Appendix V2-4A
Transportation Study

an ERM company

Sabina GOLD & SILVER CORP.

Memo

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From	Tom Morrison, P.Eng., Project Engineer
Date	October 29, 2013
Subject	Transportation Alternatives

OVERVIEW

The Back River Project occupies a remote, isolated area of southeastern Nunavut, devoid of transportation infrastructure. It is 530 kilometres from Yellowknife, 1,400 kilometres from Edmonton and 100 kilometres from the south end of Bathurst Inlet.

To construct a mine of the planned production rate of 5,000 tonnes of ore per day will require the movement of roughly 90,000 tonnes of mixed freight and 70 million litres of diesel fuel over a two-year period, followed by 16,000 tonnes of mixed freight and 40 million litres for each year the mine is in operation. In addition, a construction workforce of about 700 people and an operating workforce of about 350 people will have to be moved to and from the site on regular rotations 8-10 times each year.

The mine will produce roughly 10 tonnes of gold bullion per year, but no other marketable products. Small machines will be shipped out for repair. Small amounts of hazardous waste will be shipped out for disposal. The volume of outbound freight is therefore insignificant, compared to the volume of inbound freight.

The movement of the required volume of freight, and the necessary staff movements, will require a large-scale, complex logistics effort, which is the subject of this study. These movements, moreover, must consider the extreme nature of the Arctic climate.

Three freight movement options are available for the transportation of fuel and freight to the Project site in the required volumes. They are:

- Truck freight via Yellowknife;
- Marine transportation to Bathurst Inlet and truck freight to the site; and
- Air transportation direct to the site.

In particular, construction will entail moving several large, heavy objects to the site that cannot be airlifted by any available aircraft.

Personnel movement is in many respects the simplest logistics problem with the fewest options.

PURPOSE OF STUDY

The purpose of this study is to identify the available alternatives for moving freight and staff to/from the Back River Project and evaluate them according to the following criteria:

- Technical feasibility;
- Cost implication in terms of implementation;

- Potential impacts to the environment;
- Community acceptability or preference;
- Enhancing socio-economic effects; and
- Amenability to reclamation.

INCORPORATION OF TRADITIONAL KNOWLEDGE

Sabina has been sensitive to developing a ground transportation network that minimizes impacts on Inuit land use and which incorporates local concerns and suggestions into its design. Thus, Traditional Knowledge (TK) was considered in the selection of the ground transportation network for the Project in a number of ways. TK is widely known to provide a valuable source of information on the land and wildlife utilized by Aboriginal peoples, their culture, and harvesting practices.

For example, TK and land use studies conducted by Sabina (i.e., KIA 2012; Rescan 2012) demonstrate historic and contemporary use of the overall Project area by Inuit. Rescan (2012) demonstrates that some existing Inuit travel routes overlap or occur within close proximity to the three Project areas. Some of these routes also cross proposed transportation corridors. These travel routes are, for the most part, seasonally-dependant. Winter travel takes place over snow and ice and primarily involves the use of snow machines, while summer travel takes place primarily on water and involves the use of ocean-going boats (however, some overland travel with the use of all-terrain vehicles also occurs). These travel routes are used mainly to access harvesting locations and/or cabin and camping locations, some of which overlap or occur within close proximity to the three Project areas and proposed transportation corridors.

TK indicates that caribou harvesting is one of the most important land use activities undertaken by Inuit in the western Kitikmeot Region. Caribou provide a valuable source of food for local Inuit and harvested caribou are often shared amongst families and individuals in the home communities of hunters. Public consultations held for the Project have indicated that local concerns exist about the potential impacts of roads and other Project-related infrastructure on caribou and other wildlife. It is evident that environmental protection remains a priority for local residents.

The use of winter roads (rather than all-season roads) to connect the three Project areas minimizes the potential for impacts on Inuit land use and harvesting. For one, the winter roads will be seasonally constructed and thus represent only temporary uses of the land. The winter roads will also preferentially cross large lakes. Together, this will reduce the potential for disruption to caribou, grizzly bear, and other wildlife during summer movements; minimize loss and degradation of vegetation due to physical clearing; reduce deposition of airborne dustfall; and reduce surface compaction. Winter road use will occur only during the coldest months of the year; for the rest of the year mining and transportation activities will be limited only to the three main Project areas. Furthermore, no permanent road infrastructure will be left behind when mine closure occurs.

TK and scientific studies conducted by the Company also indicate that caribou don't reside in the Project area in significant numbers during the winter months. This is because caribou are a migratory species that generally travel north-south in the region in the summer/winter months. The KIA (2012) TK report provides spatial (see Figure 10 on page 52) and textual information that confirms this. For example, KIA (2012) notes that:

> *Although Bathurst caribou wintered primarily in the trees, outside the range of Inuit, some tuktuk [caribou] from all the herds wintered inland, although their distribution was, in general, unpredictable and sporadic. Areas such as Tahikyoak (Contwoyto Lake), Kugyoak (Perry River), Kuanyok (Ellice River) and Kilingoyak (Kent Peninsula) had a greater probability of having caribou during winter.*

KIA (2012) also notes that:

> *Inland areas with tuktuk during winter included Tahikyoak (Contwoyto Lake), Ahiak (region east of Emakyoak (Great Bear Lake), Aipkaktaktokvik (a location on Burnside River), Yamba Lake, Lac de Gras, Tahikaffaloknahik (Itchen Lake) and Aylmer Lake.*
>
> *Within Bathurst Inlet, mainland caribou wintered in the northern part of the inlet and on both east and west sides. As discussed in the Island Caribou section, these are places where the different herds would intermingle. The only place in southern Bathurst Inlet with mainland caribou in winter was Hanningayuk (Beechey Lake). Habitats used during winter consisted of rough and rocky areas because there was less snow and access to vegetation was easier.*

The use of only winter roads will thus help limit Project interactions with caribou. The potential for increased access to caribou harvesting areas by hunters (and thus increased pressure on regional caribou herds) will also be reduced, as the road will only be operated seasonally and as a private entity with restricted access.

TRUCK FREIGHT VIA YELLOWKNIFE

This option entails trucking freight to Yellowknife, thence over the Tibbitt-Contwoyto Winter Road (TCWR) to the Ekati mine turnoff, then 70 kilometres north on an established but currently unused section of the TCWR to a point near Ghurka Lake, thence over a new winter road to site.

Using this mobilization route, the Point of Sale (POS) for most equipment and materials would be Edmonton, a major supply centre in its own right and launching point for the tar sands and mining and construction in the north. Suppliers of fuel, explosives and possibly some other bulk materials will quote FOB Yellowknife and provide storage there. This mobilization route would be an extension of an existing heavily used and well proven system.

The price of bulk materials, such as fuel or explosives, bought at Yellowknife is higher than if bought at a major centre in southern Canada. Thus, a 25-kg sack of ANFO costs $22.75 in Edmonton, $32.75 in Yellowknife (44% more, $400/tonne), reflecting the cost of rehandling, trucking to Yellowknife and storage there. Trucking general freight from Edmonton to Yellowknife costs $250-300/tonne, so it is unlikely that Sabina could obtain the services provided by the supplier more cheaply than the supplier when all costs are taken into account.

The project will consume large amounts of spare parts and bulk materials that are not stocked in Yellowknife. Sabina will have to transport these from wherever their POS may be.

Two options exist for surface freight to Yellowknife: (a) Truck direct; and (b) Rail to Hay River, truck to Yellowknife. Option (b) will require trucking from POS to rail yard, rehandling twice, then trucking from Hay River to Yellowknife. Although rail haulage is cheaper per tonne-kilometre than trucking if freight can be consolidated into full car loads, the total cost of this option, including rehandling, is unlikely to be lower than option (a) and is not pursued further.

Freight would accumulate at Yellowknife during July-December each year for shipping to site during February to March of the following year. Freight would be deposited at a fenced, secure laydown area at Yellowknife, probably 2-3 hectares, with secure, heated, cold and outdoor storage. In view of the current resupply effort over the TCWR, spare laydown capacity may already exist in Yellowknife.

All construction mobilization and resupply would have to take place in a 2-month season, beginning with the opening of 700-740 km of winter road, comprising 440 km on the Tibbitt-Contwoyto Winter Road (TCWR) and approximately 260-300 km (depending on route selected) linking the TCWR to Goose site, typically the beginning of February, and ending with the thawing of the winter road, typically the end of March.

The Yellowknife laydown area would need to be fully staffed 24/7 during this period for receiving, dispatching and rehandling freight. Most freight would arrive loaded on trailers; the tractors would return south; the trailers would be taken on by approved northern trucking contractors. Some rehandling would occur, however, necessitating at least a 50-ton crane. The laydown area and dispatch service would be used the rest of the year to handle air freight for the site, staffed days only with night-time call-out.

The TCWR is currently operating at about 60% capacity – 6,500 loads were hauled during the 2013 season. Peak capacity is about 11,000 loads per year, averaging 33 tonnes per load. The road is rebuilt every year by the TCWR Joint Venture. A conversation with committee member Mr. Ron Near indicated that the TCWR would be available for Sabina to use in return for a contribution to TCWR construction and a toll per tonne-kilometre.

Sabina would have to contract the construction of the link between the TCWR and Goose site. The TCWR committee has a list of recommended contractors and engineering firms. Nuna Logistics have estimated construction rates, for both pioneering and re-establishment, at 2 kilometres per day on land (49% of route) and 10 kilometres per day on ice (51% of route). The link would therefore need to be constructed from five advance points from Goose and two intermediate 49-person camps. The camps would have to be installed during the pioneering phase, maintained permanently and reopened each winter. Nuna estimate that road construction would take 65 days, starting in early December. These camps would also be needed to provide fuel, maintenance, food and rest to the truckers. They would therefore have to be supported from Yellowknife during January-March inclusive.

Freight would be trucked from Yellowknife to Goose by trucking companies approved by the TCWR committee for their equipment, procedures and northern experience. Fuel would be hauled by tanker truck/trailer, typically holding 35,000 litres. Although explosives would require special handling, they would travel by tractor-trailer like other freight. Nuna estimate that, because of season length, freight would have to be trucked from Yellowknife to a staging point at Ghurka Lake and then hauled to site in an estimated 80-day season.

Freight would be received at Goose by a logistics crew and directed to a laydown area, tank farm or explosives store as appropriate.

Two options exist for the storage and resupply of fuel, explosives and other bulk goods at Goose:

a. Maximize surface, rather than air transport. This requires storage for 13 months'[1] supply on site, concentrates purchasing into one period of the year and incurs carrying charges for the year.
b. Minimize storage on site. This requires storage for 1 month's supply on site, with resupply by air, spreading purchasing over the year.

These two options are end-points of a continuum, possibly with an intermediate point of least cost. The total cost of resupply by air will differ between a gravel strip/Hercules combination and a hard-surface strip/jet freighter combination.

This mobilization route is capable of handling all materials and equipment for construction and operation, including very large single objects, provided that they can be assembled at Yellowknife no later than January of each year and moved to the site in February-March. Substantial experience exists on constructing, operating and cost-estimating this operation; it therefore offers reasonable predictability.

This mobilization route will function regardless of the presence or absence of a port on Bathurst Inlet. The apparent capacity of this route makes a Bathurst Inlet port and road unnecessary. A gravel airstrip will still be needed, capable of accepting Hercules and Dash-7 types of aircraft for food, incidental freight and personnel movements.

This mobilization route will handle fuel twice: loading at POS and delivery at Goose. Temporary storage may also be necessary at Ghurka Lake. The purchase price, however, will reflect the cost of the supplier trucking fuel to Yellowknife.

This mobilization route suffers from the following risks:

a. Late opening of the winter road because of a warm winter, labour shortages or construction delays;
b. Lack of trucking capacity, shortages of skilled labour and equipment, equipment breakdowns;
c. Difficulty recruiting/retaining a large expediting workforce for a short period;
d. Essential components missing the season because of permitting delays or late delivery to Yellowknife;
e. Corrosion damage to materials in transit and storage;
f. Expiry of warranties while components are in transit or storage;
g. Major accident, spillage, collapse of lake ice; and
h. Early melting of the winter road.

Regarding (d), small essential objects can be flown in, but several exist that cannot, such as ball mill parts, mine haul trucks and generators. If these miss the season, construction will be delayed by a year.

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[1] The storage cannot be allowed to be empty at the start of the resupply season. It must hold a minimum of 1 month's supply at that time. Resupply will replenish this volume as well as the storage for the year.

Regarding (g), trucking fuel limits the amount that can be spilled due to any one accident to the capacity of the truck, typically 35,000 litres.

EBA has warned of the possible closure of the Diavik and Ekati mines, leaving Sabina to operate the TCWR beyond the Gahcho Kue turn-off alone. While the closure of these mines would add to Sabina's costs, it would also free up labour, services and facilities in Yellowknife.

The ten-year trend of operating days per year suggests that the TCWR will be available for only about a month each year by the 2020s. This may pose a long-term problem for this mobilization route.

In 2013 the TCWR was open for 48 days (Figure 1); 6,017 loads were moved inbound, totalling 223,206 tonnes of freight (average 37 tonnes per load).

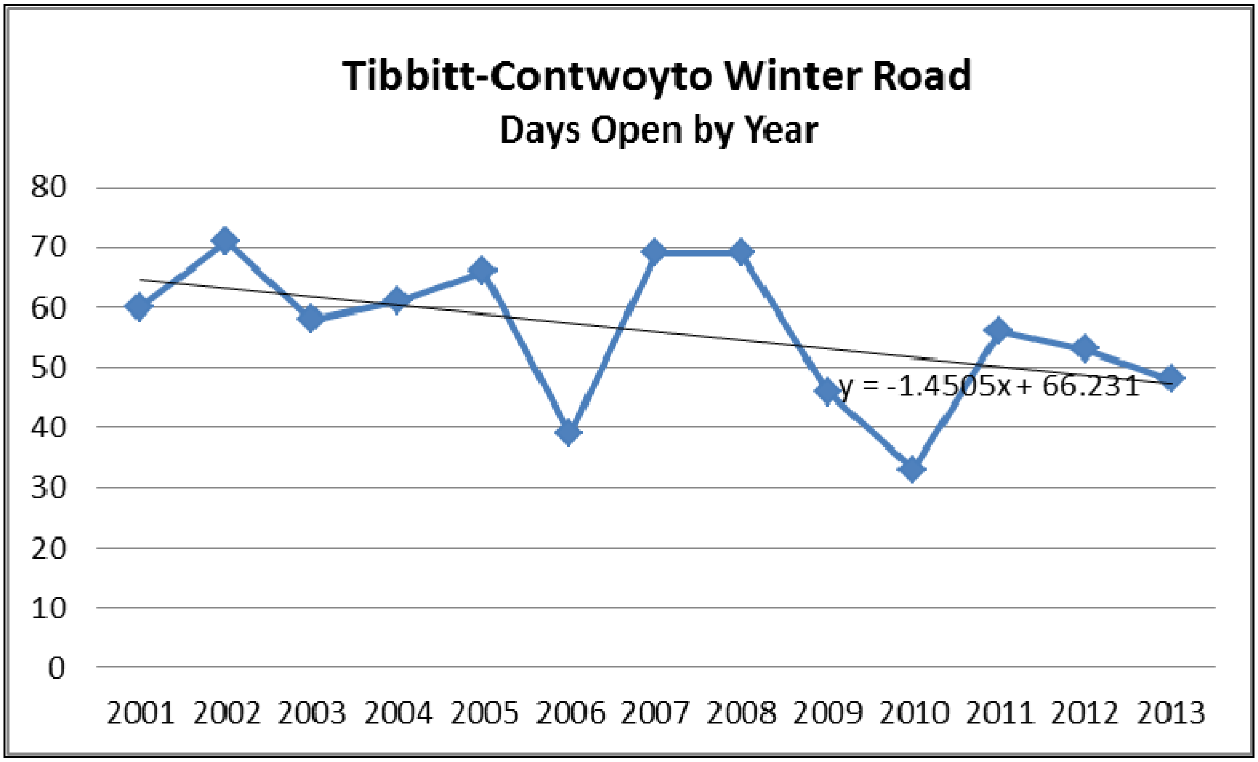

Figure 1. Days Open by Year: Tibbit-Contwoyto Winter Road

Timeline

If this mobilization route is to be used to transport major equipment in the first months of 2016, the route must be pioneered in early 2015, with all necessary permits received in the last half of 2014. The route must therefore be decided on during 2013 with initial fieldwork. Final fieldwork must be completed in the first half of 2014.

Permitting

Using a long-term winter road through Nunavut and NWT adds complexity to both the permitting and community aspects of the project. Although Sabina anticipates that an initial winter road could be established under a short-term Type B Water License in both Nunavut and NWT (Engineering to confirm water requirements), Sabina also requires approval from the land owner, including AANDC, KIA, and the Tlicho. In addition, the concept of long-term use of the winter road was not included in the Project Description submitted in June, 2012, and as such may require an additional 6 to 9 months of permitting to be included in Sabina's project plan. This change would delay the Draft EIS submission date by the similar timelines (3 to 6 months, at least) and may require additional baseline data to be collected as well as modifications to the trans-boundary and effects assessment portions of the submission. NIRB will review guidelines to ensure adequacy for this change in project, possibly requiring a new ministerial decision if the road goes through NWT.

Significant effort would be required to obtain the licenses and authorizations in all jurisdictions, as well as the social license to operate the winter road. This will need a community relations effort that SBB cannot currently support. It is estimated that Sabina would need 12 months and additional resources to secure even a short-term (2-year) approval. The longer-term use of the road would fall within Sabina's EIS process. This road would be easier to permit for short-term use, pending the currently uncertain BIPAR construction.

This option will be the most difficult to permit due to the fact that it is not included in the original Project Description; it will require significant engagement and agreements (including additional potential IBAs for long-term use) to be in place. To date there has been limited engagement with the YK Dene, and none with the Tlicho and various Metis groups. The YK Dene and Metis are against this road; the Tlicho may be against it. All of these entities will require significant engagement and some level of agreement for long-term use.

Of the three options presented, this one has the highest risk for significant permitting delays. Sabina needs the earliest possible decision on a road route.

Costs

When all costs are fully accounted for, this is not the cheapest route for freight mobilization.

Summary

- Technical feasibility: the route is feasible, subject to the risks listed above.
- Cost implication in terms of implementation: establishment of this route carries high fixed costs.
- Potential impacts to the environment: road construction entails significant environmental impact.
- Community acceptability or preference: there is known to be significant community resistance to this road.
- Enhancing socio-economic effects: implementing this route will offer significant employment throughout the north.
- Amenability to reclamation: good.

MARINE/TRUCK FREIGHT VIA BATHURST INLET

This mobilization route would originate in one or more of three major supply centres: Montreal, Edmonton and Vancouver. Supply from overseas would also be possible, given sufficient cost benefits. Potential departure ports in Canada are Belledune, New Brunswick, Becancour, Quebec, Vancouver and Hay River. Shipping would be by ship from Belledune or Becancour, barge from the other two. While shipping from either Becancour or Belledune is equally possible, physically, a recent Tetra Tech study has shown that Belledune offers equal access, more space and lower charges, compared to Becancour.

Bulk materials, such as fuel and explosives, are significantly cheaper if bought at a major centre in southern Canada than at Yellowknife.

Routes would be from the following points of sale:

- Vancouver: Truck to dock, barge to Bathurst Inlet;
- Edmonton: Truck to Hay River, barge to Bathurst Inlet; and
- Eastern Canada: Truck to Belledune, ship to Bathurst Inlet.

Shipping companies are:

- Belledune/Becancour: Groupe Degagnés; Fednav; Nunavut Eastern Arctic Shipping (NEAS);
- Hay River: Northern Transportation Co. Ltd. (NTCL); and
- Vancouver: Seaspan; Sealink; Island Tug and Barge.

Fuel tanker ships are available up to 20 million litres; fuel barges typically contain only 1 to 2 million litres. This would favour moving fuel by tanker ship from eastern Canada and unloading by floating hose. Fuel would be pumped from ship/barge to a tank farm on shore, then trucked to site in tanker trucks/trailers. Moving the whole year's supply of fuel by this means would require the construction of two tank farms, each capable of holding a year's supply (currently estimated at 40 million litres), one at Bathurst Inlet, one at Goose. This mobilization route will handle fuel five times: loading into tanker truck at POS, loading from tanker truck to ship/barge, unloading from ship/barge to tank farm at Bathurst Inlet, loading into tanker truck, unloading at Goose. In view of the volume of fuel required this could be a significant issue. Fuel purchase price would be the price at Montreal.

Explosives handling and storage requirements would favour the maximum use of bulk ammonium nitrate, which is inert, for mixing into ANFO at Goose. The option exists to fly a minimum quantity of live explosives and detonators direct to site, rather than shipping explosives by sea.

Ships sailing to Bathurst Inlet from eastern Canada must transit Transport Canada Zone 6 which has the most restricted entry season of any of the sixteen Arctic waters zones, except for the High Arctic (see Appendix A.) This limits the ships available to those shown in Table 1.

Barges from Vancouver or Hay River would take about two days longer to get to Bathurst Inlet than ships from eastern Canada, but would transit Zones 11 and 12, which have a slightly longer open season. Island Tug & Barge, Vancouver, affirm that their equipment can transit Zones 11 and 12 from early August to about October 10, the critical area being Point Barrow, Alaska, rather than the Canadian Arctic waters.

Table 1

Shipping Line	Ice class	No. of Ships (Cargo)	Entry/Exit Dates Zone 6
Groupe Desgagnes	1A	7	Aug 25-Oct 31
Groupe Desgagnes	1	1	Aug 25-Sep 30
Groupe Desgagnes	3	1	Aug 1-Nov 30
NEAS	1	3	Aug 25-Sep 30
Fednav	A	1	Aug 15-Oct 15
Fednav	1A	6	Aug 25-Oct 31
Fednav	AC4	2	July 20-Dec 31

Thus, Fednav operates thirty-seven Ice Class 1C ships but they are not allowed to transit Zone 6 at any time of the year.

Ice breaking can extend this season, at an additional cost. In this case, the alternatives include:

- Open water shipping only (2 months);
- Ice breaking of early season ice only (to extend open water to 4 months); and
- Ice breaking all year (to extend shipping window up to 12 months).

For this assessment only open water shipping (and no ice breaking) has been considered.

This mobilization route depends on a limited amount of equipment operated by third parties during a shipping season of about two months, competing with essential freight to the Arctic communities.

Tetra Tech has produced a concept for a port on Bathurst Inlet capable of handling all construction mobilization and resupply in the available shipping season. Based on initially anticipated freight tonnages, the original design comprised:

- Two ship docks;
- Barge ramp for two barges;
- Fuel storage (1 year's supply);
- Explosives storage (1 year's supply);
- Laydown area (1 year's worth of materials);
- Camp (100 people);
- Workshop;
- Airstrip; and
- Road connecting above elements.

A more detailed assessment of freight requirements has reduced this to:

- No permanent ship dock: replaced by a temporary T-shaped arrangement consisting of two barges put in place seasonally;
- Barge ramp for two barges;
- Floating hose for unloading fuel;
- Fuel storage (1 year's supply);
- Explosives storage (1 year's supply): most of this will be inert ammonium nitrate;
- Laydown area (1 year's worth of materials, smaller than original estimate);
- Camp (50 people);
- Small workshop for running repairs to trucks and equipment;
- No airstrip: operation is seasonal; aircraft can land on skis on sea ice in winter, floats on Bathurst Inlet in summer;
- All components will be within a single disturbed area;
- A desalination plant will eliminate the need to draw water from sources on land, with attendant roads and pipelines.

At first, Sabina believed that the port could not be built and used the same season. On closer consideration, Sabina came to realize that, because the Bathurst Inlet shore consists of flat, low-lying, well drained sand and coarse gravel, a sealift of material could be unloaded onto a minimally prepared site and that an initial phase of port construction could be completed the same year. Construction of the reduced components listed above could be completed the following year, concurrently with the arrival of a second sealift of material and supplies.

Sabina therefore believes that the following timeline is feasible:

- 2013: Initial fieldwork;
- 2014: Final fieldwork, permitting, design and tendering;
- 2015: Summer mobilization of port construction materials, mine equipment and supplies, initial port construction, crew housed in camp barge; barges can be frozen in over winter if necessary and unloaded over the ice;
- 2016: Winter construction of ice road Bathurst-Goose, movement of equipment and supplies to Goose site; summer completion of port construction and further sealift; and
- 2017: Repeat of 2016.

This mobilization route suffers from the following risks:

a. Late break-up of sea ice;
b. Late formation of winter road due to warm winter or construction delays;
c. Lack of trucking capacity due to shortages of labour or equipment, equipment break-downs;
d. Difficulty recruiting/retaining large expediting workforce for short period;

e. Lack of shipping space due to competing demands having greater public need;
f. Storms;
g. Major accident to ship/barge, spillage of fuel into Bathurst Inlet;
h. Major accident to truck, spillage, collapse of lake ice;
i. Corrosion damage to materials in transit or storage;
j. Expiry of warranties while components are in transit or storage;
k. Early break-up of winter road;
l. Early freeze-up of sea ice; and
m. Public resistance to industrial activity in a currently pristine environment.

Because this mobilization route depends on two different modes of transport, the risks are compounded. Any abnormal temperatures, whether colder or warmer, would adversely affect one or the other.

Other disadvantages are:

a. While the biggest single spillage risk on the mobilization route through Yellowknife is limited to a 35,000-litre truck, this mobilization route would involve a 20-million litre ship as well as 35,000-litre tanker trucks;
b. Trucking the required loads between Bathurst and Goose in the available season would require a large captive truck fleet, which could be used only for this one purpose for 2 to 3 months of the year;
c. A large crew (e.g. 50 to 100 people) would have to be recruited for a very short time (2 to 3 months); and
d. For mobilization through Yellowknife, roughly half to two-thirds of the transportation and expediting workforce could be housed in Yellowknife, indeed may already live there. For mobilization through Bathurst Inlet, the whole workforce would need camp accommodation.

Figure 2 presents the possible shipping routes to the Bathurst port. The preferred route is for the ships to follow the established shipping route used for resupplying Cambridge Bay and veer south towards the community of Kingoak on Bathurst Inlet. This route is preferred as it is an established shipping route and the principal location for sourcing project equipment, supplies and material is in eastern Canada.

Figure 3 shows the Arctic ice zones.

From the community of Kingoak to the port location, the shipping corridor has been selected based on the preferred port location, bathymetry and foreshore slope, navigation and maneuverability, avoidance of sensitive landscape, environmental, and cultural areas.

Figure 2. Maritime Routes to Bathurst Inlet

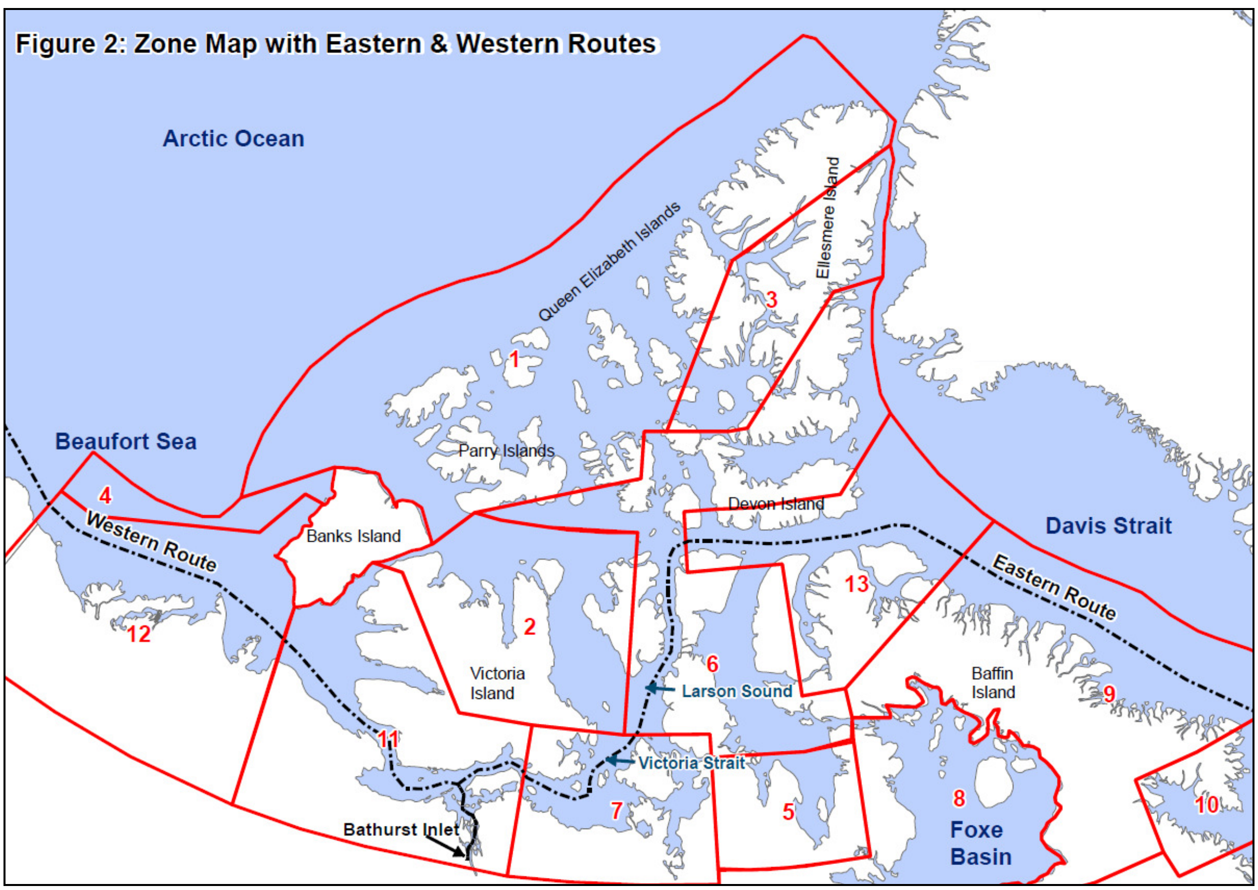

Figure 3. Arctic Ice Zones

Port Site Selection

In total, five potential port sites were considered, as shown in Figure 4. All were located on the southwest shore of Bathurst Inlet.

Selection criteria were:

- Distance from Goose site
- Shoreline topography for port construction
- Land topography for access road construction
- Steepness of sea bed immediately offshore
- Exposure to wind and sea ice
- Nature of superficial material on shore
- Stability of sea bed materials
- Depth to bedrock
- Unavailability of sites due to conflicting permitting (BIPAR)
- Taking all these factors into consideration resulted in the selection of port site #2 (Figure 4).
- Timeline
- The timeline is inherent in the above discussion.
- Permitting
- A port at Bathurst Inlet and a connecting winter road through Nunavut is currently envisioned and is the current basis for baseline and effects assessments. Sabina anticipates that an initial winter road could be established under a short-term Type B Water License (Engineering to confirm water requirements). Sabina also requires approval from the land owner including AANDC and KIA. It is estimated that it would take 9 to 12 months to obtain the short-term Type B Water License and additional authorizations from the land owners. Any work in water related to the Port could likely not commence until all project authorizations were in place. However, minor barge-related work, laydown areas, camp and moderate fuel containment would likely be permissible under exceptions as pre-development.
- This option would not create any additional baseline requirements (above what is planned in 2013) or effects assessment work - assuming that the road corridor and port location are kept the same as currently proposed. Sabina would anticipate the permitting to be done in line with current timelines.
- A possible connection to the proposed BIPAR road has been not included in the assessment as this project was suspended in the environmental assessment process in June, 2013. If the BIPAR project is re-initiated in environmental assessment and permitting and becomes available for use by the Back River Project, it will be added to the alternatives assessment.

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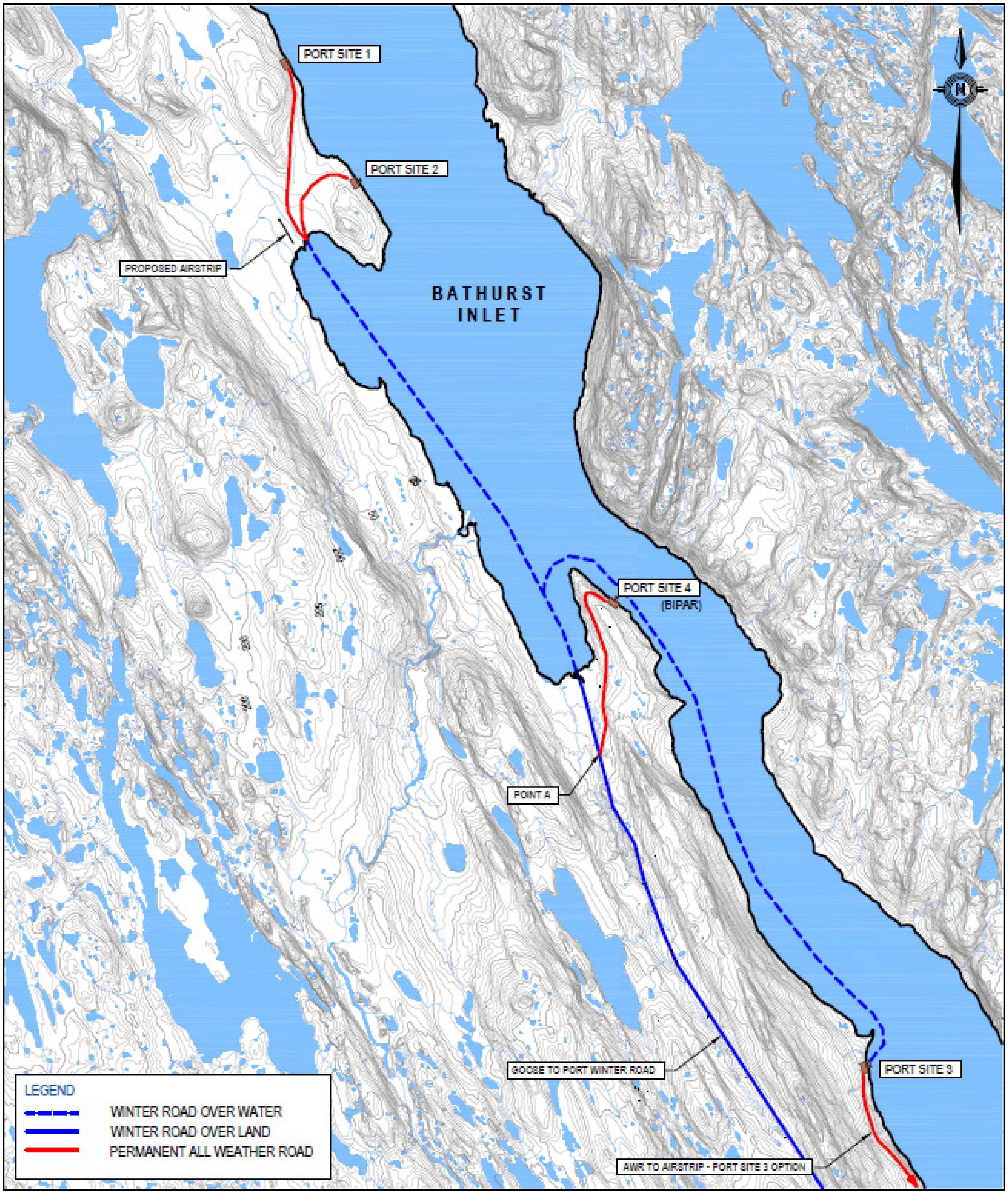

Figure 4. Potential Port Sites

- The fact that a winter road will be required to haul ore from the George site to the proposed mill at the Goose site will help to reduce the overall cost and permitting effort required for this mobilization route.
- This option is the second simplest of the three options to permit and is the basis of Sabina's current permitting plan.
- Cost
- This option offers the lowest cost per tonne of freight when all costs are taken into account.

Summary

- Technical feasibility: well established;
- Cost implication in terms of implementation: apparently offers the lowest cost per tonne of freight;
- Potential impacts to the environment: movement of limited numbers of ships and barges into and through a currently pristine environment;
- Community acceptability or preference: discussion in progress with stakeholders;
- Enhancing socio-economic effects: the shipping lines will recruit their crews from southern Canada; staff for port operation and trucking can be recruited from the north; and
- Amenability to reclamation: improved by reduced port.

AIR FREIGHT

Due to the remoteness and isolation of the Project sites, air transportation has always been essential to the development of the Back River Project.

The available air transportation alternatives include:

- Helicopter – local movement only, prohibitively expensive between site and the nearest communities.
- Float planes use nearby lakes during open water; this option is limited to single-engine and small twin turboprop aircraft (typically Twin Otter). Freight capacity is limited accordingly.
- Ice airstrips are ploughed out on frozen lake surfaces in winter; with more than 1.2 metres of ice and almost unlimited length, such airstrips can accept Hercules, Electra, Boeing 737 and other large aircraft between February and April.
- A 915-metre all-season gravel airstrip was completed at the Goose site in 2013; subject to maximum acceptable gradients and gradient changes, a 915-metre airstrip can accept small turboprop aircraft, such as a Buffalo or a Dash-8, while a 1,525-metre gravel strip will accept large aircraft such as a Hercules or an Electra. A short gravel airstrip exists at the George site, usable only by small aircraft, such as a Twin Otter.
- All-season paved runways exist in the Arctic at places such as Yellowknife, Rankin Inlet and Iqaluit, capable of accepting large jet aircraft; for reasons of cost, none has hitherto been built for a sole user.

The Goose site is the main project site and will include the most significant infrastructure and workforce. Four locations were considered for the location of a 1,525-metre all-season gravel airstrip. The currently favoured option is to extend the existing 915-metre airstrip.

The George site will be serviced from the Goose site; Sabina does not anticipate any need to extend the existing airstrip.

For large-scale, long-term supply, this mobilization route would move freight to a selected base airport by surface means and fly it direct to an airstrip at Goose. This mobilization route could originate in Edmonton, Hay River or Yellowknife. All have advantages and disadvantages.

Edmonton (1,400 km from site):

- farthest from site;
- major supply centre and POS;
- airport has 10,000-foot (3,048-metre) paved runways – no limit on aircraft acceptance;
- Sabina's consultant has contacted the airport authority and believes that it may offer incentives, e.g. buildings, tax-free fuel, for a semi-permanent air freight operations base; and
- best possibilities for an operations base.

Yellowknife (530 km from site):

- closest to site;
- POS for fuel and explosives;
- airport has 7,500-foot (2,286-metre) paved runway – will not accept very large aircraft;
- accessible from south only by truck;
- long trucking route;
- toll bridge over the Mackenzie River; and
- some possibilities for an operations base.

Hay River (727 km from site):

- accessed by rail (much cheaper than trucking);
- may be POS for fuel and explosives;
- airport has 6,000-foot (1,829-metre) paved runway – limited aircraft acceptance; and
- least possibility for an operations base.

If all construction material and resupply freight follows this mobilization route, the volume would be such that two large aircraft would be fully occupied, allowing for maintenance and other downtime. These would require hangarage, fuelling, maintenance and dispatch facilities. Freight would be deposited at a fenced, secure laydown area at the base, probably 1 hectare, with secure, heated, cold and outdoor storage. Because freight would move continuously, the laydown area would not need to be as large as those required for the other mobilization routes. Because of this need to set up a substantial operations base, one only of the above airports should be selected.

Materials bought in Hay River or Yellowknife must include the supplier's freight, handling and warehousing costs. These can be substantial; an enquiry with Orica showed that a 25-kg sack of ANFO will cost $22.75 if bought in Edmonton, $32.75 if bought in Yellowknife, a freight and handling increment of $400 per tonne. As the air freight distance increment between Edmonton and Yellowknife is 870 km, this represents $0.46 per tonne-kilometre which is substantial in terms of the figures quoted below. It is also necessary to consider the cost of aircraft fuel at the base; this would substantially affect operating costs.

Freight on the other two mobilization routes would typically travel by trailer from source to site, loaded at source and unloaded at site. This mobilization route would require freight to be loaded onto pallets or into aircraft-type freight containers. Efficient handling would be costly in labour and equipment, but essential to success.

This mobilization route would involve handling fuel twice: supplier's truck loading aircraft at base, unloading from aircraft by pipeline to tank farm at Goose. The fuel purchase price would be the price at base.

As part of the current Pre-Feasibility Study, Tetra Tech prepared preliminary cost estimates for:

a. a 5,000 x 150-foot (1,524 x 45-metre) gravel airstrip, capable of accepting a Hercules; and
b. a 6,500 x 150-foot (1,981 x 45-metre) hard-surfaced airstrip, capable of accepting a Boeing 767.

The estimates include costs for airport lighting, aprons and buildings. A 6,500-foot hard-surfaced runway at Goose would open the site to fuel-efficient, late-model Boeing 737s, making it possible to recruit employees from all parts of Canada.

In general, the bigger and/or faster the aircraft, the lower the cost per tonne-kilometre flown, as summarized in Table 2.

Table 2

Aircraft	From	Freight (t)	Fuel (L)	Cost ($/tonne-kilometre)
Hercules*	Yellowknife	17.25	22,000	3.28
Boeing 737*	Yellowknife	13.60	15,000	2.36
Boeing 767**	Edmonton	40.80	NS	1.31
DC-10**	Edmonton	79.00	NS	0.71

** Current actual, short-term charter.*
*** Estimate, long-term charter.*

The large aircraft available in North America are loaded through side doors. Very large roll-on-roll-off aircraft exist in Russia. They typically require 2,900-metre paved runways and, for practical purposes, are not available for use on this project.

This mobilization route would operate year-round. While the loading and unloading sites would have to be continuously manned, labour recruitment would be easier than for the other two mobilization routes. The workforce would be smaller and could be offered year-round employment; the loading crew would live at home in the base city; the unloading crew would be housed in Goose camp.

This mobilization route suffers from the following risks:

a. Major damage or mechanical failure to aircraft, resulting in long down time. Capacity not easily replaceable;
b. Cumulative effect of persistent weather delays;
c. Crash at Goose, fire, spillage, environmental damage; and
d. Plant site is close to extended runway centerline. Risk of aircraft hitting buildings; risk is slight, consequences would be major.

This mobilization route suffers from fewer risks than either of the other two. In particular, it allows just-in-time procurement without tying up capital in a year's inventory, which is inherent in the other two mobilization routes. It also allows smaller storage facilities for fuel and explosives at Goose.

This mobilization route would suffice for all construction materials and resupply, except for certain large objects, such as mine haul trucks, quarry drills, generators and ball mill parts. These will need to be moved to site once only and cannot be moved by any of the available aircraft types. At least one campaign will be needed, therefore, to transport this equipment by surface means. If these large objects mentioned above miss the available season for reasons of permitting or late delivery, the project will be delayed by a year.

Some projects, such as Meadowbank and Diavik, suffered serious cost overruns because of unscheduled air freight resulting from missed seasonal surface routes. Air freight is expensive in these cases because it entails short-term *ad hoc* charter arrangements using sub-optimal aircraft types. A properly set up long-term air freight operation may be as cost-effective and more convenient than seasonal surface routes.

Airstrip Site Selection

Four possible sites were examined for the location of an airstrip at the Goose site, as shown in Figure 5.

Factors taken into consideration were:

- Distance from existing and planned facilities;
- Ground topography;
- Approach obstructions;
- Impact on water bodies and courses;
- Available construction materials and proximity to sources;
- Direction of prevailing wind; and
- Character of superficial materials with particular reference to permafrost.

As a result of these considerations, it was decided to extend the existing all-season airstrip to the southeast.

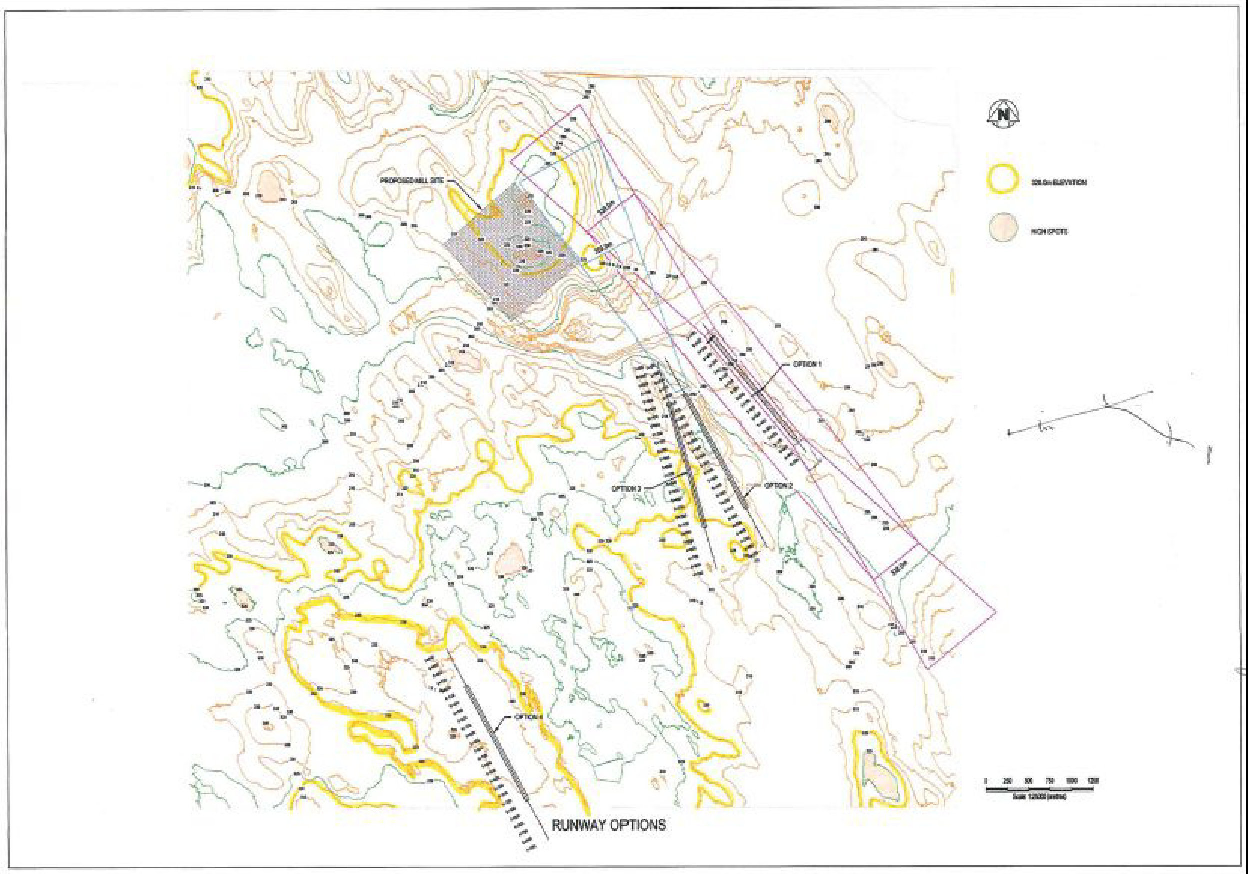

Figure 5. Airstrip Site Selection

Timeline

Earthworks to expand the existing airstrip can probably be permitted as pre-development work, following the submission of the final EIS, scheduled for the end of 2014, requiring amendments to existing licences no later than the last half of 2014, with field work completed in 2013-14.

Submission of the final EIS can trigger a further amendment application, allowing the airstrip infrastructure (e.g. paving, buildings, fuel tanks and lighting) to be completed in the summer of 2015. This will complete the airstrip for use in major mobilization in 2016.

This mobilization route would free the project from the timelines imposed by the seasons.

Permitting

Using fixed wing aircraft to resupply the mine was not considered in the initial Project Description but was added prior to guideline work. Although this scenario would add additional effort related to noise and impact on wildlife, it would significantly reduce the overall workload and complexity of the permitting process.

This option would create minor additional baseline requirements in some areas (above what is planned in 2013) but overall would significantly decrease other areas. Sabina anticipates that the permitting can be done in line with current timelines.

This option would be the simplest to permit as it reduces footprint and infrastructure requirements, e.g. road corridors and camps.

The movement of jet aircraft may be prohibited for a 2 to 3-week period to allow for caribou migration; the relevant dates are predictable well in advance and are well known.

This option is by far the easiest to permit for socio-economic considerations.

Costs

The central cost problem is that only a large jet aircraft (e.g. DC-10, MD-11, B-767, B-747) can bring the freight cost per tonne-kilometre down to a level competitive with surface means. Such aircraft require long, paved runways which are costly to construct.

Sabina is currently evaluating the cost of constructing a hard-surfaced runway of the required length. This cost would be substantial but probably no more so than the cost of constructing and port and winter roads.

The cost per freight tonne is similar to that of the other two options, but is not the lowest.

Summary

- Technical feasibility: air supply is technically feasible with the exception of large, heavy objects required during mine construction;
- Cost implication in terms of implementation: bringing cost down to acceptable levels entails costly runway construction;
- Potential impacts to the environment: occasional local noise, otherwise least environmental impact of the three options;
- Community acceptability or preference: no community impact;
- Enhancing socio-economic effects: limited employment possibilities, lowest labour component and that mostly recruited in Edmonton; and
- Amenability to reclamation: least environmental footprint, hence least amount of reclamation.

PERSONNEL MOVEMENT

Sabina and contractor employees working on the site will work regular fly-in-fly-out rotations, of a length yet to be determined, about 8 to 10 rotations per year. During construction, with an estimated 700 employees on site, this will require 5,600 to 7,000 two-way flights per year for the two years of construction, reducing to 350 employees and 2,800 to 3,500 flights per year during mine operations.

As a base case, inbound employees starting their rotations will assemble at Yellowknife by means of public airlines; outbound employees will disperse from Yellowknife by the same means on completing their rotations. Sabina will charter medium-sized turboprop passenger aircraft to fly between

Yellowknife and a gravel airstrip at the site. Smaller charter aircraft will move northern employees between site and the Arctic communities.

Sabina may construct a longer, paved runway at site to receive jet aircraft direct from cities in southern Canada.

This plan is the limit of the available options.

ACCESS AND TRANSPORATION WITHIN THE PROJECT AREAS

An all-season road connects the Goose camp with the all-season 915-metre gravel airstrip.

Transportation within the current exploration program is using helicopters. It is anticipated that the use helicopters will continue throughout all phases of the Project life as required by operational needs.

There are two options for transportation within each Property of the Project site. They are:

- All-weather roads; and
- Winter roads.

The preferred on-site transportation is a network of all-weather roads.

The winter road corridor between Goose and George Property will be used throughout all phases of mine life.

CONCLUSIONS AND RECOMMENDATIONS

Three options are available for moving the required volumes of fuel and freight in to the Back River Project:

- Truck freight via Yellowknife;
- Marine/truck freight via Bathurst Inlet;
- Air freight direct to site.

For the reasons given above, the current base case is marine/truck freight via Bathurst Inlet.

REFERENCES

KIA. 2012. Inuit Traditional Knowledge of Sabina Gold & Silver Corp.'s Back River (Hannigayok) Project. Naonaiyaotit Traditional Knowledge Project (NTKP). Prepared for Sabina Gold & Silver Corp. by Kitikmeot Inuit Association: Kugluktuk, NU.

Rescan. 2012. Back River Socio-economic and Land Use Baseline Report. Prepared for Sabina Gold & Silver Corp. by Rescan Environmental Services Ltd.: Vancouver, BC.

APPENDIX A

Transport Canada Arctic Shipping Pollution Prevention Regulations (ASPPR) Ice Strengthening Classes and Zone Entry Periods.

Table A1. ASPPR Type Ship Equivalencies

Item	Col. 1 Type of Ship	Col. II American Bureau of Shipping	Col. III Bureau Veritas	Col. IV Det Norske Veritas	Col. V Germanischer Lloyd	Col. VI Lloyd's Register of Shipping	Col. VII Nippon Kaiji Kyokai	Col. VIII Polski Rejestr Statkow	Col. IX Register of Shipping of the USSR	Col. X Registro Italiano Navale	Col. XI Registrul Naval Roman
1	Type A	A1 Ⓔ Ice strengthening Class AA AMS or A1 Ⓔ Ice strengthening Class 1AA AMS	1 3/3 E glace I - super or 1 3/3 E Ice Class 1A Super	1 A 1 ICE A or 1 A 1 ICE 1A	100 A 4 E 4 MC	100 A1 Ice Class 1 * LMC or 100A1 Ice Class 1A Super LMC	NS* (Class 1A Super Ice strengthening) MNS or NS* Class AA 1S MNS*	*KM YLA or *KM YL	KM ⊛ Y ☹ A or KM ⊛ Y ☹	100A-1.1 RG 1* or 100A-1.1 1AS	RNR ⚓M G 60 CM O or RNR ⚓M G 50 CM O
2	Type B	A1 Ⓔ Ice strengthening Class A or A1 Ⓔ Ice strengthening Class 1A AMS	1 3/3 E glace I or 1 3/3 E Ice Class 1A	1 A 1 ICE A or 1 A 1 ICE 1A	100 A 4 E 3 MC	100 A1 Ice Class 1 LMC or 100A1 Ice Class 1A LMC	NS* (Class 1A Ice strengthening) MNS* or NS* Class A 1S MNS*	*KM L1	KM ⊛ ☹ 1	100A-1.1 RG 1 or 100A-1.1 1A	RNR ⚓M G 40 CM O

(continued)

Table A1. ASPPR Type Ship Equivalencies (completed)

Item	Col. 1 Type of Ship	Col. II American Bureau of Shipping	Col. III Bureau Veritas	Col. IV Det Norske Veritas	Col. V Germanischer Lloyd	Col. VI Lloyd's Register of Shipping	Col. VII Nippon Kaiji Kyokai	Col. VIII Polski Rejestr Statkow	Col. IX Register of Shipping of the USSR	Col. X Registro Italiano Navale	Col. XI Registrul Naval Roman
3	Type C	A1 Ⓔ Ice strengthening Class B AMS or A1 Ⓔ Ice strengthening Class 1B AMS	1 3/3 E glace II or 1 3/3 E Ice Class 1B	1 A 1 ICE B or 1 A 1 ICE 1B	100 A 4 E 2 MC	100 A1 Ice Class 2 LMC or 100A1 Ice Class 1B LMC	NS* (Class 1B Ice strengthening) MNS* or NS* Class B 1S MNS*	*KM L2	KM ⊛ ☹2	100A-1.1 RG 2 or 100A-1.1 1B	RNR ⚓M G 30 CM O
4	Type D	A1 Ⓔ Ice strengthening Class C AMS or A1 Ⓔ Ice strengthening Class 1C AMS	1 3/3 E glace III or 1 3/3 E Ice Class 1C	1 A 1 ICE C or 1A1 ICE 1C	100 A 4 E 1 MC	100 A1 Ice Class 3 LMC or 100A1 Ice Class 1D LMC	NS* (Class 1C Ice strengthening) MNS* or NS* Class C 1S MNS*	*KM L3 or KM L4	KM ⊛ ☹3	100A-1.1 RG 3 or 100A-1.1 1C	RNR ⚓M G 20 CM O
5	Type E	A1 Ⓔ AMS	1 3/3 E	1 A 1	100 A 4 MC	100 A1 LMC	NS* MNS*	*KM	KM ⊛	100A-1.1	RNR ⚓M CM O

*1 The mark * in these columns is optional.*

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Table A2. Entry and Exit Dates for Zones

Item	Col. I Category	Col. II Zone 1	Col. III Zone 2	Col. IV Zone 3	Col. V Zone 4	Col. VI Zone 5	Col. VII Zone 6	Col. VIII Zone 7	Col. IX Zone 8	Col. X Zone 9	Col. XI Zone 10	Col. XII Zone 11	Col. XIII Zone 12	Col. XIV Zone 13	Col. XV Zone 14	Col. XVI Zone 15	Col. XVII Zone 16
1	Arctic Class 10	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
2	Arctic Class 8	July 1 to Oct. 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
3	Arctic Class 7	Aug. 1 to Sept. 30	Aug. 1 to Nov. 30	July 1 to Dec. 31	July 1 to Dec. 15	July 1 to Dec. 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
4	Arctic Class 6	Aug. 15 to Sept. 15	Aug. 1 to Oct. 31	July 15 to Nov. 30	July 15 to Nov. 30	Aug. 1 to Oct. 15	July 15 to Feb. 28	July 1 to Mar. 31	July 1 to Mar.31	All Year	All Year	July 1 to Mar.31	All Year	All Year	All Year	All Year	All Year
5	Arctic Class 4	Aug. 15 to Sept. 15	Aug. 15 to Oct. 15	July 15 to Oct. 31	July 15 to Nov. 15	Aug. 15 to Sept. 30	July 20 to Dec. 31	July 15 to Jan. 15	July 15 to Jan. 15	July 10 to Mar. 31	June 10 to Feb. 28	July 5 to Jan. 15	June 1 to Jan. 31	June 1 to Feb. 15	June 15 to Feb. 15	June 15 to Mar.15	June 1 to Feb. 15
6	Arctic Class 3	Aug. 20 to Sept. 15	Aug. 20 to Sept. 30	July 25 to Oct. 15	July 20 to Nov. 5	Aug. 20 to Sept. 25	Aug. 1 to Nov. 30	July 20 to Dec. 15	July 20 to Dec. 31	July 20 to Jan. 20	July 15 to Jan. 25	July 5 to Dec. 15	June 10 to Dec. 31	June 10 to Dec. 31	June 20 to Jan. 10	June 20 to Jan. 31	June 5 to Jan.10
7	Arctic Class 2	No Entry	No Entry	Aug 15. to Sept.30	Aug 1. to Oct. 31	No Entry	Aug. 15 to Nov. 20	Aug. 1 to Nov. 20	Aug. 1 to Nov. 30	Aug. 1 to Dec. 20	July 25 to Dec. 20	July 10 to Nov. 20	June 15 to Dec. 5	June 25 to Nov. 22	June 25 to Dec. 10	June 25 to Dec. 20	June 10 to Dec. 10
8	Arctic Class 1A	No Entry	No Entry	Aug. 20 to Sept. 15	Aug 20 to Sept. 30	No Entry	Aug. 25 to Oct. 31	Aug. 10 to Nov. 5	Aug. 10 to Nov. 20	Aug. 10 to Dec. 10	Aug. 1 to Dec. 10	July 15 to Nov. 10	July 1 to Nov. 10	July 15 to Oct. 31	July 1 to Nov. 30	July 1 to Dec. 10	June 20 to Nov. 30
9	Arctic Class 1	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 25 to Sept. 30	Aug. 10 to Oct. 15	Aug. 10 to Oct. 31	Aug. 10 to Oct. 31	Aug. 1 to Oct. 31	July 15 to Oct. 20	July 1 to Oct. 31	July 15 to Oct. 15	July 1 to Nov. 30	July 1 to Nov. 30	June 20 to Nov. 15
10	Type A	No Entry	No Entry	Aug. 20 to Sept. 10	Aug 20. to Sept. 20	No Entry	Aug. 15 to Oct. 15	Aug. 1 to Oct. 25	Aug. 1 to Nov. 10	Aug. 1 to Nov. 20	July 25 to Nov. 20	July 10 to Oct. 31	June 15 to Nov. 10	June 25 to Oct. 22	June 25 to Nov. 30	June 25 to Dec. 5	June 20 to Nov. 20
11	Type B	No Entry	No Entry	Aug. 20 to Sept. 5	Aug. 20 to Sept. 15	No Entry	Aug. 25 to Sept. 30	Aug. 10 to Oct. 15	Aug. 10 to Oct. 31	Aug. 10 to Oct. 31	Aug. 1 to Oct. 31	July 15 to Oct. 20	July 1 to Oct. 25	July 15 to Oct. 15	July 1 to Nov. 30	July 1 to Nov.30	June 20 to Nov. 10

(continued)

Sabina
GOLD & SILVER CORP.

Table A2. Entry and Exit Dates for Zones

Item	Col. I Category	Col. II Zone 1	Col. III Zone 2	Col. IV Zone 3	Col. V Zone 4	Col. VI Zone 5	Col. VII Zone 6	Col. VIII Zone 7	Col. IX Zone 8	Col. X Zone 9	Col. XI Zone 10	Col. XII Zone 11	Col. XIII Zone 12	Col. XIV Zone 13	Col. XV Zone 14	Col. XVI Zone 15	Col. XVII Zone 16
12	Type C	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 25 to Sept. 25	Aug. 10 to Oct. 10	Aug. 10 to Oct. 25	Aug. 10 to Oct. 25	Aug. 1 to Oct. 25	July 15 to Oct. 15	July 1 to Oct. 10	July 15 to Oct. 10	July 1 to Nov. 25	July 1 to Nov. 25	June 20 to Nov. 10
13	Type D	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 10 to Oct. 5	Aug. 15 to Oct. 20	Aug. 15 to Oct. 20	Aug. 5 to Oct. 20	July 15 to Oct. 10	July 1 to Oct. 20	July 30 to Sept. 30	July 10 to Nov. 10	July 5 to Nov. 10	July 1 to Oct. 31
14	Type E	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug. 20 to Sept. 30	Aug. 20 to Oct. 20	Aug. 20 to Oct. 15	Aug. 10 to Oct. 20	July 15 to Sept. 30	July 1 to Oct. 20	Aug. 15 to Sept. 20	July 20 to Oct. 31	July 20 to Nov. 5	July 1 to Oct. 31

¤ *August 1, if an icebreaker is available for escort, in or in the vicinity of Zone 6.*

Appendix V2-4B

Metallurgical Assessment

an ERM company

Memo

To	M. Brownhill, R.P.Bio, Manager, Environmental Approvals
From	T. Morrison, P.Eng., Project Engineer
Date	October 22, 2013
Subject	Metallurgical Assessment

RECOVERY METHODS – MINERAL PROCESSING

Introduction

Sabina proposes to process the gold ore from the Goose and George sites at a single mill site close to the Goose deposits at a nominal rate of 5,000 t/d. The Goose deposits will be the dominant sources of mill feed for the plant, and will supply mill feed throughout the projected LOM, except in Year 9. A mill dedicated to ore from the George deposits would be uneconomical and would increase the project footprint, necessitating a second tailings storage facility.

Summary

A combination of conventional gravity concentration and cyanidation is proposed for the Project. The process plant will comprise crushing, grinding, gravity concentration, cyanidation by carbon-in-leach (CIL), and gold recovery from the loaded carbon to produce gold doré.

The process plant will consist of three separate facilities at the Goose site:

- A crushing facility, including primary, secondary and tertiary crushing and related material handling facility;
- A fine ore surge bin and related feeding and reclaim systems; and
- A main process facility, including primary grinding, gravity concentration, leaching feed thickening, cyanide leaching, loaded carbon acid wash, elution and reactivation, gold electro-winning, smelting, and cyanide destruction of the leach residue.

The crushing circuits consist of a jaw crusher, a standard cone crusher, and a short head cone crusher in closed circuit with vibrating screens. These will reduce the ROM ore to a particle size of approximately 80% passing 10 mm. The crushed ore will be transported by a conveyance system to a 2,500-t surge bin, and then reclaimed and fed to a ball mill in closed circuit with two centrifugal gravity concentrators and hydrocyclones. Approximately 40% of the gold is expected to be recovered from the gravity concentration circuit. An intensive leach unit will be provided to recover gold from the gravity concentrate. The grinding circuit will reduce the crushed ore to a particle size of 80% passing 100 µm.

The hydrocyclone overflow from the primary grinding circuit will flow by gravity to a thickener where the slurry will be thickened for downstream cyanidation. The underflow of the thickener then will be diluted with process water to the optimum solids density, and cyanide leached in a CIL circuit to recover gold that has not been recovered by the gravity concentration/intensive leach circuits.

The loaded carbon from the CIL circuit will be washed by diluted acid solution, and eluted using a conventional Zadra pressure stripping process. The gold in the pregnant solution will be recovered by electro-winning. The barren solution from the elution circuit will be circulated back to the leach/elution circuit. The gold sludge produced from the electro-winning circuit will be smelted to produce gold doré bullion.

The residue from the leach circuit will be sent to a cyanide destruction circuit employing a SO_2/air process to destroy the residual WAD cyanide. The treated residue slurry will then be pumped to the lined TSF for storage.

These processes are shown in the simplified flowsheet in Figure 1 and are detailed in the following sections.

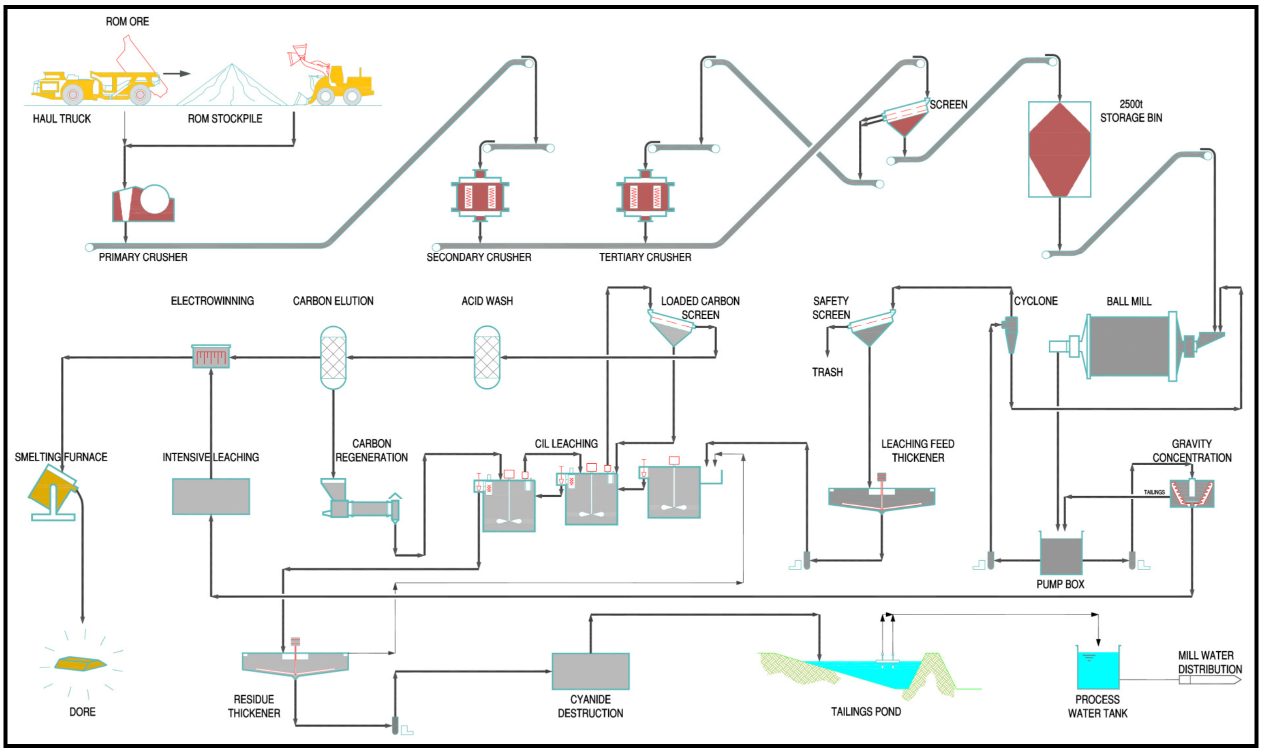

Figure 1: Simplified Process Flowsheet

PLANT DESIGN

A combination of gravity separation and direct whole ore leach processes was selected for the Project. The 2012 test program showed that the mineralization responded reasonably well to the flotation followed by flotation concentrate leach procedure. However, in general, the overall gold recovery by the gravity concentration/flotation/leach process was slightly lower than the gravity concentration/direct whole ore leach process. Because a significant amount of nugget gold occurs in the mineralization, gravity concentration and intensive leach are proposed for the recovery of liberated gold grains in the grinding circuit.

Major Process Design Criteria

The nominal throughput of the process plant is designed to be 1,825,000 t/a or 5,000 t/d. The major criteria used in the design are shown in Table A.

Table A. Major Design Criteria

Criteria	Unit	Value
General		
Daily Process Rate	t/d	5,000
Operating Day	d/a	365
Overall Gold Recovery	%	88.0
Gold Production, Average	t/a	9.1
Ore Characteristics		
Head Gold Grade , Average	g/t Au	5.69
Specific Gravity		3.05
Primary/Secondary/Tertiary Crushing		
Availability – Primary/Secondary/Tertiary Crushing	%	70
Crushing Process Rate	t/h	298
Primary Crushing Product Particle Size, 80% passing	µm	120,000
Secondary Crushing Product Particle Size, 80% passing	µm	28,000
Tertiary Crushing Product Particle Size, 80% passing	µm	10,000
Grind/Gravity/Leach		
Availability	%	92
Nominal Milling Process Rate	t/h	226
Nominal Gravity Circuit Process Rate	t/h	366
Mill Feed Size, 80% passing	µm	10,000
Primary Grind Size, 80% passing	µm	100
Bond Ball Mill Work Index - Design	kWh/t	15.1
Bond Abrasion Index	g	0.4369
Leach Method		CIL
Feed Mass to CIL Circuit	t/h	226

Process Plant Description

Primary Crushing

The crushing facility will have an average process rate of 298 t/h. A jaw crusher is proposed for primary crushing. The major equipment and facilities at the site include:

- One hydraulic rock breaker;
- One 1,200 mm-wide by 9,300 mm-long stationary grizzly;
- One apron feeder;
- One crusher unit, including a jaw crusher equipped with a 250-kW motor and a discharge conveyor;
- Belt scales; and
- One dust collection system.

The ROM ore will be trucked from the open pits or underground mine and dumped directly into the jaw crusher feed surge bin, or stockpiled and then reclaimed by a loader to the surge bin. The material will be reduced to 80% passing 120 mm by the jaw crusher. A rock breaker will be provided to break any oversize rocks.

The product from the primary crusher will be conveyed to the secondary crushing circuit.

The primary crushing area will be equipped with a dust collection system to control fugitive dust generated during crushing and conveyor loading.

Secondary Crushing

The secondary crushing circuit will be operated in open circuit. A cone crusher with a standard head will be used for crushing. The jaw crusher discharge will be conveyed to a 30 m^3 surge bin and then reclaimed by a belt feeder to the cone crusher. The crushed material from the cone crusher will discharge onto the screen feed conveyor, which will also receive the crushed material from the tertiary crusher. The conveyor will transport the combined material to a vibratory double deck screen.

The secondary and tertiary crushing areas will be equipped with a dust collection system to control fugitive dust that will be generated during crushing and transporting of the crushed material. The secondary crushing facility will include:

- One crushing unit, including a standard head cone crusher with an installed power of 355 kW and a discharge belt conveyor;
- One 30 m^3 surge bin and 1.2 m-wide by 6.6 m-long belt feeder; and
- One dust collection system.

Tertiary Crushing

The tertiary crushing circuit will consist of a short head cone crusher in closed circuit with a vibrating screen. The material in the 30 m^3 tertiary crusher surge bin will feed the crusher at a control speed. The discharge of the crusher, together with the discharge from the secondary crusher, will be conveyed to the vibratory screen equipped with double decks. The screen oversize will be recycled back by conveyance to the tertiary crusher feed surge bin. The screen undersize with a particle size of 80% passing approximately 10 mm will be delivered to the mill feed surge bin by a conveyor. The fugitive dust generated in this area will be controlled by the dust collection system provided for the cone crusher areas. The tertiary crushing circuit will include:

- One 3.0 m-wide by 6.0 m-long vibrating screen equipped with double decks;
- One crushing system including a short head cone crusher driven by a 355 kW motor and a discharge belt conveyor;
- One 30 m^3 feed surge bin;
- Associated belt conveyors, metal detectors, and self-cleaning magnets; and
- One dust collection system.

Mill Feed Surge Bin

The mill feed surge bin will have a live capacity of 2,500 t. The crushed material will be reclaimed from the bin by two belt feeders, each at a nominal rate of 113 t/h, and placed onto a belt conveyor to feed the ball mill. A dust collection system will be installed in the area to control fugitive dust.

The fine ore stocking and re-handling system will include:

- One mill feed surge bin with a live capacity of 2,500 t;
- Two reclaim belt feeders; and
- One dust collection system.

Primary Grinding, Classification, and Primary Gravity Concentration

The primary grinding circuit will consist of a ball mill in closed circuit with one hydrocyclone cluster and two centrifugal gravity concentrators in conjunction with one intensive leach unit. The grinding will be conducted as a wet process at a nominal rate of 226 t/h. The grinding/gravity concentration circuit will include:

- One 5.2 m-diameter by 8.6 m-long ball mill, equipped with a 3,700-kW motor;
- Hydrocyclone feed slurry pumps and centrifugal concentrator feed slurry pumps;
- Three 600 mm hydrocyclones;
- Two centrifugal gravity concentrators and related safety screens; and
- One particle size analyzer.

The material from the surge bin will enter the grinding circuit via the belt conveyor. The ball mill discharge will report to the hydrocyclone/gravity concentrator feed pump box, where water will be added for solid density control. Approximately 70% of the slurry in the pump box will be pumped to the hydrocyclones cluster, while the balance of the slurry in the pump box will be pumped to the gravity concentration circuit.

The hydrocyclone underflow will flow by gravity to the ball mill feed chute. The proposed circulating load of the grinding circuit is 300%. The hydrocyclone overflow will report to the leaching feed thickener. The particle size of the hydrocyclone overflow is 80% passing 100 µm. The solid density of the hydrocyclone overflow slurry will be approximately 33% w/w. Dilution water will be added to the grinding circuit as required and lime slurry will be added to the mill to adjust the slurry pH.

The gravity concentration circuit will consist of two centrifugal concentrators in a parallel arrangement. The slurry that is pumped to the gravity circuit will be screened by the gravity concentrator feed screens to remove any entrained foreign materials. The screen undersize will report to their respective centrifugal gravity concentrator to recover nugget gold grains. The tailings from the gravity concentrators will return to the hydrocyclone/gravity concentrator feed pump box by gravity. The gravity concentrate will be sent to an intensive leach system to extract the gold from the coarse gold grains. The resulting pregnant solution will be pumped to the electrowinning circuit for gold recovery. The residue from intensive cyanidation will be washed and returned to the ball mill for further grinding. The gravity concentration area will be secured and monitored by closed-circuit television (CCTV) systems. Any access to the area will be restricted to authorized personnel only.

CYANIDE LEACHING AND CARBON ADSORPTION

The hydrocyclone overflow will be screened to remove any oversize material and the trash screen undersize will flow by gravity to the leach feed thickener for optimum solid density control for downstream cyanidation. The thickener overflow will be pumped to the grinding circuit for reuse.

The thickener underflow, with a solids density of 63% w/w, will be pumped to the head of a cyanide leach bank. The overflow of the leach residue thickener will be added to dilute the cyanide leach feed to a solid density of approximately 49% w/w. The cyanidation will be performed in a CIL circuit consisting of one leach tank and six CIL tanks. Each of the tanks will have dimensions of 14.5 m diameter by 14.5 m high, and will be equipped with an agitator. The seven tanks will provide a total retention time of 48 hours. The tanks will be aerated with compressed air from three free compressors (two operations and one standby). The CIL tanks will be equipped with in-tank carbon transferring pumps and inter-stage screens to advance the loaded carbon to the preceding leach tank. The activated carbon will be added into the last leach tank, and the loaded carbon will leave the CIL circuit from the first CIL tank. Sodium cyanide will be added to the leach tanks to extract gold. Lime will be added to maintain a slurry pH of approximately 10 to 11.

The loaded carbon leaving the second tank, or the first CIL tank, will be transferred to the carbon stripping circuit while the leach residue will be sent to a carbon safety screen to recover any coarse carbon grains. The screen undersize will report to the residue thickener prior to being pumped to the cyanide destruction circuit.

The key equipment in the leach circuit includes:

- One 18.5 m-diameter high-rate thickener;
- One 14.5 m-diameter by 14.5 m-high leach tank;
- Six 14.5 m-diameter by 14.5 m-high CIL leach tanks equipped with in-tank carbon transferring pumps and screens;
- One 2.0 m-wide by 4.0 m-long leach thickener feed trash screen;
- One 2.0 m-wide by 3.0 m-long loaded carbon screen;
- One 2.0 m-wide by 4.0 m-long carbon safety screen; and
- Three dedicated oil free type air compressors.

Cyanide detection/alarm systems, safety showers, and emergency medical stations will be provided in the area to protect operators.

Carbon Stripping

The loaded carbon will be treated by acid washing and the Zadra pressure stripping process for gold desorption in two separate lines. Each line is capable of processing 3.5 t of loaded carbon within less than 24 hours. The loaded carbon will be acid washed by diluted hydrochloric acid solution to remove any contaminants prior to being transferred to two elution vessels. The acid wash will primarily remove calcium scale, which precipitates during the leach process. The acid washed carbon bed will be rinsed with fresh water.

The stripping process will include circulation of the heated barren solution through the carbon bed. The barren solution will be heated by exchanging heat with the pregnant solution through a heat recovery heat exchanger and by a steam heated exchanger. The barren solution will then flow up through the bed of the loaded carbon in the elution vessel and overflow near the top of the stripping vessel.

The pregnant solution will be cooled by exchanging heat with the barren solution and flow through a back pressure control valve to the pregnant solution holding tank for subsequent gold recovery by electrowinning. The stripped carbon will be discharged from the bottom of the vessel through a regulating valve to the stripped carbon tank.

The stripping process will include:

- Barren and pregnant solution tanks;
- Two 3.5 t acid wash vessels;
- Two 3.5 t stripping vessels;
- Four heat exchangers; and
- One steam boiler.

Carbon Reactivation

The stripped carbon will be transferred by a recessed impeller pump to a stationary dewatering screen for dewatering and to the kiln feed bin, which provides supplemental dewatering. The reactivation will be carried out in a fuel-heated rotary kiln at a temperature of 650°C to 700°C and in an inert atmosphere. The hot, reactivated carbon will discharge into a tank flooded with water where the carbon is quenched. The regenerated carbon will be circulated back into the CIL circuit after attrition treatment and screen washing. Recessed impeller pumps will deliver the regenerated carbon to the CIL circuit. Make-up fresh carbon will be added, as required. The fresh carbon will be treated by attrition prior to being used in the CIL circuit. The carbon reactivation process will include:

- One carbon reactivation kiln fired by diesel, with heat recovery function;
- One carbon quench tank and a carbon abrasion tank equipped with an attrition agitator;
- One reactivated carbon sizing screen;
- One carbon storage bin; and
- Fine carbon handling associated equipment.

Sufficient ventilation will be provided in this area to mitigate the potential impact of off-gas from the carbon regeneration kiln on the working environment.

Intensive Cyanide Leaching – Gravity Concentrate

The gravity concentrates from the centrifugal concentrators will be pumped to an intensive cyanide leach unit. The intensive leach unit, equipped with an automatic control system, will be on a batch operation basis. The high grade gravity concentrates will be leached by a solution with an elevated cyanide concentration. The pregnant solution produced from the intensive leach unit will be pumped to the eletrowinning circuit to recover the extracted gold. The intensive leach residue after washing will be pumped back to the primary grinding circuit for further grinding. The area will be secured and monitored by a CCTV system. Any access to the area will be restricted to authorized personnel only.

Gold Electrowinning and Refining

The pregnant solution from the elution system and intensive leach circuit will be pumped from the pregnant solution stock tank through electrowinning cells where the gold will be deposited on stainless steel cathodes. The depleted solution will be sent to the barren solution tank, prior to being reheated and returned to the stripping vessel or being sent to the CIL circuit. On average, the electrowinning circuit will have a capacity to process approximately 40 kg/d of gold-silver doré bullion and will include two 3.5 m^3 electrowinning cells, two direct current rectifiers, cathodes, anodes, and a pressure filter.

Periodically, the stainless steel cathodes will need to be cleaned to remove precious metals in the form of sludge. The mud will be stored in a conical bottom filter feed tank from where it is pumped to a plate and frame filter press for dewatering on a batch basis. The filter cake will be dried in an oven. Dried slimes will be mixed with flux consisting of borax, sodium nitrate, feldspar, and soda ash, and melted at approximately 1,150°C in a 175-kW induction furnace to produce gold bullion containing mostly gold and some silver and impurities.

The area will be provided with sufficient ventilation to mitigate the potential impact of off-gas produced from the melting furnace and dust generated from flux mixing. The gold room will be in a secure facility with secured entrances, which will be monitored by 24-hour CCTV surveillance. Access to the gold room will be restricted to authorized personnel only.

Treatment of Leach Residue

Leach Residue Dewatering

Residue from the CIL circuit will be pumped to an 18.5 m-diameter high-rate thickener to recover residual cyanide and water. The thickener overflow will be pumped back to the leach feed box as dilution water. The underflow of the thickener will be sent to the cyanide destruction circuit prior to being pumped to the TSF.

Cyanide Destruction

The underflow of the residue thickener will be pumped to a cyanide destruction circuit.

The WAD residual cyanide in the underflow of the thickener will be decomposed by a sulphur dioxide (SO_2)/air oxidation process. Sulphur (solid) will be used as the main SO_2 source. A sulphur burner will be provided to convert the sulphur in solid form to SO_2 gas. The equipment used will include three 6.5 m-diameter by 7.5 m-high SO_2 oxidation tanks (two operating and one standby).

Compressed air will be provided for the oxidation process. A sodium metabisulphite (MBS) mixing system will be provided to generate SO_2 for the detoxification process in the event that the sulphur burner is required to be shut down for planned and unplanned maintenance. The process will be in an enclosed area and a wet alkaline scrubbing system will be provided to control gaseous emissions. SO_2 gas alarms/monitors will also be provided to monitor SO_2 concentration in the area.

TAILINGS STORAGE

The treated CIL residue will be pumped to the TSF, located northwest of the main process plant. The CIL residue storage pond will be lined. The residue will be covered with the water to prevent sulphide mineral oxidation. The supernatant solution from the CIL residue pond will be reclaimed by pumping it to the CIL circuit for reuse.

Reagents Handling

The reagents used in the process will include:

- CIL and Gold Recovery: hydrated lime (Ca(OH)2), sodium cyanide (NaCN), activated carbon, sodium hydroxide (NaOH), and hydrochloric acid (HCl);
- Cyanide Destruction: sulphur (solid), copper sulphate (CuSO4),hydrated lime (Ca(OH)2), and metabisulphite (MBS); and
- Others: flocculant and antiscalant.

All the reagents will be prepared in a separate reagent preparation and storage facility in a containment area. The reagent storage tanks will be equipped with level indicators and instrumentation to ensure that spills do not occur during operation. Appropriate ventilation and fire and safety protection will be provided at the facility.

The liquid reagents (including HCl and antiscalant) will be added in the undiluted form to the required process circuits via individual metering pumps.

All the solid type reagents (hydrated lime, sodium hydroxide, sodium cyanide, copper sulphate, and metabisulphite if required) will be mixed with fresh water to a solution strength of 10 to 25% in the respective mixing tanks, and stored in separate holding tanks before being added to various addition points by metering pumps. The lime slurry will be distributed to various addition points through a closed pressure loop. Cyanide monitoring/alarm systems will be installed at the cyanide preparation and leaching areas. Emergency medical stations and emergency cyanide detoxification chemicals will be provided at the areas as well.

Solid sulphur will be shipped to the site and used to generate SO_2 gas for destructing residual cyanide in the leach residue. The solid sulphur will be heated and reacted with air in a sulphur burner to produce SO_2 gas. A wet scrubbing system will be provided to control gaseous emissions in the SO_2 gas generation and cyanide destruction areas. SO_2 gas alarms/monitors will also be provided to monitor SO_2 concentration in the area.

Flocculant will be delivered to the site in solid form. The flocculant will be prepared in a packaged preparation system, including a screw feeder, a flocculant eductor, and mixing devices. The flocculant mixing system will run automatically based on the solution level in the holding tank. The mixed solution will be transferred and stored in an agitated flocculant holding tank. Flocculant will be made up to a 0.2% solution strength and added via metering pumps to the leach feed thickener and the leach residue thickener.

Water Supply

Two separate water supply systems will be provided to support the process operations – one fresh water system, and one process water system for various process circuits. Both the process and fresh water tanks will be located inside the process plant.

Fresh Water Supply System

Fresh water will be supplied to one 10.0 m-diameter by 8.0 m-high storage tank from Goose Lake. Fresh water will be used primarily for the following:

- Fire water for emergency use;
- Cooling water for mill motors and mill lubrication systems;
- Gland seal water for slurry pumps;
- Potable water supply, which will be directly taken from fresh water intake pipeline; and
- Reagent preparation.

By design, the fresh water tanks will be full at all times, and will provide at least two hours of firewater in an emergency. The minimum fresh water requirement for process mill cooling, pump gland seal, and reagent preparation is estimated to be approximately 29 m^3/h on average. The potable water from Goose Lake will be treated (chlorination and filtration) and stored in a covered tank prior to delivery to various service points.

Process Water Supply System

The process water system will supply process water for the grinding/gravity, CIL leach, gold recovery, and other circuits.

Overflow from the CIL feed thickener and water from the leach residue storage pond will be pumped to an 8.0 m-diameter by 8.0 m-high process water surge tank. The water will be pumped to various service points. Overflow from the residue thickener will be used to dilute the leach feed thickener underflow. A booster pump station will be provided to pump water to the various distribution points where high pressure water is required.

Air Supply

Plant air service systems will supply air to the following areas:

- Leach circuits – high pressure air by three dedicated oil-free type air compressors;
- Cyanide destruction circuits – low pressure air by two air blowers;
- Crushing circuit – high pressure air for the dust suppression system and other services by an air compressor;
- Plant services – high pressure air for various services by two dedicated air compressors; and

- Instrumentation – instrument air will come from the plant air compressors and will be dried and stored in a dedicated air receiver.

Assay and Metallurgical Laboratory

The assay laboratory will be equipped with the necessary analytical instruments to provide routine assays for the mine, process, and environmental departments. The assay laboratory will provide standard assaying. The data obtained will be used for product quality control and routine process optimization. The assay laboratory will consist of a full set of assay instruments for gold and silver assays, and base metal analysis such as:

- Fire assay equipment;
- An atomic absorption spectrophotometer (AAS);
- An inductively coupled plasma (ICP) spectrometry for the routine assays;
- A Leco furnace; and
- Other determination instruments, such as pH and redox potential meters, and experimental balances.

An inductively coupled plasma mass spectrometry (ICP-MS) will be provided for routine chemical analyses for environmental samples. The metallurgical laboratory will perform tests to optimize the process flowsheet and improve metallurgical performance. The laboratory will be equipped with laboratory crushers, ball mills, particle size analysis devices, laboratory leach cells, gravity concentration devices, balances, and pH meters.

Process Control and Instrumentation

Overview

The plant control system will consist of a Distributed Control System (DCS) with PC-based Operator Interface Stations (OIS) located in two separate control rooms:

- Primary crusher control room; and
- Central control room (process building).

The central control room will receive the data collected from the crushing plant and will monitor and control the crushing operations, as required. The DCS, in conjunction with the OIS, will perform all equipment and process interlocking, control, alarming, trending, event logging, and report generation. DCS Input/Output (I/O) cabinets will be located in electrical rooms throughout the plant and interconnected via a plant-wide fibre optic network.

Field instrumentation will consist of microprocessor based “smart”-type devices. Instruments will be grouped into process areas and wired to local field instrument junction boxes located within those areas. Signal trunk cables will connect the field instrument junction boxes to DCS I/O cabinets.

Intelligent type motor control centres (MCCs) will be located in the electrical rooms throughout the plant. MCCs remote operation and monitoring will be via Profibus (or other approved industrial communications protocol) interface to the DCS.

Programmable logic controllers (PLCs) or others third party control systems (supplied as part of the mechanical packages) will be interfaced to the plant control system via ethernet network interfaces.

Primary Crushing Facility

A control room in the primary crushing building will be provided with a single OIS. Control and monitoring of all primary, secondary, tertiary crushing and conveying operations (including discharging onto the ball mill surge bin) will be conducted from this location. Control and monitoring functions will include the following:

- Plugged chute detection at all transfer points;
- Zero speed switches, side travel switches, emergency pull cords, and belt rip detection of all conveyors;
- Weightometers on selected conveyors to monitor feed rates and quantities;
- Equipment bearing temperatures and lubrication system status; and
- Vendors' instrumentation packages.

Data collected from the crushing plant will be provided to the central control room, located in the main process building, and to the crushing plant control system via a serial Ethernet gateway.

Process Plant

A central control room in the process building will be provided with three OIS. Control and monitoring of all processes within the plant and remote ancillary areas will be conducted from this location. Control and monitoring functions will include the following areas:

- Grinding;
- Gravity concentrator;
- Leaching and thickening;
- Loaded carbon elution;
- Electrowinning;
- Carbon regeneration;
- Fresh fire and potable water systems;
- Air supply systems, including process air, plant services air, and instrument air;
- Dust collection systems and off-gas scrubbing systems; and
- Reagent preparation.

In addition to the plant control system, a CCTV system will be installed at various locations throughout the plant including the crushing facility, the stockpile conveyor discharge point, the TSF, and the gold recovery facilities. The cameras will be monitored from the local and central control rooms.

Process control will be enhanced with the installation of an automatic sampling system. The system will collect samples from various streams for on-line particle size analysis and the daily metallurgical balance.

For the protection of operating staff, cyanide monitoring/alarm systems will be installed at the cyanide leaching area and destruction areas. An SO_2 monitor/alarm system will monitor the cyanide destruction area as well.

Communications

Site-wide communications design will incorporate reliable and state-of-the-art communications systems to ensure that personnel at the mine site have adequate voice, data, and other communication channels available. A number of integrated systems will be provided for on- and off-site communication at the plant.

A trunked radio system consisting of hand-held, mobile, and base radios will provide wide area coverage for on-site communication by operations. The trunked radio system will be interfaced to the on-site Voice over Internet Protocol (VoIP) telephone system. The proposed VoIP telephone system will feature 4-digit dialing within the mine site, access code-based long distance calling, and voicemail services. For connectivity, the telephone system will utilize the site local area network (LAN).

A site LAN will be provided to consolidate services into a single network infrastructure. Computers, cameras, telephones, and any Internet Protocol (IP) devices requiring connection to the corporate network will utilize the LAN. Further to the hardwired portion of the LAN, wireless access points will be placed in common areas such as the recreation hall, administration area, dining area, and construction office.

Voice and data communications to the mine site will be established via a microwave radio link. A tower-mounted microwave antenna and radio equipment at the site, along with three new repeater stations, will be utilized to establish a voice and data link to the Ekati mine site where Northwestel has an established communication network.

Yearly Metallurgical Performance Projection

According to the test work results and the current mine production schedule, gold recoveries for the Project are shown in Table B, as projected on a yearly basis. On average, the process plant is estimated to produce approximately 10,200 kg of gold per year for the first 5 years, or 8,900 kg of gold per year for the LOM, Further gravity concentration and cyanidation test work are recommended for more accurate metallurgical performance projections.

Table B: Yearly Gold Production Projections

Year	Mill Feed (t)	Gold Grade (g/t)	Gold Recovery (%)	Gold Production	
				kg	oz
1	1,551,250	6.76	85.8	9,000	289,000
2	1,825,000	6.91	85.7	10,800	348,000
3	1,825,000	6.68	86.6	10,600	339,000
4	1,825,000	6.35	90.0	10,400	335,000
5	1,825,000	6.18	92.0	10,400	334,000
6	1,825,000	5.61	90.3	9,300	297,000
7	1,825,000	3.86	86.7	6,100	196,000
8	1,825,000	4.03	87.0	6,400	206,000
9	662,960	3.70	86.0	2,100	68,000
Total/Average	**14,989,210**	**5.69**	**88.0**	**75,100**	**2,412,000**

Ore Processing Alternatives

The Back River gold deposits are of a type well known in Canada; although alternatives exist in theory, several decades of experience with this type of mineralization has reduced the available choices to a few options varying only in detail.

Comminution Circuit Alternatives

The options investigated include:

- Conventional three stage crushing followed by two-stage ball milling;
- Primary crushing and SAG milling followed by ball milling in closed circuit with a cyclone; and
- Two-stage crushing followed by high pressure grinding rolls (HPGR) and ball milling.

Prefeasibility results indicate that the HPGR circuit would consume less energy than the ball-mill-based or SAG-based circuits but it also carries higher risks as a relatively unknown technology and will require additional material handling. The preferred alternative for the present is a ball-mill-based circuit with pre-crushing. SAG milling was considered and will be considered in further detail at the Feasibility stage.

Alternative crushing/grinding circuit configurations such as the inclusion of secondary crushing, or where the ball mill is replaced by a Vertimill, continue to be considered, and the final selection will be made pending ongoing studies. These options have the potential to reduce the overall mill power consumption.

Flotation Alternatives

The inclusion of flotation with cyanidation of the concentrate was considered, but was not retained because the reagent cost savings were insufficient to offset the loss in gold recovery and increased capital expenditure. The flotation possibility will be considered further at the feasibility stage.

Alternatives to Cyanide

The first step in processing the crushed and ground ore is to recover any free gold using gravity recovery processes. Free gold is commonly recovered in a centrifugal gravity concentrator, which takes advantage of the high density of gold to produce a primary gravity concentrate. The primary concentrate can be upgraded either on shaking tables (analogous to panning for gold) or dissolved in an intensive leach reactor prior being sent to the refinery. Shaking tables represent a security concern due to the need for considerable manual manipulation of the concentrates. Intensive cyanidation is therefore the preferred method if there are no restrictions on the use of chemical reagents.

Recovery of the residual gold following gravity separation typically requires hydrometallurgical processes and gold dissolution requires the use of both a complexant and oxidant. The use of chlorine-chloride leaching was applied commercially in the late 1800s to recover fine gold and gold associated with sulphides until the establishment of the cyanidation process about the turn of the twentieth century. Cyanidation commonly uses oxygen as the oxidant and remains the most commonly applied process due to its low cost, high efficiency and selective dissolution of gold and silver over other metals. Despite the high toxicity of cyanide, its use has minimal risk to health, safety and the environment due to the rigorous controls employed.

The recovery of cyanide for reuse in the milling circuit is well understood and cyanide destruction prior to discharge to the tailings storage facility is technically proven. Cyanide is available as both solid salts and liquid form. It will be shipped to the Project in a solid form as part of the summer sea lift in sealed plastic bins housed within sea cans.

Chlorine is no longer used to treat primary ores due in part to its high cost. Applications using chlorine to treat refractory ores have been proposed at other mines. Other alternative chemicals to cyanide include thiosulfate and thiourea, but these involve prohibitively high reagent costs and have therefore not been applied commercially. The use of alternate reagents to cyanide has technical risks such as difficulty in metal recovery from the leach solution and thus requires additional investigations before being employed. Due to the above considerations, cyanide remains the chemical of choice for the recovery of gold.

Tailings will be treated to destroy cyanide to meet International Cyanide Management Code guidance concentrations prior to its discharge to the TSF (ICMC 2012). Any excess water from the TSF pond will be appropriately treated to meet effluent discharge criteria regarding cyanide before being release into the environment. Reclamation and closure of the TSF will see two meters of waste rock covering the tailings. This will insure the permafrost active layer remains in the cover materials and tailings remain frozen year round.