.00	1.20	284.00	0.13	3.10	1.56	0.59	0.70	391.00	1.00	139.00
	N	62.00	62.00	62.00	56.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	56.00	56.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	56.00	62.00	54.00	62.00	62.00	56.00	62.00	62.00	62.00	62.00
MM&LIFwaste (4,504,222)	Average	0.26	1.80	233.49	19.44	62.17	0.29	0.79	0.02	10.42	66.74	25.19	9.92	4.70	19.10	0.56	10.51	0.97	254.94	0.86	0.06	24.65	0.07	3.73	0.69	0.09	2.86	0.23	28.14	0.05	3.01	0.07	0.16	0.70	31.17	19.68	26.21
	Min	0.01	0.30	0.60	2.00	1.30	0.02	0.08	0.01	1.80	33.00	0.98	1.25	1.30	5.00	0.01	1.80	0.11	33.00	0.17	0.00	5.20	0.03	0.76	0.02	0.02	0.70	0.10	4.00	0.02	0.20	0.00	0.02	0.10	4.00	0.10	0.80
	5th % ile	0.04	0.57	1.75	9.45	7.25	0.02	0.18	0.01	2.45	35.75	6.42	4.55	1.74	5.00	0.08	4.10	0.23	54.00	0.27	0.01	6.35	0.03	0.90	0.05	0.02	0.95	0.10	10.10	0.02	0.80	0.01	0.03	0.10	7.00	0.10	2.50
	25th % ile	0.06	0.87	5.60	20.00	14.65	0.08	0.39	0.01	3.85	44.70	10.90	8.04	2.60	5.00	0.22	5.30	0.48	103.50	0.35	0.02	9.65	0.05	1.38	0.32	0.03	1.40	0.10	16.85	0.02	1.25	0.03	0.07	0.25	14.00	0.10	4.90
	Median	0.11	1.30	18.10	20.00	37.20	0.13	0.57	0.01	6.60	59.70	17.80	9.77	3.30	5.00	0.37	8.20	0.81	164.00	0.52	0.03	15.70	0.06	2.22	0.49	0.05	2.10	0.10	25.10	0.02	2.00	0.04	0.12	0.40	19.00	0.20	11.30
	75th % ile	0.16	2.64	58.05	20.00	81.45	0.23	0.97	0.02	16.00	81.60	33.25	12.05	6.68	5.00	0.85	14.75	1.46	354.00	1.10	0.05	37.45	0.07	3.98	0.74	0.11	3.80	0.30	37.95	0.05	4.35	0.10	0.25	1.02	40.00	0.50	42.15
	95th % ile	0.52	3.97	366.50	20.00	167.50	0.88	2.28	0.07	24.65	120.70	60.86	16.30	9.81	10.65	1.31	23.10	1.80	659.50	2.41	0.07	66.45	0.09	11.81	1.54	0.31	6.30	0.81	51.05	0.10	7.85	0.17	0.35	2.10	75.00	13.65	88.20
	Max	8.29	7.69	10000.00	33.00	784.00	5.25	4.30	0.20	44.50	154.00	154.37	18.70	12.30	940.00	3.02	37.90	4.70	906.00	3.38	1.55	76.30	0.49	28.80	6.62	0.58	16.00	1.40	146.00	0.58	12.00	0.42	0.52	2.70	210.00	1220.00	101.00
	N	71.00	71.00	71.00	70.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	70.00	70.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	70.00	71.00	70.00	71.00	71.00	70.00	71.00	71.00	71.00	71.00
UIFwaste (28,852,729)	Average	0.12	2.67	75.93	18.75	150.41	0.19	0.78	0.04	14.22	92.67	39.02	9.36	7.48	5.37	0.92	15.95	1.23	339.64	1.17	0.04	38.80	0.06	5.59	0.40	0.09	4.21	0.20	22.46	0.04	4.92	0.12	0.24	1.24	44.83	2.00	45.78
	Min	0.01	0.08	0.10	1.00	8.90	0.02	0.04	0.01	0.50	28.60	2.09	0.24	0.20	5.00	0.05	2.30	0.03	19.00	0.10	0.00	2.60	0.01	0.61	0.01	0.02	0.20	0.10	2.40	0.02	0.50	0.00	0.02	0.10	2.00	0.05	1.60
	5th % ile	0.04	1.19	0.66	8.40	23.42	0.06	0.13	0.01	4.37	49.88	13.94	3.52	3.44	5.00	0.17	7.38	0.37	121.65	0.45	0.00	13.30	0.04	1.44	0.02	0.02	1.40	0.10	4.40	0.02	1.30	0.02	0.04	0.30	18.55	0.10	10.17
	25th % ile	0.06	2.10	3.50	20.00	62.90	0.12	0.30	0.01	10.40	69.58	26.68	6.76	6.00	5.00	0.45	12.38	0.86	235.00	0.76	0.02	28.88	0.04	3.07	0.15	0.02	2.98	0.10	8.70	0.02	3.30	0.07	0.15	0.80	32.00	0.10	29.00
	Median	0.08	2.51	9.75	20.00	126.00	0.16	0.45	0.03	13.65	93.80	34.85	9.03	7.40	5.00	0.90	15.80	1.17	300.50	1.03	0.03	39.20	0.05	4.56	0.27	0.04	4.05	0.10	13.70	0.03	4.95	0.12	0.25	1.28	43.00	0.20	44.40
	75th % ile	0.11	3.26	27.30	20.00	229.00	0.22	0.90	0.05	16.95	109.15	46.18	11.80	9.20	5.00	1.30	19.25	1.51	414.00	1.36	0.04	48.85	0.06	6.94	0.45	0.10	5.13	0.30	22.08	0.05	6.30	0.16	0.32	1.60	54.00	0.40	57.90
	95th % ile	0.25	4.33	154.35	20.00	332.20	0.40	2.26	0.10	25.77	146.45	81.93	15.85	12.10	7.60	1.78	25.89	2.16	690.45	2.45	0.09	67.65	0.09	12.08	1.15	0.29	7.29	0.50	67.42	0.09	8.45	0.21	0.45	2.27	79.90	4.62	89.35
	Max	2.14	6.62	5600.00	21.00	515.00	1.21	7.26	0.64	45.20	193.00	141.00	28.40	14.50	31.00	2.69	33.50	4.55	947.00	6.18	0.21	89.40	0.85	34.50	2.98	1.01	16.00	1.00	218.00	0.44	11.00	0.33	0.59	3.20	129.00	96.30	122.90
	N	192.00	192.00	192.00	189.00	189.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	189.00	189.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	189.00	192.00	189.00	192.00	192.00	189.00	192.00	192.00	192.00	192.00
LGW&DIFwaste (8,592,433)	Average	0.13	2.38	136.97	19.43	75.84	0.33	0.53	0.07	20.50	98.48	49.33	4.47	7.07	5.77	0.48	22.22	1.55	405.05	1.68	0.05	61.51	0.05	7.59	0.26	0.07	4.07	0.22	12.70	0.05	6.41	0.08	0.17	1.58	44.45	1.66	67.55
	Min	0.02	0.25	0.40	1.00	1.90	0.02	0.08	0.01	0.40	29.20	2.13	0.65	1.10	5.00	0.01	4.10	0.04	60.00	0.11	0.00	1.50	0.02	0.99	0.02	0.02	0.20	0.10	2.80	0.02	0.40	0.00	0.02	0.10	2.00	0.06	2.80
	5th % ile	0.05	1.11	5.18	20.00	20.18	0.10	0.10	0.01	8.12	60.49	14.30	2.65	2.76	5.00	0.11	11.29	0.73	271.00	0.64	0.01	22.22	0.04	2.04	0.03	0.02	1.67	0.10	3.88	0.02	1.99	0.01	0.03	0.39	17.60	0.10	36.43
	25th % ile	0.08	2.05	12.85	20.00	38.28	0.19	0.15	0.04	17.15	86.50	36.39	3.47	6.20	5.00	0.23	18.75	1.28	340.50	1.36	0.02	51.50	0.04	4.41	0.09	0.02	2.80	0.10	5.00	0.02	6.00	0.03	0.08	1.40	32.00	0.10	60.25
	Median	0.10	2.26	24.60	20.00	59.90	0.25	0.21	0.07	19.50	99.00	45.40	3.94	7.10	5.00	0.40	22.00	1.52	370.00	1.57	0.02	63.10	0.05	6.98	0.15	0.03	3.40	0.10	6.30	0.03	6.60	0.06	0.15	1.60	37.00	0.11	69.10
	75th % ile	0.13	2.63	65.35	20.00	90.23	0.32	0.32	0.10	22.55	111.00	54.85	4.81	7.80	5.00	0.65	26.00	1.74	421.50	1.80	0.03	72.50	0.05	9.30	0.23	0.07	4.00	0.20	9.10	0.05	7.40	0.11	0.26	1.80	46.00	0.30	77.25
	95th % ile	0.24	3.58	501.80	20.00	164.20	0.60	2.20	0.17	30.46	133.11	100.00	8.80	9.60	10.00	1.07	31.71	2.23	634.70	3.20	0.06	91.61	0.07	14.62	0.63	0.21	5.64	0.60	28.00	0.10	8.83	0.18	0.35	2.30	77.00	6.03	90.91
	Max	2.25	7.25	3580.00	34.00	750.00	6.04	9.31	0.30	84.90	189.00	220.00	17.40	25.40	26.00	1.90	39.30	5.90	1610.00	7.05	2.09	148.00	0.50	59.80	3.64	0.75	44.00	2.40	268.00	1.05	11.80	0.96	0.67	4.10	388.00	89.00	116.00
	N	219.00	219.00	219.00	214.00	216.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	214.00	213.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	214.00	219.00	212.00	219.00	219.00	214.00	219.00	219.00	219.00	219.00
UGWwaste (9,872,976)	Average	0.11	2.45	100.08	19.53	111.94	0.29	0.30	0.09	20.77	106.22	49.12	4.69	7.08	5.41	0.63	24.45	1.35	329.86	1.53	0.09	62.91	0.05	9.45	0.24	0.17	4.25	0.16	14.59	0.04	7.50	0.10	0.20	1.96	45.15	0.49	71.20
	Min	0.03	0.95	1.00	1.00	8.70	0.07	0.12	0.01	7.70	49.10	1.05	2.30	3.90	5.00	0.08	6.40	0.41	96.00	0.40	0.00	16.20	0.03	1.48	0.02	0.02	0.90	0.10	3.40	0.02	0.80	0.01	0.02	0.20	13.00	0.05	3.20
	5th % ile	0.06	1.38	5.50	20.00	23.30	0.14	0.15	0.02	14.40	85.30	29.10	2.60	4.80	5.00	0.14	14.60	0.86	215.00	0.82	0.01	38.70	0.04	4.21	0.06	0.02	2.30	0.10	4.20	0.02	4.80	0.01	0.06	1.10	28.00	0.06	45.40
	25th % ile	0.08	1.79	9.40	20.00	50.00	0.22	0.18	0.06	18.60	95.00	42.30	3.30	5.63	5.00	0.30	19.20	1.13	279.00	1.27	0.02	55.50	0.04	7.26	0.12	0.04	3.00	0.10	4.80	0.02	6.60	0.07	0.10	1.62	34.00	0.10	65.20
	Median	0.09	2.20	12.90	20.00	67.20	0.26	0.24	0.09	20.80	101.00	49.88	4.00	6.85	5.00	0.49	24.10	1.34	323.00	1.50	0.02	61.40	0.05	9.20	0.18	0.09	3.70	0.10	6.40	0.03	7.40	0.10	0.21	1.84	39.00	0.10	71.80
	75th % ile	0.11	2.72	16.80	20.00	111.00	0.32	0.35	0.12	23.90	114.50	55.50	5.27	8.18	5.00	0.78	29.60	1.57	379.00	1.74	0.03	73.40	0.05	11.40	0.26	0.25	4.70	0.18	10.70	0.05	8.30	0.12	0.25	2.28	49.00	0.20	83.20
	95th % ile	0.20	3.96	28.00	20.00	364.00	0.47	0.68	0.16	26.50	144.00	68.20	9.02	10.06	9.00	1.63	36.50	1.92	457.00	2.11	0.07	90.40	0.06	15.80	0.47	0.50	6.80	0.50	24.20	0.07	10.90	0.18	0.34	3.30	75.00	2.00	93.70
	Max	0.66	8.44	5014.90	20.00	667.00	1.16	1.46	0.20	29.90	181.00	103.00	12.00	16.80	13.00	2.42	42.30	2.26	545.00	3.60	2.24	105.00	0.09	22.60	2.56	0.90	16.00	1.00	194.00	0.68	13.00	0.39	0.67	4.15	123.00	13.20	96.90
	N	81.00	81.00	81.00	78.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	78.00	78.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	78.00	81.00	77.00	81.00	81.00	78.00	81.00	81.00	81.00	81.00

Table A-3-1 Weight Averages of the Geochemistry for Goose Property Area Based on the Combined Rock Dataset for Umwelt, Llama, Echo, and Main

Group (Tonnes by Rock)	Statistic	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	Hg	K	La	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Sc	Se	Sr	Te	Th	Ti	Tl	U	V	W	Zn
		ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppb	%	ppm	%	ppm	ppm	%	ppm	%	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
PHYwaste (2,610,581)	Average	0.12	3.94	16.61	14.06	111.20	0.22	0.78	0.10	22.28	102.26	53.94	7.66	9.07	5.94	0.60	21.80	1.64	418.57	1.53	0.20	69.92	0.05	8.43	0.22	0.25	6.28	0.16	44.27	0.03	5.53	0.07	0.08	1.34	63.00	0.33	75.03
	Min	0.05	1.94	3.20	1.00	8.10	0.04	0.17	0.01	4.90	36.00	19.20	3.27	5.00	5.00	0.10	1.90	0.98	232.00	0.25	0.00	8.90	0.04	2.08	0.02	0.05	2.20	0.10	5.10	0.02	0.70	0.00	0.03	0.10	20.00	0.10	13.50
	5th % ile	0.06	2.28	4.70	1.00	19.50	0.07	0.22	0.02	10.90	63.50	20.80	4.51	6.28	5.00	0.10	12.30	1.03	240.00	0.66	0.01	32.80	0.04	2.31	0.02	0.06	2.30	0.10	5.80	0.02	2.20	0.00	0.03	0.40	24.00	0.10	42.40
	25th % ile	0.07	2.84	11.20	3.25	27.20	0.16	0.35	0.05	16.90	85.90	39.10	5.18	7.93	5.00	0.16	17.80	1.37	340.00	1.36	0.02	55.00	0.05	5.64	0.08	0.16	3.50	0.10	11.50	0.02	4.70	0.02	0.03	1.10	39.00	0.10	57.00
	Median	0.10	3.38	16.00	20.00	40.20	0.23	0.64	0.10	24.20	95.40	47.50	6.28	8.65	5.00	0.27	23.00	1.60	405.00	1.70	0.02	74.90	0.05	7.00	0.10	0.20	5.40	0.10	20.20	0.02	5.80	0.05	0.05	1.20	51.00	0.10	88.00
	75th % ile	0.13	4.08	20.20	20.00	63.70	0.30	0.85	0.14	27.00	123.00	54.40	9.63	10.63	5.75	0.37	26.40	1.80	452.00	1.88	0.03	89.90	0.06	9.90	0.17	0.30	6.80	0.10	32.10	0.03	6.60	0.11	0.10	1.70	70.00	0.20	91.80
	95th % ile	0.29	8.06	31.40	20.00	494.00	0.36	2.00	0.20	34.20	156.00	105.00	13.00	12.34	10.00	3.49	31.00	2.23	658.00	1.94	0.90	96.90	0.06	13.80	0.83	0.55	17.00	0.50	206.00	0.05	7.80	0.21	0.19	2.20	173.00	1.50	98.60
	Max	0.32	8.51	35.10	20.00	589.00	0.48	2.38	0.32	37.60	162.00	144.00	17.10	13.10	10.00	3.53	35.80	2.63	745.00	2.28	2.15	102.00	0.08	34.10	1.51	0.63	18.00	0.50	222.00	0.08	9.10	0.33	0.36	2.20	174.00	2.10	98.90
	N	21.00	21.00	21.00	18.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	18.00	18.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	18.00	21.00	16.00	21.00	21.00	18.00	21.00	21.00	21.00	21.00
QFPwaste (1,836,798)	Average	0.08	0.73	894.55	19.67	63.64	0.57	0.16	0.11	2.25	62.91	7.22	1.33	2.86	5.17	0.31	17.19	0.32	137.70	1.33	0.05	7.30	0.06	5.02	0.14	0.21	0.66	0.18	8.86	0.08	4.09	0.01	0.08	1.28	4.27	3.54	34.19
	Min	0.01	0.18	0.10	10.00	20.80	0.02	0.07	0.01	0.40	4.00	1.13	0.45	0.60	5.00	0.06	5.50	0.05	47.00	0.20	0.01	1.20	0.03	2.06	0.02	0.02	0.10	0.10	4.30	0.02	2.10	0.00	0.02	0.70	2.00	0.10	5.70
	5th % ile	0.02	0.26	0.47	20.00	27.00	0.04	0.08	0.01	0.40	26.01	1.31	0.58	1.39	5.00	0.10	9.86	0.07	66.40	0.28	0.02	1.39	0.03	2.33	0.02	0.02	0.25	0.10	4.99	0.02	2.35	0.00	0.02	0.80	2.00	0.10	12.23
	25th % ile	0.03	0.49	23.68	20.00	46.60	0.14	0.12	0.02	0.63	44.83	2.76	0.79	2.10	5.00	0.21	13.95	0.15	106.00	0.50	0.03	2.10	0.04	3.31	0.02	0.02	0.40	0.10	6.10	0.02	3.15	0.01	0.05	1.10	2.00	0.20	20.38
	Median	0.04	0.68	163.50	20.00	60.70	0.25	0.15	0.05	1.00	53.40	4.03	1.11	2.70	5.00	0.30	15.85	0.25	134.50	0.77	0.04	2.55	0.04	3.94	0.06	0.04	0.50	0.10	7.65	0.03	4.00	0.01	0.07	1.30	2.00	0.35	27.15
	75th % ile	0.07	0.82	644.00	20.00	75.10	0.34	0.20	0.11	1.78	69.15	10.17	1.37	3.40	5.00	0.37	20.50	0.35	152.50	1.91	0.06	6.20	0.05	6.22	0.14	0.11	0.60	0.18	10.58	0.06	4.88	0.01	0.08	1.50	3.00	1.08	36.63
	95th % ile	0.34	1.23	3884.50	20.00	104.80	2.16	0.28	0.15	6.28	112.00	16.76	3.34	4.37	5.00	0.50	25.70	0.70	203.90	4.05	0.10	18.86	0.08	9.23	0.31	0.32	1.18	0.36	15.93	0.31	5.56	0.02	0.15	1.70	10.65	22.65	73.71
	Max	0.54	2.58	10000.00	20.00	144.00	6.17	0.31	1.50	22.60	229.00	43.70	5.33	7.60	10.00	0.94	37.50	1.45	384.00	5.86	0.11	79.40	0.52	10.80	1.47	4.07	4.00	1.10	25.60	0.52	7.90	0.08	0.42	1.80	41.00	45.50	155.00
	N	30.00	30.00	30.00	30.00	29.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Overall Goose WR	Average	0.13	2.5	121	19	120	0.24	0.68	0.063	17	91	47	7.4	7.1	6.5	0.73	18	1.3	358	1.3	0.065	46	0.062	6.4	0.35	0.11	4.3	0.20	21	0.043	5.2	0.11	0.21	1.3	48	2.94	54
	Average in %	0.000013	2.5	0.0121	0.0019	0.0120	0.000024	0.68	0.0000063	0.0017	0.0091	0.0047	7.442	0.00071	0.00000065	0.732	0.0018	1.306	0.0358	0.00013	0.065	0.0046	0.062	0.00064	0.349	0.000011	0.00043	0.000020	0.0021	0.0000043	0.00052	0.114	0.000021	0.00013	0.0048	0.000294	0.0054

Table A-3-2 Oral Toxic Potency Screen of Metals Content of Waste Rock

Parameter	Composition of Waste Rock (%)	Oral Exposure Limit (µg/kg/day)	Toxic Potency [a]	Relative Toxic Potency	Cumulative Toxic Potency	TRV Type	Exposure Limit Reference
Arsenic	0.012	0.0056	2.15823	98.38%	98.38%	RsD	Health Canada 2010
Aluminium	2.55	143	0.01780	0.81%	99.19%	RfD	WHO 2013, 2010a,b
Iron	7.44	700	0.01063	0.48%	99.67%	p-TRV	U.S. EPA 2006
Vanadium	0.0048	2	0.00239	0.11%	99.78%	RfD	RIVM 2009
Cobalt	0.0017	1.4	0.00121	0.06%	99.84%	RfD	RIVM 2001
Lead	0.00064	0.6	0.00107	0.05%	99.89%	POD	JECFA 2011
Thallium	0.000021	0.02	0.00103	0.05%	99.93%	p-RfD	US EPA 2012
Nickel	0.0046	11	0.00042	0.02%	99.95%	RfD	Health Canada 2010b
Magnesium	1.31	5000	0.00026	0.01%	99.96%	UIL	IOM 2011
Manganese	0.036	140	0.00026	0.01%	99.98%	RfD	US EPA 2015
Uranium	0.00013	0.6	0.00022	0.01%	99.99%	RfD	Health Canada 2010b
Boron	0.0019	17.5	0.00011	0.00%	99.99%	RfD	Health Canada 2010b
Barium	0.012	200	0.00006	0.00%	99.99%	RfD	Health Canada 2010b
Copper	0.00465946	91	0.00005	0.00%	100.00%	RfD	Health Canada 2010b
Antimony	0.00001118	0.4	0.00003	0.00%	100.00%	RfD	US EPA 2015
Calcium	0.67948926	28000	0.00002	0.00%	100.00%	UIL	IOM 2011
Zinc	0.00537603	480	0.00001	0.00%	100.00%	RfD	Health Canada 2010b
Cadmium	0.00000627	1	0.00001	0.00%	100.00%	RfD	Health Canada 2010b
Chromium	0.00910000	1500	0.00001	0.00%	100.00%	RfD	US EPA 2015
Molybdenum	0.00012733	23	0.00001	0.00%	100.00%	RfD	Health Canada 2010b
Selenium	0.00002037	5.5	0.00000	0.00%	100.00%	RfD	Health Canada 2010b
Strontium	0.00214132	600	0.00000	0.00%	100.00%	RfD	US EPA 2015
Titanium	0.11376420	43000	0.00000	0.00%	100.00%	See note [b]	US EPA 2005
Silver	0.00001296	5	0.00000	0.00%	100.00%	RfD	US EPA 2015
Mercury	0.00000065	0.3	0.00000	0.00%	100.00%	RfD	Health Canada 2010b
Sodium	0.06455039	33000	0.00000	0.00%	100.00%	UIL	IOM 2011
Phosphorus	0.06152357	42000	0.00000	0.00%	100.00%	UIL	IOM 2011
		Totals	2.19384	100.00%			

Notes:

NA = no TRV available; RfD = reference dose; UIL = upper intake level; p-RfD = provisional reference dose; POD = point of departure; Shaded grey = chemicals carried forward for further assessment

a Toxic potency of each chemical was determined by dividing the composition of waste rock by the oral exposure limit.

b No oral RFD for titanium could be found in the literature reviewed. Evaluations of titanium dioxide by JECFA, SCF, and EFSA have each concluded that there are no safety concerns associated with the use of titanium dioxide as a food additive at levels ranging up to 3% (U.S. EPA, 2005). This value (3% or 30,000,000 µg/kg was converted to a dose by dividing by a body weight of 70 kg).

c. While iron represented >99.67% of the cumulative toxic potency, it was carried forward for assessment due to the large cumulative toxic potency of arsenic.

d. No TRVs were available for Ga, La, S, Sc, Te, Th, W, S, Bi and P and as such these chemicals were not included in the toxic potency screening.

Based on results of the oral toxic potency screening for human health (Table A-3-2), the following chemicals made up >99% of the total toxic potency and were selected for further evaluation in the HHRA: aluminum, arsenic and iron. While iron technically did not screen on, it was carried forward for further assessment given the large toxic potency of arsenic. No TRVs were identified in the literature reviewed for Bi, Ga, La, P, S, Sc, Te and W, and as such, these chemicals were not included in the toxic potency screening. Percent concentrations in waste rock were very low for Bi, Ga, Sc, Te, Th and W (range of 0.0000043% for Te to 0.000294% for W) and La is at low concentration (0.0018%); thus, these were not carried for further assessment. Potassium was in waste rock at 0.73%. It is an essential nutrient (US EPA, 2014) and sulfur (present at 0.35%) is an abundant element and would not be considered to drive toxicity and as such, these chemicals were not considered to be of concern.

Aluminum and arsenic had already been selected as COPCs via the baseline screening and bioaccumulation check (Volume 8-5A); iron was not previously identified and as such was added for assessment.

The final list of COPCs for evaluation in the HHRA includes:

- Aluminum
- Arsenic
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Mercury
- Nickel
- Selenium
- Thallium
- Zinc

A-5.0 REFERENCES

Alberta Health and Wellness. 2011. Guidance on Human Health Risk Assessment for Environmental Impact Assessment. Government of Alberta. August 2011. pg.21. http://www.health.alberta.ca/documents/Health-Risk-Enviro-Impact-Guide-2011.pdf

Health Canada. 2010a. Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health. Detailed Quantitative Risk Assessment for Chemicals (DQRAChem). www.healthcanada.gc.ca.

Health Canada. 2010b. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0. www.healthcanada.gc.ca

IOM (Institute of Medicine). 2011. Dietary Reference Intakes (DRIs): Tolerable Upper Intake Levels, Elements. Food and Nutrition Board, Institute of Medicine, National Academies http://iom.nationalacademies.org/Activities/Nutrition/SummaryDRIs/~/media/Files/Activity%20Files/Nutrition/DRIs/ULs%20for%20Vitamins%20and%20Elements.pdf

JECFA (Joint FAO / WHO Expert Committee on Food Additives).2011. Safety evaluation of certain food additives and contaminants / prepared by the seventy-third meeting of the Joint FAO/WHO Expert Committee on Food Additives (JECFA). WHO food additives series: 64. World Health Organization.

RIVM. 2001. Re-evaluation of human-toxicological maximum permissible risk levels. Dutch National Institute of Public Health and the Environment (Rijksinstituut Voor Volksgezondheid En Milieu). RIVM report 711701025. Available at: http://rivm.openrepository.com/rivm/bitstream/10029/9662/1/711701025.pdf

RIVM. 2009. Re-evaluation of some human toxicological Maximum Permissible Risk levels earlier evaluated in the period 1991-2001. Dutch National Institute of Public Health and the Environment (Rijksinstituut Voor Volksgezondheid En Milieu). RIVM report 711701092/2009. Available at: http://www.rivm.nl/bibliotheek/rapporten/711701092.pdf

SRK Consulting. 2015. Waste rock trace element summary. E-mail from K. Sexsmith (SRK Consulting) to C. Moore (Intrinsik) June 9, 21015.

U.S. EPA. 2015. IRIS (Integrated Risk Information System). On-Line. U.S. Environmental Protection Agency. http://www.epa.gov/iris/. Searched August, 2015.

U.S. EPA. 2014. Region 4 Human Health Risk Assessment Supplemental Guidance. January 2014 Draft Final. United States Environmental Protection Agency. Technical Services Section, Superfund Division. EPA Region 4. http://www2.epa.gov/sites/production/files/2015-09/documents/region_4_hhraguidedoc011014.pdf f

U.S. EPA. 2012. Provisional Peer-Reviewed Toxicity Values for Thallium and Compounds. Final. Superfund Health Risk Technical Support Center, National Center for Environmental Assessment, Office of Research and Development Cincinnati, OH 45268 U.S. Environmental Protection Agency

U.S. EPA (United States Environmental Protection Agency). 2006. Provisional Peer Reviewed Toxicity Values for Iron (CASRN 7439-89-6) and Compounds. Derivation of Subchronic and Chronic Oral RfDs.

U.S. EPA. 2005. Inert Ingredient Tolerance Reassessment - Titanium Dioxide. Action Memorandum, June 28th, 2005. Office of Prevention, Pesticides and Toxic Substances. United States Environmental Protection Agency.

U.S. EPA. 1989. Risk Assessment Guidance for Superfund. United States Environmental Protection Agency, Washington, DC. EPA/540/01. Pg. 5-23, 5-24.

WHO (World Health Organization). 2010a. Aluminum in Drinking Water. Background Document for Development of WHO Guidelines for Drinking-water Quality.

WHO (World Health Organization). 2010b. Aluminum Summary Statement. Available at: http://www.who.int/water_sanitation_health/dwq/chemicals/aluminium_summary_statement.doc.

WHO (World Health Organization). 2013. WHO/HSE/WSH/10.01/13. Available at: http://www.who.int/water_sanitation_health/publications/aluminium.pdf.

APPENDIX B

FOOD CHAIN MODEL AND PREDICTED CARIBOU, ARCTIC GROUND SQUIRREL, CANADA GOOSE, AND RINGED SEAL CONCENTRATIONS

B-1.0 INTRODUCTION

This appendix provides an update to the methods used in Vol 8–5A, Appendix B, to predict tissue concentrations for caribou, Arctic ground squirrel, Canada goose, and seal, using a food chain model. Much of the text from this appendix is from Appendix B of Vol 8–5A, and where changes to the methods were made, text has been updated. The food chain model used to predict metal concentrations in animal tissue estimates the fraction of metals that are retained in the tissues when wildlife ingest environmental media such as vegetation, soil and surface water. The food chain model followed the methodology described in Golder (2005).

This appendix provides details on the methodology of the food chain model and the modelled metal concentrations in the tissues of terrestrial and marine mammal country foods. The modelled metal concentrations were used in the country foods baseline study to assess the potential health risks among human consumers.

B-2.0 METHODS

The following equations were used to predict terrestrial animal tissue concentrations:

$$C_{meat}\ (mg/kg) = C_{msoil} + C_{msed} + C_{mdust} + C_{mwater} + C_{mveg} + C_{mprey}$$

where:

C_{msoil} = *Concentration in meat from the animal's exposure to metals in soil.*
C_{msed} = *Concentration in meat from the animal's exposure to metals in sediment.*
C_{mdust} = *Concentration in meat from the animal's exposure to metals in dust.*
C_{mwater} = *Concentration in meat from the animal's exposure to metals in water.*
C_{mveg} = *Concentration in meat from the animal's exposure to metals in vegetation*
C_{mprey} = *Concentration in meat from the animal's exposure to metals in prey (e.g. marine fish).*

The terrestrial wildlife uptake equations used to obtain the concentrations in animal tissue (meat) from exposure to soil, vegetation and water are presented in Table B-2.0.

Table B-2.0 Terrestrial Wildlife Uptake Equations

Pathway	Equation and Equation Parameters
Soil ingestion	C_{msoil} = BTF x C_{soil} x IR_{soil} x fw x fp
Sediment ingestion	C_{mveg} = BTF x C_{sed} x IR_{sed} x fw x fp
Dust ingestion	C_{mdust} = BTF x C_{dust} x IR_{dust} x fw x fp
Water ingestion	C_{mwater} = BTFx C_{water} x IR_{water} x fw x fp
Vegetation ingestion	C_{mveg} = BTF x C_{veg} x IR_{veg} x fw x fp
Prey ingestion	C_{mprey} = BTF x C_{prey} x IR_{prey} x fw x fp

where:
BTF = biotransfer Factor (day/kg)
IR = ingestion rate or inhalation rate for caribou, arctic ground squirrel and Canada goose (kg/day or L/day or m^3/day)
C = concentration (mg/kg for food or soil and mg/L for water)
fw = fraction of daily consumption (assumed 1; unitless)
fp = fraction of the year the animal is onsite (unitless)

For caribou, it was assumed that 90% of their diet was lichen, and 10% was composed of an even mix of sedge and berries. For Canada goose, it was assumed that 100% of their diet was an even mix of sedge and berries, while for Arctic ground squirrel it was assumed that 100% of their diet was an even mix of sedge, berries, and lichen. For Exposure Point Concentrations (EPCs) in these dietary items see Table B-2.1-1.

Since Canada goose may ingest soil from both the terrestrial environment and wetland sediment, the EPC from soil and wetland sediment were included in the model to estimate the Canada goose tissue concentration as a result of ingestion of these environmental media.

The seal tissue metal concentration, C_{mseal}, was predicted using tissue concentrations in starry flounder (*Platichthys stellatus*) using the assumption that 100% of their diet consisted of marine fish, and using the following equation:

$$C_{mseal} = BTF_{tissue\text{-}food}\ (day/kg) \times C_{fish}\ (mg/kg) \times IR_{fish}\ (kg/day) \times fw \times fp$$

B-2.1 Environmental Metal Concentrations Used in the Food Chain Model

B-2.1.1 Terrestrial Wildlife

ERM (formerly Rescan) conducted several field studies to determine the current metal concentrations in two lichen and two berry species (2013b), soil (2013a), and freshwater (2012a, 2012b). Lichen (*Cladina stygia* and *Stereocaulon paschale*) and water sedge (*Carex aquatilis*) samples were collected from within the country foods study area in 2012 and analyzed for metals (Rescan 2013b).

All media sampling locations are presented in Figures 4.2-1 to 4.3-1 within the main report (Vol8-5B; Figure 4.2-1 Soil Sampling Locations; Figure 4.2-2 Water and Sediment Quality Sampling Locations; Figure 4.2-3 Berry Sampling Locations; Figure 4.2-4 Lichen and Sedge Sampling Locations). As discussed in the main report, baseline data related to the George Exploration Camp has been removed, and the environmental baseline data provided in Table B-2 are related largely to Goose Property Area. Sample sizes at the MLA were limited (see Vol8-5B, Appendix C), and Project-related emissions are anticipated to be larger in the Goose Property area than the MLA, and therefore, the baseline data used in the model was predominantly related to Goose Property area. The baseline Exposure Point Concentrations (EPCs) used in the food chain model to predict baseline tissue concentrations were represented by the 95 percent upper confidence limit on the arithmetic mean (95UCLM), except where less than 20% of the data were detected, wherein a maximum value was used as an EPC. A summary of the EPC data used in the food chain model is presented in Table B-2.1-1, with statistical summaries of the data being presented in Appendix C.

Table B-2.1-1 Summary of Exposure Point Concentrations (EPCs) in Lichen, Berry, and Sedge Tissue, Soil, and Surface Freshwater Samples

Metal	Lichen Tissues (mg/kg wet weight) (N=10)	Berry Tissues (mg/kg wet weight) (N=13)	Sedge (mg/kg wet weight)[c] (N=18)	Goose Lake Sediment (mg/kg) (N=18)	Soil (mg/kg) (N=21)	Surface Freshwater [d] (mg/L) (N=53)
Aluminum	688	14.5	1 [a]	9759	5110	0.0216
Arsenic	0.480	0.05 [b]	0.177	15.7	5.17	0.00034
Cadmium	0.058	0.02	0.014	0.52	0.054 [b]	0.00001
Chromium	0.64	0.13 [b]	0.05 [a]	26.9	17.1	0.00030
Copper	4.62	1.22	3.77	93.5	11.7	0.00232
Iron	606	19.98	Not Analyzed	21640	10100	0.0902
Lead	1.34	0.01 [a]	0.0273	5.45	2.58	0.00040
Mercury	0.0627	0.0005 [a]	0.0019	0.073	0.0080	0.000005
Nickel	12.7	0.051	3.49	66.3	11.4	0.00642
Selenium	0.40 [a]	0.1 [a]	0.1 [a]	0.50	0.1 [a]	0.0001
Thallium	0.02 [a]	0.005 [a]	0.012	0.089	0.058 [b]	0.00005 [b]
Zinc	19.4	5.27	17.23	80.7	15.2	0.00261

Notes: *nd = non- detect; all EPCs are 95 UCLMs unless otherwise noted*

a All samples had non-detectable concentrations; EPC provided represents half the analytical method of detection

b A 95 UCLM could not be calculated due to insufficient number of detectable concentrations; as such, the maximum detected concentration was selected as the EPC.

c Three replicate samples were collected in each of 6 locations (for a total of 18 samples). The average of the 3 replicate samples in each of the six locations was calculated. Then the max of these averages was selected to represent the EPC.

d While both stream and lake surface water data exist, only lake data were used in the modelling exercise as lakes were predicted to have a greater potential for impact due to the lower flow regime compared to streams.

Data used from the soil sampling program included 21 soil samples collected from depths ranging from 0 to 5 cm below ground surface. The data used from the freshwater sampling program included surface water samples from lakes within the country foods study area collected between 2010 and 2012 (N = 53). Data for wetland sediment metal concentrations were collected from wetlands within the country foods study area in 2012 (N = 12). Plant tissue samples included 10 lichen samples and 13 berry samples, comprised of bog blueberries and bog cranberries (*Vaccinium uliginosum* and *Vaccinium vitis-idaea*). In addition, 18 water sedge samples were collected from the country foods study area (three replicate samples of six sampling locations). Appendix C summarizes the analytical results of these samples. For berry producing plants, the berries were submitted for analysis. The entire lichen plant and the above ground water portion of the water sedge plant were collected and analyzed.

B-2.1.2 Marine Wildlife

As discussed in Vol8-5A, the diet of seals is made up primarily of fish and for the purpose of this assessment it was assumed that starry flounder make up 100% of their diet. COPC concentrations in starry flounder were measured as a part of the baseline studies for the nearby Bathurst Inlet Road and Port Project (Rescan 2007). These data were used to model EPCs in ringed seal . The average (or mean) concentration of COPCs measured in starry flounder used, in part, to predict EPCs in ringed seals are presented in Table B-2.1-2.

Table B-2.1-2 Mean Metal Concentrations Measured in Starry Flounder Muscle Tissue

COPC	Metal Concentration (mg/kg wet weight)(n = 15)
Aluminum	8.89
Arsenic	2.01
Cadmium	0.00339
Chromium	0.0494
Copper	0.366
Iron	267
Lead	0.0213
Mercury	0.0525
Nickel	0.0494
Selenium	0.394
Thallium	0.00296
Zinc	6.50

Note: Iron data were not available in marine fish. Therefore, iron concentrations were predicted based on a literature BCF of 3000 L/kg (Staven et al 2003)

There are some uncertainties associated with the modelled ringed seal metal tissue concentrations based on the starry flounder collected in 2001. For example, cadmium, chromium, lead, nickel, and thallium COPCs were measured below the method detection limit and were replaced with a value of half of the detection limit to calculate the mean metal tissue concentrations. This likely over-estimated the actual concentrations of metals in the tissues due to the high method detection limits and resulted in a highly conservative estimate of human health exposure ratios. The model assumed that all exposure resulted from starry flounder as food source of the ringed seal and not from uptake of water or sediment.

B-2.2 Wildlife Characteristics

As discussed in Vol8-5A, terrestrial wildlife characteristics with respect to body weight and ingestion rates were based on values provided in guidance from the Oakridge National Laboratory (ORNL 1997), and MacDonald and Gunn (2004). Characteristics of seals and their diet were based on values provided in the *Wildlife Exposure Handbook* (U.S. EPA 1993). Water intake by seals is considered negligible (U.S. EPA 1993). Table B 2.2-1 presents the species specific characteristics that were used as inputs in the food chain model to predict tissue concentrations in terrestrial wildlife and ringed seals.

Table B-2.2-1 Terrestrial and Marine Wildlife Characteristics

Receptor	Body Weight (kg)	Air Inhalation rate (m^3/day)	Food Ingestion Rate (kg wet weight/day)	Vegetation Ingestion Rate (kg wet weight/day)	Soil Ingestion Rate (kg/day)	Sediment Ingestion rate (kg/day)	Water Ingestion Rate (L/day)	Fraction of Year at Site (Baseline)
Caribou	169	33	8.2	7.38	0.82	0	10	0.5
Ground squirrel	1.4	0.7	0.09	0.088	0.002	0	0.13	1
Canada goose	3.2	1	1.4	1.35	0.035	0.035	0.06	1
Ringed seal	90	20	2.274	not applicable	not applicable	0	negligible	1

The rationale for fraction of year spent on site for the caribou is discussed in detail in Appendix B, Vol 8-5A. For the baseline assessment, based on observational data and the information on the seasonal ranges of the caribou herds between 2007 and 2010, it is extremely unlikely that any caribou would spend all year in the country foods study area. However, although unlikely, based on collective presence of caribou from both Bathurst and Ahialk herds within or near the country foods study area, a single caribou may potentially be present at the country foods study area from May to end of October. Thus, for the purposes of this baseline assessment it was assumed that caribou have a maximum exposure period of six months in the study area. This is considered to be a highly conservative estimate of time spent in the study area. Based on collar data for the Ahialk and Bathurst herds from 1996 – 2014, typical residence time within the LSA is likely < 1% (see Volume 5).

Canada geese arrive on the central Canadian Arctic barrens in early to mid-May and generally depart by mid-September. If a pair of geese were to nest and raise young in the country foods study area, it is conceivable that residency in area would be for the entire time that they are in the Arctic. While residence time in the study area is likely, at most, five months, it was assumed to be 100% of the time for the purposes of predicting baseline tissue levels.

The country foods study area is large enough that it could overlap with the entire home range of the Arctic ground squirrel (Hubbs and Boonstra 1998). However, this species hibernates over winter from early September to late April. Thus, while residency time in the study area is likely approximately five months, it was assumed to be 100% of the time for the purposes of predicting baseline tissue levels.

Based on a report using satellite tracking indices, ringed seals typically feed within 100 km of their breeding habitat (National Marine Fisheries Service 2012). However, they can cover hundreds or thousands of kilometers to get to areas that have abundant food resources (National Marine Fisheries Service 2012). Ringed seals have been observed in Bathurst Inlet (Rescan 2013c), including the portion that is part of the country foods study area. The foraging area for ringed seals in southern Bathurst Inlet is much smaller than the habitat range of these animals which may be up to 1000s of km in summer (Heide-Jørgensen et al. 1992; Kapel et al. 1998; Teilmann et al. 1999); however, it was conservatively assumed that seals spend all year eating within the country foods area. Therefore, the seal tissue concentrations modelled in this assessment is highly conservative in nature.

B-2.3 Biotransfer Factors

Tissue concentrations were predicted, inpart, through the use of metal-specific biotransfer factors (BTFs), intake rates and media concentrations. BTFs represent the rates at which metals are taken up and absorbed into wildlife tissue (e.g., muscle) from their food. Food-to-tissue BTFs were used for water-to-tissue and soil-to-tissue transfer calculations in the absence of specific BTFs for these media. This methodology is based on a document prepared for Health Canada (Golder 2005).

No species or site-specific BTFs for caribou, Arctic ground squirrel, or seals were available, therefore beef or chicken BTFs were used. The use of these BTFs for wild mammals and birds are considered to be a standardized acceptable practice in risk assessments (RAIS 2010).

There were no BTFs specifically for the Canada goose, and beef BTFs are inappropriate, therefore chicken BTFs were used (RAIS 2010). The beef and chicken BTFs that were used for mammals and birds respectively, were obtained from the Pacific Northwest National Laboratory's (PNNL) report (Staven et al. 2003). The metal specific food-to-tissue chicken BTFs were used for all exposure pathways for Canada goose, since media-specific BTFs were not available (Table B-2.3-1).

Table B-2.3-1 Biotransfer Factors Used to Predict Metal Concentrations into Terrestrial and Marine Wildlife Tissue

Metal	BTF_{beef} (day/kg)[a]	$BTF_{chicken}$ (day/kg)	$BTF_{chicken}$ Reference
Aluminum	0.0015	0.8	Staven et al.(2003)[b]
Arsenic	0.002	0.83	Staven et al.(2003)
Cadmium	0.00055	0.8	Staven et al.(2003)
Chromium	0.0055	0.2	Staven et al.(2003)
Copper	0.01	0.5	Staven et al.(2003)
Iron	0.02	0.02	Steven et al. (2003)
Lead	0.0004	0.8	Staven et al.(2003)
Mercury	0.25	0.03	Staven et al.(2003)
Nickel	0.006	0.001	Staven et al.(2003)
Selenium	0.0150	1.12	US EPA (2005)
Thallium	0.040	0.04	Baes et al. 1984
Zinc	0.10	0.009	US EPA (2005)

[a] *RAIS (2010).*
[b] *No Avian BTF; used BTF for fluorine*

With respect to predicting possible concentrations of metals in organ meats, an evaluation of measured concentrations of metals in caribou muscle and organs and ringed seal muscle and organs was undertaken through a review of the peer reviewed literature by the leading scientists in the field of traditional food consumption assessment in Northern Canada. In order to calculate concentration ratios (or BTFs) for muscle to organ for caribou and seal, studies were sourced where metals concentrations were quantified for both muscle and organ tissues.

Chan et al. (1995) examined exposure to metals though consumption of traditional foods for Inuit living in the community of Qikiqtajuaq on Baffin Island in the eastern Arctic. Concentrations of mercury, cadmium, and lead were quantified in ringed seal, narwhal and beluga after the completion of normal preparation prior to consumption. Kuhnlein et al. (2000) completed a comprehensive study of Inuit traditional food consumption patterns in five regions of Inuit communities (Inuvialuit, Kitikmeot, Kivalliq, Qikiqtaaluk (Baffin) and Labrador). The study identified that the entire animal (meat, organs, fat, blood and bone marrow) was typically consumed. The concentrations of arsenic, cadmium, mercury, and lead in combination with results from 24-hr food consumption recall surveys were used to assess contaminant exposure. Measured concentrations of cadmium in caribou muscle and organs were documented by Gamberg (2000) in her study of contaminants in Yukon Country Foods which was prepared through grants from the Northern Contaminants Program. Cadmium tissue concentrations have also been documented by Robillard et al (2002) and Crete et al (1989) for caribou from Northern Quebec. AECOM/Gartner Lee (2005) as referenced in Areva 2014 completed analysis of muscle and organ tissues from 10 caribou (collected between 2004 and 2007) that were captured in the study area of the Faro Mine Complex Site in the Yukon.

BTFs or Concentration Ratios were calculated using the measured concentrations of cadmium and mercury in both ringed seal and caribou. Due to the fact that arsenic and lead were only quantified in the Kuhnlein et al. (2000) study BTFs were not calculated for those metals. All other metals were assumed to have a ratio of 1 with muscle, based on a lack of available data to determine appropriate ratios. Table B-2.3-2 presents ratios for selected data from these studies. The Concentration Ratios provided in Table B-2.3-2 were used to estimate organ meat (e.g., liver and kidney) concentrations based on predicted muscle concentrations. Organ meat concentrations were estimated by multiplying the predicted muscle concentration in the caribou or ringed seal by the concentration ratio listed in Table B-2.3-2. For example, caribou organ concentrations for cadmium were predicted to be 171 times higher than the concentrations in muscle.

Table B-2.3-2 Literature Based Concentration Ratio Values Used to Predict Tissue Metals Levels in Caribou and Ringed Seal Organ Meats

Chemical	Caribou Organ Meat Concentration Factor [Unitless]	Rational	Ringed Seal Organ Meat Concentration Factor [Unitless]	Rational
Cadmium	171	Average of literature based values from Robillard et al, 2002; Kuhnlein et al 2000, Chan et al 1995; AECOM 2005; Crete et al 1989 for liver	4.4	Average of literature values from Kuhnlein 2000; Chan 1995
Mercury	10	Based on single value reported by Kuhnlein 2000	9.8	Average of literature values from Kuhnlein 2000; Chan 1995

B-3.0 SAMPLE CALCULATION AND COMPLETE MODEL RESULTS

Table B-3.0-1 provides a sample calculation for the concentration of mercury in Canada goose tissue. Tables B-3.0-2 presents the estimated EPCs in the tissues of caribou, arctic ground squirrel and Canada goose as a result of metal exposure from soil, sediment, dust, surface water and vegetation. Table B-3.0-3 presents the estimated EPC in tissues of ringed seals from consumption of starry flounder.

Table B-3.0-1 Sample Calculation of Baseline Mercury Concentration in Canada Goose Tissue from Exposure to Soil, Sediment, Surface Water, and Vegetation

$C_{meat} = C_{msoil} + C_{mveg} + C_{mwater} + C_{mdust}$

and:

$C_{msoil} = BTF_{tissue\text{-}food} \times [(C_{soil}] \times IR_{soil} \times fw \times fp$

$C_{msed} = BTF_{tissue\text{-}food} \times [(C_{sed}] \times IR_{sed} \times fw \times fp$

$C_{mveg} = BTF_{tissue\text{-}food} \times [(C_{berry} + C_{water\ sedge})/2] \times IR_{veg} \times fw \times fp$

$C_{mwater} = BTF_{tissue\text{-}food} \times C_{water} \times IR_{water} \times fw \times fp$

$C_{mdust} = BTF_{tissue\text{-}food} \times C_{air} \times IR_{air} \times fw \times fp$

where:

C_{meat}	= total concentration of COPC in meat tissue from soil, vegetation and water consumption (mg/kg)
C_{msoil}	= concentration of COPC in meat tissue from soil consumption (mg/kg)
C_{msed}	= concentration of COPC in meat tissue from sediment consumption (mg/kg)
C_{mveg}	= concentration of COPC in meat tissue from vegetation consumption (mg/kg)
C_{mwater}	= concentration of COPC in meat tissue from water consumption (mg/kg)
C_{mdust}	= concentration of COPC in meat tissue from dust inhalation (mg/kg)
C_{soil}	= concentration of COPC in soil (mg/kg)
$C_{sediment}$	= concentration of COPC in sediment (mg/kg)
C_{berry}	= concentration of COPC in berries (mg/kg)
$C_{water\ sedge}$	= concentration of COPC in water sedge (mg/kg)
C_{water}	= concentration of COPC in water (mg/L)
C_{dust}	= concentration of COPC in dust (ug/m^3)
$BTF_{tissue\text{-}food}$	= bio-transfer factor from food consumption to tissues for a selected metal (day/kg)
C	= average concentration of metal in media (mg/kg)
IR	= ingestion rate of media (kg/day)
Fw	= fraction of daily consumption (assumed 1; unitless)
Fp	= fraction of the year the animal is onsite (unitless)

Calculation:

C_{msoil} = 0.03 day/kg x 0.008 mg/kg x 0.035 kg/day x 1 x 1 = 0.0000084 mg/kg

C_{msed} = 0.03 day/kg x 0.073 mg/kg x 0.035 kg/day x 1 x 1 = 0.000077 mg/kg

C_{mberry} = 0.03 day/kg x 0.0005 mg/kg x 0.7 kg/day x 1 x 1 = 0.000011 mg/kg

C_{msedge} = 0.03 day/kg x 0.0019 mg/kg x 0.7 kg/day x 1 x 1 = 0.00004 mg/kg

C_{mwater} = 0.03 day/kg x 0.00005 mg/L x 0.161 L/day x 1 x 1 = 0.0000001 mg/kg

C_{mdust} = 0.03 day/kg x 6.1E-09 ug/m^3 x 1 m^3/day x 1 x 1 x 0.001 mg/ug = 1.8E-13 mg/kg

C_{meat} = 0.00014 mg/kg wet weight

Table B-3.0-2 Estimated Concentrations in Terrestrial Wildlife from Exposure to Soil, Surface Water, Lichens and Berries (mg/kg wet weight)

COPC	Caribou Muscle Meat (mg/kg)	Caribou Liver [a] (mg/kg)	Arctic Ground Squirrel Meat (mg/kg)	Canada Goose Meat(mg/kg)
Aluminum	6.96	6.96	0.0470	0.797
Arsenic	0.00788	0.00788	0.0000632	0.737
Cadmium	0.000138	0.0236	0.00000161	0.0351
Chromium	0.052	0.052	0.00032	0.33
Copper	0.229	0.229	0.003120	3.59
Iron	130	130	1.08	29.6
Lead	0.0024	0.0024	0.000019	0.25
Mercury	0.0588	0.588	0.000493	0.000136
Nickel	0.314	0.314	0.00306	0.00520
Selenium	0.00093	0.00093	0.000010	0.031
Thallium	0.0011	0.0011	0.000019	0.00054
Zinc	8.23	8.23	0.129	0.172

COPC: Contaminants of potential concern
a Caribou liver concentrations were assumed to equal caribou muscle concentrations except where a metal-specific concentration factor was available; See Section B-2.3 for details.

Table B-3.0-3 Estimated Concentrations in Ringed Seal Tissue (Muscle; Organ Meats; Blubber)

COPC	Seal Muscle Concentration (mg/kg wet weight)	Seal Liver Concentration [a] (mg/kg wet weight)	Seal Blubber Concentration [b] (mg/kg wet weight)
Aluminum	0.0303	0.0303	0.0303
Arsenic	0.00914	0.00914	0.00914
Cadmium	0.00000424	0.0000187	0.00000424
Chromium	0.00062	0.00062	0.00062
Copper	0.00832	0.00832	0.00832
Iron	12.1	12.1	12.1
Lead	0.0000194	0.0000194	0.0000194
Mercury	0.0015	0.15	0.0015
Methyl Mercury	0.30	0.60	0
Nickel	0.000674	0.000674	0.000674
Selenium	0.0134	0.0134	0.0134
Thallium	0.000269	0.000269	0.000269
Zinc	1.48	1.48	1.48

COPC: Contaminants of potential concern
a Seal liver concentrations were assumed to equal seal muscle concentrations except where a metal-specific concentration factor was available; See Section B-2.3 for details.
b Seal blubber concentrations were assumed to equal seal muscle concentrations.

B-4.0 REFERENCES

AREVA (AREVA Resources Canada Inc.). 2014. Kiggavik Project Final Environmental Impact Statement - Terrestrial Environment

Baes III, C.F., Sharp, R.D., Sjoreen, A.L. and Shor, R.W. 1984. A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture. Research sponsored by the Office of Radiation Programs, US Environmental Agency under Interagency Agreement AD-89-F-2-A106. Prepared by the Oak Ridge National Laboratory. ORNL-5786.

Chan, H. M., Kim, C., Khoday, K., Receveur, O., and Kuhnlein, H.V. 1995. Assessment of dietary exposure to trace metals in Baffin Inuit food. Environmental health perspectives,103(7-8), 740.

Crête, M. Nault, R. and Walsh, P. 1989. Variation in cadmium content of caribou tissues from northern Quebec. Sci Total Environ 1989; 80:103-112.

Gamberg M. 2000. Contaminants in Yukon Country Foods. Prepared for Yukon Contaminants Committee and Department of Indian and Northern Affairs Northern Contaminants Program, Whitehorse, Yukon

Gartner Lee Limited 2005. Anvil Range Mine Complex – Terrestrial Effects Study: Investigation into Metal Concentrations in Vegetation, Wildlife and Soils. Prepared for Draft for Discussion. April. Deloitte & Touche Inc.

Golder and Associates. 2005. *Guidance Document for Country Foods Surveys for the Purpose of Human Health Risk Assessment*. Prepared for Health Canada.

Heide-Jørgensen, M. P., B. S. Stewart, and S. Leatherwood. 1992. Satellite tracking of ringed seals Phoca hispida off northwest Greenland. *Ecography*, 15: 56-61.

Hubbs, A. H. and R. Boonstra. 1998. Effects of food and predators on the home-range sizes of Arctic ground squirrels (Spermophilus parryii). *Canadian Journal of Zoology*:

Kapel, F. O., J. , J. Christiansen, M. P. Heide-Jørgensen, T. Härkönen, E. W. Born, L. O. Knutsen, F. Riget, and J. Teilmann. 1998. *Netting and conventional tagging used to study movements of ringed seals (Phoca hispida) in Greenland*. NAMMCO Scientific Publications, Vol. 1. N. Atl. Mar. Mamm. Comm: Tromsø, Norway.

Kuhnlein, H.V., Receveur, O., Chan, H.M. and Loring, E. 2000. Assessment of Dietary Benefit/Risk in Inuit Communities. ISBN: 0-7717-0558-1.

MacDonald, C. R. and A. Gunn. 2004. *Analysis of the ash weight and elemental composition of caribou (Rangifer tarandus) faecal pellets collected at Colomac and other sites in the NWT*. Manuscript Report No. 159. Department of Resources, Wildlife and Economic Development: Yellowknife, NWT.

National Marine Fisheries Service. 2012. *Endangered Species Act-Section 7 Consultation: Biological Opinion and Conference Report*. Prepared by National Fisheries Service: Alaska Region, AK.

ORNL. 1997. *Methods and Tools for Estimation of the Exposure of Terrestrial Wildlife to Contaminants*. Oak Ridge, Tennessee, ORNL/TM-13391:

PNNL. 2003. *A Compendium of Transfer Factors for Agricultural and Animal Products*. Prepared for the U.S. Department of Energy, PNNL-13421.

RAIS. 2010. *Chemical Factors*. http://rais.ornl.gov/index.html (accessed January 2012).

Rescan. 2007. *Bathurst Inlet Port and Road Project: Draft Environmental Impact Statement*. Vancouver, British Columbia.

Rescan. 2012a. *Back River Project: 2011 Freshwater Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. June 2012: Vancouver, British Columbia.

Rescan. 2012b. *Back River Project: 2012 Freshwater Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. 2013: Vancouver, British Columbia.

Rescan. 2012c. *Back River Project: Wildlife Baseline Report 2011*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Rescan. 2013a. *Back River Project: 2012 Soil and Terrain Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Rescan. 2013b. *Back River Project: 2012 Vegetation and Wetlands Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Rescan. 2013c. *Back River Project: 2012 Wildlife Baseline Report*. Prepared for Sabina Gold and Silver Corp. by Rescan Environmental Services Ltd. : Vancouver, British Columbia.

Robillard, S., Beauchamp, G., Paillard, G., and Bélanger, D. 2002. Levels of Cadmium, Lead, Mercury and 137Caesium in Caribou (Rangifer tarandus) Tissues from Northern Québec. March 2002. Arctic. 55: 1–9

Staven, L. H., K. Rhoads, B. A. Napier, and D. L. Strenge. 2003. *A Compendium of Transfer Factors for Agricultural and Animal Products*. PNNL-13421. Pacific Northwest National Laboratory US Department of Energy: Richland, WA.

Teilmann, J., E. W. Born, and M. Acquarone. 1999. Behaviour of ringed seals tagged with satellite transmitters in the North Water polynya during fast-ice formation. *Journal of Zoology*, 77: 1934-46.

U.S. EPA. 1993. Wildlife Exposure Factors Handbook. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=2799#Download

U.S. EPA. 2005. *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. Multimedia Planning and Permitting Division Office of Solid Waste Center for Combustion Science and Engineering, Report number: EPA530-R-05-006.

APPENDIX C

BASELINE MEDIA CONCENTRATIONS

C-1.0 BASELINE MEDIA CONCENTRATIONS

A summary of baseline media concentrations of data collected by ERM (formerly Rescan) are provided in the following tables. Full baseline datasets can be found in Volumes 5, 6 and 7 for terrestrial, freshwater and marine data, respectively.

Table C-1-1 Summary of Baseline Metal Concentrations in Surface Soil (mg/kg) in the Goose Property and Marine Laydown Areas

Chemical	Goose Property (N=21)			Marine Laydown Area (N=2)	
	Min	Max	Mean	Sample ID 089-5	Sample ID 092-5
Aluminum	2730	7070	4630	1570	674
Antimony	<0.05	<0.05	<0.05	<0.05	<0.05
Arsenic	1.07	8.76	4.18	0.870	0.352
Barium	13.0	62.4	25.4	25.2	5.39
Beryllium	<0.10	0.22	0.11	<0.1	<0.1
Bismuth	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	<0.025	0.054	0.03	<0.025	<0.025
Calcium	585	2290	1564	144	100
Chromium	7.94	24.8	15.3	2.61	1.27
Cobalt	1.58	6.42	3.87	0.75	0.25
Copper	2.17	17.20	10.01	0.55	<0.25
Iron	6870	13600	9313	3650	1320
Lead	1.54	4.06	2.33	0.91	<0.25
Lithium	2.5	12.2	7.76	<2.5	<2.5
Magnesium	1060	4620	2784	535	254
Manganese	36.9	125	75	28.5	5.6
Mercury	0.003	0.028	0.005	0.0057	<0.0025
Molybdenum	<0.25	<0.25	<0.25	<0.25	<0.25
Nickel	3.23	15.70	9.98	1.30	0.52
Phosphorus	184	571	384	109	25
Potassium	190	730	427	520	220
Selenium	<0.1	<0.1	<0.10	<0.1	<0.1
Silver	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium	<50	180	84	<50	<50
Strontium	5.29	36.00	9.59	73.4	11.7
Thallium	<0.025	0.058	0.03	<0.025	<0.025
Tin	<1	<1	<1	<1	<1
Titanium	145	507	331	28.0	27.6
Uranium	0.244	0.826	0.40	0.276	0.134
Vanadium	14.2	39.0	21.71	3.36	1.79
Zinc	6.20	22.5	13.49	3.2	1.3

Notes:
All baseline values were collected by ERM in 2012.
< = less than the reportable detection limit; value provided is the detection limit

Table C-1-2 Summary of Baseline Metal Concentrations in Lake Surface Water (mg/L) from the Goose Property (N=53)

Chemical	Minimum	Maximum	Mean
Aluminum	0.0067	0.070	0.0189
Antimony	<0.000025	0.00006	0.000033
Arsenic	0.00013	0.002	0.00029
Barium	0.00172	0.042	0.00732
Beryllium	<0.00010	<0.00010	<0.00010
Bismuth	<0.00025	<0.00025	<0.00025
Boron	<0.0025	0.011	0.00563
Cadmium	<0.000005	0.00003	0.000007
Calcium	0.924	17.500	3.60
Chromium	<0.00005	0.002	0.0002
Cobalt	<0.00005	0.005	0.0002
Copper	0.00088	0.004	0.0021
Iron	0.005	0.592	0.062
Lead	<0.000025	0.0051	0.00021
Lithium	<0.0025	<0.0025	<0.0025
Magnesium	0.729	9.405	1.96
Manganese	0.00047	0.087	0.0060
Mercury	<0.000005	<0.000005	<0.000005
Molybdenum	<0.000025	0.00011	0.000028
Nickel	0.00111	0.028	0.00510
Phosphorus	0.0021	0.023	0.0042
Potassium	0.27	2.280	0.513
Selenium	<0.00005	0.00010	0.00006
Silver	<0.000005	<0.000005	<0.000005
Sodium	0.4430	3.860	0.942
Strontium	0.00497	0.084	0.0179
Thallium	<0.000025	0.00005	0.000032
Tin	<0.00005	<0.00005	<0.00005
Titanium	<0.005	<0.005	<0.005
Uranium	<0.000005	0.000032	0.0000073
Vanadium	<0.000025	0.00055	0.00013
Zinc	<0.0005	0.008	0.0022

Notes:
All baseline values were collected by ERM in 2010 and 2012.
< = less than the reportable detection limit; value provided is the detection limit
The following Lakes were included in the summary calculations: Big Lake, Chair Lake, Echo Lake, Fox Lake, Gander Lake, Giraffe Lake, Goose Lake, Llama Lake, Mam Lake, Pong 19, Propeller Lake, Rabbit Lake, Rascal Lake, Umwelt Lake.

Table C-1-3 Summary of Baseline Metal Concentrations in Marine Surface Waters (mg/L) in Bathurst Inlet (N=29)

Chemical	Minimum	Maximum	Mean
Aluminum	<0.0025	0.239	0.044
Antimony	<0.0003	<0.00025	<0.00025
Arsenic	<0.001	<0.001	<0.001
Barium	0.0098	0.014	0.0111
Beryllium	<0.00025	<0.00025	<0.00025
Bismuth	<0.00025	<0.00025	<0.00025
Boron	2.52	4.30	3.12
Cadmium	<0.000025	0.000132	0.000070
Calcium	194	335	245
Chromium	<0.00025	0.00086	0.00030
Cobalt	<0.000025	0.00023	0.000061
Copper	0.0003	0.001	0.0008
Iron	<0.005	0.298	0.062
Lead	<0.00015	0.00033	0.00016
Lithium	0.099	0.171	0.124
Magnesium	608	1040	764
Manganese	0.00088	0.00589	0.00276
Mercury	<0.000005	<0.000005	<0.000005
Molybdenum	0.0056	0.0094	0.0070
Nickel	0.0005	0.002	0.00097
Phosphorus	<0.5	<0.5	<0.5
Potassium	174	318	231
Selenium	<0.001	<0.001	<0.001
Silver	<0.00005	<0.00005	<0.00005
Sodium	4820	9150	6499
Strontium	3.37	6.07	4.46
Thallium	<0.000025	0.000073	0.000035
Tin	<0.0005	<0.0005	<0.0005
Titanium	<0.0025	0.0120	0.0033
Uranium	0.00152	0.0026	0.0019
Vanadium	<0.00025	0.0012	0.00055
Zinc	<0.0015	0.0093	0.0044

Notes:
All baseline values were collected by ERM in 2012.
< = less than the reportable detection limit; value provided is the detection limit

Table C-1-4 Summary of Baseline Metal Concentrations in Freshwater Lake Sediments (mg/kg) from the Goose Property (N=87)

Chemical	Minimum	Maximum	Mean
Aluminum	3640	19500	9199
Antimony	<0.05	0.16	0.073
Arsenic	2.7	141	19.3
Barium	22.0	115	57.3
Beryllium	<0.10	0.85	0.38
Bismuth	<0.10	0.29	0.11
Cadmium	<0.025	1.43	0.318
Calcium	1080	3670	2509
Chromium	10.4	56.10	27.3
Cobalt	3.10	167	16.6
Copper	15.8	170	74.4
Iron	6130	85800	21351
Lead	1.79	10.70	5.01
Lithium	5.30	23.40	11.7
Magnesium	1530	6680	3719
Manganese	38.5	690	142
Mercury	0.0110	0.103	0.0547
Molybdenum	<0.25	4.21	0.852
Nickel	17.8	242	64.2
Phosphorus	247	1990	651
Potassium	290	1400	723
Selenium	<0.10	1.10	0.41
Silver	<0.05	1.35	0.16
Sodium	<50	260	115
Strontium	5.49	37.0	15.1
Thallium	<0.025	0.60	0.091
Tin	<1.0	<2.0	<1.0
Titanium	118	719	295
Uranium	0.29	2.81	1.22
Vanadium	12.1	55.2	29.3
Zinc	24.4	201	69.5

Notes:
All baseline values were collected by ERM in 2010 and 2012.
< = less than the reportable detection limit; value provided is the detection limit

Table C-1-5 Summary of Baseline Metal Concentrations in Marine Sediments (mg/kg) from Bathurst Inlet (N=24)

Chemical	Minimum	Maximum	Mean
Aluminum	1010	17700	9478
Antimony	<0.05	0.18	0.10
Arsenic	0.97	11.10	4.97
Barium	5.34	84.60	48.22
Beryllium	<0.10	0.78	0.41
Bismuth	<0.1	0.30	0.15
Cadmium	<0.025	0.057	0.026
Calcium	376	5360	2832
Chromium	2.13	45.9	25.37
Cobalt	0.64	10.4	5.90
Copper	1.05	20.4	11.84
Iron	1770	26600	14524
Lead	0.86	9.35	5.39
Lithium	2.50	33.7	18.30
Magnesium	783	11000	6232
Manganese	12.20	288	139
Mercury	<0.0025	0.0156	0.0062
Molybdenum	<0.25	1.14	0.57
Nickel	1.4	25.30	14.38
Phosphorus	131	1080	559
Potassium	310	4940	2515
Selenium	<0.10	0.24	0.12
Silver	<0.05	0.05	0.05
Sodium	1340	8130	3762
Strontium	7.3	72.8	34.8
Thallium	<0.025	0.15	0.086
Tin	<1	<1	<1.00
Titanium	34	731	415
Uranium	0.26	1.54	0.974
Vanadium	2.28	49.9	27.7
Zinc	2.40	51.2	28.0

Notes:
All baseline values were collected by ERM in 2012.
< = less than the reportable detection limit; value provided is the detection limit

Table C-1-6 Summary of Baseline Metal Concentrations in Lake Trout (*Salvelinus namaycush*; mg/kg wet weight) from the Goose Property (N=22)

Chemical	Minimum	Maximum	Mean
Aluminum	<1.0	7.1	1.3
Antimony	<0.005	0.005	0.005
Arsenic	0.0130	0.057	0.030
Barium	<0.005	0.067	0.024
Beryllium	<0.05	<0.05	<0.05
Bismuth	<0.015	0.015	0.015
Cadmium	<0.0025	<0.0025	<0.0025
Calcium	52.1	434	126
Chromium	<0.05	0.270	0.102
Cobalt	<0.01	0.010	0.010
Copper	0.163	0.361	0.282
Lead	<0.01	0.215	0.061
Lithium	<0.05	0.05	0.05
Magnesium	257	312	283
Manganese	0.065	0.211	0.111
Mercury	0.115	0.549	0.251
Molybdenum	<0.005	0.014	0.006
Nickel	<0.05	0.120	0.056
Selenium	0.32	0.540	0.375
Strontium	0.043	0.566	0.143
Thallium	<0.005	0.013	0.006
Tin	<0.025	0.025	0.025
Uranium	<0.001	0.001	0.001
Vanadium	<0.05	0.05	0.05
Zinc	3.08	6.77	4.44

Notes:
All baseline values were collected by ERM in 2011 and 2012.
< = less than the reportable detection limit; value provided is the detection limit

Table C-1-7 Summary of Baseline Metal Concentrations in Bay Mussel (*M. trossulus*) (mg/kg) from Bathurst Inlet (N=20)

Chemical	Minimum	Maximum	Mean
Aluminum	35	484	226
Antimony	<0.001	0.004	0.002
Arsenic	1.64	2.86	2.18
Barium	0.200	2.34	1.12
Beryllium	0.0028	0.022	0.011
Bismuth	<0.003	0.042	0.012
Boron	<1.3	6.97	2.51
Cadmium	1.04	3.64	2.09
Calcium	263	53100	3485
Chromium	0.190	1.10	0.585
Cobalt	0.145	0.350	0.249
Copper	1.41	2.61	2.00
Iron	50.0	370	195
Lead	0.125	0.520	0.339
Lithium	0.103	0.774	0.365
Magnesium	482	735	611
Manganese	1.24	5.49	3.44
Mercury	0.015	0.03	0.025
Molybdenum	0.052	0.20	0.104
Nickel	0.325	0.908	0.623
Phosphorus	1630	2720	2020
Potassium	1480	2220	1888
Selenium	0.655	1.23	1.00
Sodium	2330	3960	2954
Strontium	3.55	219	17.99
Thallium	<0.001	0.0049	0.0019
Tin	<0.002	0.1810	0.042
Titanium	1.15	13.9	6.44
Uranium	0.034	0.161	0.076
Vanadium	0.107	0.885	0.449
Zinc	10.6	34.5	17.3

Notes:
All baseline values were collected by ERM in 2012.
< = less than the reportable detection limit; value provided is the detection limit

Table C-1-8 Summary of Baseline Metal Concentrations in Lichens (*C. Stygia* and *S. Paschale*) in the Goose Lake Property and Marine Laydown Area

Chemical	Goose Property (N=10)			Marine Laydown Area (N=1)
	Minimum	Maximum	Mean	Sample ID 093
Aluminum	119	1340	433	190
Antimony	<0.02	<0.02	<0.02	<0.02
Arsenic	0.123	0.83	0.34	0.079
Barium	9.12	29.1	17.44	17.3
Beryllium	<0.2	<0.2	<0.2	<0.2
Bismuth	<0.06	<0.06	<0.06	<0.06
Cadmium	0.025	0.07	0.05	<0.01
Calcium	879	1940	1217	1190
Chromium	<0.2	1.01	0.42	<0.2
Cobalt	0.362	9.22	2.09	0.146
Copper	1.41	7.80	3.28	1.25
Iron	132	1020	412	205
Lead	0.175	2.76	0.82	0.376
Lithium	<0.2	0.48	0.26	<0.2
Magnesium	224	532	410	921
Manganese	40.2	107	62.3	62.8
Mercury	0.0225	0.089	0.047	0.0363
Molybdenum	<0.02	0.088	0.03	0.071
Nickel	1.16	35.7	6.15	<0.2
Phosphorus	241	411	342	475
Potassium	698	1190	923	1380
Selenium	<0.4	<0.4	<0.4	<0.4
Silver	<0.02	0.053	0.02	<0.02
Sodium	<40	<40	<40	147
Strontium	3.07	9.38	5.39	12
Thallium	<0.02	<0.02	<0.02	<0.02
Tin	<0.1	<0.1	<0.1	<0.1
Titanium	3.40	24.2	10.2	9.75
Uranium	0.0091	0.098	0.038	0.0192
Vanadium	<0.2	1.04	0.46	0.42
Zinc	8.07	22.1	16.8	13.7

Notes:
All baseline values were collected by ERM in 2012.
< = less than the reportable detection limit; value provided is the detection limit

Table C-1-9 Summary of Baseline Metal Concentrations in Bog Blueberries and Bog Cranberry (*V. vitis-idaea* and *V. uliginosum*) from the Goose Property and Marine Laydown Area

Chemical	Goose Property (N= 13) [a]			Marine Laydown Area (N=2)	
	Minimum	Maximum	Mean	Sample ID 093 [b]	Sample ID 093 [c]
Aluminum	<1	46.30	7.83	4.6	2
Antimony	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic	<0.005	0.05	0.009	<0.005	<0.005
Barium	1.50	7.77	4.03	2.3	1.46
Beryllium	<0.05	<0.05	<0.05	<0.05	<0.05
Bismuth	<0.015	<0.015	<0.015	<0.015	<0.015
Cadmium	<0.0025	0.028	0.011	<0.0025	0.0194
Calcium	143	581	317	297	158
Chromium	<0.05	0.13	0.06	<0.05	<0.05
Cobalt	<0.01	0.10	0.04	<0.01	<0.01
Copper	0.566	1.75	1.01	0.934	0.501
Iron	<1	75.30	9.02	3.2	<1
Lead	<0.01	<0.01	<0.01	<0.01	<0.01
Lithium	<0.05	0.10	0.05	<0.05	<0.05
Magnesium	68.4	225	135	117	88.4
Manganese	7.62	124	35.7	28.7	15.7
Mercury	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Molybdenum	<0.005	0.03	0.012	0.014	<0.005
Nickel	0.05	1.11	0.37	<0.05	0.13
Phosphorus	25	409	244	189	162
Potassium	100	2500	1468	1780	1090
Selenium	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	<100	<100	<100	<100	<100
Strontium	0.175	1.77	0.77	0.589	0.374
Thallium	<0.005	<0.005	<0.005	<0.005	<0.005
Tin	0.025	0.4170	0.16	<0.025	0.058
Titanium	<0.5	2.00	0.62	<0.5	<0.5
Uranium	<0.001	0.01	0.002	<0.001	<0.001
Vanadium	<0.05	0.16	0.06	<0.05	<0.05
Zinc	1.61	8.55	3.87	2.33	4.69

Notes:
All baseline values were collected by ERM in 2012.
< = less than the reportable detection limit; value provided is the detection limit
[a] For the summary statistics the two species of berry were pooled together.
[b] V. vitis-idea
[c] V. uliginosum

Table C-1-10 Summary of Baseline Metal Concentration in Water Sedge (*C. aquatitis*) from the Goose Property and Marine Laydown Area

Chemicals	Goose Property (N= 6)[a]			Marine Laydown Area (N=3)[b]
	Minimum	Maximum	Mean	Mean
Aluminum	<1	<1	1	<1
Antimony	<0.005	<0.005	0.005	<0.005
Arsenic	0.00767	0.177	0.077	0.0093
Barium	0.384	6.82	3.079	3.83
Beryllium	<0.05	<0.05	0.05	0.05
Bismuth	<0.015	<0.015	0.015	0.015
Cadmium	0.0025	0.0141	0.0077	<0.0025
Calcium	431.3	698.7	528.3	426.7
Chromium	<0.05	<0.05	0.05	<0.05
Cobalt	0.01	0.078	0.053	0.0193
Copper	2.06	3.77	2.86	1.56
Lead	<0.01	0.0273	0.013	<0.01
Lithium	<0.05	<0.05	0.05	0.13
Magnesium	310.7	661.7	446.3	513
Manganese	12.67	74.70	36.7	86.2
Mercury	0.0009	0.0019	0.0013	0.0010
Molybdenum	0.05	0.313	0.193	0.094
Nickel	0.357	3.49	2.38	0.33
Selenium	<0.1	<0.1	0.1	<0.1
Strontium	0.648	2.42	1.53	1.96
Thallium	0.005	0.012	0.0064	0.005
Tin	<0.025	<0.025	0.025	0.025
Uranium	<0.001	<0.001	0.001	<0.001
Vanadium	<0.05	<0.05	0.05	<0.05
Zinc	8.64	17.23	13.3	12.03

Notes:
All baseline values were collected by ERM in 2012.
< = less than the reportable detection limit; value provided is the detection limit
[a] For the Goose water sedges samples, 3 replicates were taken in each of 6 areas. Given the similarities within each area the 3 samples were pooled together for each location and 1 average was produce for each area. The summary statistics here are for the 6 averages.
[b] For the Marine Laydown Area sedge samples, 3 replicates were taken for 1 area. Given the similarities within the area, the 3 samples were pooled together and 1 average was produced. The summary statistics here are for the 3 replicates in one area.

APPENDIX D

SAMPLE CALCULATION OF ESTIMATED DAILY INTAKE OF ARSENIC FOR A TODDLER CONSUMING CARIBOU TISSUE IN THE BASELINE SCENARIO

D-1.0 SAMPLE CALCULATION

Calculations used to estimate the daily intake of arsenic for a toddler consuming caribou tissue in the baseline scenario is provided in this appendix. Calculations for other metals were done in a similar fashion.

$$EDI_{countryfood} = \frac{IR \times F_s \times C \times P_{as}}{BW}$$

$EDI_{countryfood}$ = estimated daily intake of country food (mg/kg body weight-day)
IR = ingestion rate (kg/day)
C = mean metal concentration in country food (mg/kg ww)
F_s = fraction of year/week consuming country foods
BW = receptor body weight (kg)
P_{as} (in caribou) = proportion of inorganic arsenic relative to total arsenic concentration

Parameter	Value
IR	0.031 kg/day
C	0.0079 mg/kg ww [a]
F_s	1
BW	16.5 kg/day
P_{as} (in caribou)	0.05 [b]

a. Predicted caribou muscle arsenic concentration
b. From Schoof et al. 1999

$$EDI_{countryfood} = \frac{0.031 \times 1 \times 0.0079 \times 0.05}{16.5}$$

$$EDI_{countryfood} = 7.4 \times 10^{-7} \left(\frac{mg}{kg_{BW}\, day} \right)$$

APPENDIX E

SAMPLE CALCULATION OF ESTIMATED DAILY LIFETIME EXPOSURE TO ARSENIC FOR AN ADULT CONSUMING LAKE TROUT TISSUE IN THE BASELINE SCENARIO

E-1.0 SAMPLE CALCULATION

Calculations used to estimate the daily lifetime exposure to arsenic for an adult consuming lake trout in the baseline scenario is provided in this appendix. Calculations for other metals were done in a similar fashion.

$$ELDE_{countryfood} = \frac{IR \times F_s \times C \times P_{as}}{BW} \times \frac{LD}{LE}$$

$ELDE_{countryfood}$	= estimated lifetime daily intake of country food (mg/kg bw/day)
IR	= ingestion rate (kg/day)
F_s	= fraction of year consuming country foods (unitless)
P_{as} (in lake trout)	= proportion of inorganic arsenic relative to total arsenic concentration
C	= metal concentration in country food (mg/kg)
LD	= life stage duration (yr)
BW	= receptor body weight (kg)
LE	= life expectancy (yr)

Parameter	Value
IR	0.113 kg/day
Fs	0.25
C	0.036 mg/kg ww [a]
P_{as} (in lake trout)	0.10 [b]
LD	60 years
LE	80 years
BW	70.7 kg

a Measured 95UCLM lake trout tissue concentration within the LSA
b From Schoof et al. 1999

$$ELDE_{countryfood} = \frac{0.113 \times 0.25 \times 0.036 \times 0.10}{70.7} \times \frac{60}{80}$$

$$ELDE_{countryfood} = 1.1 \times 10^{-6} \left(\frac{mg}{kg_{BW}\,day} \right)$$

Appendix V8-6A

Ecological Risk Assessment and Goose Lake Chemicals of Potential Concern Screening for the Project

Sabina
GOLD & SILVER CORP.

APPENDIX V8-6A

ECOLOGICAL RISK ASSESSMENT AND GOOSE LAKE CHEMICALS OF POTENTIAL CONCERN SCREENING FOR THE PROJECT

V8-6A-1.0 INTRODUCTION

This appendix describes the approach used to screen the chemicals of potential concern (COPCs) in the ecological risk assessment for the proposed Back River Project. In addition, since Goose Lake will contain effluent during operations, and water releases from the TSF Post Closure, an additional separate COPC screen was conducted related to Goose Lake drinking water with respect to human health. Details of the COPC screening for ecological receptors are provided in Sections V8-6A-2.0 to V8-6A-4, while details of the Goose Lake drinking water screening for human health are provided in Section V8-6A-5.0.

V8-6A-1.1 COPC Screening for Ecological Receptors

The COPC screenings were conducted separately for the terrestrial and aquatic receptors and screening results are presented in Sections V8-6A-2 and V8-6A-3, respectively. The terrestrial and aquatic COPC screenings consisted of three main steps.

- **Baseline screening:** For terrestrial receptors, the maximum baseline surface soil concentration of chemicals analyzed at both Goose and the MLA were compared to ecological health-based soil quality guidelines. For aquatic receptors, baseline freshwater (lake and stream) and marine surface water and sediment concentrations collected in the vicinity of Goose and the MLA were screened. The maximum baseline freshwater and marine surface water and sediment concentrations were compared to surface water and sediment aquatic life guidelines. Chemicals exceeding the ecological health-based or aquatic guidelines were carried forward for further evaluation. The COPC guideline screenings for Goose and the MLA are discussed in Section V8-6A-2.1 for terrestrial receptors and Section V8-6A-3.1.1 for freshwater aquatic receptors and V8-6A-3.3.1 for marine aquatic receptors.

- **Toxic potency screening:** A relative toxic potency screening was conducted to determine any additional COPCs that would require assessment related to future project-related emissions from dust deposition into terrestrial and aquatic environments. Screening based on the toxic potency of a chemical is a method used to identify those chemicals that constitute the majority of the total cumulative toxic potency. For terrestrial and aquatic receptors, a relative toxic potency screening was conducted based on predicted metal percentages in dusts associated with project-related emissions. Chemicals which represented >95% of the cumulative toxic potency were carried forward for assessment (See Section V8-6A-2.2 for terrestrial receptors and Section V8-6A -3.1.2 for aquatic receptors).

- **Bioaccumulation check:** In addition, a bioaccumulation check was completed where metals know to be bioaccumulative were also included for assessment. The bioaccumulation checks for terrestrial and aquatic receptors are discussed in Sections V8-6A-2.3, and V8-6A-3.1.3, V8-6A.3.2.2, V8-6A-3.3.2, respectively.

- **Goose Lake Effluent Screening**: A separate screening was also conducted for Goose Lake, which will receive effluent and aqueous releases from the TSF into the future. For this screening, the predicted maximum average monthly concentrations modelled during operations, closure and post closure within Goose Lake were evaluated against freshwater aquatic life guidelines to determine which substances, if any exceeded these guidelines and therefore merited further study. Substances identified in this screening exercise were only evaluated in Goose Lake. See Section V8-6A-3.2.

V8-6A-2.0 COPC SCREENING FOR TERRESTRIAL RECEPTORS

The COPC screening for terrestrial ecological receptors consisted of a baseline soil screening, an oral toxic potency screening and a bioaccumulation check. Details of these screening approaches are provided in Sections V8-6A-2.1, V8-6A-2.2 and V8-6A-2.3, respectively.

V8-6A-2.1 Baseline Soil Screening

The maximum baseline soil concentrations of chemicals analyzed at Goose (N=21) and the MLA (N-=2) were compared to ecological health-based soil quality guidelines. While wildlife can move about a site, the maximum baseline soil concentrations at both sites were used as a conservative basis of comparison.

Where available, ecological health-based soil quality guidelines (SQG_E) derived by the CCME (Canadian Council of Ministers of the Environment 2015; on-line), were preferentially used for comparison purposes. CCME guidelines derived for both residential / parkland and agricultural land use. While there is no agriculture on-site, agricultural guidelines are applicable to “wildlands”. Where no CCME guideline was available, either a U.S. EPA Ecological Soil Screening Levels (Eco SSLs) the Ontario Ministry of the Environment (OMOE 2011) soil component value for either mammal / bird or plant / soil organism (which ever was lower) were used.

Results of the ERA baseline soil guideline screenings are provided in Table V8-6A-1.

Table V8-6A -1	Comparison of Maximum Measured Baseline Surface Soil (0 to 5 cm) Concentrations within the Goose Property and Marine Laydown Area to Ecological Health-Based Soil Quality Guidelines (mg/kg)		
Analyte	**Maximum Soil Concentration (mg/kg)[a]**		**Soil Quality Guideline (mg/kg)**
	Goose (N=21)	**MLA (N=2)**	
Aluminum	7070	1570	pH<5.5 [c] (U.S. EPA 2003a)
Antimony	<0.05	<0.05	20 (OMOE 2011) [d]
Arsenic	8.76	0.87	17 (CCME 1997) [b]
Barium	62.4	25.2	390 (OMOE 2011) [d]
Beryllium	0.22	<0.1	4 (OMOE 2011) [d]
Bismuth	<0.1	<0.1	NGA
Cadmium	0.054	<0.025	3.8 / 10 (CCME 1999) [b]
Calcium	2290	144	NGA
Chromium	24.8	2.61	64 (CCME 1997) [b, e]
Cobalt	6.42	0.75	40 (OMOE 2011) [d]
Copper	17.20	0.55	63 (CCME 1999) [b]
Iron	13600	3650	pH 5 - 8 (U.S. EPA 2003b) [f]
Lead	4.06	0.91	70 / 300 (CCME 1999) [b]
Lithium	12.2	<2.5	NGA
Magnesium	4620	535	NGA
Manganese	125	28.5	220 (U.S. EPA 2007) [g]
Mercury	0.028	0.0057	12 (CCME 1999) [b]
Molybdenum	<0.25	<0.25	6.9 (OMOE 2011) [d]
Nickel	15.70	1.30	50 (CCME 1999) [b]
Phosphorus	571	109	NGA
Potassium	730	520	NGA
Selenium	<0.1	<0.1	1 (CCME 2009) [b]
Silver	<0.05	<0.05	20 (OMOE 2011) [d]
Sodium	180	<50	NGA
Strontium	36.00	73.4	NGA
Thallium	0.058	<0.025	1 / 1.4 (CCME 1999) [b]
Tin	<1	<1	NGA
Titanium	507	28.0	NGA
Uranium	0.826	0.276	33 / 500 (CCME 2007) [b]
Vanadium	39.0	3.36	130 (CCME 1997) [b]
Zinc	22.5	3.2	200 (CCME 1999) [b]

Notes:

< = less than the reportable detection limit; value provided is the detection limit; NDA = no data available (no phosphorus data were provided for the mine site); NGA = no guideline available; N (number of samples) = 36

Shaded cell indicates maximum concentration exceeds soil quality guideline.

a. All baseline values were collected by ERM. A summary of baseline data can be found in Appendix B of Intrinsik (2015) V8-5B.

b. CCME (2015 on-line; http://ceqg-rcqe.ccme.ca/) ecological health-based soil quality guidelines for residential / parkland and agricultural land use (agricultural guidelines are applicable to wildlands) unless otherwise stated. Where agricultural and residential / parkland are different, the agricultural guideline is presented first followed by the residential / parkland guideline. The year in which the CCME guideline was derived is presented in brackets.

c. U.S. EPA (2003a); for soils with pH <5.5 Al should be retained as a COC. The pH of 8 soil samples analyzed ranged from 5.1 to 5.9 with an average pH of 5.6.
d. OMOE (Ontario Ministry of the Environment; 2011) soil component value. Value presented is lower of the mammal / bird and plant / soil organism soil component value.
e. CCME Guideline for total chromium (derived in 1997).
f. U.S. EPA (2003b); for soils with pH between 5 and 8, iron is considered non-toxic. The pH of 8 soil samples analyzed ranged from 5.1 to 5.9 with an average pH of 5.6 and thus fall into this range.
g. US EPA (2007) Ecological Soil Screening Level (Eco SSL) for manganese. Value provided is the lower of the plant, soil invertebrate and wildlife guidelines.

As shown in Table V8-6A-1, no chemicals exceeded the available ecological health-based soil quality guidelines. No soil quality guidelines were available for bismuth, calcium, lithium, magnesium, potassium, phosphorus, sodium, strontium, tin and titanium. Calcium, magnesium, potassium, phosphorus and sodium were not carried forward for further assessment given the lack of guidelines and that these chemicals are essential nutrients in animals (NAS 2005) and would not be likely to result in adverse health effects. Bismuth and tin had no guidelines but were not detected in Goose or MLA soils (<0.1 mg/kg and <1 for bismuth and tin, respectively) and as such were not carried forward.

A maximum tolerable level (MTL) of 25 mg/kg diet was derived for lithium by the National Academy of Sciences (NAS 2005) for domestic animals including rodents and poultry. Lithium compounds are considered to have relatively low toxicity with oral LD50 values for several compounds and animal species being reported to range from 422-1165 mg/kg (RAIS 2015). The maximum lithium soil concentration at Goose was 12.2 mg/kg, while lithium was not detected in MLA soils (both samples collected had lithium concentrations <2.5 mg/kg). The mean lithium concentration at Goose was 7.76 mg/kg (See Intrinsik 2015; Appendix B; Volume 8-5B). Given the low concentrations of lithium, it was not carried forward as a result of the baseline soil screening.

An MTL of 1000 mg/kg was derived for strontium (NAS 2005). The maximum concentration of strontium at Goose and the MLA were 36 mg/kg and 73.4 mg/kg, respectively (Table V8-6A -1). While soil concentrations and MTLs are not directly comparable, the low concentrations of strontium relative to the MTLs indicates that this metals should not be of concern and was not carried forward for further assessment as part of the guideline screening for the ERA.

Maximum concentrations of titanium at Goose and the MLA were respectively 507 mg/kg and 28 mg/kg (Tables V8-6A -1). No guideline or MTL was identified for titanium; however, titanium (in the form of titanium dioxide) was reported as not being bioavailable nor absorbed via the gastrointestinal tract or skin (U.S. EPA 2005). In addition titanium dioxide was not carcinogenic in mice or rat dietary studies and chronic exposures to rats up to 5% in the diet produced no adverse effects (U.S. EPA 2005). Given this, titanium was not carried forward for further assessment.

V8-6A-2.2 Toxic Potency Screening

A chemical screening process, often referred to as relative toxic potency screening, was conducted to identify metals of potential concern for the ERA. Toxic potency screening is essentially a relative ranking system for chemicals that ranks chemicals based on the combination of toxic potency and an indicator of exposure potential, which can be emission rates, percent chemical composition of raw materials, environmental media concentrations *etc.* It is based on a screening procedure developed by the U.S. EPA (1989) and used by other regulatory agencies to determine COPCs in environmental impact statements (e.g., Alberta Health and Wellness 2011).

The toxic potency of a chemical is the dose or quantity of that chemical which is necessary to produce adverse health effects (*i.e.*, toxic effects). For example, the toxic potency of chemical A would be greater than that of chemical B if toxic effects are produced at a lower concentration of chemical A than chemical B. It is important to consider the toxic potency of chemicals when selecting the chemicals of concern for a risk assessment, as chemicals present at low concentrations with a high toxic potency may pose a greater risk potential to human receptors than chemicals which are present at higher concentrations, but with a lower toxic potency.

The ERA toxic potency screening was based on the overall weighted average of the geochemistry of the combined waste rock datasets of Umwelt, Llama, Echo and Main derived by SRK Consulting (2015)(Table V8-6A-2). Based on the air dispersion analysis conducted, the waste rock was predicted to be the dominant form of dust within the PDA (RWDI, 2015; Appendix V4-1B and 1C). Dust deposition at the MLA and winter road corridors are much lower than predicted for the Goose Property and hence the focus of the toxic potency screen was on dusts which could be deposited at Goose Property area. For the oral toxic potency screening, the weighted average percent metal composition data for waste rock were compared to ecological health-based soil quality guidelines or a maximum tolerable level.

In the toxic potency screening, the elemental weight percent values of each element were divided by the corresponding guideline or MTL for that element to yield a value that represents the individual toxic potency of that element. It must be recognized that this value is simply an expression of toxic potency that relates the amount of chemical present in the concentrate to the guideline or MTL. Thus, the units do not need to cancel out. Individual toxic potency for each chemical parameter was then expressed as a per cent of the total summed individual toxic potency of all chemical parameters considered. Following this, the chemicals were ranked in descending order of contribution to total individual toxic potency. Cumulative toxic potency was then calculated by adding the per cent individual toxic potency of the chemical with the highest individual toxic potency to that of the chemical with the next highest individual toxic potency, until the cut-off value for cumulative toxic potency is reached (95% in this case). The choice of cut-off for the cumulative toxic potency is an arbitrary decision. There is no regulatory guidance on this issue; rather, professional toxicological judgment is important in defining a reasonable and protective cut-off value. For the current toxic potency screen of concentrate, 95% cumulative toxic potency was considered a reasonable and conservative cut off value, as it is very unlikely that chemicals contributing less than 5% of the cumulative toxic potency would pose a risk to wildlife populations. Results of the oral toxic potency screening for the ERA are presented in Table V8-6A-3.

Table V8-6A -2 Weight Averages of the Geochemistry for Goose Property Area Based on the Combined Rock Dataset for Umwelt, Llama, Echo, and Main

Group (t/rock)	Statistic	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	Hg	K	La	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Sc	Se	Sr	Te	Th	Ti	Tl	U	V	W	Zn
		ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppb	%	ppm	%	ppm	ppm	%	ppm	%	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
GABwaste (2,681,125)	Average	0.11	3.21	11.49	20.79	105.91	0.05	1.52	0.12	36.53	49.47	165.79	6.27	7.77	5.84	0.56	8.18	2.10	775.48	0.55	0.21	48.76	0.12	3.85	0.18	0.07	10.27	0.34	38.31	0.02	0.87	0.37	0.21	0.13	144.73	0.20	70.21
	Minimum	0.04	1.82	0.20	3.00	2.80	0.02	0.30	0.01	22.70	22.00	68.11	3.48	4.80	5.00	0.03	3.00	0.87	429.00	0.22	0.00	29.60	0.05	0.43	0.05	0.02	1.60	0.10	8.60	0.01	0.20	0.01	0.02	0.05	54.00	0.10	38.50
	5th % ile	0.05	2.02	0.80	8.50	14.61	0.02	0.55	0.01	25.77	30.87	103.10	3.94	5.08	5.00	0.09	3.50	1.12	487.10	0.27	0.02	32.96	0.05	0.81	0.06	0.02	2.71	0.10	11.44	0.02	0.21	0.15	0.02	0.10	67.10	0.10	41.95
	25th % ile	0.07	2.35	2.03	20.00	45.18	0.02	0.80	0.06	30.50	36.08	118.25	4.69	5.98	5.00	0.30	4.85	1.41	605.00	0.36	0.03	40.05	0.06	1.35	0.10	0.02	3.60	0.20	16.25	0.02	0.40	0.25	0.10	0.10	93.50	0.10	54.60
	Median	0.10	2.71	4.10	20.00	103.50	0.02	1.00	0.10	33.75	46.50	146.50	5.69	6.85	5.00	0.55	8.55	1.70	689.00	0.50	0.04	48.00	0.08	2.08	0.13	0.02	5.55	0.30	18.65	0.02	0.85	0.32	0.20	0.10	112.00	0.10	64.75
	75th % ile	0.12	3.52	9.98	20.00	158.75	0.04	1.33	0.14	40.90	58.85	214.25	7.97	8.79	5.00	0.74	10.38	2.45	779.50	0.63	0.07	55.90	0.11	3.32	0.14	0.10	9.93	0.43	25.25	0.02	1.10	0.38	0.27	0.10	162.50	0.20	80.85
	95th % ile	0.20	6.68	26.08	37.50	207.70	0.12	5.73	0.30	53.28	77.80	242.90	10.09	13.35	10.00	1.13	12.70	4.27	1689.5	0.95	1.36	71.19	0.13	8.58	0.38	0.30	44.95	0.70	202.45	0.03	1.59	0.89	0.41	0.30	348.70	0.60	116.87
	Maximum	0.53	7.03	222.60	51.00	277.00	0.39	6.89	0.35	54.00	114.00	326.00	12.45	16.30	20.00	1.31	24.00	5.51	1740.0	1.64	2.66	78.60	1.15	61.56	2.84	0.40	47.00	1.20	284.00	0.13	3.10	1.56	0.59	0.70	391.00	1.00	139.00
	Count	62.00	62.00	62.00	56.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	56.00	56.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00	56.00	62.00	54.00	62.00	62.00	56.00	62.00	62.00	62.00	62.00
MM&LIFwaste (4,504,222)	Average	0.26	1.80	233.49	19.44	62.17	0.29	0.79	0.02	10.42	66.74	25.19	9.92	4.70	19.10	0.56	10.51	0.97	254.94	0.86	0.06	24.65	0.07	3.73	0.69	0.09	2.86	0.23	28.14	0.05	3.01	0.07	0.16	0.70	31.17	19.68	26.21
	Minimum	0.01	0.30	0.60	2.00	1.30	0.02	0.08	0.01	1.80	29.20	0.98	1.25	1.30	5.00	0.01	1.80	0.11	33.00	0.17	0.00	5.20	0.03	0.76	0.02	0.02	0.70	0.10	4.00	0.02	0.20	0.00	0.02	0.10	4.00	0.10	0.80
	5th % ile	0.04	0.57	1.75	9.45	7.25	0.02	0.18	0.01	2.45	35.75	6.42	4.55	1.74	5.00	0.08	4.10	0.23	54.00	0.27	0.01	6.35	0.03	0.90	0.05	0.02	0.95	0.10	10.10	0.02	0.80	0.01	0.03	0.10	7.00	0.10	2.50
	25th % ile	0.06	0.87	5.60	20.00	14.65	0.08	0.39	0.01	3.85	44.70	10.90	8.04	2.60	5.00	0.22	5.30	0.48	103.50	0.35	0.02	9.65	0.05	1.38	0.32	0.03	1.40	0.10	16.85	0.02	1.25	0.03	0.07	0.25	14.00	0.10	4.90
	Median	0.11	1.30	18.10	20.00	37.20	0.13	0.57	0.01	6.60	59.70	17.80	9.77	3.30	5.00	0.37	8.20	0.81	164.00	0.52	0.03	15.70	0.06	2.22	0.49	0.05	2.10	0.10	25.10	0.02	2.00	0.04	0.12	0.40	19.00	0.20	11.30
	75th % ile	0.16	2.64	58.05	20.00	81.45	0.23	0.97	0.02	16.00	81.60	33.25	12.05	6.68	5.00	0.85	14.75	1.46	354.00	1.10	0.05	37.45	0.07	3.98	0.74	0.11	3.80	0.30	37.95	0.05	4.35	0.10	0.25	1.02	40.00	0.50	42.15
	95th % ile	0.52	3.97	366.50	20.00	167.50	0.88	2.28	0.07	24.65	120.70	60.86	16.30	9.81	10.65	1.31	23.10	1.80	659.50	2.41	0.07	66.45	0.09	11.81	1.54	0.31	6.30	0.81	51.05	0.10	7.85	0.17	0.35	2.10	75.00	13.65	88.20
	Maximum	8.29	7.69	10000	33.00	784.00	5.25	4.30	0.20	44.50	154.00	154.37	18.70	12.30	940.00	3.02	37.90	4.70	906.00	3.38	1.55	76.30	0.49	28.80	6.62	0.58	16.00	1.40	146.00	0.58	12.00	0.42	0.52	2.70	210.00	1220.0	101.00
	Count	71.00	71.00	71.00	70.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	70.00	70.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	70.00	71.00	70.00	71.00	71.00	70.00	71.00	71.00	71.00	71.00
UIFwaste (28,852,729)	Average	0.12	2.67	75.93	18.75	150.41	0.19	0.78	0.04	14.22	92.67	39.02	9.36	7.48	5.37	0.92	15.95	1.23	339.64	1.17	0.04	38.80	0.06	5.59	0.40	0.09	4.21	0.20	22.46	0.04	4.92	0.12	0.24	1.24	44.83	2.00	45.78
	Minimum	0.01	0.08	0.10	1.00	8.90	0.02	0.04	0.01	0.50	28.60	2.09	0.24	0.20	5.00	0.05	2.30	0.03	19.00	0.10	0.00	2.60	0.01	0.61	0.01	0.02	0.20	0.10	2.40	0.02	0.50	0.00	0.02	0.10	2.00	0.05	1.60
	5th % ile	0.04	1.19	0.66	8.40	23.42	0.06	0.13	0.01	4.37	49.88	13.94	3.52	3.44	5.00	0.17	7.38	0.37	121.65	0.45	0.00	13.30	0.04	1.44	0.02	0.02	1.40	0.10	4.40	0.02	1.30	0.02	0.04	0.30	18.55	0.10	10.17
	25th % ile	0.06	2.10	3.50	20.00	62.90	0.12	0.30	0.01	10.40	69.58	26.68	6.76	6.00	5.00	0.45	12.38	0.86	235.00	0.76	0.02	28.88	0.04	3.07	0.15	0.02	2.98	0.10	8.70	0.02	3.30	0.07	0.15	0.80	32.00	0.10	29.00
	Median	0.08	2.51	9.75	20.00	126.00	0.16	0.45	0.03	13.65	93.80	34.85	9.03	7.40	5.00	0.90	15.80	1.17	300.50	1.03	0.03	39.20	0.05	4.56	0.27	0.04	4.05	0.10	13.70	0.03	4.95	0.12	0.25	1.28	43.00	0.20	44.40
	75th % ile	0.11	3.26	27.30	20.00	229.00	0.22	0.90	0.05	16.95	109.15	46.18	11.80	9.20	5.00	1.30	19.25	1.51	414.00	1.36	0.04	48.85	0.06	6.94	0.45	0.10	5.13	0.30	22.08	0.05	6.30	0.16	0.32	1.60	54.00	0.40	57.90
	95th % ile	0.25	4.33	154.35	20.00	332.20	0.40	2.26	0.10	25.77	146.45	81.93	15.85	12.10	7.60	1.78	25.89	2.16	690.45	2.45	0.09	67.65	0.09	12.08	1.15	0.29	7.29	0.50	67.42	0.09	8.45	0.21	0.45	2.27	79.90	4.62	89.35
	Maximum	2.14	6.62	5600.0	21.00	515.00	1.21	7.26	0.64	45.20	193.00	141.00	28.40	14.50	31.00	2.69	33.50	4.55	947.00	6.18	0.21	89.40	0.85	34.50	2.98	1.01	16.00	1.00	218.00	0.44	11.00	0.33	0.59	3.20	129.00	96.30	122.90
	Count	192.00	192.00	192.00	189.00	189.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	189.00	189.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	189.00	192.00	189.00	192.00	192.00	189.00	192.00	192.00	192.00	192.00
LGW&DIFwaste (8,592,433)	Average	0.13	2.38	136.97	19.43	75.84	0.33	0.53	0.07	20.50	98.48	49.33	4.47	7.07	5.77	0.48	22.22	1.55	405.05	1.68	0.05	61.51	0.05	7.59	0.26	0.07	4.07	0.22	12.70	0.05	6.41	0.08	0.17	1.58	44.45	1.66	67.55
	Minimum	0.02	0.25	0.40	1.00	1.90	0.02	0.08	0.01	0.40	29.20	2.13	0.65	1.10	5.00	0.01	4.10	0.04	60.00	0.11	0.00	1.50	0.02	0.99	0.02	0.02	0.20	0.10	2.80	0.02	0.40	0.00	0.02	0.10	2.00	0.06	2.80
	5th % ile	0.05	1.11	5.18	20.00	20.18	0.10	0.10	0.01	8.12	60.49	14.30	2.65	2.76	5.00	0.11	11.29	0.73	271.00	0.64	0.01	22.22	0.04	2.04	0.03	0.02	1.67	0.10	3.88	0.02	1.99	0.01	0.03	0.39	17.60	0.10	36.43
	25th % ile	0.08	2.05	12.85	20.00	38.28	0.19	0.15	0.04	17.15	86.50	36.39	3.47	6.20	5.00	0.23	18.75	1.28	340.50	1.36	0.02	51.50	0.04	4.41	0.09	0.02	2.80	0.10	5.00	0.02	6.00	0.03	0.08	1.40	32.00	0.10	60.25
	Median	0.10	2.26	24.60	20.00	59.90	0.25	0.21	0.07	19.50	99.00	45.40	3.94	7.10	5.00	0.40	22.00	1.52	370.00	1.57	0.02	63.10	0.05	6.98	0.15	0.03	3.40	0.10	6.30	0.03	6.60	0.06	0.15	1.60	37.00	0.11	69.10
	75th % ile	0.13	2.63	65.35	20.00	90.23	0.32	0.32	0.10	22.55	111.00	54.85	4.81	7.80	5.00	0.65	26.00	1.74	421.50	1.80	0.03	72.50	0.05	9.30	0.23	0.07	4.00	0.20	9.10	0.05	7.40	0.11	0.26	1.80	46.00	0.30	77.25
	95th % ile	0.24	3.58	501.80	20.00	164.20	0.60	2.20	0.17	30.46	133.11	100.00	8.80	9.60	10.00	1.07	31.71	2.23	634.70	3.20	0.06	91.61	0.07	14.62	0.63	0.21	5.64	0.60	28.00	0.10	8.83	0.18	0.35	2.30	77.00	6.03	90.91

Table V8-6A -2 Weight Averages of the Geochemistry for Goose Property Area Based on the Combined Rock Dataset for Umwelt, Llama, Echo, and Main

Group (t/rock)	Statistic	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr	Cu	Fe	Ga	Hg	K	La	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Sc	Se	Sr	Te	Th	Ti	Tl	U	V	W	Zn
		ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppb	%	ppm	%	ppm	ppm	%	ppm	%	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
	Maximum	2.25	7.25	3580.0	34.00	750.00	6.04	9.31	0.30	84.90	189.00	220.00	17.40	25.40	26.00	1.90	39.30	5.90	1610.0	7.05	2.09	148.00	0.50	59.80	3.64	0.75	44.00	2.40	268.00	1.05	11.80	0.96	0.67	4.10	388.00	89.00	116.00
	Count	219.00	219.00	219.00	214.00	216.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	214.00	213.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	219.00	214.00	219.00	212.00	219.00	219.00	214.00	219.00	219.00	219.00	219.00
UGWwaste (9,872,976)	Average	0.11	2.45	100.08	19.53	111.94	0.29	0.30	0.09	20.77	106.22	49.12	4.69	7.08	5.41	0.63	24.45	1.35	329.86	1.53	0.09	62.91	0.05	9.45	0.24	0.17	4.25	0.16	14.59	0.04	7.50	0.10	0.20	1.96	45.15	0.49	71.20
	Minimum	0.03	0.95	1.00	1.00	8.70	0.07	0.12	0.01	7.70	49.10	1.05	2.30	3.90	5.00	0.08	6.40	0.41	96.00	0.40	0.00	16.20	0.03	1.48	0.02	0.02	0.90	0.10	3.40	0.02	0.80	0.01	0.02	0.20	13.00	0.05	3.20
	5th % ile	0.06	1.38	5.50	20.00	23.30	0.14	0.15	0.02	14.40	85.30	29.10	2.60	4.80	5.00	0.14	14.60	0.86	215.00	0.82	0.01	38.70	0.04	4.21	0.06	0.02	2.30	0.10	4.20	0.02	4.80	0.01	0.06	1.10	28.00	0.06	45.40
	25th % ile	0.08	1.79	9.40	20.00	50.00	0.22	0.18	0.06	18.60	95.00	42.30	3.30	5.63	5.00	0.30	19.20	1.13	279.00	1.27	0.02	55.50	0.04	7.26	0.12	0.04	3.00	0.10	4.80	0.02	6.60	0.07	0.10	1.62	34.00	0.10	65.20
	Median	0.09	2.20	12.90	20.00	67.20	0.26	0.24	0.09	20.80	101.00	49.88	4.00	6.85	5.00	0.49	24.10	1.34	323.00	1.50	0.02	61.40	0.05	9.20	0.18	0.09	3.70	0.10	6.40	0.03	7.40	0.10	0.21	1.84	39.00	0.10	71.80
	75th % ile	0.11	2.72	16.80	20.00	111.00	0.32	0.35	0.12	23.90	114.50	55.50	5.27	8.18	5.00	0.78	29.60	1.57	379.00	1.74	0.03	73.40	0.05	11.40	0.26	0.25	4.70	0.18	10.70	0.05	8.30	0.12	0.25	2.28	49.00	0.20	83.20
	95th % ile	0.20	3.96	28.00	20.00	364.00	0.47	0.68	0.16	26.50	144.00	68.20	9.02	10.06	9.00	1.63	36.50	1.92	457.00	2.11	0.07	90.40	0.06	15.80	0.47	0.50	6.80	0.50	24.20	0.07	10.90	0.18	0.34	3.30	75.00	2.00	93.70
	Maximum	0.66	8.44	5014.9	20.00	667.00	1.16	1.46	0.20	29.90	181.00	103.00	12.00	16.80	13.00	2.42	42.30	2.26	545.00	3.60	2.24	105.00	0.09	22.60	2.56	0.90	16.00	1.00	194.00	0.68	13.00	0.39	0.67	4.15	123.00	13.20	96.90
	Count	81.00	81.00	81.00	78.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	78.00	78.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	81.00	78.00	81.00	77.00	81.00	81.00	78.00	81.00	81.00	81.00	81.00
PHYwaste (2,610,581)	Average	0.12	3.94	16.61	14.06	111.20	0.22	0.78	0.10	22.28	102.26	53.94	7.66	9.07	5.94	0.60	21.80	1.64	418.57	1.53	0.20	69.92	0.05	8.43	0.22	0.25	6.28	0.16	44.27	0.03	5.53	0.07	0.08	1.34	63.00	0.33	75.03
	Minimum	0.05	1.94	3.20	1.00	8.10	0.04	0.17	0.01	4.90	36.00	19.20	3.27	5.00	5.00	0.10	1.90	0.98	232.00	0.25	0.00	8.90	0.04	2.08	0.02	0.05	2.20	0.10	5.10	0.02	0.70	0.00	0.03	0.10	20.00	0.10	13.50
	5th % ile	0.06	2.28	4.70	1.00	19.50	0.07	0.22	0.02	10.90	63.50	20.80	4.51	6.28	5.00	0.10	12.30	1.03	240.00	0.66	0.01	32.80	0.04	2.31	0.02	0.06	2.30	0.10	5.80	0.02	2.20	0.00	0.03	0.40	24.00	0.10	42.40
	25th % ile	0.07	2.84	11.20	3.25	27.20	0.16	0.35	0.05	16.90	85.90	39.10	5.18	7.93	5.00	0.16	17.80	1.37	340.00	1.36	0.02	55.00	0.05	5.64	0.08	0.16	3.50	0.10	11.50	0.02	4.70	0.02	0.03	1.10	39.00	0.10	57.00
	Median	0.10	3.38	16.00	20.00	40.20	0.23	0.64	0.10	24.20	95.40	47.50	6.28	8.65	5.00	0.27	23.00	1.60	405.00	1.70	0.02	74.90	0.05	7.00	0.10	0.20	5.40	0.10	20.20	0.02	5.80	0.05	0.05	1.20	51.00	0.10	88.00
	75th % ile	0.13	4.08	20.20	20.00	63.70	0.30	0.85	0.14	27.00	123.00	54.40	9.63	10.63	5.75	0.37	26.40	1.80	452.00	1.88	0.03	89.90	0.06	9.90	0.17	0.30	6.80	0.10	32.10	0.03	6.60	0.11	0.10	1.70	70.00	0.20	91.80
	95th % ile	0.29	8.06	31.40	20.00	494.00	0.36	2.00	0.20	34.20	156.00	105.00	13.00	12.34	10.00	3.49	31.00	2.23	658.00	1.94	0.90	96.90	0.06	13.80	0.83	0.55	17.00	0.50	206.00	0.05	7.80	0.21	0.19	2.20	173.00	1.50	98.60
	Maximum	0.32	8.51	35.10	20.00	589.00	0.48	2.38	0.32	37.60	162.00	144.00	17.10	13.10	10.00	3.53	35.80	2.63	745.00	2.28	2.15	102.00	0.08	34.10	1.51	0.63	18.00	0.50	222.00	0.08	9.10	0.33	0.36	2.20	174.00	2.10	98.90
	Count	21.00	21.00	21.00	18.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	18.00	18.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	18.00	21.00	16.00	21.00	21.00	18.00	21.00	21.00	21.00	21.00
QFPwaste (1,836,798)	Average	0.08	0.73	894.55	19.67	63.64	0.57	0.16	0.11	2.25	62.91	7.22	1.33	2.86	5.17	0.31	17.19	0.32	137.70	1.33	0.05	7.30	0.06	5.02	0.14	0.21	0.66	0.18	8.86	0.08	4.09	0.01	0.08	1.28	4.27	3.54	34.19
	Minimum	0.01	0.18	0.10	10.00	20.80	0.02	0.07	0.01	0.40	4.00	1.13	0.45	0.60	5.00	0.06	5.50	0.05	47.00	0.20	0.01	1.20	0.03	2.06	0.02	0.02	0.10	0.10	4.30	0.02	2.10	0.00	0.02	0.70	2.00	0.10	5.70
	5th % ile	0.02	0.26	0.47	20.00	27.00	0.04	0.08	0.01	0.40	26.01	1.31	0.58	1.39	5.00	0.10	9.86	0.07	66.40	0.28	0.02	1.39	0.03	2.33	0.02	0.02	0.25	0.10	4.99	0.02	2.35	0.00	0.02	0.80	2.00	0.10	12.23
	25th % ile	0.03	0.49	23.68	20.00	46.60	0.14	0.12	0.02	0.63	44.83	2.76	0.79	2.10	5.00	0.21	13.95	0.15	106.00	0.50	0.03	2.10	0.04	3.31	0.02	0.02	0.40	0.10	6.10	0.02	3.15	0.01	0.05	1.10	2.00	0.20	20.38
	Median	0.04	0.68	163.50	20.00	60.70	0.25	0.15	0.05	1.00	53.40	4.03	1.11	2.70	5.00	0.30	15.85	0.25	134.50	0.77	0.04	2.55	0.04	3.94	0.06	0.04	0.50	0.10	7.65	0.03	4.00	0.01	0.07	1.30	2.00	0.35	27.15
	75th % ile	0.07	0.82	644.00	20.00	75.10	0.34	0.20	0.11	1.78	69.15	10.17	1.37	3.40	5.00	0.37	20.50	0.35	152.50	1.91	0.06	6.20	0.05	6.22	0.14	0.11	0.60	0.18	10.58	0.06	4.88	0.01	0.08	1.50	3.00	1.08	36.63
	95th % ile	0.34	1.23	3884.5	20.00	104.80	2.16	0.28	0.15	6.28	112.00	16.76	3.34	4.37	5.00	0.50	25.70	0.70	203.90	4.05	0.10	18.86	0.08	9.23	0.31	0.32	1.18	0.36	15.93	0.31	5.56	0.02	0.15	1.70	10.65	22.65	73.71
	Maximum	0.54	2.58	10000	20.00	144.00	6.17	0.31	1.50	22.60	229.00	43.70	5.33	7.60	10.00	0.94	37.50	1.45	384.00	5.86	0.11	79.40	0.52	10.80	1.47	4.07	4.00	1.10	25.60	0.52	7.90	0.08	0.42	1.80	41.00	45.50	155.00
	Count	30.00	30.00	30.00	30.00	29.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Overall Goose WR	Average	0.13	2.5	121	19	120	0.24	0.68	0.063	17	91	47	7.4	7.1	6.5	0.73	18	1.3	358	1.3	0.065	46	0.062	6.4	0.35	0.11	4.3	0.20	21	0.043	5.2	0.11	0.21	1.3	48	2.94	54
	Average in %	0.000013	2.5	0.0121	0.0019	0.0120	0.000024	0.68	0.0000063	0.0017	0.0091	0.0047	7.442	0.00071	0.0000065	0.732	0.0018	1.306	0.0358	0.00013	0.065	0.0046	0.062	0.00064	0.349	0.000011	0.00043	0.000020	0.0021	0.0000043	0.00052	0.114	0.000021	0.00013	0.0048	0.000294	0.0054

Table V8-6A -3 Toxic Potency Screen of Metals Content of Waste Rock

Parameter	% Composition of Waste Rock	SQG or MTL (mg/kg)	Toxic Potency[a]	Relative Toxic Potency	Cumulative Toxic Potency	SQG_E or MTL	SQG_E / MTL Reference
Iron	7.44	500	0.01488	50.50%	50.50%	MTL	NAS 2005 [b]
Aluminium	2.55	200	0.01273	43.19%	93.69%	MTL	NAS 2005 [b]
Arsenic	0.012	17	0.00071	2.41%	96.10%	SQG_E	CCME 2015 (1997) [c]
Magnesium	1.31	5000	0.00026	0.89%	96.99%	MTL	NAS 2005 [b]
Manganese	0.036	220	0.00016	0.55%	97.54%	SQG_E	U.S. EPA 2007 [d]
Chromium	0.0091	64	0.00014	0.48%	98.03%	SQG_E	CCME 2015 (1997) [c, e]
Nickel	0.0046	50	0.000092	0.31%	98.34%	SQG_E	CCME 2015 (1999) [c]
Copper	0.0047	63	0.000074	0.25%	98.59%	SQG_E	CCME 2015 (1999) [c]
Potassium	0.73	10000	0.000073	0.25%	98.84%	MTL	NAS 2005 [b]
Sulfur	0.35	5000	0.000070	0.24%	99.07%	MTL	NAS 2005 [b]
Cobalt	0.0017	40	0.000043	0.14%	99.22%	SQG_E	OMOE, 2011 [f]
Vanadium	0.0048	130	0.000037	0.12%	99.34%	SQG_E	CCME 2015 (1997) [c]
Calcium	0.68	20000	0.000034	0.12%	99.46%	MTL	NAS 2005 [b]
Barium	0.0120	390	0.000031	0.10%	99.56%	SQG_E	OMOE, 2011 [f]
Zinc	0.0054	200	0.000027	0.09%	99.65%	SQG_E	CCME 2015 (1999) [c]
Thallium	0.000021	1	0.000021	0.07%	99.72%	SQG_E	CCME 2015 (1999) [c]
Selenium	0.000020	1	0.000020	0.07%	99.79%	SQG_E	CCME 2015 (2009) [c]
Molybdenum	0.00013	6.9	0.000018	0.06%	99.85%	SQG_E	OMOE, 2011 [f]
Boron	0.0019	150	0.000013	0.04%	99.90%	MTL	NAS 2005 [b]
Phosphorus	0.062	6000	0.000010	0.03%	99.93%	MTL	NAS 2005 [b]
Lead	0.00064	70	0.0000092	0.03%	99.96%	SQG_E	CCME 2015 (1999) [c]
Uranium	0.00013	33	0.000004	0.01%	99.98%	SQG_E	CCME 2015 (2007) [c]
Strontium	0.0021	1000	0.000002	0.01%	99.98%	MTL	NAS 2005 [b]
Cadmium	0.0000063	3.8	0.000002	0.01%	99.99%	SQG_E	CCME 2015 (1999) [c]
Sodium	0.065	40000	0.000002	0.01%	100.00%	MTL	NAS 2005 [b]
Silver	0.000013	20	0.000001	0.00%	100.00%	SQG_E	OMOE 2011[f]
Antimony	0.000011	20	0.000001	0.00%	100.00%	SQG_E	OMOE 2011 [f]
Mercury	0.00000065	12	0.000000	0.00%	100.00%	SQG_E	CCME 2015 (1999) [c]
Bismuth	0.000024	500	0.000000	0.00%	100.00%	MTL	NAS 2005 [b]
		Total	0.02947	100.00%			

Notes:

Shaded grey= chemicals carried forward for further assessment; NGA = No guideline or MTL available; SQG_E = Soil quality guideline for environmental health; MTL = maximum tolerable level.

No SQG_E or MTL was identified in the literature reviewed for Ti, La, Ga, Sc, Te, Th or W and as such, these chemicals were not included in the toxic potency screening. Percent concentrations in waste rock were very low for Ga, Sc, Te, Th and W (range of 0.0000043% for Te to 0.000294% for W) and La is at low concentration (0.0018%); thus, these were not carried for further assessment. Ti was present in waste rock at a higher concentration (0.114%), but was also not carried forward for further assessment since exposures to up to 5% of titanium dioxide in the diet did not have any adverse effects in chronic rat studies nor was it carcinogenic (US EPA 2005).

a. Toxic potency of each chemical was determined by dividing the composition of waste rock by the MTL or SQG_E

b. Maximum tolerable level from NAS 2005 is based on MTL for rodents.

c. The CCME (2015) ecological health-based soil quality guidelines were obtained on-line from the CCME website under soil quality guidelines, fact sheets which are provided for each individual chemical (2015 on-line; http://ceqg-rcqe.ccme.ca/). The year in bracket is the year the guideline was derived.

d. US EPA (2007) Ecological Soil Screening Level (Eco SSL) for manganese. Value provided is the lower of the plant, soil invertebrate and wildlife guidelines.

e. CCME Guideline for total chromium (derived in 1997).

f. OMOE (Ontario Ministry of the Environment; 2011) soil component values. Value provided is lower of the mammal / bird and plant / soil organism soil component value.

Based on results of the oral toxic potency screening for ecological health (Table V8-6A -3), the following chemicals made up >95% of the total toxic potency and were selected for further evaluation in the ERA: aluminum, arsenic and iron.

V8-6A-2.3 Bioaccumulation Check

The ERM baseline screening approach (See Table 3.3-1; Volume 8-5A) identified the following chemicals as having bioaccumulation or biomagnification potential: arsenic, cadmium, lead, mercury, nickel, selenium, thallium and zinc. No discussion was provided in Volume 8-5A regarding whether chemicals were bioaccumulative in terrestrial or aquatic ecosystems. As such, all of these chemicals were carried forward from the bioaccumulation check as COPCs in the terrestrial ERA.

V8-6A-2.4 Overall COPC List for Terrestrial Receptors in the ERA

Based on the baseline screening, toxic potency screening and bioaccumulation check, the following COPCs were selected for assessment of terrestrial receptors in the ERA:

- Aluminum
- Arsenic
- Cadmium
- Iron
- Lead
- Mercury
- Nickel
- Selenium
- Thallium
- Zinc

V8-6A-3.0 COPC SCREENING FOR AQUATIC RECEPTORS

The COPC screening was conducted separately for freshwater and marine aquatic receptors. For freshwater receptors, the screening consisted of comparison of the maximum baseline surface water and sediment data to freshwater aquatic life guidelines in addition to a toxic potency screening (based on predicted future dusts) and a bioaccumulation check. An additional freshwater screening was done related to predicted effluent in Goose Lake. For marine aquatic life, the screening consisted of comparison of baseline surface water and sediment data to marine aquatic life guidelines. Insufficient marine guidelines were available to do a toxic potency screening; however a bioaccumulation check was done for marine environments. Details of the freshwater screening and the Goose Lake effluent screening are provided in Sections V8-6A-2.2.1 and V8-6A-2.2.2, respectively. The marine screening approach is provided in Section V8-6A-2.2.3.

V8-6A-3.1 Freshwater Aquatic Receptors (Related to Baseline and Dust Deposition)

V8-6A-3.1.1 Baseline Surface Water and Sediment Screening

Screening of maximum baseline concentrations in freshwater sediments and surface waters (from lakes and streams) in Goose were conducted and are presented in Tables V8-6A-4 and V8-6A-5. Chemicals which exceeded guidelines were carried forward for further assessment.

Results of the surface water screening are provided in Table V8-6A-4 and show that the maximum baseline surface water concentrations were less than guidelines with the exception of cobalt, copper, iron , lead and nickel in lake water and aluminum, cadmium, cobalt, copper, iron, and nickel in streams. No freshwater aquatic water quality guidelines were available for bismuth, calcium, magnesium, phosphorus, potassium, sodium, tin and titanium. Calcium, magnesium, phosphorus, potassium and sodium are nutrients and would not be expected to drive potential risks at the site and were not carried forward for further assessment as a result of the guideline screening. Titanium is generally insoluble in water and has low aquatic toxicity to freshwater fish (US EPA, 2005) and as such was not carried forward. Bismuth is present in the ore at only 0.000024% (See Section V8-6A-3.1.2) and as such, incremental increases would not be expected to increase over baseline. Tin was not reported as being present in the waste rock. As such, bismuth and tin were not carried forward.

With respect to sediments, the maximum baseline concentration of arsenic, cadmium, chromium, iron, manganese and nickel concentrations in lakes and streams exceeded guidelines, while copper, silver and zinc exceeded in lakes only (See Table V8-6A-5). For silver, only one of the 87 baseline sediment samples collected in freshwater lakes (1.35 mg/kg) exceeded the BC MOE (2015b) sediment quality guideline of 0.5 mg/kg. This guideline is a "lower sediment quality guideline" which is equivalent to the CCME's threshold effect level or ISQG (BC MOE, 2015b), rather than a probable effect level. The next highest baseline lake silver concentration is 0.49 mg/kg. Given this silver was not carried forward for further assessment. Limited freshwater sediment quality guidelines were identified. The baseline data for lakes and streams are from a pristine area. As such, chemicals without guidelines were excluded for further evaluation, with the exception of chemicals identified as being present in the waste rock which were included in the toxic potency screening (See Section 3.1.2).

Table V8-6A-4 Comparison of Maximum Measured Baseline Surface Water Concentrations in Freshwater Lakes and Streams to Freshwater Aquatic Life Guidelines (mg/L)

Analyte	Maximum Concentration (mg/L)[a]		FWAL Surface Water Quality Guideline (mg/L) [d]	Guideline Source
	Lake (N=53)[b]	Stream (N=110)[c]		
Aluminum	0.070	0.163	0.100	CCME 2015 [e]
Antimony	0.000060	0.000050	0.009	BC MOE 2015a [f]
Arsenic	0.0016	0.0014	0.005	CCME 2015
Barium	0.042	0.063	1	BC MOE 2015a
Beryllium	0.00010	0.00010	0.00013	BC MOE 2015a [f]
Bismuth	0.00025	0.00025	NGA	
Boron	0.011	0.0092	1.5	CCME, 2015
Cadmium	0.000033	0.00022	0.00004	CCME 2015 [h]
Calcium	17.5	32.7	NGA	
Chromium	0.0017	0.00075	0.0089	CCME 2015 [g]
Cobalt	0.0051	0.011	0.004	BC MOE 2015a [f]
Copper	0.0041	0.0040	0.002	CCME 2015 [i]
Iron	0.592	0.50	0.30	CCME 2015
Lead	0.0051	0.000262	0.001	CCME 2015 [j]
Lithium	0.0025	0.0025	0.440	MDEQ 2015 [l]
Magnesium	9.41	13.1	NGA	
Manganese	0.087	0.072	0.622	MDEQ 2015
Mercury	0.0000050	0.0000050	0.000026	CCME 2015
Molybdenum	0.00011	0.000081	0.073	CCME 2015
Nickel	0.028	0.057	0.025	CCME 2015 [k]
Phosphorus	0.023	0.014	NGA	
Potassium	2.28	1.04	NGA	
Selenium	0.00010	0.000050	0.0010	CCME 2015
Silver	0.0000050	0.000017	0.00010	CCME 2015
Sodium	3.86	2.24	NGA	
Strontium	0.084	0.166	21	MDEQ 2015 [l]
Thallium	0.000050	0.000050	0.0008	CCME 2015
Tin	0.000050	0.000050	NGA	
Titanium	0.0050	0.0050	NGA	
Uranium	0.000032	0.000030	0.015	CCME 2015
Vanadium	0.00055	0.00038	0.027	MDEQ 2015 [l]
Zinc	0.0075	0.024	0.03	CCME 2015

Notes: *Shaded cell indicates maximum concentration exceeds water quality guideline; FWAL = freshwater aquatic life*
< = less than the reportable detection limit; value provided is half the detection limit; NGA = no guideline available

a. All baseline values were collected by ERM, including hardness and pH values. A summary of baseline data can be found in Appendix B of Intrinsik (2015) V8-5B.

b. The following lakes were included: Big Lake, Chair Lake, Echo Lake, Fox Lake, Gander Lake, Giraffe Lake, Goose Lake, Llama Lake, Mam Lake, Pong 19, Propeller Lake, Rabbit Lake, Rascal Lake, Umwelt Lake.

c. The following streams were included: Chair, Echo, Gander, Giraffe, Goose, Llama, Pond 19, Propeller, Wolf, and Moby

d. Guidelines are from CCME found on-line (http://ceqg-rcqe.ccme.ca/); freshwater surface water quality guidelines for the protection of aquatic life. Accessed in August 2015.

e. If the pH <6.5 then the guideline is 5 ug/L (or 0.005 mg/L); CCME 2015

f. BC MOE (2015a) guidelines found on-line (http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines). Accessed in August, 2015

g. Guideline is for Chromium 3+

h. CCME guideline calculated using the following equation provided by CCME : CWQG (µg/L) = 10{0.83(log[hardness]) – 2.46 }

*i. CCME guideline calculated using the following equation provided by CCME : CWQG (µg/L) = 0.2 * e{0.8545[ln(hardness)]-1.465}*

j. CCME guideline calculated using the following equation provided by CCME : CWQG (µg/L)= e{1.273[ln(hardness)]-4.705}

k. CCME guideline calculated using the following equation provided by CCME : CWQG (µg/L) = e{0.76[ln(hardness)]+1.06}

l. MDEQ (Michigan Department of Environmental Quality), 2015. Michigan Rule 57 Water Quality Values. Surface Water Assessment. Final Chronic Value (FCV) is provided as guideline. http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3686_3728-11383--,00.html

Table V8-6A-5 Comparison of Maximum Measured Baseline Freshwater Sediment Concentrations within Lake and Streams to Ecological Health-Based Sediment Quality Guidelines (mg/kg)

Analyte	Maximum Concentration (mg/kg) [a]		Freshwater Sediment Quality Guideline (mg/kg) [d]	
	Lake (N=87)[b]	Stream (N = 40)[c]	CCME- PEL	CCME-ISQG
Aluminum	19500	23700	NGA	NGA
Antimony	0.16	0.05	NGA	NGA
Arsenic	141	27.5	17	5.9
Barium	115	91.7	NGA	NGA
Beryllium	0.85	0.49	NGA	NGA
Bismuth	0.29	0.29	NGA	NGA
Cadmium	1.43	0.71	3.5	0.6
Calcium	3670	4530	NGA	NGA
Chromium [e]	56.1	75.3	90	37.3
Cobalt	167	118	NGA	NGA
Copper	170	NDA	197	35.7
Iron	85800	45400	43,766 [f]	21,200 [f]
Lead	10.7	11.4	91.3	35
Lithium	23.4	54.1	NGA	NGA
Magnesium	6680	18500	NGA	NGA
Manganese	690	6960	1400 [f]	460 [f]
Mercury	0.10	0.11	0.486	0.17
Molybdenum	4.21	1.47	NGA	NGA
Nickel	242	122	75 [f]	16 [f]
Phosphorus	1990	912	NGA	NGA
Potassium	1400	980	NGA	NGA
Selenium	1.10	0.66	NGA	NGA
Silver	1.35	0.11	NGA	0.5 [f]
Sodium	260	180	NGA	NGA
Strontium	37	32	NGA	NGA
Thallium	0.60	0.17	NGA	NGA
Tin	<2.00	<1.0	NGA	NGA
Titanium	719	413	NGA	NGA
Uranium	2.81	1.07	NGA	NGA
Vanadium	55.20	41.8	NGA	NGA
Zinc	201	86.7	315	123

Notes:
< = less than the reportable detection limit; value provided is half the detection limit; NGA = no guideline available; NDA = no data available; PEL= probable effect level; ISQG = interim sediment quality guideline
Shaded cell indicates maximum sediment concentration from lake or stream exceeds sediment quality guideline.
a. All baseline values were collected by ERM. A summary of baseline data can be found in Appendix B of Intrinsik (2015) V8-5B
b. The following lakes were included: Big Lake, Chair Lake, Echo Lake, Fox Lake, Gander Lake, Giraffe Lake, Goose Lake, Llama Lake, Mam Lake, Pong 19, Propeller Lake, Rabbit Lake, Rascal Lake, Umwelt Lake.
c. The following streams were included: Chair, Gander, Giraffe, Goose, Moby, Pond 19, Propeller, and Wolf.
d. Guidelines are from CCME found on-line (unless otherwise noted); http://ceqg-rcqe.ccme.ca/) ecological health-based Accessed in August 2015.
e. Guideline is for Chromium 3^+
f. Guideline is working quality sediment guideline from BC MOE (2015b); http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/waterqualityguidesobjs/work-water-quality-guidelines.pdf

A summary of exceedances over freshwater aquatic life guidelines is presented in Table V8-6A-6.

Table V8-6A-6 Chemicals with Maximum Baseline Water and / or Sediment Concentration that Exceed Freshwater Aquatic Life Guidelines

	Media in Which Maximum Baseline Concentration Exceeded Guideline and Chemical was Carried Forward for Further Assessment			
Chemical	**Freshwater Lake**	**Freshwater Stream**	**Lake Sediment**	**Stream Sediment**
Aluminum	No	**Yes**	No	No
Arsenic	No	No	**Yes**	**Yes**
Cadmium	No	**Yes**	**Yes**	**Yes**
Chromium	No	No	**Yes**	**Yes**
Cobalt	**Yes**	**Yes**	No	No
Copper	**Yes**	**Yes**	**Yes**	No
Iron	**Yes**	**Yes**	**Yes**	**Yes**
Lead	**Yes**	No	No	No
Manganese	No	No	**Yes**	**Yes**
Nickel	**Yes**	**Yes**	**Yes**	**Yes**
Zinc	No	No	**Yes**	No

Based on results in Table V8-6A-6, the following metals were carried forward for assessment in freshwater as a result of the guideline screening:

- Aluminum
- Arsenic
- Cadmium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Manganese
- Nickel
- Zinc

V8-6A-3.1.2 Toxic Potency Screening

As per the terrestrial screening approach (Section V8-6A-2.0), a relative toxic potency screen was conducted for the aquatic receptors, using the relative % of metals within the waste rock geochemistry, and an indicator of toxic potency, based on freshwater aquatic life chronic exposure water quality guidelines. Freshwater aquatic life guidelines were preferentially selected from CCME (2015 on-line), followed by BC MOE (2015a on-line), and if no guidelines were available from these jurisdictions, guidelines were used from the Michigan Department of Environmental Quality (MDEQ 2015). Table V8-6A-7 presents the outcomes of the screening effort.

Table V8-6A-7 Aquatic Toxic Potency Screen of Metals Content of Waste Rock						
Parameter	**% Composition of Waste Rock**	**FWALG (mg/L)**	**Toxic Potency[a]**	**Relative Toxic Potency**	**Cumulative Toxic Potency**	**Source**
Aluminium	2.55	0.1	25.45779	43.86%	43.86%	CCME 2015
Iron	7.44	0.3	24.80663	42.74%	86.60%	CCME 2015
Arsenic	0.012	0.005	2.41722	4.16%	90.77%	CCME 2015
Copper	0.0047	0.002	2.32973	4.01%	94.78%	CCME 2015
Chromium	0.0091	0.0089	1.02247	1.76%	96.55%	CCME 2015
Lead	0.00064	0.001	0.64128	1.10%	97.65%	CCME 2015
Cobalt	0.0017	0.004	0.42500	0.73%	98.38%	BC MOE 2015a
Nickel	0.0046	0.025	0.18367	0.32%	98.70%	CCME 2015
Zinc	0.0054	0.03	0.17920	0.31%	99.01%	CCME 2015
Vanadium	0.0048	0.027	0.17728	0.31%	99.31%	MDNR 2010
Silver	0.000013	0.0001	0.12956	0.22%	99.54%	CCME 2015
Cadmium	0.0000063	0.00005	0.12542	0.22%	99.75%	CCME 2015
Manganese	0.0358	0.8	0.04476	0.08%	99.83%	BC MOE 2015a
Thallium	0.000021	0.0008	0.02566	0.04%	99.87%	CCME 2015
Mercury	0.00000065	0.000026	0.02510	0.04%	99.92%	CCME 2015
Selenium	0.000020	0.001	0.02037	0.04%	99.95%	CCME 2015
Barium	0.0120	1	0.01200	0.02%	99.97%	BC MOE 2015a
Sulfur	0.35	128 [b]	0.00884	0.02%	99.99%	BC MOE 2015a
Uranium	0.00013	0.015	0.00273	0.00%	99.99%	CCME 2015
Molybdenum	0.00013	0.073	0.00174	0.00%	100.00%	CCME 2015
Boron	0.0019	1.5	0.00127	0.00%	100.00%	CCME 2015
Antimony	0.000011	0.009	0.00124	0.00%	100.00%	BC MOE 2015a
Strontium	0.0021	21	0.00010	0.00%	100.00%	MDEQ 2015
		Total	**58.04**	**100.00%**		

Notes:

Shaded grey= chemicals carried forward for further assessment; FWALG = Fresh Water Aquatic Life Guideline

No freshwater aquatic life guideline was identified in the literature reviewed for Bi, Ca, Ga, K, La, Mn, Na, P, Sc, Te, Ti, Th or W, and as such, these chemicals were not included in the toxic potency screening.

a. Toxic potency of each chemical was determined by dividing the composition of waste rock by Fresh Water Aquatic Life Guideline (FWALG)

b. No sulfur guideline was available so BC MOE (2015a) guideline for sulphate was used

Using a 95% cut-off, as per the terrestrial COPC toxic potency, aluminum, iron, arsenic, copper and chromium screen on for further assessment. No freshwater aquatic life guideline was identified in the literature reviewed for Bi, Ca, Ga, K, La, Mn, Na, P, Sc, Te, Ti, Th or W, and as such, these chemicals were not included in the toxic potency screening. Percent concentrations in waste rock were very low for Bi, Ga, Sc, Te, Th and W (range of 0.0000043% for Te to 0.000294% for W) and La is at low concentration (0.0018%); thus, these were not carried for further assessment. Ti was present in waste rock at a higher concentration (0.114%), but was also not carried forward for further assessment based on the insoluble nature of Ti in water and low acute toxicity of Ti to freshwater fish (US EPA 2005). Calcium, magnesium, phosphorus, potassium and sodium did not have guidelines and percent in waste rock ranged from 0.038% for magnesium to 0.732% for potassium. These chemicals are part of natural metabolism processes for aquatic species and would not be expected to pose a significant risk from dust. As such, these chemicals were not carried forward in the guideline screening.

V8-6A-3.1.3 Bioaccumulation Check

The ERM baseline screening approach (See Table 3.3-1; Appendix Volume 8-5A) identified the following chemicals as having bioaccumulation or biomagnification potential: arsenic, cadmium, lead, mercury, nickel, selenium, thallium and zinc. No discussion was provided as to whether chemicals were bioaccumulative in terrestrial or aquatic ecosystems. As such, all of these chemicals were carried forward from the bioaccumulation check as COPCs in the aquatic ERA.

V8-6A-3.1.4 Overall COPC List for Freshwater Aquatic Receptors in the ERA Related to Dust Deposition

Based on the baseline screening, toxic potency screening and bioaccumulation check, the following COPCs were selected for assessment of terrestrial receptors in the ERA:

- Aluminum
- Arsenic
- Cadmium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Manganese
- Mercury
- Nickel
- Selenium
- Thallium
- Zinc

V8-6A-3.2 Goose Lake Effluent Screening

V8-6A-3.2.1 Surface Water Screening Against Freshwater Aquatic Life Guidelines

To conduct the Goose Lake screening related to effluent discharges into Goose Lake in the Post Closure phase, water quality modelling provided by SRK (2015; Appendix V2-7H) was used. In this modelling effort, the Prediction Node 3 (PN3) which is considered to best represent future lake-wide concentrations within Goose Lake was used. Water Quality from other Prediction Nodes associated with various discharge points around the lake related to Water Management features was also estimated by SRK (2015), but since these nodes represent concentrations at point of discharge, and aquatic life exposures would be more appropriately represented by a lake-wide concentration, PN3 was the focus of the screening effort. The maximum average monthly concentration during operations, closure and post closure were predicted for each chemical by SRK (2015) (which SRK referred to as a Max Recorded value). These predictions were used to identify COPCs, by comparing the maximum recorded to freshwater aquatic life guidelines. These comparisons are presented in Table V8-6A-8.

Based on the comparisons provided, weak acid dissociable cyanide (WAD_CN), nitrite, arsenic, beryllium and copper exceed freshwater aquatic life guidelines, and hence, would be included as COPCs based on the screening process.

No freshwater aquatic water quality guidelines were available for bismuth, calcium, magnesium, phosphorus, potassium, silicon, sodium, tellurium, tin, titanium and zirconium. While calcium, magnesium, phosphorus, potassium and sodium are nutrients, effluent could contain high concentrations of these and as such, they have been carried forward for further assessment as a result of the guideline screening. Titanium is generally insoluble in water and has low aquatic toxicity to freshwater fish (US EPA, 2005) and as such was not carried forward. Environmental concerns related to tin are associated with the organic form, as opposed to the inorganic form, and hence, tin was not carried forward. Bismuth, silicon, tellurium and zirconium were carried forward for further assessment.

Table V8-6A-8 Goose Lake Effluent COPC Screening Based on Maximum Predicted Values at Closure for Prediction Node 3 (PN3) compared to Fresh Water Aquatic Life (FWAL) Guidelines

Metal	FWAL Guideline (mg/L)	PN3	
		Maximum Average (mg/L)[a]	Selected As COPC?
Free_CN	0.005[d,l]	0.0013	No
Total_CN_N	0.005 [d,l]	0.0007	No
WAD_CN	0.005[d,l]	0.0069	Yes
CNO_N	0.005[d,l]	0.00015	No
Sulphate	250	72	No
Chloride	120	34	No
Ammonia_N	12.58	0.14	No
Nitrate_N	3.0	0.66	No
Nitrite_N	0.06	0.18	Yes
Aluminum	0.1[c]	0.049	No
Antimony	0.009[d]	0.0046	No
Arsenic	0.005	0.0086	Yes
Barium	1	0.051	No
Beryllium	0.00013[d]	0.00026	Yes
Bismuth	NGA	0.00091	Yes
Boron	1.5	0.035	No
Cadmium	0.00005[f]	0.000018	No
Calcium	NGA	120	Yes
Chromium	0.0089[e]	0.00025	No
Cobalt	0.004[d]	0.0036	No
Copper	0.002[g]	0.0026	Yes
Iron	0.3	0.094	No
Lead	0.001[h]	0.00012	No
Lithium	0.44[k]	0.057	No
Magnesium	NGA	9.1	Yes
Manganese	0.62[k]	0.025	No
Mercury	0.000026	0.000016	No
Molybdenum	0.073	0.0081	No
Nickel	0.025[j]	0.0098	No
Phosphorus	NGA	0.029	Yes
Potassium	NGA	3.4	Yes
Selenium	0.001	0.00041	No
Silicon	NGA	0.36	Yes
Silver	0.0001	0.00007	No
Sodium	NGA	50	Yes
Strontium	21[k]	2.4	No
Tellurium	NGA	0.0026	Yes
Thallium	0.0008	0.000091	No
Tin	NGA	0.00018	No
Titanium	NGA	0.013	No
Uranium	0.015	0.000018	No
Vanadium	0.027	0.00037	No
Zinc	0.03	0.0062	No
Zirconium	NGA	0.00052	Yes

Notes:
NGA = no guideline available; NA = not applicable; FWAL = freshwater aquatic life
Shaded cell indicates maximum concentration exceeds water quality guideline, or no guideline was available and chemical was determined to warrant further assessment.
Guideline from CCME unless otherwise noted.

a. Predicted maximum average monthly concentration during operations, closure and post closure calculated by SRK (2015); values referred to by SRK as "maximum recorded value". Hardness of 27 $CaCO_3$ (provided by SRK) and pH value of 7 based on baseline data from ERM were applied to guidelines where appropriate. A summary of baseline data can be found in Appendix B of Intrinsik (2015) V8-5B.
b. Guidelines are from CCME found on-line (http://ceqg-rcqe.ccme.ca/); freshwater surface water quality guidelines for the protection of aquatic life. Accessed in August 2015.
c. If the pH <6.5 then the guideline is 5 ug/L (or 0.005 mg/L); CCME 2015
d. BC MOE guidelines found on-line (http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines). Accessed in August, 2015
e. Guideline is for Chromium 3+
f. CCME guideline calculated using the following equation provided by CCME : CWQG (µg/L) = 10{0.83(log[hardness]) – 2.46 }
g. CCME guideline calculated using the following equation provided by CCME : CWQG (µg/L) = 0.2 * e{0.8545[ln(hardness)]-1.465}
h. CCME guideline calculated using the following equation provided by CCME : CWQG (µg/L)= e{1.273[ln(hardness)]-4.705}
j. CCME guideline calculated using the following equation provided by CCME : CWQG (µg/L) = e{0.76[ln(hardness)]+1.06}
k. MDEQ (Michigan Department of Environmental Quality), 2015. Michigan Rule 57 Water Quality Values. Surface Water Assessment. Final Chronic Value (FCV) is provided as guideline. http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3686_3728-11383--,00.html
l. BC MOE (2015) guideline for weak-acid dissociable cyanide (as CN); this guideline was applied to other cyanide forms as they were considered less toxic. The BC MOE (2015) reported that cyanate was much less toxic than cyanide. BC MOE (2015) reported that the lowest concentration of cyanate (as CNO) reported to cause mortality to rainbow trout exposed for 96 hours was 7.3 mg/L. Other tests have indicated that the 96 h LC50 of cyanate to rainbow trout was usually greater than 20 mg/L.

Based on this screening, the following chemicals were over guidelines, or screened on for Goose Lake effluent due to a lack of guidelines:

- weak acid dissociable cyanide (WAD-CN)
- nitrite,
- arsenic,
- beryllium,
- bismuth,
- calcium,
- copper,
- magnesium,
- phosphorous,
- potassium,
- silicon,
- sodium,
- tellurium and
- zirconium

V8-6A-3.2.2 Bioaccumulation Check

The ERM baseline screening approach (See Table 3.3-1; Volume 8-5A) identified the following chemicals as having bioaccumulation or biomagnification potential: arsenic, cadmium, lead, mercury, nickel, selenium, thallium and zinc. No discussion was provided as to whether chemicals were bioaccumulative in terrestrial or aquatic ecosystems. As such, all of these chemicals were carried forward from the bioaccumulation check as COPCs in the aquatic ERA.

V8-6A-3.2.3 Overall COPC List for Freshwater Aquatic Receptors Related to Goose Lake Effluent

Based on the results of the Goose Lake effluent screening, the following chemicals were carried forward as COPCs:

- weak acid dissociable cyanide (WAD-CN)
- nitrite,
- arsenic,
- beryllium,
- bismuth,
- cadmium,
- calcium,
- copper,
- manganese,
- mercury,
- nickel,
- phosphorus,
- potassium,
- selenium,
- silicon,
- sodium,
- thallium,
- tellurium,
- zinc, and
- zirconium

V8-6A-3.3 Marine Aquatic Receptors

Screening of COPCs for marine receptors was slightly different than that of freshwater receptors due to the paucity of marine water and sediment quality guidelines available. As a result of this, no toxic potency screening was conducted for the marine environment. The marine COPC screening therefore consisted of comparison of maximum baseline concentrations to marine guidelines and a bioaccumulation check. Results of the marine COPC screening are provided in the following sections.

V8-6A-3.3.1 Baseline Surface Water and Sediment Screening

Screening of baseline aquatic media (i.e., sediments and surface waters) in the MLA was conducted and is presented in Tables V8-6A-9 and V8-6A-10. Chemicals which exceeded guidelines were carried forward for further assessment. Few marine water and sediment quality guidelines were identified. Given the baseline area is pristine and this comparison is on baseline data only, potential risks would not be expected for the chemicals without guidelines. As such chemicals without guidelines were not carried forward for further assessment.

Comparison of maximum marine baseline surface water concentrations to available guidelines shows that boron and cadmium are over guidelines (See Table V8-6A-9). When maximum marine baseline sediment concentrations are examined, arsenic and copper were in exceedance (See Table V8-6A-10). As a result of the comparison of marine baseline data to applicable guidelines, arsenic, boron, cadmium and copper were carried forward for further assessment.

Table V8-6A -9	Comparison of Maximum Measured Baseline Marine Surface Water Concentrations to Marine Surface Water Quality Guidelines Protective of Aquatic Life (mg/L)		
Analyte	**Maximum Concentration (mg/L) (N=29) [a]**	**Marine Aquatic Life Surface Water Quality Guideline (mg/L) [b]**	**Guideline Source**
Aluminum	0.163	NGA	
Antimony	0.000050	NGA	
Arsenic	0.0014	NGA	
Barium	0.063	NGA	
Beryllium	0.00010	NGA	
Bismuth	0.00025	NGA	
Boron	4.3	1.2 [c]	BC MOE 2015
Cadmium	0.000132	0.00012	CCME 2015
Calcium	335	NGA	
Chromium	0.00086	NGA	
Cobalt	0.000227	NGA	
Copper	0.00136	0.002 [c]	BC MOE 2015
Iron	0.298	NGA	
Lead	0.00033	0.002 [c]	BC MOE 2015
Lithium	0.171	NGA	
Magnesium	1040	NGA	
Manganese	0.00589	NGA	
Mercury	0.000005	0.000016	CCME 2015
Molybdenum	0.0094	NGA	
Nickel	0.00183	NGA	
Phosphorus	0.5	NGA	
Potassium	318	NGA	
Selenium	0.001	0.002 [c]	BC MOE 2015
Silver	0.00005	0.0015 [c]	BC MOE 2015
Sodium	9150	NGA	
Strontium	6.07	NGA	
Thallium	0.000073	NGA	
Tin	0.0005	NGA	
Titanium	0.012	NGA	
Uranium	0.00256	NGA	
Vanadium	0.00117	NGA	
Zinc	0.0093	0.01 [c]	BC MOE 2015

Notes:

< = less than the reportable detection limit; value provided is half the detection limit; NGA = no guideline available

Shaded cell indicates maximum concentration from marine surface water exceeds water quality guideline

a. All baseline values were collected by ERM. A summary of baseline data can be found in Appendix B of Intrinsik (2015) V8-5B.

b. Guidelines are from CCME found on-line (http://ceqg-rcqe.ccme.ca/) unless otherwise stated; guideline is the marine surface water quality guidelines for the protection of aquatic life. Accessed in August 2015.

c. BC MOE guidelines on-line (http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines). Accessed in August, 2015

Table V8-6A-10 Comparison of Maximum Measured Baseline Marine Sediment Concentrations Collected in the Vicinity of the Marine Laydown Area to Ecological Health-Based Sediment Quality Guidelines (mg/kg)			
Analyte	**Maximum Concentration (mg/kg) (N= 24)[a]**	**Marine Sediment Quality Guidelines (mg/kg)[b]**	
		CCME- PEL	**CCME-ISQG**
Aluminum	17700	NGA	NGA
Antimony	0.18	NGA	NGA
Arsenic	11.1	41.6	7.24
Barium	84.6	NGA	NGA
Beryllium	0.78	NGA	NGA
Bismuth	0.3	NGA	NGA
Cadmium	0.057	4.2	0.7
Calcium	5360	NGA	NGA
Chromium	45.9	160[c]	52.3[c]
Cobalt	10.4	NGA	NGA
Copper	20.4	108	18.7
Iron	26600	NGA	NGA
Lead	9.35	112	30.2
Lithium	33.7	NGA	NGA
Magnesium	11000	NGA	NGA
Manganese	288	NGA	NGA
Mercury	0.0156	0.70	0.13
Molybdenum	1.14	NGA	NGA
Nickel	25.3	NGA	NGA
Phosphorus	1080	NGA	NGA
Potassium	4940	NGA	NGA
Selenium	0.24	NGA	NGA
Silver	<0.05	NGA	NGA
Sodium	8130	NGA	NGA
Strontium	72.8	NGA	NGA
Thallium	0.153	NGA	NGA
Tin	<1	NGA	NGA
Titanium	731	NGA	NGA
Uranium	1.54	NGA	NGA
Vanadium	49.9	NGA	NGA
Zinc	51.2	271	124

Notes:

< = less than the reportable detection limit; value provided is half the detection limit; NGA = no guideline available; PEL= probable effect level; ISQG = interim sediment quality guideline

Shaded cell indicates maximum sediment concentration from Lake or Stream exceeds sediment quality guideline.

a - All baseline values were collected by ERM. A summary of baseline data can be found in Appendix B of Intrinsik (2015) V8-5B.

b - Guidelines are from CCME found on-line; http://ceqg-rcqe.ccme.ca/) ecological health-based Accessed in August 2015.

c - Guideline is for Chromium 3+

V8-6A-3.3.2 Bioaccumulation Check

The ERM baseline screening approach (See Table 3.3-1; Volume 8-5A) identified the following chemicals as having bioaccumulation or biomagnification potential: arsenic, cadmium, lead, mercury, nickel, selenium, thallium and zinc. No discussion was provided as to whether chemicals were bioaccumulative in terrestrial or aquatic ecosystems. As such, all of these chemicals were carried forward from the bioaccumulation check as COPCs in the aquatic ERA.

V8-6A-3.3.3 Overall COPC List for Marine Aquatic Receptors in the ERA

Based on the baseline screening, toxic potency screening and bioaccumulation check, the following COPCs were selected for assessment of marine receptors in the ERA:

- Arsenic
- Boron
- Cadmium
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Thallium
- Zinc

V8-6A-4.0 COPCs SELECTED FOR ECOLOGICAL RECEPTORS IN THE ERA

Table V8-6A-11 provides the COPCs selected via the various screening methods for the ecological receptors in terrestrial and aquatic environments.

Table V8-6A-11 COPCs in Terrestrial, Freshwater and Marine Environments for the ERA

COPC	Terrestrial ERA	Aquatic ERA		
		Freshwater (Dust Deposition)	Freshwater (Goose Lake Effluent)	Marine
Aluminum	Yes	Yes		
Arsenic	Yes	Yes	Yes	Yes
Beryllium			Yes	
Bismuth			Yes	
Boron				Yes
Cadmium	Yes	Yes	Yes	Yes
Calcium			Yes	
Chromium		Yes		
Cobalt		Yes		
Copper		Yes	Yes	Yes
Iron	Yes	Yes		
Lead	Yes	Yes		Yes
Magnesium			Yes	
Manganese		Yes		
Mercury	Yes	Yes	Yes	Yes
Nickel	Yes	Yes	Yes	Yes
Phosphorus			Yes	
Potassium			Yes	
Selenium	Yes	Yes	Yes	Yes
Silicon			Yes	
Sodium			Yes	
Thallium	Yes	Yes	Yes	Yes
Tellurium			Yes	
Zinc	Yes	Yes	Yes	Yes
Zirconium			Yes	
WAD-N			Yes	
Nitrite (N)			Yes	

Notes:
Yes = chemicals was selected as a COPC for that specific environment

V8-6A-5.0 COPC SCREENING FOR GOOSE LAKE DRINKING WATER FOR HUMANS

Since Goose Lake will contain effluent releases from mining operations and the TSF in the future, an additional screening was conducted for this lake, separately. Based on predictive future modelling conducted by SRK (Appendix V2-7H) related to Goose Lake, maximum predicted concentrations of various metals and compounds at 5 prediction nodes within the lake were screened against drinking water quality guidelines (Health Canada 2014). Maximum concentrations exceeding guidelines and metals with no drinking water guidelines were either screened into the assessment, or are discussed further (see below). Table V8-6A-12 summarizes the screening.

Table V8-6a-12: Screening of Maximum Predicted Value at Closure for each Predictor Node against Health Canada Drinking Water Quality Guideline (mg/L)

Parameter	Drinking Water Quality Guideline (mg/L)[a]	PN4		PN9		PN6		PN3		PN10		Selected COPC[d]
		Max Recorded (mg/L)	Over guideline?	Max Recorded (mg/L)	Over guideline?	Max Recorded (mg/L)	Over guideline?	Max Recorded (mg/L)	Over guideline?	Max Recorded (mg/L)	Over guideline?	
Free_CN	0.2	0.00097	no	0.00099	no	0.001	no	0.0013	no	0.001	no	
Total_CN_N	0.2	0.00052	no	0.00053	no	0.00054	no	0.0007	no	0.00054	no	
Sulphate	500	47	no	20	no	260	no	72	no	100	no	
Chloride	250	180	no	0.99	no	82	no	34	no	1700	yes	Chloride
Ammonia_N	NGR	0.96	no	1.4	no	0.24	no	0.14	no	0.014	no	
Nitrate_N	45	1.6	no	2.3	no	1.9	no	0.66	no	0.54	no	
Nitirite_N	1	0.078	no	0.11	no	0.36	no	0.18	no	0.031	no	
Aluminum	0.1	0.042	no	0.049	no	0.11	yes	0.049	no	0.071	no	Aluminum
Antimony	0.006	0.00031	no	0.00024	no	0.02	yes	0.0046	no	0.00059	no	Antimony
Arsenic	0.01	0.0096	no	0.01	no	0.023	yes	0.0086	no	0.019	yes	Arsenic
Barium	1	0.19	no	0.0051	no	0.0074	no	0.051	no	0.52	no	
Beryllium	0.016	0.00021	no	0.0002	no	0.0002	no	0.00026	no	0.00024	no	
Bismuth	NGA	0.0018	no	0.00049	no	0.0005	no	0.00091	no	0.0041	no	Bismuth
Boron	5	0.12	no	0.0049	no	0.012	no	0.035	no	0.34	no	
Cadmium	0.005	0.000035	no	0.0000099	no	0.000021	no	0.000018	no	0.000082	no	
Calcium	NGA	490	no	5.5	no	46	no	120	no	1400	no	Calcium
Chromium	0.05	0.00032	no	0.00015	no	0.00039	no	0.00025	no	0.00063	no	
Cobalt	0.0012[b]	0.0004	no	0.00023	no	0.015	yes	0.0036	yes	0.00087	no	Cobalt
Copper	1	0.0021	no	0.0018	no	0.0041	no	0.0026	no	0.0028	no	
Iron	0.3	0.14	no	0.082	no	0.23	no	0.094	no	0.35	yes	Iron
Lead	0.01	0.00018	no	0.000049	no	0.00026	no	0.00012	no	0.00041	no	
Lithium	0.008[b]	0.21	yes	0.0049	no	0.005	no	0.057	yes	0.6	yes	Lithium
Magnesium	NGA	32	no	1.9	no	7.9	no	9.1	no	87	no	Magnesium
Manganese	0.05	0.09	yes	0.013	no	0.032	no	0.025	no	0.25	yes	Manganese
Mercury	0.001	0.000013	no	0.000011	no	0.000024	no	0.000016	no	0.000015	no	
Molybdenum	0.02[b]	0.0014	no	0.00025	no	0.035	yes	0.0081	no	0.0037	no	Molybdenum
Nickel	0.08[b]	0.0086	no	0.013	no	0.019	no	0.0098	no	0.013	no	
Phosphorus	NGA	0.1	no	0.0038	no	0.049	no	0.029	no	0.29	no	Phosphorus
Potassium	NGA	7.5	no	0.33	no	10	no	3.4	no	21	no	Potassium
Selenium	0.05	0.00041	no	0.00017	no	0.001	no	0.00041	no	0.00085	no	
Silicon	NGA	0.27	no	0.27	no	0.36	no	0.36	no	0.28	no	Silicon
Silver	0.02[b]	0.000036	no	0.000011	no	0.00025	no	0.00007	no	0.000083	no	
Sodium	200	200	no	0.65	no	44	no	50	no	570	yes	Sodium
Strontium	1.5[c]	9.7	yes	0.0093	no	0.098	no	2.4	yes	28	yes	Strontium
Tellerium	NGA	0.0019	no	0.002	no	0.002	no	0.0026	no	0.002	no	Tellerium
Thallium	0.00004	0.00018	yes	0.000049	yes	0.00005	yes	0.000091	yes	0.00041	yes	Thallium
Thorium	NGA	0	no	0	no	0.0000095	no	0.0000021	no	0	no	Thorium
Tin	2.46[b]	0.00035	no	0.000099	no	0.00017	no	0.00018	no	0.00082	no	
Titanium	NGA	0.012	no	0.0099	no	0.01	no	0.013	no	0.017	no	Titanium
Uranium	0.02	0.000035	no	0.0000099	no	0.00001	no	0.000018	no	0.000082	no	
Vanadium	0.02[b]	0.001	no	0.000052	no	0.00099	no	0.00037	no	0.0029	no	
Zinc	5	0.012	no	0.005	no	0.0063	no	0.0062	no	0.029	no	
Zirconium	NGA	0.00039	no	0.00039	no	0.0004	no	0.00052	no	0.0004	no	Zirconium

Notes:

Shaded values highlight where baseline + project exceed the guideline. NGR = no guideline required , NGA = no guideline available

a. Unless otherwise noted, all drinking water guidelines are from Health Canada 2014 Drinking Water Guidelines

b. U.S EPA 2015 Regional screening values for Residential Tap water, using a Hazard Quotient of 0.1 multiplied by 2, to calculate a drinking water guideline as a HQ of 0.2.

c. US EPA (2014) Federal Register: Proposed Rules Volume 79, Number 202

d. Parameters were selected as potential COPCs if they exceeded guideline values in at least one receptor location or if guideline values were unavailable.

Based on this screening, a number of potential contaminants were identified as potential COPCs. Several of these substances do not require further assessment, as follows:

- Where drinking water quality guidelines were not based on a health-endpoint, these substances were not carried forward. These include chloride (guideline based on corrosion and taste); iron (guideline based on taste and laundry staining); sodium (guideline based on taste); manganese (guideline based on taste and laundry staining); aluminum (guideline based on operational water treatment issues) (Health Canada 2014).
- Where substances are considered essential elements, they do not require assessment in human health risk assessments (US EPA 2014). These substances include calcium, chloride, magnesium, phosphorus, potassium and sodium.
- Where substances are lacking guidelines but are reported to be of low toxicity, they were not carried forward (bismuth; silicon; titanium; tellurium; zirconium). Bismuth is a common ingredient in over-the-counter treatments for gastrointestinal distress (e.g., Pepto-Bismol), and hence is given orally at reasonably large doses, relative to incidental drinking water from a lake. Silicon is relatively non-toxic. The European Food Safety Authority (EFSA, 2009) concluded that the use of silicon dioxide up to 1500 mg SiO_2/day added to food supplements is of no safety concern. Therefore, silicon via the oral pathway was not considered further. With respect to titanium, evaluations of titanium dioxide by JECFA, SCF, and EFSA have each concluded that there are no safety concerns associated with the use of titanium dioxide as a food additive at levels ranging up to 3% (US EPA, 2005). For tellurium and zirconium, both of these elements are of low toxicity (oral LD50: > 5000 mg/kg bw; 14 day study; ECHA 2015; SDS 2010), and hence, would not be associated with any overt toxicity in the instance of incidental drinking water exposures. As such, titanium, tellurium and zirconium via the oral route was not considered further.

Based on the screening presented in Table V8-6A-12, and the information provided above, the following substances screen on for further assessment in Goose Lake, related to effluent and TSF aqueous discharge:

- Antimony
- Arsenic
- Cobalt
- Lithium
- Molybdenum
- Strontium
- Thallium

V8-6A-6.0 REFERENCES

Alberta Health and Wellness. 2011. Guidance on Human Health Risk Assessment for Environmental Impact Assessment. Government of Alberta. August 2011. pg.21. http://www.health.alberta.ca/documents/Health-Risk-Enviro-Impact-Guide-2011.pdf

BC MOE. 2015a. British Columbia Water Quality Guidelines. On-line. http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines

BC MOE. 2015b. British Columbia Working Water Quality Guidelines for British Columbia (2015). British Columbia Ministry of the Environment. http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/waterqualityguidesobjs/work-water-quality-guidelines.pdf

CCME. 2015. Canadian Environmental Quality Guidelines Summary Table. On-line. Canadian Council of Ministers of the Environment. http://www.ccme.ca/index.html

ECHA. 2015. ECHA Dossier – Zirconium. European Chemicals Agency. Available at: http://apps.echa.europa.eu/registered/data/dossiers/DISS-9eb8f8b8-2f51-1cd4-e044-00144f67d031/AGGR-53693fe7-2365-4b58-91f3-46ff119130f4_DISS-9eb8f8b8-2f51-1cd4-e044-00144f67d031.html#AGGR-53693fe7-2365-4b58-91f3-46ff119130f4

ESFA (European Food Safety Authority). 2009. The EFSA Journal (2009) 1132, 1-24 Scientific Opinion of the Panel on Food Additives and Nutrient Sources added to Food Calcium silicate and silicon dioxide/silicic acid gel added for nutritional purposes to food supplements (Questions No EFSA-Q-2005-140, EFSA-Q-2006-220, EFSA-Q-2005-098, EFSA-Q-2005-099) Adopted on 5 June 2009.

Health Canada 2014. Guidelines for Canadian Drinking Water Quality Summary Table. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment October 2014 http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sum_guide-res_recom/index-eng.php (accessed August 2015)

MDEQ (Michigan Department of Environmental Quality), 2015. Michigan Rule 57 Water Quality Values. Surface Water Assessment. Final Chronic Value (FCV) is provided as guideline. http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3686_3728-11383--,00.html

NAS (National Academy of Sciences). 2005. Mineral Tolerance of Animals, 2nd ed. Committee on Minerals and Toxic Substances in Diets and Water for Animals, Board of Agriculture and Natural Resources, Division on Earth and Life Sciences, National Research Council. The National Academies Press, Washington, D.C. URL: http://www.nap.edu/catalog/11309.html

OMOE (Ontario Ministry of the Environment). 2011. Rationale for the development of soil and groundwater standards for use at contaminates sites in Ontario. April 15, 2011. https://dr6j45jk9xcmk.cloudfront.net/documents/999/3-6-4-rationale-for-the-development-of-soil-and.pdf

RAIS. 2015. The Risk Assessment Information System. Toxicity Profiles. Condensed Toxicity Summary for Lithium. http://rais.ornl.gov/tox/profiles/lith_c.html

SDS. 2010. Safety Data Sheet – Tellurium. Acros Organics. Available at: https://www.fishersci.com/shop/msdsproxy?productName=AC315991000&productDescription=TELLURIUM+POWDER+-200M+100G&catNo=AC31599-1000+&vendorId=VN00032119&storeId=10652

SRK Consulting. 2015. Waste rock trace element summary. E-mail from K. Sexsmith (SRK Consulting) to C. Moore (Intrinsik) June 9, 2015.

U.S. EPA. 1989. Risk Assessment Guidance for Superfund. United States Environmental Protection Agency, Washington, DC. EPA/540/01. Pg. 5-23, 5-24. http://www.epa.gov/oswer/riskassessment/ragsa/pdf/rags_a.pdf

U.S. EPA. 2003a. Ecological Soil Screening Level for Aluminum: Interim Final. OSWER Directive 9285.7-60. United States Environmental Protection Agency. http://www.epa.gov/ecotox/ecossl/pdf/eco-ssl_aluminum.pdf

U.S. EPA. 2003b. Ecological Soil Screening Level for Iron. Interim Final. OSWER Directive OSWER Directive 9285.7-69. http://www.epa.gov/ecotox/ecossl/pdf/eco-ssl_iron.pdf

U.S. EPA. 2005. Inert Ingredient Tolerance Reassessment - Titanium Dioxide. Action Memorandum, June 28th, 2005. Office of Prevention, Pesticides and Toxic Substances. United States Environmental Protection Agency.

U.S. EPA. 2007. Ecological Soil Screening Level for Manganese. Interim Final. OSWER Directive. OSWER Directive 9285.7-71. United States Environmental Protection Agency. http://www.epa.gov/ecotox/ecossl/pdf/eco-ssl_manganese.pdf

U.S. EPA. 2014. Region 4 Human Health Risk Assessment Supplemental Guidance. January 2014 Draft Final. United States Environmental Protection Agency. Technical Services Section, Superfund Division. EPA Region 4. http://www2.epa.gov/sites/production/files/2015-09/documents/region_4_hhraguidedoc011014.pdf f

Appendix V8-6B

Risk Assessment Model Appendix

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GOLD & SILVER CORP.

APPENDIX V8-6B

RISK ASSESSMENT MODEL APPENDIX

V8 – 6B Model Appendix

This appendix presents the exposure model work sheets for predicting future concentrations in various environmental media, associated with incremental increase related to Project emissions. A worked example is presented in Appendix V8-6C, which illustrates specific calculations for various media. Equations are also presented in Chapter 6, which present the specific approaches used to calculate the future increments of various COPCs in soils, vegetation, surface waters, sediments, etc.

The tables presented in this appendix are described as follows:

- V8-6B – Table 1a: Summary of Baseline Exposure Point Concentrations in each Media for Baseline Scenario (Soil; Surface Soil; Sediment; Surface Water; Dust)
  - In this table, the Exposure Point Concentrations (EPCs) for each of COPC are present in both the baseline ERA scenario and baseline HHRA scenario. The baseline for the ERA and HHRA are identical. Baseline EPCs are further described in V8-6b: Table 5a and 5b.
  - In baseline, there is no increment from deposition, as the baseline data are measured, and hence include both deposition and uptake from soils. Hence all values under the various deposition columns are zero.
  - Baseline soil and surface soil are equal, as they are measured data from shallow soil samples.
  - The columns entitled Total in Table 1a equal measured baseline (as there is no depositional component)
  - COPC lists between the ERA and HHRA differ slightly, but for simplicities sake, the lists are identical in this appendix.

- V8-6B – Table 1b: Summary of Predicted Future Increments in each media for Project Scenario(Soil; Surface Soil; Sediment; Surface Water; Dust)
  - In this table, the Project increment contributed to soil, sediments, surface waters, dust and deposition are presented. For example, aluminum deposition in the ERA scenario is 1.3 E+02 mg/m2/year (last column of Table) which adds 4.35 mg/kg to the soil over a 10 year period (4th column of table). The equations used to calculate these increments are provided in Appendix V8-6C (worked example).
  - The columns entitled Total in Table 1b equals the total of the deposition increment. This equals the Project Increment over the 10 year operating period.
  - COPC lists between the ERA and HHRA differ slightly, but for simplicities sake, the lists are identical in this appendix.

- V8-6B – Table2a: Summary of Baseline and Predicted Future Increments in Vegetation Environment Media for Baseline Scenarios: Environmental Concentrations - Baseline
  - In this table, the Exposure Point Concentrations (EPCs) for each of COPC are present in both the baseline ERA scenario and baseline HHRA scenario. The baseline for the ERA and HHRA are identical. Baseline EPCs are further described in V8-6b: Table 5a and 5b.
  - In baseline, there is no increment from deposition, as the baseline data are measured, and hence include both deposition and uptake from soils. Hence all values under the various deposition columns are zero.
  - The vegetation concentrations listed under "soil" are the measured baseline concentrations of each COPC in each media (mg/kg – wet weight; also listed in V8-6B: Table 5a).
  - The columns entitled Sum or Total in Table 2a equal baseline (as there is no depositional component)

  - o COPC lists between the ERA and HHRA differ slightly, but for simplicities sake, the lists are identical in this appendix.
  - o
- V8-6B – Table 2b: Summary of Baseline and Predicted Future Increments in Vegetation Environment Media for Baseline Scenarios: Environmental Concentrations – Project Increment
  - o In this table, the Project increment contributed to vegetation via dust deposition onto vegetation is presented, as well as the Project increment contributed from soil (0 – 20 cm depth, as per US EPA 2005). The equations used to calculate these increments are provided in Appendix V8-6C (worked example).
  - o The columns entitled Sum or Total in Table 2b are the total of the deposition increment + the soil uptake increment (Total lichen = lichen deposition + lichen soil). This equals the Project Increment over the 10 year operating period.
  - o COPC lists between the ERA and HHRA differ slightly, but for simplicities sake, the lists are identical in this appendix.
- Table V8-6B – Table 3: Bioconcentration Factors for HHRA and ERA (wet weight basis)
  - o The site-specific values listed are calculated using the data in V8-6B Tables 5a and 5b (and are presented also in Table 5c)
  - o Where baseline data were non-detect, literature based values were used unless the application of these values did not result in a reasonable prediction of baseline levels. In these situations, literature based values were based on non-detect values.
- Table V8-6B: Predicted Deposition Rates for COPC based on Air Quality Predictions (mg/m^2/year)
  - o This table provides the approach taken to convert the dust deposition provided by RWDI (2015) (mg/dm^2/year) into chemical-specific deposition, based on site-specific geochemistry.
- Table V8-6B-Table 5a and 5b: Summary of Exposure Point Concentrations (EPC)
- Table V8-6B – Table 6: Summary of Predicted Site-specific Bioconcentration Factors (BCFs)
  - o These BCFs are calculated from the data in Tables 5a and b, as described in the footnotes to this table.

Please refer to V8-6C for a worked example of predicted future concentrations.

V8-6B-Table 1a: Summary of Baseline and Predicted Future Increments in each Media for Baseline Scenario (Soil; Surface Soil; Sediment; Surface Water and Dust)

Site	Chemical	Baseline Soil	Deposition Soil	Total Soil	Surface Soil	Deposition Surface Soil	Total Surface Soil	Sediment	Deposition Sediment	Total Sediment	Baseline Goose Lake_SW	Deposition Goose Lake_SW	Total Goose Lake_SW	Baseline Fox Lake_SW	Deposition Fox Lake_SW	Total Fox Lake_SW	Big Lake_SW	Deposition Big Lake_SW	Total Big Lake_SW	Total Marine_SW	Dust	Deposition
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/L	mg/m2/yr	mg/L	mg/L	mg/m2/yr	mg/L	mg/L	mg/m2/yr	mg/L	mg/L	ug/m3	mg/m2/yr
ERA	Aluminum	5.11E+03	0.00E+00	5.11E+03	5.11E+03	0.00E+00	5.11E+03	9.76E+03	0.00E+00	9.76E+03	1.10E-02	0.00E+00	1.10E-02	2.16E-02	0.00E+00	2.16E-02	2.16E-02	0.00E+00	2.16E-02	6.49E-02	3.88E-03	0.00E+00
ERA	Arsenic	5.17E+00	0.00E+00	5.17E+00	5.17E+00	0.00E+00	5.17E+00	1.57E+01	0.00E+00	1.57E+01	2.00E-04	0.00E+00	2.00E-04	3.40E-04	0.00E+00	3.40E-04	3.40E-04	0.00E+00	3.40E-04	1.00E-03	3.93E-06	0.00E+00
ERA	Arsenic cancer	5.17E+00	0.00E+00	5.17E+00	5.17E+00	0.00E+00	5.17E+00	1.57E+01	0.00E+00	1.57E+01	2.00E-04	0.00E+00	2.00E-04	3.40E-04	0.00E+00	3.40E-04	3.40E-04	0.00E+00	3.40E-04	1.00E-03	3.93E-06	0.00E+00
ERA	Cadmium	5.40E-02	0.00E+00	5.40E-02	5.40E-02	0.00E+00	5.40E-02	5.17E-01	0.00E+00	5.17E-01	1.00E-05	0.00E+00	1.00E-05	1.00E-05	0.00E+00	1.00E-05	1.00E-05	0.00E+00	1.00E-05	8.20E-05	4.10E-08	0.00E+00
ERA	Chromium	1.71E+01	0.00E+00	1.71E+01	1.71E+01	0.00E+00	1.71E+01	2.69E+01	0.00E+00	2.69E+01	1.50E-04	0.00E+00	1.50E-04	3.00E-04	0.00E+00	3.00E-04	3.00E-04	0.00E+00	3.00E-04	8.60E-04	1.30E-05	0.00E+00
ERA	Cobalt	4.38E+00	0.00E+00	4.38E+00	4.38E+00	0.00E+00	4.38E+00	1.93E+01	0.00E+00	1.93E+01	1.20E-04	0.00E+00	1.20E-04	4.50E-04	0.00E+00	4.50E-04	4.50E-04	0.00E+00	4.50E-04	7.90E-05	3.33E-06	0.00E+00
ERA	Copper	1.17E+01	0.00E+00	1.17E+01	1.17E+01	0.00E+00	1.17E+01	9.35E+01	0.00E+00	9.35E+01	1.40E-03	0.00E+00	1.40E-03	2.32E-03	0.00E+00	2.32E-03	2.32E-03	0.00E+00	2.32E-03	9.00E-04	8.91E-06	0.00E+00
ERA	Iron	1.01E+04	0.00E+00	1.01E+04	1.01E+04	0.00E+00	1.01E+04	2.16E+04	0.00E+00	2.16E+04	1.40E-02	0.00E+00	1.40E-02	9.02E-02	0.00E+00	9.02E-02	9.02E-02	0.00E+00	9.02E-02	8.90E-02	7.68E-03	0.00E+00
ERA	Lead	2.58E+00	0.00E+00	2.58E+00	2.58E+00	0.00E+00	2.58E+00	5.45E+00	0.00E+00	5.45E+00	5.00E-05	0.00E+00	5.00E-05	4.00E-04	0.00E+00	4.00E-04	4.00E-04	0.00E+00	4.00E-04	3.30E-04	1.96E-06	0.00E+00
ERA	Manganese	8.34E+01	0.00E+00	8.34E+01	8.34E+01	0.00E+00	8.34E+01	1.79E+02	0.00E+00	1.79E+02	1.90E-03	0.00E+00	1.90E-03	9.32E-03	0.00E+00	9.32E-03	9.32E-03	0.00E+00	9.32E-03	3.16E-03	6.34E-05	0.00E+00
ERA	Mercury	8.00E-03	0.00E+00	8.00E-03	8.00E-03	0.00E+00	8.00E-03	7.31E-02	0.00E+00	7.31E-02	1.00E-05	0.00E+00	1.00E-05	5.00E-06	0.00E+00	5.00E-06	5.00E-06	0.00E+00	5.00E-06	5.00E-06	6.08E-09	0.00E+00
ERA	Methyl Mercury	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.90E-07	0.00E+00	5.90E-07	2.95E-07	0.00E+00	2.95E-07	2.95E-07	0.00E+00	2.95E-07	2.95E-07	0.00E+00	0.00E+00
ERA	Methyl Mercury2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.90E-07	0.00E+00	5.90E-07	2.95E-07	0.00E+00	2.95E-07	2.95E-07	0.00E+00	2.95E-07	2.95E-07	0.00E+00	0.00E+00
ERA	Nickel	1.14E+01	0.00E+00	1.14E+01	1.14E+01	0.00E+00	1.14E+01	6.63E+01	0.00E+00	6.63E+01	3.30E-03	0.00E+00	3.30E-03	6.42E-03	0.00E+00	6.42E-03	6.42E-03	0.00E+00	6.42E-03	1.06E-03	8.66E-06	0.00E+00
ERA	Selenium	1.00E-01	0.00E+00	1.00E-01	1.00E-01	0.00E+00	1.00E-01	5.02E-01	0.00E+00	5.02E-01	1.00E-04	0.00E+00	1.00E-04	1.00E-04	0.00E+00	1.00E-04	1.00E-04	0.00E+00	1.00E-04	1.00E-03	7.60E-08	0.00E+00
ERA	Thallium	5.80E-02	0.00E+00	5.80E-02	5.80E-02	0.00E+00	5.80E-02	8.88E-02	0.00E+00	8.88E-02	5.00E-05	0.00E+00	5.00E-05	5.00E-05	0.00E+00	5.00E-05	5.00E-05	0.00E+00	5.00E-05	4.10E-05	4.41E-08	0.00E+00
ERA	Zinc	1.52E+01	0.00E+00	1.52E+01	1.52E+01	0.00E+00	1.52E+01	8.07E+01	0.00E+00	8.07E+01	3.00E-03	0.00E+00	3.00E-03	2.61E-03	0.00E+00	2.61E-03	2.61E-03	0.00E+00	2.61E-03	5.30E-03	1.16E-05	0.00E+00
HHRA	Aluminum	5.11E+03	0.00E+00	5.11E+03	5.11E+03	0.00E+00	5.11E+03	9.89E+03	0.00E+00	9.89E+03	1.10E-02	0.00E+00	1.10E-02	2.16E-02	0.00E+00	2.16E-02	2.16E-02	0.00E+00	2.16E-02	6.49E-02	3.88E-03	0.00E+00
HHRA	Arsenic	5.17E+00	0.00E+00	5.17E+00	5.17E+00	0.00E+00	5.17E+00	2.37E+01	0.00E+00	2.37E+01	2.00E-04	0.00E+00	2.00E-04	3.40E-04	0.00E+00	3.40E-04	3.40E-04	0.00E+00	3.40E-04	1.00E-03	3.93E-06	0.00E+00
HHRA	Arsenic cancer	5.17E+00	0.00E+00	5.17E+00	5.17E+00	0.00E+00	5.17E+00	2.37E+01	0.00E+00	2.37E+01	2.00E-04	0.00E+00	2.00E-04	3.40E-04	0.00E+00	3.40E-04	3.40E-04	0.00E+00	3.40E-04	1.00E-03	3.93E-06	0.00E+00
HHRA	Cadmium	5.40E-02	0.00E+00	5.40E-02	5.40E-02	0.00E+00	5.40E-02	3.67E-01	0.00E+00	3.67E-01	1.00E-05	0.00E+00	1.00E-05	1.00E-05	0.00E+00	1.00E-05	1.00E-05	0.00E+00	1.00E-05	8.20E-05	4.10E-08	0.00E+00
HHRA	Chromium	1.71E+01	0.00E+00	1.71E+01	1.71E+01	0.00E+00	1.71E+01	2.94E+01	0.00E+00	2.94E+01	1.50E-04	0.00E+00	1.50E-04	3.00E-04	0.00E+00	3.00E-04	3.00E-04	0.00E+00	3.00E-04	8.60E-04	1.30E-05	0.00E+00
HHRA	Cobalt	4.38E+00	0.00E+00	4.38E+00	4.38E+00	0.00E+00	4.38E+00	2.04E+01	0.00E+00	2.04E+01	1.20E-04	0.00E+00	1.20E-04	4.50E-04	0.00E+00	4.50E-04	4.50E-04	0.00E+00	4.50E-04	7.90E-05	3.33E-06	0.00E+00
HHRA	Copper	1.17E+01	0.00E+00	1.17E+01	1.17E+01	0.00E+00	1.17E+01	8.25E+01	0.00E+00	8.25E+01	1.40E-03	0.00E+00	1.40E-03	2.32E-03	0.00E+00	2.32E-03	2.32E-03	0.00E+00	2.32E-03	9.00E-04	8.91E-06	0.00E+00
HHRA	Iron	1.01E+04	0.00E+00	1.01E+04	1.01E+04	0.00E+00	1.01E+04	2.45E+04	0.00E+00	2.45E+04	1.40E-02	0.00E+00	1.40E-02	9.02E-02	0.00E+00	9.02E-02	9.02E-02	0.00E+00	9.02E-02	8.90E-02	7.68E-03	0.00E+00
HHRA	Lead	2.58E+00	0.00E+00	2.58E+00	2.58E+00	0.00E+00	2.58E+00	5.38E+00	0.00E+00	5.38E+00	5.00E-05	0.00E+00	5.00E-05	4.00E-04	0.00E+00	4.00E-04	4.00E-04	0.00E+00	4.00E-04	3.30E-04	1.96E-06	0.00E+00
HHRA	Manganese	8.34E+01	0.00E+00	8.34E+01	8.34E+01	0.00E+00	8.34E+01	1.65E+02	0.00E+00	1.65E+02	1.90E-03	0.00E+00	1.90E-03	9.32E-03	0.00E+00	9.32E-03	9.32E-03	0.00E+00	9.32E-03	3.16E-03	6.34E-05	0.00E+00
HHRA	Mercury	8.00E-03	0.00E+00	8.00E-03	8.00E-03	0.00E+00	8.00E-03	5.99E-02	0.00E+00	5.99E-02	1.00E-05	0.00E+00	1.00E-05	5.00E-06	0.00E+00	5.00E-06	5.00E-06	0.00E+00	5.00E-06	5.00E-06	6.08E-09	0.00E+00

Site	Chemical	Baseline Soil	Deposition Soil	Total Soil	Surface Soil	Deposition Surface Soil	Total Surface Soil	Sediment	Deposition Sediment	Total Sediment	Baseline Goose Lake_SW	Deposition Goose Lake_SW	Total Goose Lake_SW	Baseline Fox Lake_SW	Deposition Fox Lake_SW	Total Fox Lake_SW	Big Lake_SW	Deposition Big Lake_SW	Total Big Lake_SW	Total Marine_SW	Dust	Deposition
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/L	mg/m2/yr	mg/L	mg/L	mg/m2/yr	mg/L	mg/L	mg/m2/yr	mg/L	mg/L	ug/m3	mg/m2/yr
HHRA	Methyl Mercury	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.90E-07	0.00E+00	5.90E-07	2.95E-07	0.00E+00	2.95E-07	2.95E-07	0.00E+00	2.95E-07	2.95E-07	0.00E+00	0.00E+00
HHRA	Methyl Mercury2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.90E-07	0.00E+00	5.90E-07	2.95E-07	0.00E+00	2.95E-07	2.95E-07	0.00E+00	2.95E-07	2.95E-07	0.00E+00	0.00E+00
HHRA	Nickel	1.14E+01	0.00E+00	1.14E+01	1.14E+01	0.00E+00	1.14E+01	7.11E+01	0.00E+00	7.11E+01	3.30E-03	0.00E+00	3.30E-03	6.42E-03	0.00E+00	6.42E-03	6.42E-03	0.00E+00	6.42E-03	1.06E-03	8.66E-06	0.00E+00
HHRA	Selenium	1.00E-01	0.00E+00	1.00E-01	1.00E-01	0.00E+00	1.00E-01	4.60E-01	0.00E+00	4.60E-01	1.00E-04	0.00E+00	1.00E-04	1.00E-04	0.00E+00	1.00E-04	1.00E-04	0.00E+00	1.00E-04	1.00E-03	7.60E-08	0.00E+00
HHRA	Thallium	5.80E-02	0.00E+00	5.80E-02	5.80E-02	0.00E+00	5.80E-02	1.05E-01	0.00E+00	1.05E-01	5.00E-05	0.00E+00	5.00E-05	5.00E-05	0.00E+00	5.00E-05	5.00E-05	0.00E+00	5.00E-05	4.10E-05	4.41E-08	0.00E+00
HHRA	Zinc	1.52E+01	0.00E+00	1.52E+01	1.52E+01	0.00E+00	1.52E+01	7.60E+01	0.00E+00	7.60E+01	3.00E-03	0.00E+00	3.00E-03	2.61E-03	0.00E+00	2.61E-03	2.61E-03	0.00E+00	2.61E-03	5.30E-03	1.16E-05	0.00E+00

VB-6B-Table 1b: Summary of Baseline and Predicted Future Increments in each Media for Project Scenario (Soil; Surface Soil; Sediment; Surface Water and Dust)

Site	Chemical	Baseline Soil	Deposition Soil	Total Soil	Surface Soil	Deposition Surface Soil	Total Surface Soil	Sediment	Deposition Sediment	Total Sediment	Baseline Goose Lake_SW	Deposition Goose Lake_SW	Total Goose Lake_SW	Baseline Fox Lake_SW	Deposition Fox Lake_SW	Total Fox Lake_SW	Big Lake_SW	Deposition Big Lake_SW	Total Big Lake_SW	Total Marine_SW	Dust	Deposition
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/L	mg/m2/yr	mg/L	mg/L	mg/m2/yr	mg/L	mg/L	mg/m2/yr	mg/L	mg/L	ug/m3	mg/m2/yr
ERA	Aluminum	0.00E+00	4.35E+00	4.35E+00	0.00E+00	4.35E+01	4.35E+01	0.00E+00	1.29E+02	1.29E+02	1.60E-02	0.00E+00[c]	1.60E-02	0.00E+00	3.54E+01	1.67E-02	0.00E+00	8.94E+00	2.97E-03	0.00E+00	3.31E-05	1.30E+02[a]
ERA	Arsenic	0.00E+00	2.11E-02	2.11E-02	0.00E+00	2.11E-01	2.11E-01	0.00E+00	6.26E-01	6.26E-01	3.80E-03	0.00E+00[c]	3.80E-03	0.00E+00	1.71E-01	8.09E-05	0.00E+00	4.33E-02	1.44E-05	0.00E+00	1.60E-07	6.32E-01[a]
ERA	Arsenic cancer	0.00E+00	2.11E-02	2.11E-02	0.00E+00	2.11E-01	2.11E-01	0.00E+00	6.26E-01	6.26E-01	3.80E-03	0.00E+00[c]	3.80E-03	0.00E+00	1.71E-01	8.09E-05	0.00E+00	4.33E-02	1.44E-05	0.00E+00	1.60E-07	6.32E-01[a]
ERA	Cadmium	0.00E+00	1.10E-05	1.10E-05	0.00E+00	1.10E-04	1.10E-04	0.00E+00	3.26E-04	3.26E-04	0.00E+00	0.00E+00[c]	0.00E+00	0.00E+00	8.92E-05	4.21E-08	0.00E+00	2.25E-05	7.49E-09	0.00E+00	8.33E-11	3.29E-04[a]
ERA	Chromium	0.00E+00	1.58E-02	1.58E-02	0.00E+00	1.58E-01	1.58E-01	0.00E+00	4.71E-01	4.71E-01	0.00E+00	0.00E+00[c]	0.00E+00	0.00E+00	1.29E-01	6.09E-05	0.00E+00	3.26E-02	1.08E-05	0.00E+00	1.20E-07	4.75E-01[a]
ERA	Cobalt	0.00E+00	2.96E-03	2.96E-03	0.00E+00	2.96E-02	2.96E-02	0.00E+00	8.79E-02	8.79E-02	3.00E-05	0.00E+00[c]	3.00E-05	0.00E+00	2.41E-02	1.14E-05	0.00E+00	6.08E-03	2.02E-06	0.00E+00	2.25E-08	8.87E-02[a]
ERA	Copper	0.00E+00	8.18E-03	8.18E-03	0.00E+00	8.18E-02	8.18E-02	0.00E+00	2.43E-01	2.43E-01	4.00E-04	0.00E+00[c]	4.00E-04	0.00E+00	6.66E-02	3.14E-05	0.00E+00	1.68E-02	5.59E-06	0.00E+00	6.21E-08	2.45E-01[a]
ERA	Iron	0.00E+00	1.29E+01	1.29E+01	0.00E+00	1.29E+02	1.29E+02	0.00E+00	3.85E+02	3.85E+02	1.90E-02	0.00E+00[c]	1.90E-02	0.00E+00	1.05E+02	4.98E-02	0.00E+00	2.66E+01	8.85E-03	0.00E+00	9.84E-05	3.88E+02[a]
ERA	Lead	0.00E+00	1.11E-03	1.11E-03	0.00E+00	1.11E-02	1.11E-02	0.00E+00	3.31E-02	3.31E-02	0.00E+00	0.00E+00[c]	0.00E+00	0.00E+00	9.06E-03	4.28E-06	0.00E+00	2.29E-03	7.61E-07	0.00E+00	8.46E-09	3.34E-02[a]
ERA	Manganese	0.00E+00	6.23E-02	6.23E-02	0.00E+00	6.23E-01	6.23E-01	0.00E+00	1.85E+00	1.85E+00	3.30E-03	0.00E+00[c]	3.30E-03	0.00E+00	5.07E-01	2.39E-04	0.00E+00	1.28E-01	4.26E-05	0.00E+00	4.73E-07	1.87E+00[a]
ERA	Mercury	0.00E+00	1.13E-06	1.13E-06	0.00E+00	1.13E-05	1.13E-05	0.00E+00	3.36E-05	3.36E-05	2.00E-06	0.00E+00[c]	2.00E-06	0.00E+00	9.21E-06	4.35E-09	0.00E+00	2.33E-06	7.73E-10	0.00E+00	8.59E-12	3.39E-05[a]
ERA	Methyl Mercury	0.00E+00	2.26E-08	2.26E-08	0.00E+00	2.26E-07	2.26E-07	0.00E+00	6.72E-07	6.72E-07	1.00E-07	0.00E+00[c]	1.00E-07	0.00E+00	1.84E-07	8.69E-11	0.00E+00	4.65E-08	1.55E-11	0.00E+00	1.72E-13	6.79E-07[a]
ERA	Methyl Mercury2	0.00E+00	2.26E-08	2.26E-08	0.00E+00	2.26E-07	2.26E-07	0.00E+00	6.72E-07	6.72E-07	1.00E-07	0.00E+00[c]	1.00E-07	0.00E+00	1.84E-07	8.69E-11	0.00E+00	4.65E-08	1.55E-11	0.00E+00	1.72E-13	6.79E-07[a]
ERA	Nickel	0.00E+00	8.00E-03	8.00E-03	0.00E+00	8.00E-02	8.00E-02	0.00E+00	2.38E-01	2.38E-01	2.60E-03	0.00E+00[c]	2.60E-03	0.00E+00	6.51E-02	3.08E-05	0.00E+00	1.65E-02	5.47E-06	0.00E+00	6.08E-08	2.40E-01[a]
ERA	Selenium	0.00E+00	3.48E-05	3.48E-05	0.00E+00	3.48E-04	3.48E-04	0.00E+00	1.03E-03	1.03E-03	7.00E-05	0.00E+00[c]	7.00E-05	0.00E+00	2.83E-04	1.34E-07	0.00E+00	7.15E-05	2.38E-08	0.00E+00	2.64E-10	1.04E-03[a]
ERA	Thallium	0.00E+00	3.65E-05	3.65E-05	0.00E+00	3.65E-04	3.65E-04	0.00E+00	1.09E-03	1.09E-03	0.00E+00	0.00E+00[c]	0.00E+00	0.00E+00	2.97E-04	1.40E-07	0.00E+00	7.51E-05	2.50E-08	0.00E+00	2.78E-10	1.10E-03[a]
ERA	Zinc	0.00E+00	9.40E-03	9.40E-03	0.00E+00	9.40E-02	9.40E-02	0.00E+00	2.79E-01	2.79E-01	7.00E-04	0.00E+00[c]	7.00E-04	0.00E+00	7.65E-02	3.61E-05	0.00E+00	1.93E-02	6.42E-06	0.00E+00	7.14E-08	2.82E-01[a]
HHRA	Aluminum	0.00E+00	1.98E+00	1.98E+00	0.00E+00	1.98E+01	1.98E+01	0.00E+00	1.18E+01	1.18E+01	1.60E-02	0.00E+00[c]	1.60E-02	0.00E+00	3.54E+01	1.67E-02	0.00E+00	8.94E+00	2.97E-03	0.00E+00	1.50E-05	5.93E+01[b]
HHRA	Arsenic	0.00E+00	9.57E-03	9.57E-03	0.00E+00	9.57E-02	9.57E-02	0.00E+00	5.71E-02	5.71E-02	3.80E-03	0.00E+00[c]	3.80E-03	0.00E+00	1.71E-01	8.09E-05	0.00E+00	4.33E-02	1.44E-05	0.00E+00	7.27E-08	2.87E-01[b]
HHRA	Arsenic cancer	0.00E+00	9.57E-03	9.57E-03	0.00E+00	9.57E-02	9.57E-02	0.00E+00	5.71E-02	5.71E-02	3.80E-03	0.00E+00[c]	3.80E-03	0.00E+00	1.71E-01	8.09E-05	0.00E+00	4.33E-02	1.44E-05	0.00E+00	7.27E-08	2.87E-01[b]
HHRA	Cadmium	0.00E+00	4.98E-06	4.98E-06	0.00E+00	4.98E-05	4.98E-05	0.00E+00	2.97E-05	2.97E-05	0.00E+00	0.00E+00[c]	0.00E+00	0.00E+00	8.92E-05	4.21E-08	0.00E+00	2.25E-05	7.49E-09	0.00E+00	3.79E-11	1.49E-04[b]
HHRA	Chromium	0.00E+00	7.20E-03	7.20E-03	0.00E+00	7.20E-02	7.20E-02	0.00E+00	4.30E-02	4.30E-02	0.00E+00	0.00E+00[c]	0.00E+00	0.00E+00	1.29E-01	6.09E-05	0.00E+00	3.26E-02	1.08E-05	0.00E+00	5.47E-08	2.16E-01[b]
HHRA	Cobalt	0.00E+00	1.34E-03	1.34E-03	0.00E+00	1.34E-02	1.34E-02	0.00E+00	8.03E-03	8.03E-03	3.00E-05	0.00E+00[c]	3.00E-05	0.00E+00	2.41E-02	1.14E-05	0.00E+00	6.08E-03	2.02E-06	0.00E+00	1.02E-08	4.03E-02[b]
HHRA	Copper	0.00E+00	3.72E-03	3.72E-03	0.00E+00	3.72E-02	3.72E-02	0.00E+00	2.22E-02	2.22E-02	4.00E-04	0.00E+00[c]	4.00E-04	0.00E+00	6.66E-02	3.14E-05	0.00E+00	1.68E-02	5.59E-06	0.00E+00	2.82E-08	1.12E-01[b]
HHRA	Iron	0.00E+00	5.89E+00	5.89E+00	0.00E+00	5.89E+01	5.89E+01	0.00E+00	3.51E+01	3.51E+01	1.90E-02	0.00E+00[c]	1.90E-02	0.00E+00	1.05E+02	4.98E-02	0.00E+00	2.66E+01	8.85E-03	0.00E+00	4.47E-05	1.77E+02[b]
HHRA	Lead	0.00E+00	5.06E-04	5.06E-04	0.00E+00	5.06E-03	5.06E-03	0.00E+00	3.02E-03	3.02E-03	0.00E+00	0.00E+00[c]	0.00E+00	0.00E+00	9.06E-03	4.28E-06	0.00E+00	2.29E-03	7.61E-07	0.00E+00	3.85E-09	1.52E-02[b]
HHRA	Manganese	0.00E+00	2.83E-02	2.83E-02	0.00E+00	2.83E-01	2.83E-01	0.00E+00	1.69E-01	1.69E-01	3.30E-03	0.00E+00[c]	3.30E-03	0.00E+00	5.07E-01	2.39E-04	0.00E+00	1.28E-01	4.26E-05	0.00E+00	2.15E-07	8.49E-01[b]
HHRA	Mercury	0.00E+00	5.14E-07	5.14E-07	0.00E+00	5.14E-06	5.14E-06	0.00E+00	3.07E-06	3.07E-06	2.00E-06	0.00E+00[c]	2.00E-06	0.00E+00	9.21E-06	4.35E-09	0.00E+00	2.33E-06	7.73E-10	0.00E+00	3.91E-12	1.54E-05[b]

Site	Chemical	Baseline Soil	Deposition Soil	Total Soil	Surface Soil	Deposition Surface Soil	Total Surface Soil	Sediment	Deposition Sediment	Total Sediment	Baseline Goose Lake_SW	Deposition Goose Lake_SW	Total Goose Lake_SW	Baseline Fox Lake_SW	Deposition Fox Lake_SW	Total Fox Lake_SW	Big Lake_SW	Deposition Big Lake_SW	Total Big Lake_SW	Total Marine_SW	Dust	Deposition
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/L	mg/m2/yr	mg/L	mg/L	mg/m2/yr	mg/L	mg/L	mg/m2/yr	mg/L	mg/L	ug/m3	mg/m2/yr
HHRA	Methyl Mercury	0.00E+00	1.03E-08	1.03E-08	0.00E+00	1.03E-07	1.03E-07	0.00E+00	6.14E-08	6.14E-08	1.00E-07	0.00E+00[c]	1.00E-07	0.00E+00	1.84E-07	8.69E-11	0.00E+00	4.65E-08	1.55E-11	0.00E+00	7.81E-14	3.08E-07[b]
HHRA	Methyl Mercury2	0.00E+00	1.03E-08	1.03E-08	0.00E+00	1.03E-07	1.03E-07	0.00E+00	6.14E-08	6.14E-08	1.00E-07	0.00E+00[c]	1.00E-07	0.00E+00	1.84E-07	8.69E-11	0.00E+00	4.65E-08	1.55E-11	0.00E+00	7.81E-14	3.08E-07[b]
HHRA	Nickel	0.00E+00	3.64E-03	3.64E-03	0.00E+00	3.64E-02	3.64E-02	0.00E+00	2.17E-02	2.17E-02	2.60E-03	0.00E+00[c]	2.60E-03	0.00E+00	6.51E-02	3.08E-05	0.00E+00	1.65E-02	5.47E-06	0.00E+00	2.76E-08	1.09E-01[b]
HHRA	Selenium	0.00E+00	1.58E-05	1.58E-05	0.00E+00	1.58E-04	1.58E-04	0.00E+00	9.44E-05	9.44E-05	7.00E-05	0.00E+00[c]	7.00E-05	0.00E+00	2.83E-04	1.34E-07	0.00E+00	7.15E-05	2.38E-08	0.00E+00	1.20E-10	4.75E-04[b]
HHRA	Thallium	0.00E+00	1.66E-05	1.66E-05	0.00E+00	1.66E-04	1.66E-04	0.00E+00	9.91E-05	9.91E-05	0.00E+00	0.00E+00[c]	0.00E+00	0.00E+00	2.97E-04	1.40E-07	0.00E+00	7.51E-05	2.50E-08	0.00E+00	1.26E-10	4.98E-04[b]
HHRA	Zinc	0.00E+00	4.27E-03	4.27E-03	0.00E+00	4.27E-02	4.27E-02	0.00E+00	2.55E-02	2.55E-02	7.00E-04	0.00E+00[c]	7.00E-04	0.00E+00	7.65E-02	3.61E-05	0.00E+00	1.93E-02	6.42E-06	0.00E+00	3.25E-08	1.28E-01[b]

Notes:

a. Average deposition (0.143 mg/dm2/day)inside PDA used to predict vegetation and soil impacts (from RWDI, 2015)

b. Max deposition (0.065 mg/dm2/day) outside PDA used to predict vegetation and soil impacts (from RWDI, 2015)

c. Deposition for Goose Lake considered separately as mine contact water/dust and run-off as well as effluent contributions from water treatment features in water quality modelling conducted by SRK (SRK, 2015)

VB-6B-Table 2a: Summary of Baseline and Predicted Future Increments in Environmental Media for Baseline Scenarios: Vegetation

Scenario	Site	Chemical	Environmental Concentrations - Baseline								
			Lichen Deposition mg/kg ww	Lichen Soil mg/kg ww	Lichen Total mg/kg ww	Berries Deposition mg/kg ww	Berries Soil mg/kg ww	Berries SUM mg/kg ww	Sedge Deposition mg/kg ww	Sedge Soil mg/kg ww	Sedge SUM mg/kg ww
Baseline	ERA	Aluminum	0.00E+00	6.88E+02	6.88E+02	0.00E+00	1.45E+01	1.45E+01	0.00E+00	1.00E+00	1.00E+00
Baseline	ERA	Arsenic	0.00E+00	4.80E-01	4.80E-01	0.00E+00	5.00E-02	5.00E-02	0.00E+00	1.77E-01	1.77E-01
Baseline	ERA	Arsenic_cancer	0.00E+00	4.80E-01	4.80E-01	0.00E+00	5.00E-02	5.00E-02	0.00E+00	1.77E-01	1.77E-01
Baseline	ERA	Cadmium	0.00E+00	6.00E-02	6.00E-02	0.00E+00	2.00E-02	2.00E-02	0.00E+00	1.41E-02	1.41E-02
Baseline	ERA	Chromium	0.00E+00	6.40E-01	6.40E-01	0.00E+00	1.30E-01	1.30E-01	0.00E+00	5.00E-02	5.00E-02
Baseline	ERA	Cobalt	0.00E+00	3.73E+00	3.73E+00	0.00E+00	5.00E-02	5.00E-02	0.00E+00	7.80E-02	7.80E-02
Baseline	ERA	Copper	0.00E+00	4.62E+00	4.62E+00	0.00E+00	1.22E+00	1.22E+00	0.00E+00	3.77E+00	3.77E+00
Baseline	ERA	Iron	0.00E+00	6.06E+02	6.06E+02	0.00E+00	2.00E+01	2.00E+01	0.00E+00	5.05E+02	5.05E+02
Baseline	ERA	Lead	0.00E+00	1.34E+00	1.34E+00	0.00E+00	1.00E-02	1.00E-02	0.00E+00	2.73E-02	2.73E-02
Baseline	ERA	Manganese	0.00E+00	7.69E+01	7.69E+01	0.00E+00	5.38E+01	5.38E+01	0.00E+00	7.47E+01	7.47E+01
Baseline	ERA	Mercury	0.00E+00	6.27E-02	6.27E-02	0.00E+00	5.00E-04	5.00E-04	0.00E+00	1.90E-03	1.90E-03
Baseline	ERA	Methyl Mercury	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Baseline	ERA	Methyl Mercury2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Baseline	ERA	Nickel	0.00E+00	1.27E+01	1.27E+01	0.00E+00	5.10E-02	5.10E-02	0.00E+00	3.49E+00	3.49E+00
Baseline	ERA	Selenium	0.00E+00	5.00E-03	5.00E-03	0.00E+00	5.00E-03	5.00E-03	0.00E+00	5.00E-03	5.00E-03
Baseline	ERA	Thallium	0.00E+00	2.32E-05	2.32E-05	0.00E+00	2.32E-05	2.32E-05	0.00E+00	1.20E-02	1.20E-02
Baseline	ERA	Zinc	0.00E+00	1.94E+01	1.94E+01	0.00E+00	5.27E+00	5.27E+00	0.00E+00	1.72E+01	1.72E+01
Baseline	HHRA	Aluminum	0.00E+00	6.88E+02	6.88E+02	0.00E+00	1.45E+01	1.45E+01	0.00E+00	1.00E+00	1.00E+00
Baseline	HHRA	Arsenic	0.00E+00	4.80E-01	4.80E-01	0.00E+00	5.00E-02	5.00E-02	0.00E+00	1.77E-01	1.77E-01
Baseline	HHRA	Arsenic_cancer	0.00E+00	4.80E-01	4.80E-01	0.00E+00	5.00E-02	5.00E-02	0.00E+00	1.77E-01	1.77E-01
Baseline	HHRA	Cadmium	0.00E+00	6.00E-02	6.00E-02	0.00E+00	2.00E-02	2.00E-02	0.00E+00	1.41E-02	1.41E-02
Baseline	HHRA	Chromium	0.00E+00	6.40E-01	6.40E-01	0.00E+00	1.30E-01	1.30E-01	0.00E+00	5.00E-02	5.00E-02
Baseline	HHRA	Cobalt	0.00E+00	3.73E+00	3.73E+00	0.00E+00	5.00E-02	5.00E-02	0.00E+00	7.80E-02	7.80E-02
Baseline	HHRA	Copper	0.00E+00	4.62E+00	4.62E+00	0.00E+00	1.22E+00	1.22E+00	0.00E+00	3.77E+00	3.77E+00
Baseline	HHRA	Iron	0.00E+00	6.06E+02	6.06E+02	0.00E+00	2.00E+01	2.00E+01	0.00E+00	5.05E+02	5.05E+02
Baseline	HHRA	Lead	0.00E+00	1.34E+00	1.34E+00	0.00E+00	1.00E-02	1.00E-02	0.00E+00	2.73E-02	2.73E-02
Baseline	HHRA	Manganese	0.00E+00	7.69E+01	7.69E+01	0.00E+00	5.38E+01	5.38E+01	0.00E+00	7.47E+01	7.47E+01
Baseline	HHRA	Mercury	0.00E+00	6.27E-02	6.27E-02	0.00E+00	5.00E-04	5.00E-04	0.00E+00	1.90E-03	1.90E-03
Baseline	HHRA	Methyl Mercury	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Baseline	HHRA	Methyl Mercury2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Baseline	HHRA	Nickel	0.00E+00	1.27E+01	1.27E+01	0.00E+00	5.10E-02	5.10E-02	0.00E+00	3.49E+00	3.49E+00
Baseline	HHRA	Selenium	0.00E+00	5.00E-03	5.00E-03	0.00E+00	5.00E-03	5.00E-03	0.00E+00	5.00E-03	5.00E-03
Baseline	HHRA	Thallium	0.00E+00	2.32E-05	2.32E-05	0.00E+00	2.32E-05	2.32E-05	0.00E+00	1.20E-02	1.20E-02
Baseline	HHRA	Zinc	0.00E+00	1.94E+01	1.94E+01	0.00E+00	5.27E+00	5.27E+00	0.00E+00	1.72E+01	1.72E+01

VB-6B-Table 2b: Summary of Baseline and Predicted Future Increments in Environmental Media for Project Scenarios: Vegetation

Scenario	Site	Chemical	Environmental Concentrations - Project Increment								
			Lichen Deposition mg/kg ww	Lichen Soil mg/kg ww	Lichen Total mg/kg ww	Berries Deposition mg/kg ww	Berries Soil mg/kg ww	Berries SUM mg/kg ww	Sedge Deposition mg/kg ww	Sedge Soil mg/kg ww	Sedge SUM mg/kg ww
Project	ERA	Aluminum	9.03E-01	5.86E-01	1.49E+00	2.75E+00	1.24E-02	2.76E+00	3.33E-01	8.51E-04	3.34E-01
Project	ERA	Arsenic_cancer	4.37E-03	1.95E-03	6.32E-03	1.33E-02	2.04E-04	1.35E-02	1.61E-03	7.21E-04	2.33E-03
Project	ERA	Cadmium	2.27E-06	1.22E-05	1.45E-05	6.93E-06	4.06E-06	1.10E-05	8.39E-07	2.86E-06	3.70E-06
Project	ERA	Chromium	3.29E-03	5.93E-04	3.88E-03	1.00E-02	1.20E-04	1.01E-02	1.21E-03	4.63E-05	1.26E-03
Project	ERA	Cobalt	6.14E-04	2.52E-03	3.13E-03	1.87E-03	3.38E-05	1.91E-03	2.26E-04	5.27E-05	2.79E-04
Project	ERA	Copper	1.70E-03	3.22E-03	4.92E-03	5.17E-03	8.51E-04	6.02E-03	6.26E-04	2.63E-03	3.26E-03
Project	ERA	Iron	2.69E+00	7.77E-01	3.46E+00	8.19E+00	2.56E-02	8.22E+00	9.91E-01	6.47E-01	1.64E+00
Project	ERA	Lead	2.31E-04	5.78E-04	8.09E-04	7.05E-04	4.32E-06	7.09E-04	8.52E-05	1.18E-05	9.70E-05
Project	ERA	Manganese	1.29E-02	5.74E-02	7.04E-02	3.94E-02	4.02E-02	7.96E-02	4.77E-03	5.58E-02	6.06E-02
Project	ERA	Mercury	2.35E-07	8.86E-06	9.10E-06	7.16E-07	7.07E-08	7.86E-07	8.66E-08	2.69E-07	3.55E-07
Project	ERA	Methyl Mercury	4.69E-09	0.00E+00	4.69E-09	1.43E-08	0.00E+00	1.43E-08	1.73E-09	0.00E+00	1.73E-09
Project	ERA	Methyl Mercury2	4.69E-09	0.00E+00	4.69E-09	1.43E-08	0.00E+00	1.43E-08	1.73E-09	0.00E+00	1.73E-09
Project	ERA	Nickel	1.66E-03	8.92E-03	1.06E-02	5.06E-03	3.58E-05	5.10E-03	6.13E-04	2.45E-03	3.06E-03
Project	ERA	Selenium	7.22E-06	1.74E-06	8.96E-06	2.20E-05	1.74E-06	2.38E-05	2.66E-06	1.74E-06	4.40E-06
Project	ERA	Thallium	7.58E-06	1.46E-08	7.60E-06	2.31E-05	1.46E-08	2.31E-05	2.80E-06	7.56E-06	1.04E-05
Project	ERA	Zinc	1.95E-03	1.20E-02	1.39E-02	5.94E-03	3.26E-03	9.20E-03	7.19E-04	1.06E-02	1.14E-02
Project	HHRA	Aluminum	4.10E-01	2.66E-01	6.77E-01	1.25E+00	5.62E-03	1.26E+00	1.51E-01	3.87E-04	1.52E-01
Project	HHRA	Arsenic	1.99E-03	8.88E-04	2.87E-03	6.05E-03	9.25E-05	6.15E-03	7.33E-04	3.28E-04	1.06E-03
Project	HHRA	Arsenic_cancer	1.99E-03	8.88E-04	2.87E-03	6.05E-03	9.25E-05	6.15E-03	7.33E-04	3.28E-04	1.06E-03
Project	HHRA	Cadmium	1.03E-06	5.54E-06	6.57E-06	3.15E-06	1.85E-06	5.00E-06	3.81E-07	1.30E-06	1.68E-06
Project	HHRA	Chromium	1.49E-03	2.69E-04	1.76E-03	4.55E-03	5.47E-05	4.61E-03	5.51E-04	2.10E-05	5.72E-04
Project	HHRA	Cobalt	2.79E-04	1.14E-03	1.42E-03	8.51E-04	1.53E-05	8.66E-04	1.03E-04	2.39E-05	1.27E-04
Project	HHRA	Copper	7.71E-04	1.47E-03	2.24E-03	2.35E-03	3.87E-04	2.74E-03	2.85E-04	1.20E-03	1.48E-03
Project	HHRA	Iron	1.22E+00	3.53E-01	1.57E+00	3.72E+00	1.16E-02	3.74E+00	4.51E-01	2.94E-01	7.45E-01
Project	HHRA	Lead	1.05E-04	2.63E-04	3.68E-04	3.20E-04	1.96E-06	3.22E-04	3.87E-05	5.36E-06	4.41E-05
Project	HHRA	Manganese	5.88E-03	2.61E-02	3.20E-02	1.79E-02	1.83E-02	3.62E-02	2.17E-03	2.54E-02	2.75E-02
Project	HHRA	Mercury	1.07E-07	4.03E-06	4.14E-06	3.25E-07	3.21E-08	3.57E-07	3.94E-08	1.22E-07	1.61E-07
Project	HHRA	Methyl Mercury	2.13E-09	0.00E+00	2.13E-09	6.50E-09	0.00E+00	6.50E-09	7.87E-10	0.00E+00	7.87E-10
Project	HHRA	Methyl Mercury2	2.13E-09	0.00E+00	2.13E-09	6.50E-09	0.00E+00	6.50E-09	7.87E-10	0.00E+00	7.87E-10
Project	HHRA	Nickel	7.55E-04	4.06E-03	4.81E-03	2.30E-03	1.63E-05	2.32E-03	2.79E-04	1.11E-03	1.39E-03
Project	HHRA	Selenium	3.28E-06	7.91E-07	4.07E-06	1.00E-05	7.91E-07	1.08E-05	1.21E-06	7.91E-07	2.00E-06
Project	HHRA	Thallium	3.45E-06	6.64E-09	3.45E-06	1.05E-05	6.64E-09	1.05E-05	1.27E-06	3.44E-06	4.71E-06
Project	HHRA	Zinc	8.86E-04	5.44E-03	6.33E-03	2.70E-03	1.48E-03	4.18E-03	3.27E-04	4.84E-03	5.17E-03

V8-6B-Table3: Bio-concentration Factors for the HHRA and ERA (wet weight (ww) basis)

Media	Chemical	UF	Comment
Berries	Aluminum	2.84E-03	Site-specific
Berries	Arsenic	9.67E-03	Site-specific
Berries	Arsenic_cancer	9.67E-03	Site-specific
Berries	Cadmium	3.70E-01	Site-specific
Berries	Chromium	7.60E-03	Site-specific
Berries	Cobalt	1.14E-02	Site-specific
Berries	Copper	1.04E-01	Site-specific
Berries	Iron	1.98E-03	Site-specific
Berries	Lead	3.88E-03	Baseline non-detect <0.01; But used BCF based on DL as BCF from Staven et al 2003 higher
Berries	Manganese	6.45E-01	Site-specific
Berries	Mercury	6.25E-02	Baseline non-detect <0.0005; But used BCF based on DL as BCF from Staven et al 2003 higher
Berries	Methyl Mercury	0.00E+00	Not available
Berries	Methyl Mercury2	0.00E+00	Not available
Berries	Nickel	4.48E-03	Site-specific
Berries	Selenium	5.00E-02	Baseline non-detect <0.1; Used Berries BCF from Staven et al 2003
Berries	Thallium	4.00E-04	Baseline non-detect <0.005; Used Berries BCF from Staven et al 2003
Berries	Zinc	3.47E-01	Site-specific
Freshwater_Fish	Aluminum	8.80E+01	Site-specific
Freshwater_Fish	Arsenic	1.06E+02	Site-specific
Freshwater_Fish	Arsenic_cancer	1.06E+02	Site-specific
Freshwater_Fish	Cadmium	2.50E+02	Site-specific
Freshwater_Fish	Chromium	4.33E+02	Site-specific
Freshwater_Fish	Cobalt	2.22E+01	Site-specific
Freshwater_Fish	Copper	1.32E+02	Site-specific
Freshwater_Fish	Iron	2.00E+02	Staven et al 2003
Freshwater_Fish	Lead	2.23E+02	Site-specific
Freshwater_Fish	Manganese	1.35E+01	Site-specific
Freshwater_Fish	Mercury	1.51E+02	Site-specific; Assumed 5% of total inorganic
Freshwater_Fish	Methyl Mercury	1.02E+06	Site-specific
Freshwater_Fish	Methyl Mercury2	1.02E+06	Site-specific
Freshwater_Fish	Nickel	9.35E+00	Site-specific
Freshwater_Fish	Selenium	4.00E+03	Site-specific
Freshwater_Fish	Thallium	1.40E+02	Site-specific
Freshwater_Fish	Zinc	1.85E+03	Site-specific
Goose_Fish	Aluminum	9.09E+01	Site-specific
Goose_Fish	Arsenic	1.45E+02	Site-specific
Goose_Fish	Arsenic_cancer	1.45E+02	Site-specific
Goose_Fish	Cadmium	2.50E+02	Site-specific
Goose_Fish	Chromium	9.33E+02	Site-specific
Goose_Fish	Cobalt	8.33E+01	Site-specific
Goose_Fish	Copper	2.33E+02	Site-specific
Goose_Fish	Iron	2.00E+02	Staven et al 2003
Goose_Fish	Lead	3.08E+03	Site-specific
Goose_Fish	Manganese	5.63E+01	Site-specific
Goose_Fish	Mercury	9.63E+01	Site-specific; Assumed 5% of total inorganic
Goose_Fish	Methyl Mercury	6.53E+05	Site-specific
Goose_Fish	Methyl Mercury2	6.53E+05	Site-specific
Goose_Fish	Nickel	2.15E+01	Site-specific
Goose_Fish	Selenium	3.67E+03	Site-specific
Goose_Fish	Thallium	1.60E+02	Site-specific
Goose_Fish	Zinc	1.43E+03	Site-specific
Lichen	Aluminum	1.35E-01	Site-specific
Lichen	Arsenic	9.28E-02	Site-specific
Lichen	Arsenic_cancer	9.28E-02	Site-specific
Lichen	Cadmium	1.11E+00	Site-specific
Lichen	Chromium	3.74E-02	Site-specific
Lichen	Cobalt	8.52E-01	Site-specific
Lichen	Copper	3.94E-01	Site-specific
Lichen	Iron	6.00E-02	Site-specific
Lichen	Lead	5.19E-01	Site-specific
Lichen	Manganese	9.22E-01	Site-specific

Media	Chemical	UF	Comment
Lichen	Mercury	7.84E+00	Site-specific
Lichen	Methyl Mercury	0.00E+00	Not assessed
Lichen	Methyl Mercury2	0.00E+00	Not assessed
Lichen	Nickel	1.12E+00	Site-specific
Lichen	Selenium	5.00E-02	Baseline non-detect <0.4; Used Berries BCF from Staven et al 2003
Lichen	Thallium	4.00E-04	Baseline non-detect <0.02; Used Berries BCF from Staven et al 2003
Lichen	Zinc	1.27E+00	Site-specific
Marine_Fish	Aluminum	1.37E+02	Site-specific
Marine_Fish	Arsenic	2.01E+03	Site-specific
Marine_Fish	Arsenic_cancer	2.01E+03	Site-specific
Marine_Fish	Cadmium	4.13E+01	Site-specific
Marine_Fish	Chromium	5.74E+01	Site-specific
Marine_Fish	Cobalt	0.00E+00	Not assessed
Marine_Fish	Copper	4.07E+02	Site-specific
Marine_Fish	Iron	3.00E+03	Staven et al 2003
Marine_Fish	Lead	6.45E+01	Site-specific
Marine_Fish	Manganese	0.00E+00	Not assessed
Marine_Fish	Mercury	5.25E+02	Site-specific; Assumed 5% of total inorganic
Marine_Fish	Methyl Mercury	1.78E+05	Site-specific
Marine_Fish	Methyl Mercury2	1.78E+05	Site-specific
Marine_Fish	Nickel	4.66E+01	Site-specific
Marine_Fish	Selenium	3.94E+02	Site-specific
Marine_Fish	Thallium	7.22E+01	Site-specific
Marine_Fish	Zinc	1.23E+03	Site-specific
Mussels	Aluminum	4.51E+03	Site-specific
Mussels	Arsenic	2.32E+03	Site-specific
Mussels	Arsenic_cancer	2.32E+03	Site-specific
Mussels	Cadmium	2.90E+04	Site-specific
Mussels	Chromium	8.20E+02	Site-specific
Mussels	Cobalt	3.49E+03	Site-specific
Mussels	Copper	2.39E+03	Site-specific
Mussels	Iron	2.70E+03	Site-specific
Mussels	Lead	1.17E+03	Site-specific
Mussels	Manganese	1.28E+03	Site-specific
Mussels	Mercury	1.32E+01	Site-specific; Assumed 5% of total inorganic
Mussels	Methyl Mercury	8.95E+04	Site-specific
Mussels	Methyl Mercury2	8.95E+04	Site-specific
Mussels	Nickel	6.68E+02	Site-specific
Mussels	Selenium	1.06E+03	Site-specific
Mussels	Thallium	6.10E+01	Site-specific
Mussels	Zinc	3.75E+03	Site-specific
Sedge	Aluminum	1.96E-04	Baseline non-detect <1; However BCF from Staven et al 2003 unavailable
Sedge	Arsenic	3.42E-02	Site-specific
Sedge	Arsenic_cancer	3.42E-02	Site-specific
Sedge	Cadmium	2.61E-01	Site-specific
Sedge	Chromium	2.92E-03	Baseline non-detect <0.05; But used BCF based on DL as BCF from Staven et al 2003 higher
Sedge	Cobalt	1.78E-02	Site-specific
Sedge	Copper	3.22E-01	Site-specific
Sedge	Iron	5.00E-02	Staven et al 2003
Sedge	Lead	1.06E-02	Site-specific
Sedge	Manganese	8.96E-01	Site-specific
Sedge	Mercury	2.38E-01	Site-specific
Sedge	Methyl Mercury	0.00E+00	Not assessed
Sedge	Methyl Mercury2	0.00E+00	Not assessed
Sedge	Nickel	3.06E-01	Site-specific
Sedge	Selenium	5.00E-02	Baseline non-detect <0.1; Used Berries BCF from Staven et al 2003
Sedge	Thallium	2.07E-01	Site-specific
Sedge	Zinc	1.13E+00	Site-specific

V8-6B-Table 4: Predicted Deposition Rates for COPC Based on Air Quality Predictions (mg/m^2/year)

Chemical	Location	Average deposition Rate in PDA (ERA Scenario)	Maximum Outside of PDA (HHRA Scenario)	Average Deposition Rate for Big Lake	Average Deposition Rate for Fox Lake	Average Deposition Rate for Rascal Lake	Max Deposition Rate Outside PDA (MLA-MAX)
	Predicted loading from air quality (mg/dm^2/d)	1.43E-01	6.50E-02	9.80E-03	3.88E-02	9.60E-02	5.50E-03
	Converted deposition (mg/m^2/year)[a]	5.22E+03	2.37E+03	3.58E+02	1.42E+03	3.50E+03	2.01E+02
	Percent Composition Geochemistry[c]	Chemical Deposition (mg/m^2/year)[b]	Chemical Deposition (mg/m^2/year)	Chemical Deposition (mg/m^2/year)	Chemical Deposition (mg/m^2/year)	Chemical Deposition (mg/m^2/year)	Chemical Deposition (mg/m^2/year)
Aluminum	2.5%	1.30E+02	5.93E+01	8.94E+00	3.54E+01	8.76E+01	5.02E+00
Arsenic	0.0121%	6.32E-01	2.87E-01	4.33E-02	1.71E-01	4.24E-01	2.43E-02
Arsenic_cancer	0.0121%	6.32E-01	2.87E-01	4.33E-02	1.71E-01	4.24E-01	2.43E-02
Cadmium	0.0000063%	3.29E-04	1.49E-04	2.25E-05	8.92E-05	2.21E-04	1.26E-05
Chromium	0.0091%	4.75E-01	2.16E-01	3.26E-02	1.29E-01	3.19E-01	1.83E-02
Cobalt	0.0017%	8.87E-02	4.03E-02	6.08E-03	2.41E-02	5.96E-02	3.41E-03
Copper	0.0047%	2.45E-01	1.12E-01	1.68E-02	6.66E-02	1.65E-01	9.44E-03
Iron	7.442%	3.88E+02	1.77E+02	2.66E+01	1.05E+02	2.61E+02	1.49E+01
Lead	0.00064%	3.34E-02	1.52E-02	2.29E-03	9.06E-03	2.24E-02	1.28E-03
Manganese	0.0358%	1.87E+00	8.49E-01	1.28E-01	5.07E-01	1.25E+00	7.19E-02
Mercury	0.00000065%	3.39E-05	1.54E-05	2.33E-06	9.21E-06	2.28E-05	1.30E-06
Methyl Mercury	0.000000013%[d]	6.79E-07	3.08E-07	4.65E-08	1.84E-07	4.56E-07	2.61E-08
Methyl Mercury2	0.000000013%[d]	6.79E-07	3.08E-07	4.65E-08	1.84E-07	4.56E-07	2.61E-08
Nickel	0.0046%	2.40E-01	1.09E-01	1.65E-02	6.51E-02	1.61E-01	9.23E-03
Selenium	0.000020%	1.04E-03	4.75E-04	7.15E-05	2.83E-04	7.01E-04	4.02E-05
Thallium	0.000021%	1.10E-03	4.98E-04	7.51E-05	2.97E-04	7.36E-04	4.22E-05
Zinc	0.0054%	2.82E-01	1.28E-01	1.93E-02	7.65E-02	1.89E-01	1.08E-02

Notes:

*a. Example calculation for converted deposition: predicted loading from air deposition multiplied by 100 and 365 days (1.43E-01mg/dm^2/d * 100 * 365days = 5.22E+03mg/m^2/year)*

*b. Example calculation for chemical deposition: percent composition is multiplied by converted deposition (5.22E+03mg/m^2/year3*0.025 = 1.3E+02mg/m^2/year)*

c. See Appendix V8-6A for additional details on geochemistry data used to characterize metals concetrations

d. Assumed 2% of deposited total mercury converted to MeHg (US EPA 2005)

V8-6B-Table 5a: Summary of Exposure Point Concentrations (EPC)

Chemical	Area	Media Specific Concentrations Based on 95UCLM unless otherwise noted								
		Soil [mg/kg]	Lake Sediment [mg/kg]	Stream Sediment [mg/kg]	Marine Sediment [mg/kg]	Wetland Sediment [mg/kg]	Lake Surface Water [mg/L]	Goose Surface Water [mg/L][e]	Stream Surface Water [mg/L]	Marine Surface Water [mg/L]
Aluminum	Goose	5110	9888	8729	11666	5608	0.0216	0.011	0.043	0.0649
Arsenic	Goose	5.17	23.7	10.3	6.21	16.9	0.00034	0.0002	0.000346	<0.001[b]
Arsenic_cancer	Goose	5.17	23.7	10.3	6.21	16.9	0.00034	0.0002	0.000346	<0.001[b]
Cadmium	Goose	0.054[c]	0.367	0.113	0.057[c]	0.344	0.00001	0.00001	0.00003	0.000082
Chromium	Goose	17.1	29.4	27.9	31.2	15	0.0003	0.00015	0.00027	0.00086
Cobalt	Goose	4.38	20.4	16.61	7.1	21.01	0.00045	0.00012	0.00163	0.000079
Copper	Goose	11.72	82.5		14.5	47.8	0.00232	0.0014	0.00197	0.0009
Iron	Goose	10101	24489	18106	17728	10529	0.09021	0.014	0.127	0.089
Lead	Goose	2.58	5.38	3.41	6.5	3.53	0.0004	0.00005	0.000262[c]	0.00033
Manganese	Goose	83.4	165	757	171.2	87.5	0.00932	0.0019	0.01158	0.00316
Mercury	Goose	0.008	0.0599	0.0187	0.01	0.106	0.000005[c]	0.00001	0.000005[b]	<0.000005[b]
Methyl Mercury	Goose	NDA	NDA	NDA	NDA	NDA	0.000000295[d]	0.00000059[d]	0.000000295[d]	0.000000295[d]
Methyl Mercury2	Goose	NDA	NDA	NDA	NDA	NDA	0.000000295[d]	0.00000059[d]	0.000000295[d]	0.000000295[d]
Nickel	Goose	11.39	71.1	31.8	17.49	57.7	0.00642	0.0033	0.01065	0.00106
Selenium	Goose	<0.1[b]	0.46	0.66[c]	0.24[c]	0.48	0.0001	0.0001	0.00005[b]	<0.001[b]
Thallium	Goose	0.058[c]	0.105	0.17	0.106[c]	0.076	0.00005	0.00005	0.00005[b]	0.000041
Zinc	Goose	15.2	76	36.2	34.6	28.4	0.00261	0.003	0.0046	0.0053

Notes: NDA: No data available

a. All baseline values are from measured data collected by Rescan (see baseline data reports). A summary of baseline data can be found in Appendix B of Intrinsik (2015) Appendix V8-5B.

b. Value provided is based on the detection limit.

c. Value provided is the maximum concentration.

d. Assumed MeHg 5.9% of THg

e. Based on median value for Goose Lake, as provided by SRK (Appendix V2-7H)

V8-6B-Table 5b: Summary of Exposure Point Concentrations (EPC)

Chemical	Area	Media Specific Concentrations Based on 95UCLM unless otherwise noted						
		Lichen [mg/kg-ww]	Berries [mg/kg-ww]	Sedge [mg/kg-ww]	Freshwater Fish [mg/kg ww]	Goose Fish [mg/kg ww]	Marine Fish [mg/kg-ww]	Mussels [mg/kg-ww]
Aluminum	Goose	688	14.52	<1[b]	1.9	<1[b]	8.89[e]	293
Arsenic	Goose	0.48	0.05[c]	0.177	0.036	0.029	2.01[e]	2.32
Arsenic_cancer	Goose	0.48	0.05	0.177	0.036	0.029	2.01[e]	2.32
Cadmium	Goose	0.06	0.02	0.0141	0.0025	<0.0025[b]	0.00339[e]	2.38
Chromium	Goose	0.64	0.13[c]	<0.05[b]	0.13	0.14	0.0494[e]	0.705
Cobalt	Goose	3.73	0.05	0.078	0.01	<0.01[b]	NDA	0.276
Copper	Goose	4.62	1.22	3.77	0.307	0.326	0.366[e]	2.15
Iron	Goose	606	19.98	NDA	NDA	NDA	NDA	240
Lead	Goose	1.34	<0.01[b]	0.0273	0.089	0.154	0.0213[e]	0.387
Manganese	Goose	76.9	53.8	74.7	0.126	0.107	NA	4.03
Mercury	Goose	0.0627	<0.0005[b]	0.0019	0.01505[d]	0.01925[d]	0.0525[e]	0.00132[e]
Methyl Mercury	Goose	NDA	NDA	NDA	0.301	0.385	0.0525[e]	0.0264
Methyl Mercury2	Goose	NDA	NDA	NDA	0.301	0.385	0.0525[e]	0.0264
Nickel	Goose	12.7	0.051	3.49	0.06	0.071	0.0494[e]	0.708
Selenium	Goose	<0.4[b]	<0.1[b]	<0.1[b]	0.4	0.367	0.394[e]	1.062
Thallium	Goose	<0.02[b]	<0.005[b]	0.012	0.007	0.008	0.00296[e]	0.0025
Zinc	Goose	19.36	5.27	17.23	4.84	4.28	6.5[e]	19.9

Notes: *NDA: No Data Available*

a. All baseline values were collected by ERM. A summary of baseline data can be found in Appendix B of Intrinsik (2015) V8-5B.

b. Value provided is based on the detection limit.

c. Value provided is the maximum concentration.

d. Total mercury was assumed to equal methyl mercury in fish; inorganic Mercury concentration was assumed to be 5% of THg

e. Based on 2006 concentrations (Rescan). See baseline data volume

V8-6B-Table 6: Summary of Predicted Site-specific Bio-concentration factors (BCF)

Chemical	Area	Project-Specific BCFs						
		Lichen[a]	Berries[a]	Sedge[a]	Freshwater Fish[b]	Goose Fish[c]	Marine Fish[d]	Mussels[e]
Aluminum	Goose	1.35E-01	2.84E-03	1.96E-04	8.80E+01	9.09E+01	1.37E+02	4.51E+03
Arsenic	Goose	9.28E-02	9.67E-03	3.42E-02	1.06E+02	1.45E+02	2.01E+03	2.32E+03
Arsenic_cancer	Goose	9.28E-02	9.67E-03	3.42E-02	1.06E+02	1.45E+02	2.01E+03	2.32E+03
Cadmium	Goose	1.11E+00	3.70E-01	2.61E-01	2.50E+02	2.50E+02	4.13E+01	2.90E+04
Chromium	Goose	3.74E-02	7.60E-03	2.92E-03	4.33E+02	9.33E+02	5.74E+01	8.20E+02
Cobalt	Goose	8.52E-01	1.14E-02	1.78E-02	2.22E+01	8.33E+01	NDA	3.49E+03
Copper	Goose	3.94E-01	1.04E-01	3.22E-01	1.32E+02	2.33E+02	4.07E+02	2.39E+03
Iron	Goose	6.00E-02	1.98E-03	NDA	NDA	NDA	NDA	2.70E+03
Lead	Goose	5.19E-01	3.88E-03	1.06E-02	2.23E+02	3.08E+03	6.45E+01	1.17E+03
Manganese	Goose	9.22E-01	6.45E-01	8.96E-01	1.35E+01	5.63E+01	NDA	1.28E+03
Mercury	Goose	7.84E+00	6.25E-02	2.38E-01	3.01E+03	1.93E+03	1.05E+04	2.64E+02
Methyl Mercury	Goose	NDA	NDA	NDA	1.02E+06	6.53E+05	1.78E+05	8.95E+04
Methyl Mercury2	Goose	NDA	NDA	NDA	1.02E+06	6.53E+05	1.78E+05	8.95E+04
Nickel	Goose	1.12E+00	4.48E-03	3.06E-01	9.35E+00	2.15E+01	4.66E+01	6.68E+02
Selenium	Goose	4.00E+00	1.00E+00	1.00E+00	4.00E+03	3.67E+03	3.94E+02	1.06E+03
Thallium	Goose	3.45E-01	8.62E-02	2.07E-01	1.40E+02	1.60E+02	7.22E+01	6.10E+01
Zinc	Goose	1.27E+00	3.47E-01	1.13E+00	1.85E+03	1.43E+03	1.23E+03	3.75E+03

Notes:

a. Vegetation bioconcentration factors are calculated by taking the vegetation concentration in Table 5 divided by soil concentration in Table 5.

b. Freshwater fish bioconcentration factors are calculated by taking the freshwater fish concentration in Table 5 divided by Lake Surface Water concentration in Table 5.

c. Goose fish bioconcentration factors are calculated by taking the Goose fish concentration in Table 5 divided by Goose Surface Water concentration in Table 5.

d. Marine fish bioconcentration factors are calculated by taking the Marine fish concentration in Table 5 divided by Marine Surface Water concentration in Table 5.

e. Mussel bioconcentration factors are calculated by taking the mussel concentration in Table 5 divided by Marine Surface Water concentration in Table 5.

Appendix V8-6C

Risk Assessment Model Appendix – Worked Example for Predicted Future Media Concentrations

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GOLD & SILVER CORP.

APPENDIX V8-6C

RISK ASSESSMENT MODEL APPENDIX – WORKED EXAMPLE FOR PREDICTED FUTURE MEDIA CONCENTRATIONS

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Glossary

µg/m³	microgram per cubic metre
µg/mg	microgram per milligram
BCF	Bioconcentration factor(s)
BD	bulk density
C	chemical concentration
CF	conversion factor
cm	centimetre
COPC	chemical(s) of potential concern
D	deposition
DL	dust level
DW	dry weight
e.g.	Latin “for example”
HHRA	human health risk assessment
kg	kilogram(s)
kg/kg	kilogram(s) per kilogram
kg/m^2	kilogram(s) per square metre
kg/m^3	kilogram(s) per cubic metre
LSA	local study area
m	metre(s)
m^2	squared metre(s)
m^3	cubic metre(s)
mg/kg	milligram(s) per kilogram
mg/kg/yr	milligram(s) per kilogram per year
mg/L	milligram(s) per litre
mg/m^2/yr	milligram(s) per squared metre per year
PDA	Project Development Area
US EPA OSW	United States Environmental Protection Agency Office of Solid Waste
US EPA	United States Environmental Protection Agency
WW	wet weight
yrs	years

V8-6C-1.0 INTRODUCTION

The screening level human health and ecological risk assessment (SL – HHRA and SL - ERA) focused on direct and indirect health risks associated with air and water emissions from the Back River Project (the Project). The Project will emit chemicals of potential concern (COPCs) directly into air and surface water from various sources, thus people and wildlife using the land and foraging in areas near the Project, as well as off-duty workers in the area, could be directly exposed to the COPCs via various exposure routes. For humans, inhalation and ingestion are the primary exposure routes, whereas for aquatic life the primary routes would be ingestion and dermal contact, and terrestrial wildlife would be primarily exposed through ingestion.

In addition to the primary routes of exposure (e.g., inhalation of air, ingestion of drinking water, etc.), people may also be exposed to the COPCs via secondary exposure pathways. Some COPCs emitted to the atmosphere via air emissions may be deposited onto the soils and plants surrounding the Project area. Depending on the fate, transport and persistence of the COPCs in the environment, chemical deposition and changes in surface water quality could affect the chemical concentrations in soils, water and foods (i.e., plants, game and fish) derived from the local study area (LSA).

Health risks associated with consumption of fish and other country foods in baseline were characterized through a detailed multimedia exposure model and are presented in Volume 8, Chapter 5, with details being provided in V8-5A, and V8-5B and associated appendices.

This appendix provides an example of the calculations used to estimate media concentrations resulting from the Project in the future (future incremental Project-related concentrations). Many of the methods, equations and assumptions used to predict concentrations in various environmental media were provided by the United States Environmental Protection Agency Office of Solid Waste (U.S. EPA OSW 2005) and Health Canada (2012). These future incremental predictions were added to baseline concentrations, to predict Baseline + Project concentrations within various media. These future were then compared against environmental quality guidelines, and against the 95%ile of baseline to determine whether increased contributions from the project would be of concern from either a human health or ecological exposure perspective (see Chapter 6, V8).

V8-6C-2.0 ENVIRONMENTAL MEDIA CONCENTRATIONS

In order to quantify potential human and ecological exposures through multiple exposure pathways as a result of emissions from the Project, predicted chemical concentrations in various environmental media were required to estimate exposures and characterize risks. Chemical concentrations in the following media were estimated:

- Soil;
- Sediment;
- Surface water;
- Foods consumed by wildlife (lichen, berries, sedge);
- Traditional food (berries);
- Dusts;

However, when available, measured chemical concentrations in soil, surface water, and plants, as well as fish and wild game meat were used to characterize baseline exposures.

This worked example is presented for arsenic concentrations in media for the Future Case.

V8-6C-2.1.1 Chemical Deposition

For the purposes of the worked example, the maximum annual average deposition rate of arsenic in the Project Development Area (PDA) was predicted to be 6.32E-01 mg/m^2/yr in the Future Case. The maximum annual average deposition rate outside the PDA was predicted to be 2.87E-01 mg/m^2/yr. For Rascal Lake, Fox Lake and Big Lake, the annual average deposition rates were 0.424E+00 mg/m^2/yr, 1.71E-01 mg/m^2/yr and 4.33E-02 mg/m^2/yr, respectively.

V8-6C-3.0 CHEMICAL CONCENTRATIONS IN SOIL

V8-6C-3.1 Predicted Chemical Concentrations in Soil

Soil concentrations were estimated based on the predicted chemical-specific deposition rates. Deposition to soil on a mass basis was calculated using the following equation:

$$D_S = \frac{D_{tot} \times tD}{Z_S \times BD}$$

Where:

Ds	=	chemical-specific soil concentration based on deposition (mg/kg)
Dtot	=	chemical-specific deposition rate (mg/m2/yr)
tD	=	time period over which deposition occurs (yrs)
Zs	=	soil mixing zone depth (m)
BD	=	soil bulk density (kg/m^3)

For the current assessment, the bulk density was assumed to be 1,500 kg/m^3, and soil concentrations were predicted for two mixing depths (*i.e.*, 2 cm and 20 cm) to calculate surface soil and soil concentrations, respectively. Finally, the assessment assumed deposition occurred for 10 years without any losses from abiotic or biotic degradation.

Example 1 Deposition of arsenic to surface soil for prediction of ecological exposure (2 cm soil depth)

$$D_S = \frac{6.32E-01^{a} \times 10}{0.02 \times 1500}$$

$$D_S = 2.11E-01\ mg/kg$$

Notes:
a. See Appendix V8-6B Table 4 for value.

Example 2 Deposition of arsenic to surface soil for prediction of human exposure

Same calculation method as above

The arsenic concentration in surface soil was assumed to be equivalent to the predicted deposition concentration in the Future Case.

Example 3 Deposition of arsenic to soil for prediction of ecological exposure (20 cm soil depth)

$$D_S = \frac{6.32E - 01^{a} \times 10}{0.2 \times 1500}$$

$$D_S = 2.11E - 02\ mg\ /\ kg$$

Notes:
a. See Appendix V8-6B Table 4 for value.

Example 4 Deposition of arsenic to soil for prediction of human exposure

Same calculation method as above

The arsenic concentration in soil was assumed to be equivalent to the predicted deposition concentration in the Future Case.

V8-6C-3.2 Calculation of Sediment Concentrations

The assessment assumed deposition to sediment occurred for 10 years without any losses from abiotic or biotic degradation. In addition, the sediment mixing depth was assumed to be 3 cm (U.S. EPA OSW 2005). Sediment concentrations were calculated on a mass per mass basis (mg/kg) based on the following equation:

$$C_{SED} = \frac{D_{SED} \times tD}{Z_{SED} \times BD}$$

Where:

C_{sed} = sediment concentration over exposure duration (mg/kg sediment)
D_{sed} = deposition to sediment (mg of chemical/kg of sediment/yr)
tD = time period over which deposition occurs (yrs)
Z_{sed} = sediment mixing zone depth (m)
BD = sediment bulk density (kg/m^3)

Example 5 Concentration of arsenic in sediment for the prediction of ecological exposure (Rascal Lake)

$$C_{SED} = \frac{0.424^{a} \times 10}{0.03 \times 1000}$$

$$C_{SED} = 1.41E-01\ mg\ /\ kg$$

Notes:

a. See Appendix V8-6B Table 4 for value.

V8-6C-4.0 CHEMICAL CONCENTRATIONS IN SURFACE WATER

Chemical concentrations in surface water at Fox Lake and Big Lake were calculated based on one year of deposition using the following equation:

$$Csw = \frac{Dsw \times La}{Lv \times CF} + Csw_{measured}$$

Where:

C_{sw}	=	surface water concentration (mg/L)
$C_{sw\_measured}$	=	measured surface water concentration (mg/L)
D_{sw}	=	deposition to surface water ($mg/m^2/yr$)
L_a	=	area of lake (m^2)
L_v	=	volume of lake (m^3)
CF	=	conversion factor from m^3 to L ($1{,}000\ L/m^3$)

Example 6 Concentration of arsenic in surface water at Fox Lake

$$Csw = \frac{1.71E-01^{a} \times 720{,}640}{1{,}526{,}160 \times 1000} + 0$$

$$Csw = 8.09E-05\ mg/L$$

Notes:

a. See Appendix V8-6B Table 4 for value.

Example 7 Concentration of arsenic in surface water at Big Lake

$$Csw = \frac{4.33E-02^{a} \times 4{,}037{,}590}{12{,}141{,}340 \times 1000} + 0$$

$$Csw = 1.44E-05\ mg\ /\ L$$

Notes:

a. See Appendix V8-6B Table 4 for value.

Future chemical concentrations in Goose Lake were predicted based on water quality modelling at various Prediction Nodes (PN) by SRK (2015). These predictions included mine contact water and surface run-off as well as effluent discharge from various water management features. Therefore, deposition modelling to Goose Lake was not required.

V8-6C-5.0 CHEMICAL CONCENTRATIONS IN DUST

The chemical concentrations in dust were calculated using the measured and/or predicted soil concentration, as follows (Health Canada 2012):

$$C_{dust} = DL \times C_S \times CF$$

Where:

C_{dust}	=	chemical concentration in dust (µg/m³)
DL	=	dust level (kg/m³)
C_s	=	surface soil concentration from deposition over time (mg/kg)
CF	=	conversion factor from mg to µg (1,000 µg/mg)

A dust level of 0.76 µg/m³ (7.6E-10 kg/m³) was recommended by Health Canada (2012).

Example 8 Concentration of arsenic in dust for the prediction of ecological exposure

$$C_{dust} = 7.6E-10 \times 2.11E-01^{a} \times 1000$$

$$C_{dust} = 1.6E-07 \mu g\ /\ m^{3}$$

Notes:

a. See Example 1 Calculation.

Example 96 Concentration of arsenic in dust for prediction of human exposure

Same calculation method as above

No adjustments were made to the predicted dust concentrations to account for seasonal reduction in dust levels that would be expected during winter months when the ground is frozen and/or covered with snow.

V8-6C-6.0 CHEMICAL CONCENTRATIONS IN PLANTS

The methodology used to estimate the contribution from each route of the chemical uptake in plants are described in the following sections. The following mechanisms were included when estimating the uptake of the chemicals into the tissue of plants.

- air to above-ground plants (particle deposition to leaves or foliage)
- soil to above-ground plants (root uptake)

The worked example is provided for berries; however, Table V8-6C-1 presents the input parameters that were used for berries, lichen and sedge. The same methods of calculation were used for berries, lichen and sedge.

Table V8-6C-1 Input Parameters for Predicting Plant Concentrations

Parameter	Abbreviation	Berries	Lichen	Sedge
Intercept fraction [unitless]	R_p	0.39	0.769	0.769
Plant surface loss coefficient [yr^{-1}]	k_p	18	18	18
Length of plant exposure [year]	T_p	0.329	0.329	0.329
Yield or productivity [kg DW/m²]	Y_p	0.25	5.66	5.66

V8-6C-6.1 Plant Concentrations as a Result of Direct Deposition

The following equation was used to predict concentrations of berries for consumption by ecological receptors as a result of deposition processes on a dry weight (DW) basis (US EPA OSW 2005):

$$Pd = \frac{D_{tot} \times Rp \times [1.0 - \exp(-kp \times Tp)]}{Yp \times kp}$$

Where:

- *Pd* = berry concentration as a result of direct deposition (mg/kg DW)
- D_{tot} = deposition rate of COPC (mg/m²/yr)
- *Rp* = intercept fraction of edible portions of plant (unitless)
- *kp* = plant surface loss coefficient (yr^{-1})
- *Tp* = length of plant exposure to deposition per harvest of the edible portion of the ith plant group (yr)
- *Yp* = yield or productivity (kg DW/m²)

The US EPA OSW (2005) recommends the use of the default intercept fraction of edible portions of plant (*Rp*) value (unitless), because it represents the most current information available with respect to productivity and relative ingestion rates. A default *Rp* value of 0.39 was recommended for berries.

The *kp* value is a measure of the amount of chemical lost as a result of removal by wind and water and growth dilution. The US EPA OSW (2005) recommends a default *kp* value of 18 yr^{-1} for vegetation, which corresponds to a 14-day half-life.

The US EPA OSW (2005) recommends using a *Yp* value of 0.25 kg DW/m² for berries.

Example 10 Concentration of arsenic in vegetation as a result of direct deposition for prediction of ecological exposures

$$Pd = \frac{6.32E - 01^{a} \times 0.39 \times [1.0 - \exp(-18 \times 0.329)]}{0.25 \times 18}$$

$$Pd = 5.46E - 02\, mg\ /\ kg\ \ DW$$

Notes:

a. See Appendix V8-6B Table 4 for value.

Dry weight concentration was converted to wet weight based on the following equation:

$$C_{ww} = C_{dw} \times (1 - MC)$$

Example 11 Conversion of dry weight to wet weight

$$C_{WW} = 0.0546 \times (1 - 0.76)$$

$$Pd = 1.3E - 02\ mg\ /\ kg\ \ WW$$

V8-6C-7.0 PLANT CONCENTRATIONS AS A RESULT OF ROOT UPTAKE

COPC present in soil can be taken up into edible portions of plants. Soil to plant bioconcentration factors (BCFs) were used to predict above-ground plant concentrations as a result of root uptake.

V8-6C-7.1 Soil to Plant Bioconcentration Factor

Site specific soil to plant BCFs were used to calculate arsenic concentrations in plants. Site-specific BCFs were calculated based on the following equation:

$$BCF = \frac{Pr}{Cs}$$

Where:

BCF = plant-soil bioconcentration factor for above-ground plant (kg soil/kg plant WW)

Pr = chemical concentration in above-ground plant as a result of root uptake (mg/kg WW)

C_s = chemical concentration in soil (mg/kg)

Example 12 Bioconcentration factor for arsenic in berries as a result of root uptake for the prediction of ecological exposure

$$BCF = \frac{0.05^a}{5.17^b}$$

$$BCF = 9.67E - 03\ mg/kg\ WW$$

Notes:

a. Appendix V8-6B Table 5b for value.

b. Appendix V8-6B Table 5a for value.

V8-6C-8.0 CONCENTRATIONS IN FORAGE CONSUMED BY ECOLOGICAL RECEPTORS

The following equation was used to predict the chemical concentration in berries as a result of root uptake (US EPA OSW 2005).

$$Pr = C_s \times BCF$$

Where:

Pr = chemical concentration in above-ground plant as a result of root uptake (mg/kg WW)

C_s = chemical concentration in soil (mg/kg)

BCF = plant-soil bioconcentration factor for above-ground plant (kg soil/kg plant WW)

Example 13 Concentration of arsenic in berries as a result of root uptake for the prediction of ecological exposure

$$Pr = 2.11E - 02^{a} \times 9.67E - 03$$

$$Pr = 2.04E - 04\ mg\ /\ kg\ WW$$

Notes:
a. See Example 3 Calculation.

V8-6C-9.0 TOTAL CHEMICAL CONCENTRATION IN PLANTS

The following equation was used to estimate the chemical concentration in berries as a result of direct deposition and root uptake.

$$C_{plant} = (Pd + Pr)$$

Where:

C_{plant} = total chemical concentration in plant (mg/kg).

Pd = plant concentration as a result of direct deposition (mg/kg)

Pr = chemical concentration in above-ground plants as a result of root uptake (mg/kg)

Example 14 Concentration of arsenic in berries as a result of direct deposition and root uptake for the prediction of ecological exposure

$$C_{plant} = (1.3E - 02^{a} + 2.04E - 04^{b})$$

$$C_{plant} = 1.3E - 02\ mg\ /\ kg\ WW$$

Notes:
a. See Example 11 Calculation.
b. See Example 13 Calculation.

Example 7 Concentration of arsenic in berries as a result of direct deposition and root uptake for the prediction of human exposure

Same calculation method as above.

V8-6C-10.0 REFERENCES

Health Canada. 2012. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0. Prepared by; Contaminated Sites Division, Safe Environments Directorate, Ottawa, ON. September 2010, revised 2012.

US EPA OSW. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Final. US EPA Region VI. Multimedia Planning and Permitting Division. Center for Combustion Science and Engineering. Office of Solid Waste.