# APPENDIX 10A-3

# CONSTRUCTION RISK MANAGEMENT REPORT

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# 1. Summary

As part of Baffinland Iron Mines Corporation's Mary River Iron Ore Project, Hatch conducted a qualitative risk management assessment of the project. Following the risk management workshop that was held on July 25, 2011, a project risk register was compiled with inputs from key project stakeholders. Project risks were collectively identified and ranked according to probability of occurrence and impact. Mitigation actions were then provided for each risk by the stakeholder groups divided by project area.

A total of 310 risks were identified by the project team. Of the total risks identified, 71 (23%) were classified as low risks, 231 (74%) as medium risks, and 8 (3%) as high risks. These risks were ranked by consequence and likelihood on a five-point scale. Figure 1- shows a summary of project risks plotted on the resulting consequence – likelihood matrix. This matrix has been aligned with ArcelorMittal's classification of low, medium and high risks. The numbers on the matrix below denote the number of risk events that occurred for each combination of likelihood and consequence.

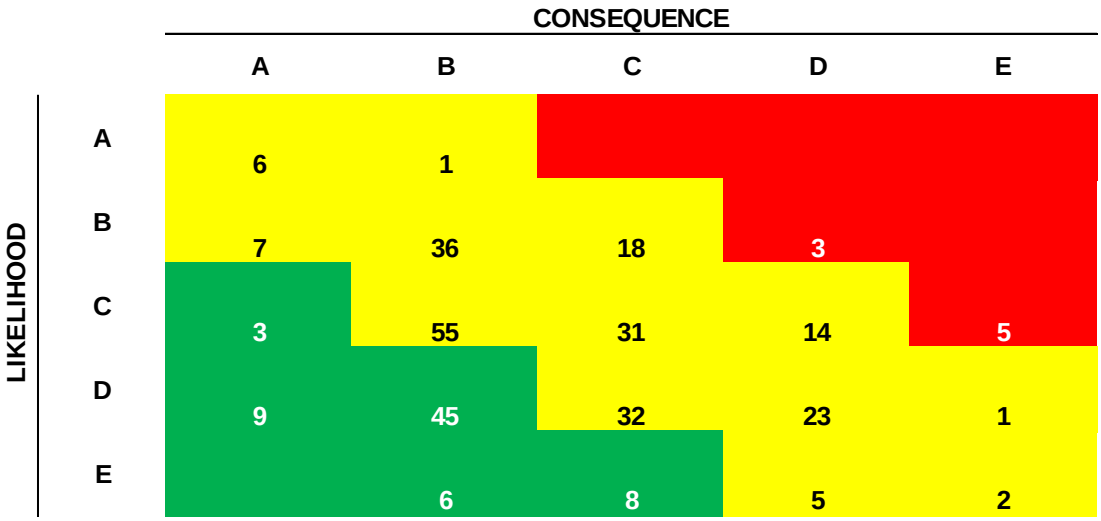



**Figure 1-: Risk Status Summary**

The high risks include those associated with construction injuries due to working over open water at dock area; lower availability of operations equipment due to insufficient cold temperature design; crew fatigue due to 24 hour darkness or sunlight; inability to respond to fires during construction due to unreliable water truck; lack of power supply during construction due to unreliable fuel supply; and inability to transport modules to Mary River site on current Tote Road due to undefined modularization strategy.

Follow up recommendations include assignment of responsibilities and due dates to the identified mitigation actions, and constant update of the risk register throughout project execution in order to identify new risks, modify the rating of existing risks and eliminate risks that are no longer valid. Additionally, a selection of risks is to be quantified, in terms of costs, as part of the Quantitative Risk Assessment, in order to determine the associated contingency amount to be carried by the project as it moves into execution.

# 2. Introduction

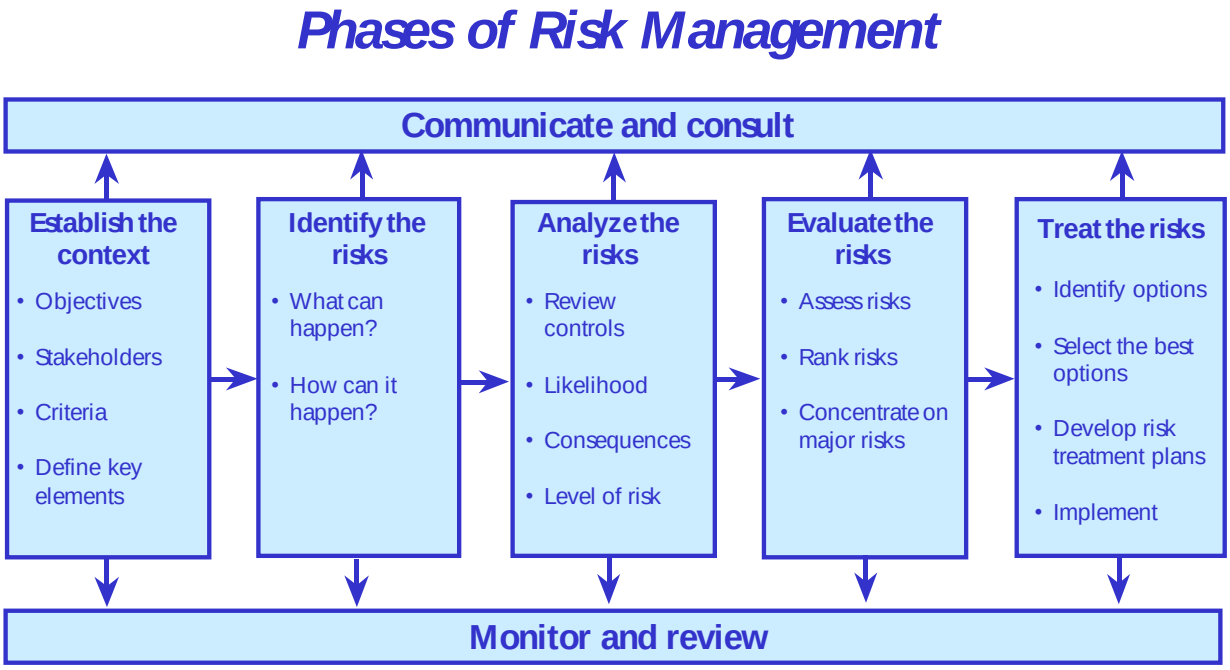
As part of Baffinland Iron Mines Corporation's Mary River Iron Ore Project, Hatch conducted a risk management assessment of the project. The risk assessment involved a qualitative review of risks associated with technical performance (only when influenced by design), project cost, project schedule, health and safety, reputation, legal/regulatory and environmental.

The focus of the risk assessment was on higher level risks representing threats to the success of the project. Opportunities were also captured. The scope included project execution risks only, excluding environmental permitting. Additionally, operational risks that could be caused or mitigated by design, were also included in the scope. The risk ranking according to probability of occurrence and impact, was done at a pre-mitigation level. Mitigation actions were also identified for each risk; however, a post-mitigation ranking was not included as part of the scope.

## 2.1 Risk Management Process

Risk management on Hatch projects is a core function that supports the achievement of business and project objectives through proactive rather than reactive management at all stages of the project life cycle. Sound risk management processes also support effective communication amongst key stakeholders and is integrated into the decision making and change management processes on projects.

The risk management process that Hatch used was the model detailed in the internationally recognised Australian Risk Management Standard, AS/NZS 4360, and illustrated in Figure 2- below. The process followed a five step approach: 1) Establishing the context, objectives and criteria; 2) collectively identifying risks by project area; 3) collectively analyzing the risks from a likelihood and consequence perspective; 4) ranking the risks by their resulting combined score; and 5) treating the risk by identifying mitigation actions.




AS/NZS 4360 Risk Management

**Figure 2-: Risk Management Process**

The first step, **establishing the context**, involved a review with key members of the project team in order to identify the following:

- Clear definition of the **internal context** that considered the project criteria, objectives, project scope, strategic importance of the project to the organisation, organisations risk management policy and key internal stakeholders.
- Clear definition of the **external context** that involved the exploration of the "environment" in which the project will be executed; for example, political, industrial, business, social, interfaces with other projects, operations etc. Key external stakeholders and interested parties in the project were identified.
- The **risk management context** involved establishing the goals, objectives, strategies and scope of the project for the risk management process.
- ***Risk evaluation criteria*** were developed after considering the objectives of the project and the key project stakeholders. The critical success factors for the project included technical performance, project cost, project schedule, health & safety, reputation, legal/regulatory, and environment. Scales were developed to assess the likelihood and impact of risks on the project's objectives. In line with ArcelorMittal's risk management procedures, a five-point scale for likelihood and consequences was used.

The second step, **risk identification**, was a critical step in the overall process and was comprehensive as a risk that was not identified at this stage was excluded from further analysis – hence the need for regular reviews and treating risk as a continuous project activity. All risk issues, whether or not under the control of the project team, were included in the scope of this activity that sought to

identify all risks that must be managed to achieve the project objectives. Risks were "brainstormed" in a workshop environment using a structured what-if approach. Once sources of risk and events had been identified, possible causes were captured in the risk register. These assisted in the development of mitigations to reduce the risk level.

The third step, **risk analysis**, assisted with the ranking and/or short-listing of risks and provided a logical framework for a rational and systematic discussion. The investigation relied on gathering and utilising existing information and knowledge from the members of the project team to identify the causes and quantify the consequences and likelihood of the risks. The main purpose of quantification is not as an absolute measure, but rather as a means of prioritising risks.

The fourth step, **risk evaluation**, took the consequences and likelihoods that were allocated in the previous step and using a risk matrix, assigned levels of severity to each risk. Ranking risks by severity allowed focussing of effort for risk treatment on the most severe risks and also for the team to determine at which level the identified risks could be considered as being treated adequately by normal project practices and systems.

The fifth step, **treating risks**, involved developing risk reduction actions. Where risks could not be eliminated, risk reduction was driven by the ALARP philosophy: reduce risks to "as low as reasonably practicable". That is, apply risk reduction measures to the point where the cost is not disproportionate to the risk reduction achieved.

Finally, mitigation actions need to be followed up, by assigning a responsible person or team and a due date. The resulting risk register is meant to be a live document, which needs to be constantly monitored, reviewed and updated with new risks throughout the execution of the project. Other tools for ongoing monitoring and review of risks include:

- Maintenance and publishing a Risk Watch List
- Risk Review Meetings, or an agenda item on general project meetings, etc
- Personal interviews/reviews by the Risk Manager with key staff from time to time
- A cost or schedule trend program

## 2.2 Classification of Likelihood and Consequences

In step three of the Hatch risk management process, each risk was classified in terms of likelihood and consequence using a 5-point scale. Table 2- below shows the likelihood ratings and corresponding probabilities, whilst Table 2- below shows the consequence ratings and descriptions of how each rating pertains to technical performance, project cost, project schedule, health and safety, reputation, legal/regulatory and environmental.

**Table 2-: Likelihood Table**

| Rating | Likelihood Description and Indicative Frequency | Indicative Probability |
|---|---|---|
| A - 5 | Almost Certain: Very high probability of occurrence could occur several times per year or several times during project execution. Has occurred several times on similar projects. | >0.8 |
| B - 4 | Likely: High probability, likely to occur approximately once per year or once during project execution. Similar event has occurred once per year on similar projects. | 0.5 to 0.8 |
| C - 3 | Moderate: Possible, reasonable probability that it may occur at least once in a 1 to 10 year period or at least once during every three project executions. A similar event has occurred at the above times on other similar projects. | 0.1 to 0.5 |
| D - 2 | Unlikely: Plausible, unlikely to occur during the project, could likely occur over the next 10 to 40 years or once during every 10 project executions. A similar event has occurred at the above times on other similar projects. | 0.02 to 0.1 |
| E - 1 | Rare: Very low likelihood but not impossible, unlikely to occur during the next 40 years or during at least 10 project executions. A similar event has occurred at the above times on similar projects. | <0.02 |

**Table 2-: Consequence Table**

| Rating | Technical Performance | Project Cost | Project Schedule | Health & Safety | Reputation | Legal/Regulatory | Environment |
|---|---|---|---|---|---|---|---|
| E - 5 (Catastrophic) | 60% of design capacity not achieved Increase in operating costs | Greater than 30% cost overrun | Greater than 50% delay in project completion | Fatality | Adverse global media coverage Govt inquiry Major public concerns Major loss of shareholder support | Very significant fines and prosecutions Multiple litigations | Long term environmental damage – 5 years or more requiring > $5M to remediate, study and/or penalties |
| D - 4 (Major) | Cannot achieve 80% of design capacity without significant capital expenditure Increase in operating costs | 16% to 30% cost overrun | 17% to 50% delay in project completion | Serious or multiple Injury resulting in permanent disabilities | Adverse national media coverage Govt member involved Senior mgt changed Significant shareholder support | Significant fines and prosecution. Very serious litigation, including class actions | Medium term – 1 to 5 years environmental damage requiring $1 to $5M to remediate, study and/or penalties |
| C - 3 (Significant) | Cannot achieve 100% design capacity without significant capital expenditure 10% to 30% increase in operating costs | 6% to 15% cost overrun | 8% to 17% delay in completion of the project | Serious injuries Extended lost time | Adverse media coverage Board involved Significant decrease in Shareholder support | Major breach of regulation. Major litigation | Short-term < 1 year environmental damage requiring up to $1M to remediate, study and/or penalties |
| B - 2 (Moderate) | Cannot achieve 100% design capacity without some capital expenditure <10% increase in OPEX | 0.5% to 5% overrun | 3% to 8% delay in the completion of the project | Significant injury Limited lost time | Adverse local media coverage Report to Board Shareholder concerns raised | Serious breach of regulation with investigation or report to authority with prosecution and/or moderate fine possible. | Environmental damage requiring up to $250K to remediate, study and/or penalties |
| A - 1 (Minor) | Minor Difficulties | Less than 0.5% Within budgeted costs | Less than 3% delay | Minor injuries or near miss – no lost time | No media attention Issue raised by workers | Low level legal or approval issue | Negligible environmental impact, managed within budgets |

## 2.3 Determining Risk Ratings

Risk ratings were presented in the form of a coloured risk matrix to highlight the key risks to the project team (refer to Figure 2- below). Depending on the risk rating, the risk wass classified as low (green zone, with a resulting rating from 1 to 6), medium (yellow zone, with a resulting rating from 7 to 19) or high (red zone, with a resulting rating from 20 to 25). At the end of the risk management assessment, the risk ratings were tallied and displayed on the risk map.

| | | CONSEQUENCE | | | | |
|---|---|---|---|---|---|---|
| | | A | B | C | D | E |
| LIKELIHOOD | A | 11 | 16 | 20 | 23 | 25 |
| | B | 7 | 12 | 17 | 21 | 24 |
| | C | 4 | 8 | 13 | 18 | 22 |
| | D | 2 | 5 | 9 | 14 | 19 |
| | E | 1 | 3 | 6 | 10 | 15 |

**Figure 2-: Risk Map Showing How Risk Ratings Are Calculated**

# 3. Results of Risk Management Assessment

A total of 310 risks were identified by the project team. Of the total risks identified, 71 (23%) were classified as low risks, 231 (74%) as medium risks, and 8 (3%) as high risks. Figure 3- below shows the breakdown of risks.

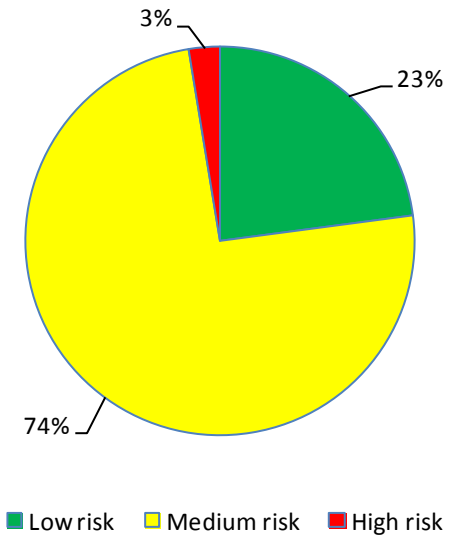



**Figure 3-: Risk Status Distribution**

## 3.1 High Risks (Red)

As mentioned previously, 3% of the total risks identified were classified as high risks. High risks are defined as having a risk rating of between 20 and 25, inclusive. Table 3- below provides a description of the project key risks and the associated mitigation actions.

**Table 3-: Summary of High Risks**

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000/5000 | 66 | Increased risk of construction injuries | Working over open water at dock area, ice on working surfaces | Hyperthermia, injury, human Fatality | e | c | 22 | Short Term | Move as much equipment off the dock as possible (option 4 with conveyor on land, radial quadrant shiploaders with conveyors and major part of equipment on land). Modularization, large supply contracts |
| 1000/5000 | 67 | Availability of equipment less than predicted/lower operating days per annum | Insufficient cold temperature design, high failure rate | Operational delays | e | c | 22 | Short Term | Ensure proper cold temperature design - lessons learned other cold application areas (Port Cartier, Oil Sands, Voisey's Bay etc.) |
| 2000 | 69 | Crew fatigue | 24 hours darkness | Falling asleep - fatality | e | c | 22 | Short Term | Alerter equip locomotives, 2 man crews, 10 hour maximum work shifts, Fatigue management plan in Place. Canadian Hours of Service Rules respected. |
| 2000 | 73 | Crew fatigue | 24 hours sunlight | Falling asleep - fatality | e | c | 22 | Short Term | Alerter equip locomotives, 2 man crews, 10 hour maximum work shifts, Fatigue management plan in Place. Canadian Hours of Service Rules respected. |
| 4000 | 264 | Unable to respond to fires during construction | Water truck not reliable (no other backup water source) | Damage to environment, H&S, potential fatality | e | c | 22 | Short Term | Portable fire extinguisher in appropriate locations. Keep temporary facilities well spaced to reduce the risk of fires spreading. Proper education on fire prevention |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 4000 | 256 | Lack of power supply during construction - Mary River | Power outages due to reliability/fuel supply | delay in schedule | d | b | 21 | Short Term | Redundancy on the fuel and power supply. Maintenance program in place and procure quality product. Ensure the proper spare parts are available at the site. |
| 4000 | 257 | Lack of power supply during construction - (SP) | Power outages due to reliability/fuel supply | delay in schedule | d | b | 21 | Short Term | Redundancy on the fuel and power supply. Maintenance program in place and procure quality product. Ensure the proper spare parts are available at the site. |
| 4000 | 273 | Unable to transport modules to MR site on current Tote Road | Modularization strategy remains undefined | increased cost / delayed schedule | d | b | 21 | Short Term | More planning in modularization strategy. Coordination with AMEC and Hatch logistics to match road capacity with heavy hauls. Winter heavy hauls. |

## 3.2 Medium Risks (Yellow)

As mentioned previously, 74% of the total risks identified were classified as medium risks. Medium risks are defined as having a risk rating between 7 and 19, inclusive. Table 3- below provides a description of the project risks and the associated mitigation actions.

**Table 3-: Summary of Medium Risks**

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 4000 | 267 | Permafrost - design criteria changes | Increase in average temperature on site due to climate change - causes permafrost to react differently to design assumptions | Increased cost / delayed schedule | e | d | 19 | Short Term | Assess risk of climate change over lifetime of mine and design accordingly (e.g. allowing for creep in the permafrost). Use state of the art/proven technologies from similar design conditions. Engineering capability to adjust design to quickly accommodate actual permafrost levels |
| 1000/5000 | 11 | Road Accidents on site - major accident with permanent injury | High traffic volumes, poor driving conditions, construction & mining activities on the same road, unfamiliarity with arctic driving conditions, road width and grade | Schedule delay, safety consequences | d | c | 18 | Short Term | Limit number of contractors on site - modularization, large packages. Transport logistics (time, accompanied freights etc). Traffic Rule Monitoring (vehicle satellite tracking with regular reports). Driver grading/education/coding |
| 1000/5000 | 46 | Delayed construction | Rail load out and dumper interface with rail construction | Schedule delay | d | c | 18 | Short Term | Detailed construction schedule. Site work interface / coordination. Disconnected construction programs. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000/5000 | 50 | Delayed construction | Late Engineering impact on schedule - result in missing shipping | Schedule delay | d | c | 18 | Short Term | Phased engineering and procurement. Critical path expediting. Detailed work-around planning |
| 2000 | 146 | Ammonium leakage | Tunnels | Not applicable to construction work train operation | d | c | 18 | Short Term | The main solid residue from the detonation of the explosives will be Carbon. Incomplete detonation through a miss-fire could cause some nitrate and ammonia to be present. However, miss-fires are a special occurrence requiring specific safety measures and procedures. Should a miss-fire occur then the explosive superintendent will carry out a further controlled blast to ensure complete detonation of the explosive products |
| 3000 - Steensby Two Floating Constructi on Docks | 237 | Project delay | Unloading rates slower than expected, bottleneck at construction docks | Increased cost, schedule delay, some materials are returned and delivered 9 months later | d | c | 18 | Short Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |
| 3000- Milne Floating Dock and Lightering Operations | 246 | Project delay | Unloading rates slower than expected, bottleneck at construction docks | increased cost, schedule delay, some materials are returned and delivered 9 months later | d | c | 18 | Short Term | Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 4000 | 262 | Delay in opening Steensby Airstrip | Difficult ground conditions | increased cost / delayed schedule | d | c | 18 | Short Term | Get proper drill hole data for boreholes in area. Sufficient construction and blasting equipment to expedite the construction program. Conservative planning |
| 4000 | 275 | Unable to service multiple work fronts | Resource availability - materials | delay in schedule | d | c | 18 | Short Term | Proper logistics and planning to anticipate shortfall of materials. Possibly order more, where possible, of spares/materials. Stockpile critical spares at sites. |
| 4000 | 276 | Unable to service multiple work fronts | Resource availability - labour | delay in schedule | d | c | 18 | Short Term | Early engagement of construction contractors to provide the proper resources. Training and development of the local Inuit. Quality camps. Above standard wages. Retention benefits programme (bonus incentives). Labor study. |
| 4000 | 279 | Limited vendor capacity | Busy vendors and tight market conditions | increased cost / delayed schedule | d | c | 18 | Short Term | Put in bonuses and incentives into vendor contracts. Engage vendors early to ensure that they're on board. |
| 4000 | 286 | Failure to supply contractor with owner supply equipment | Sea lift season shortened due to severe weather | increased cost / delayed schedule | d | c | 18 | Short Term | Proper logistics and planning to anticipate shortfall of materials. Possibly order more, where possible, of spares/materials. Stockpile critical spares at sites. Conservative logistics planning. |
| 4000 | 291 | Contractor Qualifications | Unavailable qualified contractors | increased cost / delayed schedule | d | c | 18 | Short Term | Prequalify contractors. Provide incentives. Minimise number of contractors. Work with the contractor to ensure project/contract is fair and |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | successful. |
| 4000 | 296 | Late deliveries | Failure of effective Logistics | increased cost / delayed schedule | d | c | 18 | Short Term | Select the best logistics supplier. Continuous monitoring of logistics performance. Better planning of the logistics. Build float into the schedule. |
| 4000 | 297 | Not being self-sufficient on site | Inadequate planning | increased cost / delayed schedule | d | c | 18 | Short Term | Better planning using experienced people for site conditions. Develop contingency plans, Emergency response plans. Maintain adequate spares on site. Early establishment of shop tools and skills to support site infrastructure. |
| 1000/5000 | 16 | Site safety | Spread of site, multiple work faces | Operator/worker isolation in case of accident, wildlife attacks on construction workers, recreational trespassing into dangerous areas | c | b | 17 | Short Term | Safety plan, procedures and training, daily toolbox talks. |
| 1000/5000 | 20 | Labor issues | Demobilization slowdown | Schedule delays, labour unrest, vandalism, rework | c | b | 17 | Short Term | Pro-active contractor demobilization / relocation strategy / completion bonuses |
| 1000/5000 | 21 | Labor issues | Transition from contractor to operator | Schedule delays, labour unrest, quality control, rework | c | b | 17 | Short Term | Pro-active management and completion bonuses |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000/5000 | 22 | Scarcity of expertise/specialized skills | Competition between areas, contractors, competition with other projects | Schedule delays, quality, rework | c | b | 17 | Short Term | Ensure attractive work place and conditions |
| 1000 | 27 | Fly rock damaging the crusher | Blasting proximity | Production delay, injuries | c | b | 17 | Short Term | Relocate the primary crusher. Implement proper blasting procedures during operations. |
| 1000/5000 | 52 | Dust contamination & spillage underneath conveyor | Open conveyors to shiploader and open stockpiles | Environmental contamination | c | b | 17 | Short Term | Closed return side of conveyors. Completely enclosed shiploader conveyors with return spillage and conveyor cleaning handling plan as per 2 shiploader solution - non slewing shiploader or radial quadrant shiploaders. |
| 1000/5000 | 58 | Inadequate concrete setting and integrity in cold weather | Cold weather work | Rework | c | b | 17 | Short Term | Heating, maximize use of pre-cast. Proper winter protection needed for engineered backfill and concrete production and placement. Aggregate preparation facility required where engineered backfill is required. |
| 2000 | 131 | Ore cars - snow under trucks & body | Uncovered rolling stock | Ore cars availability delayed | c | b | 17 | Short Term | Manually clear snow around ore car wheels with shovels and front end loader. Maintain lowest possible inventory of ore wagons in order to reduce car storage. Prep ore cars sufficiently ahead of time to permit timely startup operations. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 132 | Locos - response time for breakdown or emergencies | Uncovered rolling stock | Delay to train operation | c | b | 17 | Short Term | Assure adequate manning and training for locomotive and maintenance crews. |
| 2000 | 137 | Slide protection at portals | Steep rock face | Not applicable to construction work train operation | c | b | 17 | Short Term | At the tunnel portal location it is intended to utilize a 10 m long corrugated steel liner. This liner will be partially backfilled with reinforced earth. The liner prevents rock fall from impacting the track. In addition to this during the construction work rock scaling, stabilization and reinforcement will occur on the rock slopes around the portals. These measures will assist in reducing the rock fall hazard. It is also intended to check scale the natural slopes around the portals to similarly mitigate the rock fall risk. |
| 2000 | 138 | Drilling program (construction accessibility) | Steep rock face | Not applicable to construction work train operation | c | b | 17 | Short Term | |
| 4000 | 258 | Lack of power supply during construction | Poor distribution around site | delay in schedule | c | b | 17 | Short Term | Stock of portable gen sets. Identify gen set that are transportable by air. |
| 4000 | 269 | Drill hole locations do not match the site plan | Site plan changes after geotech programme finished or due to inaccessibility of | increased cost / delayed schedule | c | b | 17 | Short Term | Where insufficient geotechnical information is available, design conservatively. During construction - have sufficient people/knowledge on site to deal with changes in the |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | site | | | | | | ground condition (and any redesign). |
| 4000 | 280 | Unable to attract skilled labour to site | Lack of incentives to attract labour/competition with other northern works | increased cost / delayed schedule | c | b | 17 | Short Term | Training and development of the local Inuit. Quality camps. Above standard wages. Retention benefits programme (bonus incentives) |
| 4000 | 282 | Unable to attract skilled labour to site | quality of temporary camp facility | increased cost / delayed schedule | c | b | 17 | Short Term | Design/procure a desirable camp with appropriate recreational facilities, good food |
| 4000 | 287 | Warranty validity period | Long lead time between ordering, delivery of material to port, then to site, commissioning | | c | b | 17 | Short Term | Early definition of warranty period during the bidding process. Negotiate validity periods properly. Ensure the warranty period only starts at the startup of equipment. Ensure that correct warranty period is written into the contract. Ensure warranty compliant storage conditions. |
| 4000 | 289 | Lack of redundancy of materials/insufficient materials on site | Failure to identify the undefinable | Delay in schedule | c | b | 17 | Short Term | Ensure that logistics and procurement team is experienced. As far as possible, use people who have worked in similar environments. Use equipment that have reliable service history in similar weather/geographic conditions. |
| 4000 | 309 | Not enough fuel (Steensby) | Poor planning and unforeseen consumption | Increased cost / delayed schedule | c | b | 17 | Short Term | Have extra capacity of fuel available at Steensby. Store fuel in barge over winter. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 79 | Delay construction of bridges / infrastructure | Water crossing restrictions | Delay and cost | c | a | 16 | Short Term | Collaborate with contractor rail partners to optimize. Early regulator engagement and EIS acceptance |
| 2000 | 101 | Severity of derailment at high embankment (Jordan Rail Issue) | | Delay to construction, damage to rolling stock and track | e | e | 15 | Short Term | Minimal risk account slow speed of construction work train. Temporary Slow orders to be applied. |
| 3000 - Ore Dock | 221 | Construction delays | Catastrophic accident during Marine construction, & Fatality | Increased cost / delayed schedule | e | e | 15 | Short Term | Prepare Safety Procedures - Constantly Audit Safety Procedures. Ensure training |
| 1000/5000 | 1 | Late delivery of equipment - major | Extended lead time / short window to deliver equipment items | Delayed schedule, equipment unavailable | d | d | 14 | Medium Term | Prioritize critical path items. Detailed delivery schedules for these items. Specific sub-contract control. Contingency plan/s for temporary operations without specific equipment. Expediting plans |
| 2000 | 88 | Deliveries of contractor equipment/materials to site - major | DAMAGE DURING SHIPMENT, INABILITY TO OFFLOAD | Delay and cost | d | d | 14 | Medium Term | Logistics planning and rigging plans |
| 2000 | 106 | Unable to attract workforce | Shortage of skilled & general workforce, language problems, 3000 man construction | Could result in reduced availability of planned construction work train. | d | d | 14 | Medium Term | Commence a native training course for locomotive drivers in advance of need. Contract qualified locomotive drivers |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | team | | | | | | |
| 2000 | 110 | Governing bodies for special permits: hazardous materials, communications software, operating regulations, airstrip permits, environmental - snow, ice. | Permitting | Not applicable to construction work train operation | d | d | 14 | Medium Term | Early regulatory engagement and acceptance |
| 2000 | 116 | Late equipment delivery | Material & equipment | Delays and cost | d | d | 14 | Medium Term | Identify & order long lead equipment |
| 2000 | 120 | Bridge foundation design - incorrect assumptions | Permafrost | Not applicable to construction work train operation | d | d | 14 | Medium Term | |
| 2000 | 150 | CO2 mask for stalled trains (ventilation) | Tunnels | Cost | d | d | 14 | Medium Term | Short tunnel lengths. Where appropriate tunnel design to include CO2 Mask stations |
| 3000 - Freight Dock | 189 | Environmental accident | Fuel spills on water (Major) | Damage to Environment and Reputation | d | d | 14 | Medium Term | Ensure that the contractors use vessels and barges that are a registered class. Ensure that contractors have proper procedures and that enforce the procedures. Audit loading and |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | unloading procedures. Contractors to have full response procedures and communication procedures in place |
| 3000 - Ore Dock | 203 | Constructability difficulties | Unexpected geotech conditions (Post Summer Programme) | Increased cost and schedule delay | d | d | 14 | Medium Term | Additional geotechnical investigation to obtain the necessary geotechnical parameters. Select appropriate dock design. |
| 3000 - Ore Dock | 213 | Loss of support for the dock | Poor placing of mattress | Compromise the structural integrity of the dock | d | d | 14 | Medium Term | Appropriate placing techniques and inspection |
| 3000 - Ore Dock | 215 | Construction delays | Limited activities due to interaction marine mammals | increased cost / delayed schedule | d | d | 14 | Medium Term | Minimize activities that might result in such restrictions. Be aware of possible restrictions. Obtain appropriate permits. |
| 3000 - Ore Dock | 217 | Construction delays | Loss of material / components offshore (Major) | Increased cost / delayed schedule | d | d | 14 | Medium Term | Minimize risk by good risk management practices |
| 3000 - Ore Dock | 220 | Construction delays | Catastrophic accident during construction, i.e. barge sinking in construction dock area | Increased cost / delayed schedule | d | d | 14 | Medium Term | Specify that all floating vessels and barges are a registered class. Ensure appropriate operational procedures and training. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000 - Ore Dock | 229 | Environmental accident | Fuel spills on water (Major) | Damage to Environment and Reputation | d | d | 14 | Medium Term | Ensure that the contractors use vessels and barges that are a registered class. Ensure that contractors have proper procedures and that they enforce the procedures. Audit loading and unloading procedures. Contractor to have full response procedures and communication procedures in place. Adequate training. |
| 3000 - Ore Dock | 235 | Project delay | Failure to involve all stakeholders such as insurers | Increased costs, schedule delay | d | d | 14 | Medium Term | Proper and comprehensive assignment of responsibility amongst stakeholders, particularly insurers |
| 3000 - Steensby Two Floating Constructi on Docks | 243 | Fuel Spills | Transferring fuel across the water with floating lines / breakage / Major | Damage to Environment and Reputation | d | d | 14 | Medium Term | Ensure that the contractors use vessels and barges that are a registered class. Ensure that contractors have proper procedures and that they enforce the procedures. Audit loading and unloading procedures. Contractor to have full response procedures, communication procedures in place, and adequate training |
| 3000 - Steensby Two Floating Constructi on Docks | 245 | Dock Insufficient Size | Large components arrive before freight dock completed | Increased cost / delayed schedule | d | d | 14 | Medium Term | Logistics to review delivery dates and anticipated completion date of freight dock. Logistics to prepare a detailed plan |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000-Milne Floating Dock and Lightering Operations | 252 | Fuel Spills | Transferring fuel across the water with floating lines / breakage / Major | Damage to Environment and Reputation | d | d | 14 | Medium Term | Ensure that the contractors use vessels and barges that are a registered class. Ensure that contractors have proper procedures and that they enforce the procedures. Audit loading and unloading procedures. Contractor to have full response procedures, communication procedures in place, and adequate training |
| 3000-Milne Floating Dock and Lightering Operations | 254 | Dock Insufficient Size | Too Large of components arrive for facilities on shore | Increased cost / delayed schedule | d | d | 14 | Medium Term | Logistics to review delivery dates and anticipated completion date of freight dock. Logistics to prepare a detailed plan |
| 4000 | 261 | Delay in opening Steensby Airstrip | Delayed Permits (18 months for Federal approval) | Delay in schedule | d | d | 14 | Medium Term | Initiate early design for Steensby. Ensure 100% complete quality design (any mistakes result in resetting the permit process) |
| 4000 | 265 | Risk of Fire to Fuel System during construction | Due to fuel handling & storage | Damage to environment, H&S, potential fatality | d | d | 14 | Medium Term | Proper fire protection facilities at the Fuel farm. Proper training on fuel handling, storage and fire prevention. Keep ignition sources away from fuel systems. No smoking areas clearly delineated and enforced. |
| 4000 | 274 | Unable to service multiple work fronts | Resource availability - aircraft | Delay in schedule | d | d | 14 | Medium Term | Identify possible backup aircraft. Consider partnering with a aircraft/air carrier company (to supply larger helicopters for example) |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 4000 | 283 | Failure to supply contractor with Major owner supply equipment | Late procurement/ordering | Increased cost / delayed schedule | d | d | 14 | Medium Term | Early planning. Early supplier involvement. Partnership and alliance with key suppliers. Penalties and incentives for contracts. Minimize free issue equipment |
| 1000/5000 | 18 | Camp closure | Mold, infectious disease outbreak, fire | Schedule delay, camp rebuild/disinfecting program | c | c | 13 | Medium Term | Mine site consists of more than one camp which could facilitate assistance in case of camp closure Facilities need to be inspected regularly for mold, Cleaned regularly with disinfectant. Quarantine is possible with individual wings and rooms. Fire response equipment and team will be available at site on a continuous basis. Training will be provided at site for all those interested. |
| 1000/5000 | 26 | Site Rework - low cost fabrication | Poor pre-assembly quality | Increased cost, schedule delays, quality | c | c | 13 | Medium Term | Low cost fabrication QA and QC plan - certified welders, increased QA presence at fabrication shops. Advance pre-assembly and testing |
| 1000 | 31 | Prestripping delays | Tire supply, explosives availability, diesel fuel logistics during prestripping | Schedule delay | c | c | 13 | Medium Term | Transport logistics, transport communication plan, delivery tagging |
| 1000/5000 | 47 | Delayed construction | Single source sub-contractor non-performance | Schedule delay, rework | c | c | 13 | Medium Term | Subcontractor commercial conditions, incentivize performance. Use of large reputable companies. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 72 | Reflection (visibility), | 24 hours sunlight | Blurred vision | c | c | 13 | Medium Term | Supply appropriate eyewear or tinting of cab windows |
| 2000 | 86 | BIM procurement, free-issue materials | Free-issue equipment, risk allocation | Delay and cost | c | c | 13 | Medium Term | EPCM management and coordination |
| 2000 | 118 | Bridge foundation design - timing of construction | Permafrost | Not applicable to construction work train operation | c | c | 13 | Medium Term | Tight control of construction sequencing |
| 2000 | 136 | Impact to rail operations | Seismic event | Delay and cost | c | c | 13 | Medium Term | Adequate design and construction |
| 2000 | 145 | Rock fall into lake | Tunnels | Not applicable to construction work train operation | c | c | 13 | Medium Term | It is noted that adjacent to the lake there are a number of vertical cliff faces that contain potentially unstable rock. It is recognized that there have been recent rock falls that have naturally occurred and caused rock to fall into the lake. This is an ongoing weathering process that is typical for this terrain in such an arctic environment. During our site visits we have not observed a large scale rock mass or failure that could potentially or immanently fall into the lake. Potential rock fall is limited to at most boulder sized rock. It is conceivable that during construction blasting vibrations reaching the surface could cause inherently |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | unstable rock, on the verge of failure, to fall into the lake. However such inherently unstable rock is likely to fail due to natural processes at some point in the future (irrespective of construction activities), furthermore the size of these rocks is a boulder-size, and construction activities should not cause large scale slope failure to occur (based on our site observations and assuming good construction practices. |
| 2000 | 157 | Understand wear rate, consumables, proper list required, time for replacement part to site, method of transport replacement parts | Warranties / spares | Not applicable to construction work train operation | c | c | 13 | Medium Term | Regular inspection and updated records to facilitate revision of requisition volumes for spares and materials |
| 3000 - Ore Dock | 201 | More dredging and blasting required | Unexpected geotech conditions (unable to complete the summer program) | Increased cost and schedule delay | c | c | 13 | Medium Term | Additional geotechnical investigation to obtain the necessary geotechnical parameters |
| 3000 - Ore Dock | 205 | More dredging and blasting required | Bathymetry incorrect (not properly | Increased cost and schedule delay | c | c | 13 | Medium Term | Additional bathymetry/geophysical investigations |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | calibrated yet) | | | | | | |
| 3000 - Ore Dock | 233 | Dewatering Complications of Dredged Material | Under specified methods, Inadequate redundancy | | c | c | 13 | Medium Term | Appropriate sampling, appropriate permits, properly prepared specifications and data for contractors |
| 3000 - Ore Dock | 234 | Brittle fracture | Low Temperatures | Sudden failure of components | c | c | 13 | Medium Term | Appropriate designs and specifications, good shop and field inspection |
| 3000 - Ore Dock | 236 | Damage | Growlers during Construction | Increased costs, schedule delay | c | c | 13 | Medium Term | Contingency plans, including provision to divert growlers, well documented |
| 3000 - Steensby Two Floating Constructi on Docks | 238 | Lightering operations are Halted | Ice Flows Back into Harbour in Early Summer | Increased cost / delayed schedule | c | c | 13 | Medium Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |
| 3000 - Steensby Two Floating Constructi on Docks | 239 | Lightering operations are Halted | Ice forms in harbour in Early Fall | Increased cost / delayed schedule | c | c | 13 | Medium Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |
| 3000 - Steensby Two Floating Constructi | 240 | Lightering operations are Halted | wind / wave / fog | Increased cost / delayed schedule | c | c | 13 | Medium Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| on Docks | | | | | | | | | |
| 3000 - Steensby Two Floating Constructi on Docks | 241 | Ships cannot be unloaded | Lightering and docks are over utilized - during the summer period | Increased cost / delayed schedule | c | c | 13 | Medium Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |
| 3000- Milne Floating Dock and Lightering Operations | 248 | Lightering operations are Halted | Ice forms in harbour in Early Fall | Increased cost / delayed schedule | c | c | 13 | Medium Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |
| 3000- Milne Floating Dock and Lightering Operations | 249 | Lightering operations are Halted | wind / wave / fog | Increased cost / delayed schedule | c | c | 13 | Medium Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |
| 3000- Milne Floating Dock and Lightering Operations | 250 | Ships cannot be unloaded | Lightering beach over utilized - during the summer period | Increased cost / delayed schedule | c | c | 13 | Medium Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 4000 | 260 | Lack of power supply during construction | Delay in generator delivery | Delay in schedule | c | c | 13 | Medium Term | Better planning and early involvement of the suppliers. Redundancy of generator suppliers. |
| 4000 | 277 | Unable to service multiple work fronts | Early thaw of ice road/late arrival of sea lift | Delay in schedule | c | c | 13 | Medium Term | Plan to mobilise and move equipment, materials quickly. Prioritize heavy lifts and large loads for early on in the mobilisation period. Backup air lift plan of critical smaller items |
| 4000 | 278 | Insufficient contractors with Arctic experience | Too much competition for arctic experienced contractors | Increased cost / delayed schedule / H&S | c | c | 13 | Medium Term | Early engagement of construction contractors to provide the proper resources. Training and development of the local Inuit. Quality camps. Above standard wages. Retention benefits programme (bonus incentives). Labor study. |
| 4000 | 288 | Lack of redundancy of materials/insufficient materials on site | Poor planning | Delay in schedule | c | c | 13 | Medium Term | Better planning - holistic view of entire project, project areas. Logistics are key. Maintain and manage extra site inventory of key materials |
| 4000 | 293 | Contractor cost increase | Contracting strategy selection | Increased cost | c | c | 13 | Medium Term | Use the proper/appropriate type of contracts (if engineering is not done 80-85%, don't use lump sum, use unit price). Provide unit rates of material (e.g. concrete) rather than defined quantities, where possible. Define contractors' core competencies to ensure that they perform well in particular area of expertise. Will |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | mitigate cost increases. Complete engineering to avoid rework |
| 4000 | 304 | Material shows up at Steensby instead of Milne or vice versa. - not flyable | Logistics errors | Delay in schedule | c | c | 13 | Medium Term | Proper labeling of all equipment using RFID (GPS tracking system). Proper planning, QA/QC of all ships and equipment before leaving the dock/warehouse. CWP-driven logistic |
| 4000 | 305 | Supplier/contractor bankruptcies | Supplier / contractor over commitment | Increased cost / delayed schedule | c | c | 13 | Medium Term | Ensure better prequalification of suppliers. B&D financial prescreening. Get financial statement. Bonding. Parental guarantees. Ensure title held by project |
| 4000 | 308 | Quarry material does not meet specifications | Lack of quarry testing | Increased cost / delayed schedule | c | c | 13 | Medium Term | Ensure adequate geotechnical investigation at quarries. Have backup quarry site possibilities. Check specification standards. Quarry site alternatives. Use product |
| 4000 | 310 | Major equipment breakdown (e.g., batch plant) | Poor maintenance, bad feed | Delay in schedule | c | c | 13 | Medium Term | Use reliable suppliers. Regular maintenance plan. Spare part availability. Screen the feed |
| 1000/5000 | 5 | Unavailability of construction equipment - major | Road congestion to mine site / weight (load) limitations at bridges | Delayed schedule, equipment unavailable | b | b | 12 | Medium Term | Logistics schedule/plan for transport from Milne port to Mary river. Align with critical path items. Contingency plan to predict possible congestion and contingency plans, rescheduling |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | etc. Plans to tie in with construction schedule/sequence. Ensure road is in adequate condition |
| 1000/5000 | 14 | Dilution of supervision, productivity | Spread of site, multiple work faces | Lower productivity, quality control, rework | b | b | 12 | Medium Term | Limit number of contractors on site - modularization, large packages. |
| 1000 | 28 | Limiting access to ore body | Waste dump footprint | Loss of reserve or re-planning | b | b | 12 | Medium Term | Complete condemnation drilling program to the north. |
| 1000/5000 | 44 | Steensby Delayed construction | Availability of causeway, Bottleneck of causeway, size of causeway, lightering, mainland transport | Schedule delay | b | b | 12 | Medium Term | Use the Ice Platform to transport during winter Items from Mainland to Island. Especially all large heavy items as access will not be restricted by the ice logistics: alternative Ice road. Smaller loads to island. |
| 1000/5000 | 56 | Safety and delays to construction | Foreign workers communication and leadership | Schedule delays, safety risks | b | b | 12 | Medium Term | Large subcontracts with reputable companies. Sufficient contractor employed interpreters and management in case of foreign supply. |
| 2000 | 94 | Delayed recovery from derailment | Insufficient equipment | Delay to construction | b | b | 12 | Medium Term | Ensure that Hydraulic rerail equipment available with construction work train |
| 2000 | 95 | Delayed recovery from derailment | Inclement weather | Delay to construction | b | b | 12 | Medium Term | Ensure that Hydraulic rerail equipment available with construction work train |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 96 | Derailment of construction train | Excess speed | Delay to construction, damage to rolling stock and track | b | b | 12 | Medium Term | Enforce speed restrictions by proper training and event recorder downloads |
| 2000 | 97 | Derailment of construction train | Rail breaks | Delay to construction, damage to rolling stock and track | b | b | 12 | Medium Term | Develop a rail break protocol to minimize impact. |
| 2000 | 98 | Derailment of construction train | Signal breakdowns | Not Applicable - Signal system not installed prior to track construction | b | b | 12 | Medium Term | |
| 2000 | 99 | Derailment of construction train | Driver distraction | Delay to construction, damage to rolling stock and track | b | b | 12 | Medium Term | Alerter equip locomotives, 2 man crews |
| 2000 | 100 | Drifting in tunnels, transitions between cut/fill, culverts | Drifting snow | Delay to construction | b | b | 12 | Medium Term | Construct snow barriers (snow fences) to reduce normal adverse effect of drifting snow. Should not affect construction work train operation. (Unlikely to impact significantly - track laying will not occur with that much snow on the ground). |
| 2000 | 129 | Circuits working in extreme cold weather | Rolling stock | Not applicable to construction work train operation | b | b | 12 | Medium Term | Signals not in operation during track construction |
| 2000 | 135 | Warranty problems | Damage during sea lift | Delay and cost | b | b | 12 | Medium Term | Adequate planning and packaging |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 139 | Rock cuts | Steep rock face | Not applicable to construction work train operation | b | b | 12 | Medium Term | In order to mitigate rock fall from the rock cuts along the alignment three general approaches will be taken. Firstly during construction the slopes will be excavated to a suitable angle such that kinematic instability does not take place or is limited as far as practicable. With this process the rock cut is excavated to an inherently stable angle. Having a kinematically stable slope helps to prevent rock fall. Secondly, during construction scaling, trim blasting and rock bolting will be utilized at selective locations to prevent long term instability from forming. Finally the main key measure to prevent rock fall is the design and construction of a suitable catchment adjacent to the toe of the rock cut. It is this measure that over the lifetime of the project will prevent rock fall hazard. In addition to these measures, design and construction practices it is recognized that there is a section of the line where a very high rock fall hazard exists. Along this section of the line additional measures will be implemented such as slide / alarm fences, as well as the excavation of a catchment and barrier |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | walled ditch. |
| 2000 | 140 | Snow clearance | Train operations | Delay to train operation | b | b | 12 | Medium Term | Operate locomotives only periodically or with snow plow |
| 2000 | 141 | Operations | Train operations | Not applicable to construction work train operation | b | b | 12 | Medium Term | |
| 2000 | 143 | Permanent darkness | Train operations | Crew moral | b | b | 12 | Medium Term | Periodically change crews out - impact no different for the rest of the construction teams |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 144 | Geotech information not available | Tunnels | Not applicable to construction work train operation | b | b | 12 | Medium Term | Standard practice for tunnel construction is that during excavation the support and rock reinforcement measures are tailored to suit the ground conditions exposed. We have therefore developed a number of support classes for given rock mass qualities (as assessed using the NGI Q-System). The designed support is permanent. For example, galvanized fully grouted rock bolts will be installed that should be suitable for the design life of the project. One aspect that is a concern is that of long term freezing and thawing of the rock mass within the tunnel from the tunnel portals. For this aspect we have proposed an observational approach to define both the intensity and extent of the area of concern. The tunnel design has suitable dimensions such that if, at some time in the future, insulation is required to prevent thaw back of the rock mass from the tunnel walls, then this can be placed without projecting into the standard AREMA "clearance box". |
| 2000 | 147 | Rock falls (internal) | Tunnels | Derailment - damage to rolling stock | b | b | 12 | Medium Term | Proper tunnel inspection protocol, where necessary install rock fall detectors. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 148 | Icicles on tunnel roof | Tunnels | Damage to rolling stock | b | b | 12 | Medium Term | Proper tunnel inspection protocol to include physical inspection after prolong periods of inactivity and other periods where appropriate |
| 2000 | 149 | Man way access | Tunnels | Cost | b | b | 12 | Medium Term | Tunnel design to provide for man way access |
| 2000 | 151 | Special steel for bridges, couplings, ties, rail, wheels | Type of railway materials for cold weather | Not applicable to construction work train operation | b | b | 12 | Medium Term | |
| 2000 | 158 | Blizzards | Weather conditions | Delay to operation when severe | b | b | 12 | Medium Term | Stop train operation run inspection train prior to resuming normal operation. Should not affect construction work train operation |
| 2000 | 159 | Cold weather | Weather conditions | Reduced train size | b | b | 12 | Medium Term | Develop protocol to provide for extreme cold conditions for respective area causing air brake pressure problems. Should not affect construction work train operation. |
| 2000 | 160 | Summer frechette | Weather conditions | Reduce train speeds | b | b | 12 | Medium Term | Place temporary train speed limits in affected areas. Should not affect construction work train operation. |
| 2000 | 161 | Survival suits | Weather conditions | Not applicable to construction work train operation | b | b | 12 | Medium Term | Work train will not be operating in extreme cold weather. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 162 | Blizzards, cold weather, summer frechette, survival suits, emergency generators on locomotives, equipment & material standards for extreme cold weather | Weather conditions | Not applicable to construction work train operation | b | b | 12 | Medium Term | Work train will not be operating in extreme cold weather. |
| 2000 | 163 | Emergency generators on locomotives | Weather conditions | Not applicable to construction work train operation | b | b | 12 | Medium Term | Work train will not be operating in extreme cold weather. |
| 2000 | 164 | Equipment & material standards for extreme cold weather | Weather conditions | Not applicable to construction work train operation | b | b | 12 | Medium Term | Work train will not be operating in extreme cold weather. |
| 4000 | 268 | In-situ geotech conditions do not match design assumptions | Not enough drill holes due to weather constraints and equipment downtime | Increased cost / delayed schedule | b | b | 12 | Medium Term | Where insufficient geotechnical information is available, design conservatively. Increase drilling programming. During construction - have sufficient people/knowledge on site to deal with changes in the ground condition (and any redesign). |
| 4000 | 270 | Poor geotechnical samples obtained | 3 different configurations of drills available (used for different applications) | Increased cost / delayed schedule | b | b | 12 | Medium Term | Where poor core samples exist, take a conservative design approach. Due additional drilling in area of poor sampling |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 4000 | 281 | Unable to attract skilled labour to site | Reliability of local labour supply | Increased cost / delayed schedule | b | b | 12 | Medium Term | Training, transport and development of the local Inuit. Start the skills programme early. Provide bonus incentives (if appropriate). Labor study |
| 4000 | 284 | Failure to supply contractor with Minor owner supply equipment | Late procurement/ordering | Increased cost / delayed schedule | b | b | 12 | Medium Term | Early planning. Early supplier involvement. Partnership and alliance with key suppliers. Have key spare parts available. Minimize free issue equipment |
| 4000 | 294 | Safety Issues | Cultural / language differences | Delay in schedule / H&S | b | b | 12 | Medium Term | Extensive safety training programme. Train workers in diversity, cultural sensitivity, have translators if required. Multilingual safety signs. Site specific and job specific safety training. Pre-screen workers for English literacy and assign tasks accordingly |
| 4000 | 301 | Water supply or discharge freezes (Mary River and Steensby) | Pipes bursting and personnel injuries/lack of water supply | H&S | b | b | 12 | Medium Term | Ensure redundancy of spares. Proper maintenance and inspection programme of the pipelines. Insulate and heat trace water supply and discharge. |
| 1000/5000 | 6 | Unavailability of construction equipment - minor | Congestion at Milne Port resulting in ship returning unloaded | Delayed schedule, equipment unavailable | a | a | 11 | Medium Term | Logistics schedule at Milne port. Align with critical path items. Contingency plan to predict possible congestion and contingency plans, rescheduling, alternative supply, temporary solutions etc. Plans to tie in with construction schedule/sequence. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000/5000 | 9 | Road Accidents on site - minor equipment | High traffic volumes, poor driving conditions, construction & mining activities on the same road, unfamiliarity with arctic driving conditions, road width and grade | Schedule delay, safety consequences | a | a | 11 | Medium Term | Limit number of contractors on site - modularization, large packages. Transport logistics (time, accompanied freights etc). Traffic Rule Monitoring (vehicle satellite tracking with regular reports). Driver grading/education/coding |
| 1000 | 32 | Prestripping delays | Interference with ROM primary crusher construction | Schedule delay | a | a | 11 | Medium Term | Project construction management - implement two routes of travel for pit access. |
| 1000/5000 | 55 | Safety and delays to construction | Crane availability and crane cold operation for equipment erection | Schedule delays | a | a | 11 | Medium Term | Construction planning and equipment maintenance |
| 1000/5000 | 63 | Slow mean time to repair | Unheated enclosures for materials handling equipment, open conveyors | Maintenance at extreme temperatures | a | a | 11 | Medium Term | Allow for portable local heating in unheated enclosed areas. Design equipment to ensure spacious access for heavily dressed maintenance personnel |
| 2000 | 68 | Insufficient lighting | 24 hours darkness | Employee Injury, Delay to construction | a | a | 11 | Medium Term | Ensure sufficient flood lighting at work site / RFID for locating equipment in containers |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000/5000 | 23 | Loss of Major components at sea | Weather / storm, improper handling | Major schedule delay | c | e | 10 | Medium Term | Prioritize critical path items. Detailed delivery schedules for these items. Contingency plan/s for temporary operations without specific equipment / Place marine insurance with delayed start up provisions. |
| 1000/5000 | 40 | Wildlife Risk | Wildlife attack on construction personnel | Human Fatality | d | e | 10 | Medium Term | Safety procedures and training |
| 2000 | 107 | Unable to attract workforce | Camp/Accommodations, food, travel | Could result in reduced availability of planned construction work train. | d | e | 10 | Medium Term | Commence a native training course for locomotive drivers in advance of need. Contract qualified locomotive drivers |
| 3000 - Freight Dock | 181 | Construction delays | Catastrophic accident during Marine construction, & Fatality | Increased cost / delayed schedule | d | e | 10 | Medium Term | Prepare Safety Procedures - Constantly Audit Safety Procedures. Ensure training |
| 3000 - Ore Dock | 214 | Less Suitable Design Selection | Options and design | Flaws in final design by marine partner | d | e | 10 | Medium Term | Appropriate and timely reviews by owner's engineer. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000/5000 | 10 | Road Accidents on site - major equipment | High traffic volumes, poor driving conditions, construction & mining activities on the same road, unfamiliarity with arctic driving conditions, road width and grade | Schedule delay, safety consequences | c | d | 9 | Medium Term | Limit number of contractors on site - modularization, large packages. Transport logistics (time, accompanied freights etc). Traffic Rule Monitoring (vehicle satellite tracking with regular reports). Driver grading/education/coding |
| 1000/5000 | 24 | Incorrect delivery of equipment / major modules | Transport logistics failure | Schedule delays, additional shipping logistics | c | d | 9 | Medium Term | Robust systems such as Hatch iPas MP / direct control logistics by EPCM team. |
| 1000/5000 | 25 | Not able to send equipment as modules to site, as planned | Shipping limitations resulting in equipment assembly at site instead of modules to site | Increased cost, increased labor, schedule delays, quality (excessive site welding, special pre-warming provision) | c | d | 9 | Medium Term | Alternative delivery and construction plans. Plans to reduce site welding (e.g. bolted connections), smaller logical sub assemblies. Thorough assessment of shipping capacities and limitations. |
| 1000/5000 | 29 | Lower project payoff | Handling of larger than anticipated portions of off-spec material | More blending required, equipment congestion, throughput limitation | c | d | 9 | Medium Term | Allow for more off-spec storage at the mine (pre-crushing and post-crushing). Extensive mining plan with accurate pre-drilling and sampling. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000 | 30 | ARD drainage | Suboptimal design | Rework drainage lines | c | d | 9 | Medium Term | Layout/design/implement collection ditches below all waste dumps and ore stockpiles. |
| 1000/5000 | 60 | Reduced Port throughput | Availability of equipment less than predicted/lower operating days per annum due to inability to meet cold spec. | Throughput less than design | c | d | 9 | Medium Term | Higher throughput in design - determine bottlenecks and implement contingency plans to eliminate bottlenecks. |
| 2000 | 76 | Delayed delivery of rail bridge girder material | Special order material, timing with steel fabricators | Delay and cost | c | d | 9 | Medium Term | Collaborate with contractor rail partners to optimize |
| 2000 | 92 | Diluted supervision and quality control | Multiple work faces - management of construction, support of linear construction | Delay and cost | c | d | 9 | Medium Term | Adequate pre-planning and maintenance of site supervision ratio |
| 2000 | 102 | Ammonium leaching | Explosives - mis-fired holes | Not applicable to construction work train operation | c | d | 9 | Medium Term | |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 114 | Ice Road unavailable | Weather (too warm), early access to work sites in 2012, re-build each year, failure of road, security controlled access to road, access to water, environmental cleanups | Not applicable to construction work train operation | c | d | 9 | Medium Term | Work-around planning |
| 2000 | 119 | Bridge foundation design - thermal erosion (melting) | Permafrost | Not applicable to construction work train operation | c | d | 9 | Medium Term | Regular inspection, and ultimately the use of thermosyphons if necessary |
| 2000 | 133 | Delayed delivery | unable to deliver to annual sea lift | Delay and cost | c | d | 9 | Medium Term | Adequate planning, procurement and expediting |
| 3000 - Freight Dock | 174 | Loss of foundation support for the dock | Scour from ship propellers (During Operations) | Compromise the structural integrity of the dock | c | d | 9 | Medium Term | Scour Protection will be installed at the base of the dock. The Scour protection will require review once BIM has selected the size and prop force of Ice Breaking tugs |
| 3000 - Freight Dock | 175 | Construction delays | Limited activities due to interaction marine mammals | increased cost / delayed schedule | c | d | 9 | Medium Term | An Air curtain will be placed around the area where the sheet piles are vibrated |
| 3000 - Freight Dock | 194 | Project delay | Unloading rates slower than expected, bottleneck at | increased cost / delayed schedule | c | d | 9 | Medium Term | Logistics to review onland unloading and traffic capabilities and near dock storage. Logistics to prepare a detailed plan |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | construction docks | | | | | | |
| 3000 - Freight Dock | 196 | Dock over utilized | Unloading rates more and /or slower than expected, dock used for fueling , freight, tugs and maintenance | increased cost / delayed schedule | c | d | 9 | Medium Term | Logistics to review onland unloading and traffic capabilities and near dock storage. Logistics to prepare a detailed plan. The design to allow for dock expansion |
| 3000 - Island Bridge | 199 | Excessive settlement of Fill Abutments or causeway | Harbour bottom - unstable materials | increased cost / delayed schedule | c | d | 9 | Medium Term | Additional geotechnical investigation to obtain the necessary geotechnical parameters |
| 3000 - Ore Dock | 202 | Move ore dock | Unexpected geotech conditions (unable to complete the summer program) | increased cost and schedule delay | c | d | 9 | Medium Term | Additional geotechnical investigation to obtain the necessary geotechnical parameters. Select appropriate dock design. |
| 3000 - Ore Dock | 206 | Move ore dock | Bathymetry incorrect (not properly calibrated yet) | increased cost and schedule delay | c | d | 9 | Medium Term | Additional bathymetry/geophysical investigations |
| 3000 - Ore Dock | 207 | Constructability difficulties | Bathymetry incorrect (not properly calibrated yet) | increased cost and schedule delay | c | d | 9 | Medium Term | Additional bathymetry/geophysical investigations |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000 - Ore Dock | 212 | Loss of support for the dock | Scour from ship propellers (During Operations) | Compromise the structural integrity of the dock | c | d | 9 | Medium Term | Scour Protection will be installed at the base of the dock. The Scour protection will require review once BIM has selected the size and prop force of Ice Breaking tugs |
| 3000 - Ore Dock | 222 | Operations Stop | Dock settles differentially | Disruption of operation, expensive repairs, loss of revenue | c | d | 9 | Medium Term | Appropriate designs based on good sub surface information, good construction practice and inspection. Dock design to accommodate some settlement. |
| 3000 - Ore Dock | 225 | Project delay | Procurement delays (Major) | increased cost, schedule delay | c | d | 9 | Medium Term | Scheduling, critical path items, regular reviews, continuous expediting of critical elements |
| 3000 - Ore Dock | 232 | Dredging | Under specified methods, Inadequate redundancy | increased cost, schedule delay | c | d | 9 | Medium Term | Appropriate sampling, appropriate permits, properly prepared specifications and data for contractors |
| 3000 - Steensby Two Floating Construction Docks | 244 | Delivery is not completed | Inadequate Logistics Planning | increased cost / delayed schedule | c | d | 9 | Medium Term | Conservative logistics planning and air freight alternatives |
| 3000- Milne Floating Dock and Lightering Operations | 247 | Lightering operations are Halted | Ice Flows Back into Harbour in Early Summer | increased cost / delayed schedule | c | d | 9 | Medium Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000-Milne Floating Dock and Lightering Operations | 253 | Delivery is not completed | Inadequate Logistics Planning | increased cost / delayed schedule | c | d | 9 | Medium Term | Conservative logistics planning and air freight alternatives |
| 4000 | 285 | Failure to supply contractor with owner supply equipment | Poor QA/QC at vendor shop with rework required | increased cost / delayed schedule | c | d | 9 | Medium Term | Prequalification of vendors. Proper QA/QC inspection. Proper ITP in place to qualify the vendor. On site inspectors (in workshops/yard) for critical or long lead equipment |
| 4000 | 295 | Rework at site / construction delays | Failure for QA/QC at shops and marshalling yards | increased cost / delayed schedule | c | d | 9 | Medium Term | Proper on-site inspection. Use qualified/experienced suppliers. |
| 4000 | 298 | Damage to shared infrastructure / equipment | Inappropriate maintenance, inexperience operators, overuse | increased cost / delayed schedule | c | d | 9 | Medium Term | Prequalification of vendors. Use experienced contractors and labour. Establish the proper preventative maintenance programme. Use reliable equipment with a proven arctic history. Provide proper operator training prior to operating or maintaining equipment. Plan to not overuse equipment. Specify equipment appropriately |
| 4000 | 302 | Strike at shipping company, ship yard, etc. | Labor unrest | delay in schedule | c | d | 9 | Medium Term | Incentives and penalties. Partner with different shipping companies to spread the risk. Use alternative providers for shipping, where appropriate. Pre-qualify / assess labor unrest issues |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 4000 | 303 | Loss of major components at sea | Weather, poor loading tie-downs | delay in schedule | c | d | 9 | Medium Term | Use ship suppliers that you have a previous track record with. Ensure good relationships with the suppliers. If possible, use standardization of equipment. Inspect all loads prior to shipping |
| 1000/5000 | 2 | Late delivery of equipment - minor | Extended lead time / short window to deliver equipment items | Delayed schedule, equipment unavailable | b | c | 8 | Medium Term | Prioritize critical path items. Detailed delivery schedules for these items. Specific sub-contract control. Contingency plan/s for temporary operations without specific equipment. Expediting plans |
| 1000/5000 | 3 | Unavailability of equipment/components - minor | Rubber supply shortage (tires, conveyor belts), arctic grade steel, large slew bearings | Delayed schedule, equipment unavailable | b | c | 8 | Medium Term | List of all items that could be in short supply. List of possible suppliers. Preferred supplier early negotiations including quantity and rates |
| 1000/5000 | 4 | Unavailability of construction equipment - major at port | Congestion at Milne Port resulting in ship returning unloaded | Delayed schedule, equipment unavailable | b | c | 8 | Medium Term | Logistics schedule at Milne port. Align with critical path items. Contingency plan to predict possible congestion and contingency plans, rescheduling etc. Plans to tie in with construction schedule/sequence. |
| 1000/5000 | 8 | Damage to Electrical and electronic equipment | Exposure to extreme low temperatures during transport and storage at site | Delayed schedule, warrantee issues, re-work | b | c | 8 | Medium Term | Transport and storage specification and logistics plan (heated transport and storage for selected equipment). Packing specification/requirements / work with suppliers to expand warranty |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000 | 13 | Road Accidents on site - major accident with minor injury | Haul truck loss of control | Equipment loss, injury | b | c | 8 | Medium Term | Haul truck run-out |
| 1000 | 42 | Explosives Storage Location | Not optimal design | Store relocation, distribution logistics | b | c | 8 | Medium Term | Complete thorough review of regulations and implement accordingly. |
| 1000 | 43 | Reduced Mine throughput | Reduced productivity (design base 300 days assumed availability) | Revenue Income | b | c | 8 | Medium Term | Contingency increased instantaneous throughput. Larger stockpile areas. Maximized system throughput. Bottleneck management |
| 1000/5000 | 45 | Delayed construction | Anomalous geology (hard / loose material) | Schedule delay, re-design | b | c | 8 | Medium Term | Implement comprehensive geotech drilling program for critical crushing infrastructure. |
| 1000/5000 | 48 | Delayed construction | Multi source sub-contractor interface management | Schedule delay, interface construction items not ordered | b | c | 8 | Medium Term | Detailed construction schedules. Detailed CWPs. Detailed enquiries and detailed bid evaluations. Active interface management by EPCM contractor |
| 1000/5000 | 49 | Delayed construction | Large lifts from water at the docks sensitive to wind conditions | Schedule delay, equipment locked in | b | c | 8 | Medium Term | Detailed delivery schedule: planning weather downtime. Barging alternatives, detailed wind and wave studies |
| 1000/5000 | 51 | Delayed commissioning | Commissioning spares logistic failure | Schedule delay | b | c | 8 | Medium Term | Commissioning spares program with main supply contracts. Pre-test and factory acceptance testing and pre |
| 1000/5000 | 53 | Sea Water contamination | Water runoff from stockpiles at | Environmental contamination | b | c | 8 | Medium Term | Stockpile drainage design and waste water handling programme |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | Steensby | | | | | | |
| 1000 | 54 | Sea Water contamination | Diesel Fuel spill | Environmental contamination | b | c | 8 | Medium Term | Emergency response vessel at port site 24/7. Vessel will be equipped with all the Water Containment spill response equipment necessary to handle a fuel spill. |
| 1000/5000 | 57 | Fire Risk during construction | Welding on material handling equipment, fire management and protection during construction | Equipment damage, schedule delays | b | c | 8 | Medium Term | Hot Work permit and procedure in place during construction. Fire response vehicle and team available at site 24/7. Large equipment and facilities will be equipped with fire suppression systems. |
| 1000/5000 | 64 | Expiry of equipment warrantees | Long storage periods on site due to small delivery window | Product support, re-ordering of failed parts | b | c | 8 | Medium Term | Ensure procurement contract to allow for warranty extension clauses in case of extended construction. Storage methodology to enable extended warranty as per sub- supplier recommendation. |
| 1000/5000 | 65 | Invalidation of equipment warrantees | Incorrect storage in arctic temperature in both installed and un-installed equipment | Product support, re-ordering of failed parts, re-work | b | c | 8 | Medium Term | Site storage to sub-supplier agreed conditions, adherence to that and proof of adherence to that. |
| 2000 | 74 | Inability to support rail construction | Lack of access road, access to work fronts | Delay and cost | b | c | 8 | Medium Term | Collaborate with contractor rail partners to optimize |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 75 | Inadequate quantity & quality of ballast material | Only one quarry identified as suitable for ballast | Delay and cost | b | c | 8 | Medium Term | |
| 2000 | 84 | Unavailability of concrete | Weather conditions | Delay and cost | b | c | 8 | Medium Term | Consider using bridge deck pans |
| 2000 | 90 | Warranties of Construction equipment | | Delay and cost | b | c | 8 | Medium Term | Ensure procurement contract to allow for warranty extension clauses in case of extended construction. Storage methodology to enable extended warranty as per sub- supplier recommendation. |
| 2000 | 91 | Delay due to customs clearance at port | OFFSHORE EQUIPMENT | Delay and cost | b | c | 8 | Medium Term | Ensure freight forwarder responsible for customs pre-clearance |
| 2000 | 105 | Fire | Overheated equipment starting fires; people ; fire suppression systems; | Delay and cost | b | c | 8 | Medium Term | |
| 2000 | 111 | Piers for bridges impact design/cost/schedule, no bedrock found so designing for permafrost | Geotech | Not applicable to construction work train operation | b | c | 8 | Medium Term | Additional geotech and contingency planning. Ensure sufficient materials on site for contingency planning |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 113 | Remove more material than planned | Cuts & fills, permafrost conditions, rock suitability | Delays and cost | b | c | 8 | Medium Term | Adequate risk allocations in contracts. |
| 2000 | 123 | Unsuitable quarry material | Top layer quarry unsuitable | Delays and cost | b | c | 8 | Medium Term | Adequate planning and additional geotechnical investigations |
| 2000 | 124 | Location time/cost to access | Quarries | Delays and cost | b | c | 8 | Medium Term | |
| 2000 | 127 | Air brakes (failure) | Rolling stock | Failure to make proper train stops | b | c | 8 | Medium Term | Proper training of locomotive drivers in train handling, air brake test and air brake continuity. |
| 2000 | 128 | Moisture in air | Rolling stock | Delay to train operation | b | c | 8 | Medium Term | Reduce train size to accommodate proper brake pipe taper. Should not affect construction work train operation. |
| 2000 | 130 | Covered storage of spare locomotives | Rolling stock | Cost | b | c | 8 | Medium Term | Consider temporary shelters. |
| 2000 | 142 | Signals | Train operations | Not applicable to construction work train operation | b | c | 8 | Medium Term | Signals not in operation during track construction |
| 2000 | 153 | Test track | Type of railway materials for cold weather | Not applicable to construction work train operation | b | c | 8 | Medium Term | |
| 2000 | 155 | Type of welding for track | Type of railway materials for cold weather | Not applicable to construction work train operation | b | c | 8 | Medium Term | Flash Butt Welding has been specified for rail welds, including those executed during maintenance to maintain material homogeneity |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 156 | Special cold weather material availability | | Not applicable to construction work train operation | b | c | 8 | Medium Term | Material requirements will not be finally defined until orders are placed. Functional specs will require serviceability through the required temperature range. Suppliers will be responsible for the availability of suitable materials |
| 3000 - Freight Dock | 166 | More dredging required | Unexpected geotech conditions (unable to complete the summer program) | Increased cost | b | c | 8 | Medium Term | Complete a comprehensive 6 - 8 borehole program at the freight dock in the winter of 2011 or the spring of 2012 |
| 3000 - Freight Dock | 167 | Move Freight dock | Unexpected geotech conditions (unable to complete the summer program) | Increased cost | b | c | 8 | Medium Term | Complete a comprehensive 6 - 8 borehole program at the freight dock in the winter of 2011 or the spring of 2012 |
| 3000 - Freight Dock | 170 | More dredging required | Bathymetry incorrect (not properly calibrated yet) | Increased cost | b | c | 8 | Medium Term | Complete a verifying Bathymetry Program at the freight dock in the summer of 2011 |
| 3000 - Freight Dock | 183 | Project delay | Partnering arrangement fails at the end of Phase 1 | No project sanctioned, increased cost, schedule delay | b | c | 8 | Medium Term | BIM / Hatch be prepared to complete final design over the Winter of 2012 for tendering in the winter and spring of 2012. |
| 3000 - Freight Dock | 184 | Project delay | Phase 2 design delays | No project sanctioned, increased cost, | b | c | 8 | Medium Term | BIM / Hatch be prepared to complete final design over the Winter of 2012 for tendering in the winter and spring |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | schedule delay | | | | | of 2012. |
| 3000 - Freight Dock | 190 | Project delay | Weather conditions during construction | increased cost / delayed schedule | b | c | 8 | Medium Term | Ensure contractor has sufficient resources and has allocated weather condition delays in the schedule |
| 3000 - Ore Dock | 218 | Construction delays | Loss of material / components offshore (Minor) | increased cost / delayed schedule | b | c | 8 | Medium Term | Minimize risk by good risk management practices |
| 3000 - Ore Dock | 219 | Construction delays | Loss of material / components on land | increased cost / delayed schedule | b | c | 8 | Medium Term | Good accounting and housekeeping practices, appropriate security, spares for critical items |
| 3000 - Ore Dock | 223 | Project delay | Partnering arrangement fails at the end of phase 1 | Increased cost, schedule delay | b | c | 8 | Medium Term | BIM / Hatch be prepared to complete final design over the Winter of 2012 for tendering in the winter and spring of 2012. |
| 3000 - Ore Dock | 224 | Project delay | Phase 2 design delays | Increased cost, schedule delay | b | c | 8 | Medium Term | Good communications, regular meetings, workshops. Push detailed design into vendors/contractor scope. Expedite design in the workshop. Support and expedite design effort of contractors. |
| 3000 - Ore Dock | 230 | Project delay | Weather conditions during construction | increased cost, schedule delay | b | c | 8 | Medium Term | Maximize pre fabrication, reduce on site labor. Minimize winter work. Plan must anticipate significant weather delays |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000 - Steensby Two Floating Constructi on Docks | 242 | Lightering operations are Slowed | Onshore storage is overcrowded | increased cost / delayed schedule | b | c | 8 | Medium Term | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |
| 4000 | 263 | Low labour productivity in construction at Steensby due to delay in airstrip | More movement of staff by helicopter/twin otter from MR | increased cost | b | c | 8 | Medium Term | Early opening of airstrip. Work on multiple fronts. Have round the clock construction during the construction period. Possibly bring workers in by boat (summer only). |
| 4000 | 266 | Risk of Fire during construction | Due to combustibles e.g. welding, poor housekeeping etc | Damage to environment, H&S, potential fatality | b | c | 8 | Medium Term | Proper fire protection facilities available. Proper training on storage and fire prevention. Keep ignition sources away from potential combustibles. No smoking areas clearly delineated and enforced. Hot permits for welding enforced. |
| 4000 | 271 | Unidentified archaeological sites | Not enough investigation (due to new location of site facilities) | delay in schedule | b | c | 8 | Medium Term | Constant communication with the archaeologist on site with regards to new layout changes to ensure that any potential archaeological sites are properly identified and mitigated in time. Early and ongoing archaeological investigations. |
| 4000 | 272 | Archaeological Sites | Mitigation identified can only be completed in the next season | delay in schedule | b | c | 8 | Medium Term | Flexibility within the sequencing of construction activities (multiple fronts). Include early and ongoing archaeological investigations. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 4000 | 290 | Lack of qualified engineering staff | Availability of resources in particular arctic engineering experience | increased cost / delayed schedule | b | c | 8 | Medium Term | Attract the best engineers. Hire the experienced companies. Mentor the new engineers to improve the skill base. Ensure proper checking procedures. Completion incentives |
| 4000 | 299 | Delay in permitting | Major safety incident prior to obtaining permits | delay in schedule | b | c | 8 | Medium Term | Maintain state of the art safety programme. Enforce personal safety plans. Proper training of hazard identification, safe workplace practices. Hire higher skilled people. Cultivate a culture of safety on the sites. |
| 4000 | 300 | Unauthorized personnel/wide life animals in restricted areas. (e.g., Snowmobiles traversing the site.) | No fencing /protective barriers for the job site | H&S | b | c | 8 | Medium Term | For personnel - put up signage to prevent snowmobile crossing. Engage a site security contractor to control access to site. |
| 4000 | 306 | Labour productivity poor or less than adequate | due to arctic weather conditions and remoteness | increased cost / delayed schedule | b | c | 8 | Medium Term | Provide incentives. Use experienced contractors. Plan with conservative labor productivity rate |
| 4000 | 307 | Poor contractor selection /execution | contractor misrepresentation and overextension | increased cost / delayed schedule | b | c | 8 | Medium Term | Ensure better prequalification of suppliers. B&D financial prescreening. Use contractors with northern experience |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 4000 | 311 | Insufficient accommodation for workforce during construction | Poor planning, unforeseen demands | increased cost / delayed schedule | b | c | 8 | Medium Term | Proper construction planning for the construction project. And logistics associated with rotation, beds, food. Develop long term relationship with camp supplier. |
| 1000/5000 | 12 | Road Accidents on site - minor accident with minor injury | High traffic volumes, poor driving conditions, construction & mining activities on the same road, unfamiliarity with arctic driving conditions, road width and grade | Schedule delay, safety consequences | a | b | 7 | Medium Term | Limit number of contractors on site - modularization, large packages. Transport logistics (time, accompanied freights etc). Traffic Rule Monitoring (vehicle satellite tracking with regular reports). Driver grading/education/coding |
| 1000/5000 | 17 | Infectious diseases/illnesses | Camp concentration, close living conditions, mold | Lower productivity, schedule delays | a | b | 7 | Medium Term | Weekly inspections of facilities being used by groups of people and areas of high moisture content. Camps need to be in great condition at the start so there's pride in keeping it that way and it needs to sized properly for the number of men and washroom facilities should cleaned thoroughly daily / screening before you come to site, medical testing |
| 1000/5000 | 19 | Labor issues | Stranded labor / remote sites | Schedule delays | a | b | 7 | Medium Term | Transport logistics, vehicle tracking, transport communication plan |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000/5000 | 38 | Primary crusher damage and delays | Handling of frost chunks, oversize material and foreign material | Operational delays | a | b | 7 | Medium Term | Implement operational procedures to stockpile frost chunks for processing in summer months. |
| 2000 | 103 | Project delay | Explosive delivery truck breakdown | Delay and cost | a | b | 7 | Medium Term | |
| 2000 | 134 | Long periods of "storage" | Sea Lift | Not applicable to construction work train operation | a | b | 7 | Medium Term | |
| 2000 | 165 | Nesting/breeding, migrations, death of wildlife | wildlife interaction | Dead or failure to breed wildlife and minor derailment | a | b | 7 | Medium Term | Ensure that Hydraulic rerail equipment available with construction work train, and construction programme follows best practice under advisement of wildlife specialists. |

## 3.3 Low Risks (Green)

As mentioned earlier, 23% of the total risks identified were classified as low risks. Low risks are defined as having a risk rating of less than or equal to 6. Table 3- below provides a description of the project risks and the associated mitigation actions.

**Table 3-: Summary of Low Risks**

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000/5000 | 41 | Uncovering of archeological artifacts on site | Uncovering of archeological artifacts on site | Schedule delay | c | e | 6 | Medium Term | Revise mine plans to alternate mining area contingency plans |
| 2000 | 115 | Overseas fabrication - embargos bringing into Canada | Logistics | Delays and cost | c | e | 6 | Medium Term | Vendor pre-qualification and early engagement with contractor |
| 2000 | 121 | Bridge foundation design - construction experience | Permafrost | Not applicable to construction work train operation | c | e | 6 | Medium Term | Regular inspection required |
| 3000 - Freight Dock | 173 | Ship impact during operations | Poor design | Damage to dock, equipment, ship | c | e | 6 | Medium Term | Design Defense systems (Fenders) to properly protect the dock against construction and operational vessels - The ice breaking tugs will be required to have a safe practice procedure when using the dock in the winter for refueling. Berthing operations assisted by tugs |
| 3000 - Freight Dock | 180 | Construction delays | Catastrophic accident during construction, i.e. barge sinking in | increased cost / delayed schedule | c | e | 6 | Medium Term | Specify that all floating vessels and barges are a registered class. Ensure appropriate operational procedures and training. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | construction dock area | | | | | | |
| 3000 - Freight Dock | 182 | Operations Stop | Dock settles differentially | Disruption of operation, expensive repairs, loss of revenue | c | e | 6 | Medium Term | Complete a comprehensive 6 - 8 borehole program at the freight dock in the winter of 2011 or the spring of 2012 - reassess geotechnical conditions |
| 3000 - Ore Dock | 210 | Suboptimal dock | Design-build product is unsuitable for the site | Will not function as required | c | e | 6 | Medium Term | Appropriate and timely reviews by owner's engineer. Appropriate technical requirements by BIM. |
| 3000 - Ore Dock | 211 | Ship impact during operations | Poor design | Damage to dock, equipment, ship | c | e | 6 | Medium Term | Design Defense systems (Fenders) to properly protect the dock against construction and operational vessels - The ice breaking tugs will be required to have a safe practice procedure when using the dock in the winter for refueling. Berthing operations assisted by tugs |
| 1000 | 35 | Prestripping delays | Contracting type (mine or contractor) | Schedule delays, training, ramp up time | b | d | 5 | No Action | Contract out prestripping. Target equipment preparation and pre-production operations for 1st qtr 2016 ahead instead of 2nd qtr. |
| 1000 | 36 | Prestripping delays | Contractor ability to establish camp/logistics to settle workforce | Schedule delays | b | d | 5 | No Action | Camps are due to be in place the year before prestrip commences. |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 1000 | 37 | Prestripping delays | Operational preparation/equip ment not ready | Schedule delay | b | d | 5 | No Action | Target equipment preparation and pre-production operations for 1st qtr 2016 ahead instead of 2nd qtr. |
| 1000/5000 | 59 | Fail to ship/reduced Port throughput | Insufficient storage capacity at Steensby | Loss of revenue, demurrage | b | d | 5 | No Action | Ensure adequate storage capacity at Steensby and Mary River |
| 2000 | 71 | Degradation of cables | 24 hours sunlight | Not applicable to construction work train operation | b | d | 5 | No Action | |
| 2000 | 77 | Delayed delivery of rail bridge girder material | Weight of girders, transportation problems on ships and roads (weight and dimensions) | Delay to commissioning resulting in cost and schedule impacts to BIM | b | d | 5 | No Action | Pre-order of equipment, ordering of contingency pieces of standard sizes with each shipment to have spare. Collaborate with contractor rail partners to optimize |
| 2000 | 78 | Delay construction of bridges / infrastructure | Limited access to construction site | Delay to commissioning resulting in cost and schedule impacts to BIM | b | d | 5 | No Action | Pre-order of equipment, ordering of contingency pieces of standard sizes with each shipment to have spare, preplanning with contractors to ensure enough flexibility in schedule for adjustment of work sites. Collaborate with contractor rail partners to optimize |
| 2000 | 80 | Poor communication system | Use a telecom system based on un-licensed frequencies or in case the railway VHF radio overlaps with the other VHF | Delayed data transfer | b | d | 5 | No Action | Properly defining the frequency plan for the railway VHF radio.<br>VHF frequencies shall be selected in licensed bands compliant with CSA / AREMA standards.)<br>To avoid any risk of overlap between VHF systems, technical coordination is required between consultants |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | systems contemplated for the project. | | | | | | during project preparation and between telecom contractors (for the railway, the mine, the port, Tote road) during construction. |
| 2000 | 81 | Poor communication system | Bandwidth | Miscommunications between functions of rail, port or mine that may result in confusion of instruction, injury or fatality | b | d | 5 | No Action | Confirm communication frequencies and emergency bands early. Provide EMI/EMC analysis to identify interference possibilities, ensure a back-up communication system is in place and tested regularly |
| 2000 | 82 | Poor communication system | No tower constructed yet | Delayed service for construction and operation | b | d | 5 | No Action | For construction have contractors responsible for their own systems. For IT&C of the rail, pre construct towers prior to shipping, test transmission along entire site to identify dark territories, have 3 level emergency redundancy systems in case of incident |
| 2000 | 83 | Poor communication system | Radio dead spots | Possible fatality due to lack of communication through operations | b | d | 5 | No Action | Confirm communication frequencies and emergency bands early. Provide EMI/EMC analysis to identify interference possibilities, ensure a back-up communication system is in place and tested regularly, identify |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | dark territories and have operational procedures |
| 2000 | 85 | Unavailability of concrete | distance of batch plant to area where required | Delay and cost | b | d | 5 | No Action | Consider using bridge deck pans |
| 2000 | 87 | Interface with warehousing | Improper storage | May result in equipment not being available when required, voiding of warranty, equipment going missing | b | d | 5 | No Action | Establish warehousing protocols and pre-planning for required controlled conditions, automated inventory system and prioritize deliveries with contingency of parts for loss and damage. |
| 2000 | 89 | Deliveries of contractor equipment/materials to site - minor | Damage during shipment, inability to offload | may result in delays to construction with additional cost and schedule impact for commissioning | b | d | 5 | No Action | Establish prioritize deliveries with contingency of parts for loss and damage. |
| 2000 | 108 | Additional material handling | Insufficient quarry data | Not applicable to construction work train operation | b | d | 5 | No Action | |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 109 | Handling of contractor equipment & material | Contractor / supplier supply - paperwork, inspection, holdup, handover, liability / insurance of getting equipment to site | Not applicable to construction work train operation | b | d | 5 | No Action | |
| 2000 | 112 | Construction constraints, firewalls for software, government restraints, time to get approvals | Governing body (mines act) | Not applicable to construction work train operation | b | d | 5 | No Action | |
| 2000 | 117 | Equipment unsuitable for cold weather operations | | Breakdowns, delay and costs | b | d | 5 | No Action | Track laying, etc will not occur during the coldest period of the year. Design specs need to anticipate for cold weather |
| 2000 | 122 | Rockfill supply | Insufficient or widely spaced quarries | Delays and cost | b | d | 5 | No Action | Adequate planning and additional geotechnical investigations |
| 2000 | 125 | Rockfill supply | animal nesting at quarry sites | Delay and cost | b | d | 5 | No Action | Adequate planning |
| 2000 | 126 | Safe zone | Quarries | Not applicable to construction work train operation | b | d | 5 | No Action | |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 152 | Testing wheels/locos | Type of railway materials for cold weather | Not applicable to construction work train operation | b | d | 5 | No Action | Ultra-cold weather operation not applicable to work train. |
| 2000 | 154 | Testing & commissioning plan not yet completed | Type of railway materials for cold weather | Not applicable to construction work train operation | b | d | 5 | No Action | |
| 3000 - Freight Dock | 168 | Constructability difficulties | Unexpected geotech conditions (Post Summer Programme) | Increased cost | b | d | 5 | No Action | The comprehensive 6 - 8 borehole program at the freight dock in the winter of 2011 or the spring of 2012 - will reduce risk further |
| 3000 - Freight Dock | 171 | Constructability difficulties | Bathymetry incorrect (not properly calibrated yet) | Increased cost | b | d | 5 | No Action | The verifying Bathymetry Program at the freight dock in the summer of 2011 - will reduce risk further |
| 3000 - Freight Dock | 172 | Interface with land-based design | Datum incorrect (not properly calibrated yet) | Increased cost | b | d | 5 | No Action | The verifying Bathymetry Program at the freight dock in the summer of 2011 - will reduce risk further |
| 3000 - Freight Dock | 176 | Construction delays | Excessive siltation | increased cost / delayed schedule | b | d | 5 | No Action | Silt Curtains will be placed around the in water work area |
| 3000 - Freight Dock | 185 | Project delay | Procurement delays (Major) | increased cost / delayed schedule | b | d | 5 | No Action | Hatch EPCM - to monitor procurement of materials and implement iPas MP. Continue use of lightering operations |
| 3000 - Freight Dock | 186 | Project delay | Procurement delays (Minor) | increased cost / delayed schedule | b | d | 5 | No Action | Hatch EPCM - to monitor procurement of materials and implement iPas MP. Continue use of lightering operations |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000 - Freight Dock | 187 | Project delay | Short supply of construction labor | increased cost / delayed schedule | b | d | 5 | No Action | Hatch EPCM - to monitor availability of labour |
| 3000 - Freight Dock | 191 | More dredging required | Over specified methods, excessive redundancy | increased cost | b | d | 5 | No Action | Complete a comprehensive 6 - 8 borehole program at the freight dock in the winter of 2011 or the spring of 2012 to fully assess the requirements of dredging |
| 3000 - Freight Dock | 192 | More dredging required | Under specified methods, Inadequate redundancy | increased cost / delayed schedule | b | d | 5 | No Action | Complete a comprehensive 6 - 8 borehole program at the freight dock in the winter of 2011 or the spring of 2012 to fully assess the requirements of dredging |
| 3000 - Freight Dock | 193 | Dewatering Complications of Dredged Material | Under specified methods, Inadequate redundancy | increased cost / delayed schedule | b | d | 5 | No Action | Complete a comprehensive 6 - 8 borehole program at the freight dock in the winter of 2011 or the spring of 2012 to fully assess the requirements of dredging disposal |
| 3000 - Freight Dock | 195 | Dock Storage Inadequate | Operations require more storage space at time of loading unloading of Multipurpose vessels | increased cost | b | d | 5 | No Action | Logistics to review onland unloading and traffic capabilities and near dock storage. Logistics to prepare a detailed plan |
| 3000 - Freight Dock | 197 | Damage | Growlers during construction (north location) | increased cost | b | d | 5 | | Delay installation of sheet piles until growlers are gone |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000 - Island Bridge | 198 | Cannot Access Island with materials, equipment or fuel | Bridge or Causeway not constructed in time | increased cost / delayed schedule | b | d | 5 | No Action | Reduce risks by ensuring that permits are issued on time. Choose simple construction methods. Ensure that construction materials and equipment are available in time. |
| 3000 - Ore Dock | 204 | Grounding of vessels | Bathymetry incorrect (not properly calibrated yet) | increased cost and schedule delay | b | d | 5 | No Action | Additional bathymetry/geophysical investigations Review Navigational Channels and Possible aids with Shippers |
| 3000 - Ore Dock | 208 | Interface with land-based design | Datum incorrect (not properly calibrated yet) | Will not function as required | b | d | 5 | No Action | Additional bathymetry/geophysical investigations and confirm datums |
| 3000 - Ore Dock | 209 | Grounding of vessels | Datum incorrect (not properly calibrated yet) | Loss of Equipment | b | d | 5 | No Action | Additional bathymetry/geophysical investigations and confirm datums |
| 3000 - Ore Dock | 216 | Construction delays | Excessive siltation | increased cost / delayed schedule | b | d | 5 | No Action | Appropriate specifications, good inspection |
| 3000 - Ore Dock | 226 | Project delay | Procurement delays (Minor) | increased cost, schedule delay | b | d | 5 | No Action | Scheduling, critical path items, regular reviews, continuous expediting of critical elements |
| 3000 - Ore Dock | 227 | Project delay | Short supply of construction labor | increased cost, schedule delay | b | d | 5 | No Action | Maximize pre fabrication, reduce on site labor, labor study, attractive site conditions |
| 3000 - Ore Dock | 231 | Dredging | Over specified methods, excessive redundancy | increased tender cost | b | d | 5 | No Action | Appropriate sampling, appropriate permits, properly prepared specifications and data for contractors |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000-Milne Floating Dock and Lightering Operations | 251 | Lightering operations are Slowed | Onshore storage is overcrowded | increased cost / delayed schedule | b | d | 5 | No Action | Ensure conservative offloading rate and dock usage utilization. Logistics to review onland unloading and traffic capabilities and storage. Logistics to prepare a detailed plan. |
| 4000 | 292 | Performance Bonding / Insurance | Contractor to meet conformance to bonding/insurance requirements. | increased cost | b | d | 5 | No Action | Consider shared risk/pain and gain. Consider use of appropriate contract wording/language. Use, if possible, the concept of open book. |
| 1000/5000 | 7 | Unavailability of construction equipment - minor | Road congestion to mine site / weight (load) limitations at bridges | Delayed schedule, equipment unavailable | a | c | 4 | No Action | Logistics schedule/plan for transport from Milne port to Mary river. Align with critical path items. Contingency plan to predict possible congestion and contingency plans, rescheduling, alternative supply, temporary solutions etc. Plans to tie in with construction schedule/sequence. |
| 1000/5000 | 39 | Wildlife Risk | Accidental death due to pre-strip and construction operations | Schedule delays | a | c | 4 | No Action | Mine ops will have a procedure that clears the blast zone of people and wildlife before each shot is taken. |
| 2000 | 93 | Delayed recovery from derailment | Poor access and communications | May result in operation delays and cost impact to owner for late deliveries. May also result in injuries to workers | a | c | 4 | No Action | Ensure that Hydraulic rerail equipment available with construction work train |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | if derailment area not properly secured | | | | | |
| 2000 | 104 | Project delay | Run out of explosives rock type determines quantities required | Delay and cost | b | e | 3 | No Action | Planning, local stores and fly-in |
| 3000 - Freight Dock | 169 | Grounding of vessels | Bathymetry incorrect (not properly calibrated yet) | Increased cost | b | e | 3 | No Action | The verifying Bathymetry Program at the freight dock in the summer of 2011 - will reduce risk further |
| 3000 - Freight Dock | 177 | Construction delays | Loss of material / components offshore (Major) | increased cost / delayed schedule | b | e | 3 | No Action | Ensure that the contractors use vessels and barges that are a registered class. Ensure that contractors have proper procedures and that enforce the procedures |
| 3000 - Freight Dock | 178 | Construction delays | Loss of material / components offshore (Minor) | increased cost / delayed schedule | b | e | 3 | No Action | Ensure that the contractors use vessels and barges that are a registered class. Ensure that contractors have proper procedures and that enforce the procedures |
| 3000 - Freight Dock | 179 | Construction delays | Loss of material / components on land | increased cost / delayed schedule | b | e | 3 | No Action | Ensure that contractors have proper procedures and that enforce the procedures |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000 - Island Bridge | 200 | Damage | Growlers during construction | delay in schedule | b | e | 3 | No Action | Design to minimize possibility of damage. Keep bridge abutments above High Tide |
| 1000/5000 | 15 | Site security | Spread of site, multiple work faces | Theft of equipment, trespassing, accidental hurting/killing of wild life | a | d | 2 | No Action | Install effective site security |
| 1000 | 33 | Prestripping delays | Workshops not ready to maintain equipment, controls of equipment freezing up | Schedule delay | a | d | 2 | No Action | Temporary infrastructure slated to be on sealift of 2012. Ready for prestrip the following year. Temp foundations will be used to construct temp service shops. Liner to be used under backfill until concrete is available. |
| 1000/5000 | 61 | High fine content in lumps - penalty on lump quality | Fines agglomeration | Revenue loss/penalty | a | d | 2 | No Action | Implement contingency plan to crush at port of delivery or to provide screens at Mary River. Undertake agglomeration testing |
| 1000/5000 | 62 | Overload of fines handling equipment | High Fines Ratio | Overload Equipment, unload conveyors | a | d | 2 | No Action | Emergency off-spec load out area (option 4) -treat high fines content as off-spec |
| 2000 | 70 | Degradation of equipment | 24 hours sunlight | Not applicable to construction work train operation | a | d | 2 | No Action | |
| 3000 - Freight Dock | 188 | Project delay | Short supply of construction consumables | increased cost / delayed schedule | a | d | 2 | No Action | Hatch EPCM - to monitor procurement of materials and implement iPas MP |

| Area | ID | Risk Issue | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Risk Mitigation |
|---|---|---|---|---|---|---|---|---|---|
| 3000 - Ore Dock | 228 | Project delay | Short supply of construction consumables | increased cost, schedule delay | a | d | 2 | No Action | Maximize pre fabrication, reduce on site labor |
| 4000 | 255 | Lack of power supply during construction - Milne | Power outages due to reliability/fuel supply | delay in schedule | a | d | 2 | No Action | Redundancy on the fuel and power supply. Maintenance program in place and procure quality product. Ensure the proper spare parts are available at the site. |
| 4000 | 259 | Lack of power supply during construction | Unreliable contractor supply/owner supply | delay in schedule | a | d | 2 | No Action | Prequalify contractors. Put in penalties and incentives into contract. Consider different providers at each site. |

## 3.4 Opportunities

In addition to the "threats" identified in the tables above, several opportunities were identified that pertain to design, construction, ore quality and operations. Table 3- below provides a description of the opportunities and the associated actions.

**Table 3-: Summary of Opportunities**

| Area | Opportunity | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Actions |
|---|---|---|---|---|---|---|---|---|
| Design | Increased cost for waste handling | Suboptimal dump design | Rehandling and storage, equipment congestion | d | a | 23 | Immediate | |
| Operations | Additional shipping during open water months using conventional vessels. | | High | d | c | 18 | | Consider in stockpiling and marketing plans. |
| Operations | Potential increase in resources and reserves: deposits 1, 2 and 3 are all open at depth and have potential strike extensions. Deposits 4 and 5 identified from outcrop mapping and group magnetics. | | High<br>May be able to increase LOM or production rates, increasing output to 30 mtpa. | d | c | 18 | | Further exploration and testing work to define resources in other deposits. Expedite geological work and mine planning. Mine deposit 1 at a higher rate while evaluating other options. |
| Operations | Blending strategy for both options to be developed. | | Reduction in operating costs, increase revenue. | d | c | 18 | | Mine plan development work to examine blending opportunities during mining, mine stockpiling, reclaiming, crushing and port stockpiling. |

| Area | Opportunity | Causes | Consequences | Consequence Rating | Likelihood Rating | Risk Rating | Priority | Actions |
|---|---|---|---|---|---|---|---|---|
| Construction | Capital reduction opportunities (various) | | Medium/high | c | b | 17 | | Update feasibility study and complete value engineering. |
| Operations | Modify railway operations plan to use shorter trains. | | Faster cycle times, decreased capital, increased operating costs. | d | d | 14 | | Conduct trade-off study. |
| Ore quality and other | Ore quality: increase in lump ratio beyond 75%. | | Low Increase in revenue. | c | c | 13 | | Assess ratio with more testing of larger bulk samples instead of core samples. Examine trade-off between lump and other ore specifications based pricing mechanisms. |
| Ore quality and other | Exploration potential in the Mary River region. | | Low at this time. Ability to use project infrastructure (rail, port, power generation) to exploit other deposits in the area. | b | b | 12 | | Continue exploration program in region during/after project completion. |
| Design | Optimization of process flowsheet. | | Low Potential to increase lump ratio, decrease capital and operating costs. | b | d | 5 | | Use simulation model to validate equipment sizing and throughputs. |

# 4. Conclusions and Recommendations

The top 5 risks, shown in Table 4- below, were classified as having catastrophic consequences with moderate likelihood, which gave them a risk rating of 22.

**Table 4-: Top Five Risks**

| Area | ID | Risk Issue | Causes | Consequences | Risk Mitigation |
|---|---|---|---|---|---|
| 1000/5000 | 66 | Increased risk of construction injuries | Working over open water at dock area, ice on working surfaces | Hyperthermia, injury, human Fatality | Move as much equipment off the dock as possible (option 4 with conveyor on land, radial quadrant shiploaders with conveyors and major part of equipment on land). Modularization, large supply contracts |
| 1000/5000 | 67 | Availability of equipment less than predicted/lower operating days per annum | Insufficient cold temperature design, high failure rate | Operational delays | Ensure proper cold temperature design - lessons learned other cold application areas (Port Cartier, Oil Sands, Voisey's Bay etc.) |
| 2000 | 69 | Crew fatigue | 24 hours darkness | Falling asleep - fatality | Alerter equip locomotives, 2 man crews, 10 hour maximum work shifts, Fatigue management plan in Place. Canadian Hours of Service Rules respected. |
| 2000 | 73 | Crew fatigue | 24 hours sunlight | Falling asleep - fatality | Alerter equip locomotives, 2 man crews, 10 hour maximum work shifts, Fatigue management plan in Place. Canadian Hours of Service Rules respected. |
| 4000 | 264 | Unable to respond to fires during construction | Water truck not reliable (no other backup water source) | Damage to environment, H&S, potential fatality | Portable fire extinguisher in appropriate locations. Keep temporary facilities well spaced to reduce the risk of fires spreading. Proper education on fire prevention |

Follow up recommendations include assignment of responsibilities and due dates to the identified mitigation actions, and constant update of the risk register throughout project execution in order to identify new risks, modify the rating of existing risks and eliminate risks that are no longer valid. Additionally, a selection of risks is to be quantified, in terms of costs, as part of the Quantitative Risk Assessment, in order to determine the associated contingency amount to be carried by the project as it moves into execution.