22.0 ASSESSMENT OF EFFECTS OF POTENTIAL ACCIDENTS OR MALFUNCTIONS

22.1 INTRODUCTION

Under CEAA 2012, the environmental assessment of a designated project must address environmental effects of accidents or malfunctions that may occur in relation to the designated Project. Accidents or malfunctions refer to events or upset conditions that are not part of normal activity/operation of the Project as planned, and are related to the failure of Project works. The risk of accidents or malfunctions can be reduced or eliminated through good planning and design, adoption of safety measures and emergency response planning.

22.2 APPROACH

The approach used to identify and assess potential accidents or malfunctions is described in this section. The process will include the following key steps:

1. Identify potential accidents or malfunctions; describe the general operating conditions that would lead to each accident or malfunction; and screen those accidents or malfunctions that warrant further investigation, (based on consideration of the potential for residual adverse effects on VCs).

2. For those accidents or malfunctions requiring further investigation, identify the safety measures that will be implemented to reduce or eliminate the risk of each accident or malfunction.

3. Identify the emergency response measures that could be implemented to manage the potential residual adverse effects of each accident or malfunction, should it occur.

4. Describe the potential residual adverse effects (after controls or safety measures have been applied) on VCs that would result from each accident or malfunction.

5. Assess the residual risk (after controls or safety measures have been applied) of each accident or malfunction based on the likelihood of the event occurring and the potential consequences of the event. Determinations of likelihood and severity consider the lifespan of each project component (as required by the EIS Guidelines).
22.2.1 Identification of Accidents or Malfunctions

Section 22.3 discusses each accident or malfunction key event scenario that was identified as having the potential to occur over the LOM. Accidents or malfunctions were selected for further assessment based on a general analysis of the mechanisms that would lead to each accident or malfunction and the potential for that event to adversely affect the VCs identified in the EA Report.

22.2.2 Safety Measures

The Project is being designed, and will be constructed and operated, according to the highest standard practices for health, safety, and environmental protection to reduce the risk of potential Project-related environmental effects, including those that could result from accidents or malfunctions. Safety measures will be put in place to reduce the potential for accidents or malfunctions to the extent feasible by following these general principles:

- use the highest standard management practices for carrying out the Project while controlling permitted or allowable releases to the environment and consequently limit environmental effects;
- incorporate safety and reliability into the design of Project components, and application of principles and practices of process and mine safety management;
- develop and apply procedures and training aimed at safe operation of the facilities that prevent or avoid the potential upset conditions that might lead to accidents or malfunctions;
- provide training in operational procedures and environmental emergency response procedures, including safety measures to prevent accidents or malfunctions; and
- develop and implement an environmental management program for the Project to outline the proposed environmental protection measures and commitments to be carried out by GGM and their contractors.

22.2.3 Emergency Response Plan

The Emergency Response Plan (ERP) will describe actions to be carried out in the event of an accident or malfunction, and procedures/protocols to provide rapid response to these events. The ERP will also outline incident reporting and investigation.

Plans and procedures that will be developed include:

- training employees in operational procedures and environmental emergency response procedures including safety measures to respond to accidents or malfunctions; and
- preparing and maintaining an Emergency Response Plan.
Response procedures will include standard practices to be implemented for a range of scenarios based on the magnitude of potential risks. The ERP will focus on response measures for conservative case accident or malfunction scenarios, but will also include mechanisms for corrective or maintenance actions for less severe events. The priorities of the ERP will be 1) the protection of life, 2) the protection of the environment, 3) the protection of property. The ERP will be developed prior to the initiation of relevant construction and operation activities.

The purpose of the ERP is to:

- facilitate the prompt, efficient and safe response actions for addressing emergencies or compliance issues;
- identify the organization, responsibilities and reporting procedures of the emergency response team;
- provide site information on the facilities and contingencies in place should an emergency or compliance issue occur; and
- provide support and information on available resources, facilities and trained personnel in the event that an emergency occurs.

### 22.2.4 Effects Assessment

Section 22.4 provides a qualitative analysis of the potential residual adverse effects of each selected accident or malfunction. This analysis includes consideration of engineering and technical studies prepared as part of the EA, and relies on the expertise of the Project team.

The effects assessment focuses on the likelihood of each accident or malfunction and addresses safety measures and management approaches. The assessment focuses on environmental effects that have the potential to exceed the effects of regular operation of the mine. For example, emissions to the air from the operation of heavy machinery to clean up a spill would be considered within the regular operation of the mine, since heavy machinery is used on a daily basis.

Due to the unique nature of accidents or malfunctions, each event has the potential to affect different VCs. The analysis focuses on the individual key VCs that might be affected for each specific accident or malfunction. Significance thresholds that are used in this assessment are presented for each VC in Chapters 7.0 through 19.0.

### 22.2.5 Risk Assessment

Section 22.5 provides an assessment of the residual risk of each selected accident or malfunction. This is based on the potential residual adverse effects associated with each accident or malfunction (considering emergency response measures that will be implemented) and the likelihood of the event occurring (after safety measures are applied).
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Likelihood and severity are based on experience and judgment of qualified professionals using a qualitative scale to rate the residual risk from very low to very high, as defined in Section 22.5.

22.2.6 Influence of Consultation on the Identification of Issues in the Assessment Process

Consultation has been ongoing throughout the EA process, and will continue through permitting and the life of the Project. GGM will continue to meet with agencies, Aboriginal communities and stakeholders (including the general public) to provide updates, receive feedback, address comments and maintain communication. See Chapter 3.0 for more details on the consultation process, and Appendix C for the RoC that includes comments received during the development of the Draft EIS/EA.

Timing of Comments

Comments regarding accidents and malfunctions were raised during consultation and engagement activities at a number of stages of the EA process, including:

- following requests for comments on EA material, including:
  - the draft and final Terms of Reference;
  - baseline reports and methodologies; and
  - the results of the comparative analysis of alternatives.
- during Public Information Centers for the public and Aboriginal communities to present the results of studies, EA methodologies and other Project information;
- during meetings with government agencies and Aboriginal communities related to baseline studies and the EA process; and
- from other correspondence or communications received throughout the EA process.

Commenters

Comments regarding accidents and malfunctions were raised by the following agencies, Aboriginal communities or stakeholders:

- Aroland First Nation;
- DFO;
- Ginoogaming First Nation;
- Long Lake #58 First Nation;
- Métis Nation of Ontario;
- MOECC; and
Consideration of Key Issues

Potential issues were identified as consultation activities took place, and they have been addressed through direct responses and in the Draft EIS/EA, as appropriate. A summary of the key issues directly related to accidents and malfunctions, and how these issues were addressed is provided below:

<table>
<thead>
<tr>
<th>Key Issue</th>
<th>How Issue was Addressed in Design or EIS/EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of the importance of providing an assessment of potential</td>
<td>Tailings management facility dam failures and stockpile slope failures are identified as potential accident or malfunction events. These events are assessed in consideration of the risk of occurrence (based on safety measures and emergency response measures) and potential effects in a conservative case scenario. TMF dam breach assessments will be undertaken as the Project design advances. The TMF set-back is approximately 125 m from Kenogamisis Lake. The seepage collection system and service road will act to prevent the Kenogamisis Lake high water levels from encroaching on the TMF dam. The TMF dams have been designed to meet the requirements of the Lakes and River Improvement Act (LRIA)(MNR 2011) and the Canadian Dam Association guidelines.</td>
</tr>
<tr>
<td>accidents and malfunctions related to a tailings dam breach on Kenogamisis</td>
<td></td>
</tr>
<tr>
<td>Lake and slope failures of the WRSAs.</td>
<td></td>
</tr>
<tr>
<td>Identification of the importance of considering accidental fuel spills.</td>
<td>Fuel spills are identified as a potential accident or malfunction event. These events are assessed in consideration of the risk of occurrence (based on safety measures and emergency response measures) and potential effects in a conservative case scenario. A spill contingency plan will be developed to address spill prevention and response.</td>
</tr>
<tr>
<td>Questions regarding the potential for accidents and malfunctions regarding</td>
<td>Water processing and collection failures are identified as potential accident or malfunction events. These events are assessed in consideration of the risk of occurrence (based on safety measures and emergency response measures) and potential effects in a conservative case scenario.</td>
</tr>
<tr>
<td>the water system.</td>
<td></td>
</tr>
<tr>
<td>Questions regarding the potential for accidents and malfunctions regarding</td>
<td>Spills from vehicle collisions are identified as potential accident or malfunction events. These events are assessed in consideration of the risk of occurrence (based on safety measures and emergency response measures) and potential effects in a conservative case scenario. A spill contingency plan will be developed to address spill prevention and response.</td>
</tr>
<tr>
<td>vehicle accidents from increased traffic.</td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Key Issue</th>
<th>How Issue was Addressed in Design or EIS/EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setbacks from Kenogamisis Lake for the WRSAs and TMF must provide enough time and space to implement contingency or mitigating measures to effectively control environmental effects in the event of an accident or malfunction.</td>
<td>As part of the detailed design a commitment has been made by GGM to maintain a minimum 30 m buffer from the high water level of Kenogamisis Lake for most Project infrastructure, with the exception of in-water infrastructure (e.g., watercourse crossings, diversion dams and flood protection berms, and water intakes and discharge structures). The potential effects of accidents or malfunctions related to the TMF and WRSAs are assessed in consideration of identified setback distances. Facilities are designed based on geotechnical work and engineered for stability.</td>
</tr>
<tr>
<td>Identification of the importance of developing a contingency plan during the EA so that a plan will be in place to respond to and mitigate unanticipated effects.</td>
<td>Emergency response measures are identified and discussed for key accidents and malfunctions. They have been referenced in the EA at a conceptual level.</td>
</tr>
<tr>
<td>Identification of the need to assess flood risk related to the potential for accidents and malfunctions.</td>
<td>The risk and potential effects of a failure of the Goldfield Creek diversion is assessed as an accident or malfunction event, including related to heavy precipitation events. Flood risk and appropriate design will also be applied during detailed design.</td>
</tr>
<tr>
<td>Consideration of potential for spills and the effects on human health.</td>
<td>Various accident or malfunction events related to spills and effluent releases are assessed related to risk and potential effects. Further details on potential effects on human health are addressed in Appendix F8.</td>
</tr>
<tr>
<td>Potential Issues regarding the use of a natural lining for the TMF, considering the recent tailings breach at the Lac Des Ilse Mine.</td>
<td>TMF design will account for site specific foundation conditions. TMF dam failures are identified as potential accident or malfunction events. These events are assessed in consideration of the risk of occurrence (based on safety measures and emergency response measures) and potential effects in a conservative case scenario. TMF dam breach assessments will be undertaken as the Project design advances. The TMF setback is approximately 125 m from Kenogamisis Lake. The seepage collection system and service road will further act as a barrier between the facility and Kenogamisis Lake. The TMF dams have been designed to meet the requirements of the LRIA (MNR 2011) and the Canadian Dam Association guidelines.</td>
</tr>
</tbody>
</table>

22.3 SCREENING OF ACCIDENTS OR MALFUNCTIONS FOR ASSESSMENT

Based on professional judgment, experience with other mining projects, and in consideration of comments provided by agencies, Aboriginal communities and the public, the following key accidents or malfunction scenarios have been identified (Table 22-1) as having the potential to occur as a result of the Project. A description of the conditions that would lead to each...
accident or malfunction, and consideration of the potential for adverse effects on VCs are used to screen those accidents or malfunctions that warrant further assessment in Section 22.4.

Table 22-1: Potential Key Accidents or Malfunction Scenarios

<table>
<thead>
<tr>
<th>Potential Accident or Malfunction</th>
<th>General Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMF Dam Failure or Overtopping</td>
<td>Failure or overtopping of the TMF dam would result in the release of tailings solids and effluent.</td>
</tr>
<tr>
<td>Tailings Pipeline Failure</td>
<td>Failure of the TMF pipeline would result in the release of tailings slurry.</td>
</tr>
<tr>
<td>Processing Plant Failure</td>
<td>Failure of a component of the processing system could result in the release of liquids, reagents or gasses.</td>
</tr>
<tr>
<td>Effluent Treatment Plant or Pipeline Failure</td>
<td>Failure of the effluent treatment system or related pipelines would result in the release of untreated effluent from mine processes or sewage treatment.</td>
</tr>
<tr>
<td>Seepage, Drainage and Water Collection System Failure</td>
<td>Failure of the seepage, drainage and water collection system would result in the release of mine contact water or other effluent controlled by the system.</td>
</tr>
<tr>
<td>Fuel Spill</td>
<td>Failure of the storage and handling systems for diesel and natural gas would result in the release of petroleum related products.</td>
</tr>
<tr>
<td>Hazardous Material Spill</td>
<td>Failure of the storage and handling systems for hazardous materials would result in the release of these materials (e.g., mill reagents required for ore processing).</td>
</tr>
<tr>
<td>Open Pit Slope Failure</td>
<td>Failure of the open pit slope would result in areas adjacent to the open pit slumping into the pit.</td>
</tr>
<tr>
<td>Stockpile or Overburden Slope Failure</td>
<td>Failure of a stockpile or overburden slope would result in the release of waste rock, overburden or topsoil outside the storage areas.</td>
</tr>
<tr>
<td>Loss of Stability of Historical Tailings</td>
<td>Loss of stability of the historical tailings may result in damage to a portion of the relocated Highway 11 or waste rock storage area.</td>
</tr>
<tr>
<td>Goldfield Creek Diversion Failure</td>
<td>Failure of the Goldfield Creek diversion would result in erosion and the release of sediment to downstream watercourses and lakes.</td>
</tr>
<tr>
<td>Blasting</td>
<td>Uncontrolled or unmanaged blasting would result in noise and vibration disturbance or damage from flyrock.</td>
</tr>
<tr>
<td>Fires</td>
<td>A fire may result in the destruction of vegetation and natural features or project infrastructure surrounding the PDA, and the release of smoke, combustion gases and ash.</td>
</tr>
<tr>
<td>Spills from Vehicle Collisions</td>
<td>Vehicle collisions involving mine equipment or transport trucks may result in the release of hazardous materials such as mill reagents and fuel, or other non-hazardous materials such as construction material.</td>
</tr>
</tbody>
</table>
22.3.1 Description of Potential Accidents or Malfunctions

22.3.1.1 Tailings Management Facility Dam Failure or Overtopping

An engineered TMF will be built to store mine waste in the form of tailings from the ore milling and processing plant, as outlined in Appendix K. The TMF site selection process has been carried out in accordance with Environment and Climate Change Canada’s Guidelines for the Assessment of Alternatives for Mine Waste Disposal (Environment Canada 2011), Appendix G1.

The TMF set-back is generally 125 m from Kenogamisis Lake. The seepage collection system and service road will generally act to prevent the Kenogamisis Lake high water levels from encroaching on the TMF dam. The TMF will be formed using embankment dams raised in stages using mine rock and till. Tailings slurry will be discharged in the TMF, allowing the tailings to separate from the liquid effluent and deposit in the form of a beach. An emergency spillway will pass flows in excess of the environmental design flood to maintain dam stability while controlling releases to the environment to meet discharge requirements. A loss of containment could occur as a result of overtopping due to extreme floods, overtopping due to high operating levels prior to a flood, dam foundation failures due to high pore pressures induced by construction, dam foundation failure due to undetected soft strata, surface erosion of the dam slopes, and internal erosion due to lack of adequate filters.

Proper site selection, design and engineering will reduce the risk of a TMF dam failure, but if such a failure were to occur, the potential to affect surface water, fish and fish habitat, groundwater, vegetation and wetlands and wildlife habitat exists. The potential also exists for subsequent effects on land and resource uses, including traditional uses.

Based on the potential for residual adverse effects on a number of VCs, further effects assessment is provided in Section 22.4 below.

22.3.1.2 Tailings Pipeline Failure

A pipeline will be used to transfer tailings from the process plant to the TMF. The pipeline to the TMF will be composed of three separate sections in order to fulfill varying pressure requirements. The portion of pipeline leaving the processing plant will be a 250 m buried rubber lined pipe. Along the haul road, approximately 4.6 km high-density polyethylene double walled pipeline will be installed with a wireless leak detection system. The last section of pipe will consist of approximately 5.0 km of high-density polyethylene pipeline located along the TMF berm. A pipeline rupture or leak due to the structural failure of a portion of the pipeline would result in a spill of tailings into the PDA. A pipeline leak may involve a large rupture, but could also involve a small release over an extended period of time that is not initially detected by routine monitoring. Parameters that are expected to be found in elevated concentrations in the tailings slurry include mercury, silver, arsenic, cobalt, copper, antimony and uranium. A more detailed description of the characteristics of the tailings is provided in Appendix E6.
GGM will develop a safety and surveillance plan that include routine visual inspection of the pipeline and will have a pump pressure monitoring system intended to trip an alarm in the event of a major pipeline rupture resulting in a loss of pressure. GGM will also construct a safety pond with geomembrane for the tailings pipeline, which will be large enough to contain 110% of the total pipeline volume. The calculated volume is approximately 1000 m³. To drain the tailings pipeline, a fail-safe open valve will be installed to open the line in case of electrical failure. The safety pond will be kept empty and rainwater will be removed whenever accumulated.

If, despite these precautions, a release of tailings slurry were to occur from a TMF pipeline failure, it would be captured by the drainage and water collection system around the perimeter of the PDA. Spills would have limited potential to affect groundwater, as they would be confined to the soils within the timeframe of a cleanup response and appropriately contained and remediated before migration to the groundwater table could occur. No releases to the environment or residual adverse effects on VCs are anticipated, and therefore no further effects assessment is required.

### 22.3.1.3 Processing Plant Failure

The Project will extract gold from gold-bearing ore by using cyanide leaching. Cyanide will be shipped to the site and stored in a solid phase (sodium cyanide pellets), used in the mill in a liquid phase (as free cyanide and in complex with metals) and in the gaseous phase (as hydrogen cyanide). In addition, prior to transfer to the TMF, tailings slurry will undergo SO₂/air treatment in the process plant for cyanide detoxification. A release of cyanide in its various forms or SO₂ may occur in the event of an accident or equipment malfunction.

Solid cyanide will be transported to the mill from a supplier and handling the material will be done in the processing plant in contained areas. In its solid form, the potential for a release of cyanide to the environment is very limited, and clean-up would be simple compared to a liquid form.

The mixing of the solid cyanide to create a liquid solution will also be done in the processing plant in a controlled and self-contained area, so a spill would not be able to exit the building. The only way for cyanide solution to exit the processing plant area would be a tailings pipeline failure (which is addressed in section 22.3.1.2), or the simultaneous rupture of at least two or three leach tanks into the containment pad. The leach pad is designed to contain approximately 130% of a complete leach tank with supplemental volume available to manage additional volumes in the detox pad and mill.

Cyanide gas can be released into the environment if the pH of the leach solution or cyanide preparation solution approaches 9 or lower. As the pH lowers more cyanide would be volatilized from solution into a gaseous form. There would need to be a prolonged (several hours) failure of the lime feed to the mill while continuing to feed cyanide and ore into the mill to affect the pH to this extent, through either a rupture in the lime feed or multiple prolonged valve failures while
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continuing to feed cyanide and ore into the mill. However, a failure of the lime supply would force a mill stoppage before the solution would be affected to such an extent as to cause the release of cyanide gas.

During the SO$_2$/air treatment, a control logic will adjust the required air input into the chamber to obtain combustion and generation of SO$_2$. The gas is then cooled prior to direct injection into the treatment tanks. Flow, temperature, and pressure controls on inputs and outputs of the system control the SO$_2$ production. The system can be placed into a standby mode by feeding fresh sulfur or air into the system.

To safeguard against potential processing failures or malfunctions, processing facilities will be designed according to the highest engineering standards for safe operation, with appropriate ventilation systems. Employees will be properly trained, with an emphasis on safety and accident prevention. This process is a technically-proven and well-established technology with high reliability during normal operations.

GGM also intends to become a signatory to the International Cyanide Management Code, and will abide by code criteria for the safe and responsible use, transport and management of cyanide products.

All cyanide handling activities will be limited to the processing plant, and undertaken following the highest standard management practices. Releases would be very unlikely, and would be contained within the facility, which will be designed with the capacity to manage even a conservative case scenario failure. No releases to the environment or residual adverse effects on VCs are anticipated, and therefore no further effects assessment is required.

22.3.1.4 Effluent Treatment Plant or Pipeline Failure

Effluent spills may be caused by the failure of mine water and sewage treatment facilities or associated pipelines. Excess mine water and sewage will be treated in separate plants so that discharge meets relevant standards prior to its release to the receiving environment. In the event of a mechanical or instrument failure in the treatment plants, or a rupture or leak in one of the pipes, effluent may be released within the PDA that does not meet discharge standards.

Water management for the mine site includes directing water collected from the site through a treatment pond, which is then directed to an online treatment facility before being released to the Southwest Arm of Kenogamisis Lake (for further details, refer to Appendix F5). The drainage and collection system provides sedimentation and water entering the process water treatment plant will require limited additional treatment, reducing the potential effects of a release. The sewage treatment facility will also have a direct outlet to Kenogamisis Lake. In both cases, release beyond the PDA would be at the downstream end of treatment, with limited concentrations of parameters of potential concern that could affect PWQOs. Such releases would be detected and addressed rapidly, including the shutdown of effluent release. In
addition, the assimilative capacity of the Southwest Arm of Kenogamisis Lake is high, further reducing the potential for adverse effects (Appendix F6).

A release of effluent from a processing plant or pipeline failure within the PDA would be captured and treated by the drainage and water collection system around the perimeter of the PDA. Spills would have limited potential to affect groundwater, as they would be confined to the soils within the timeframe of a cleanup response and appropriately contained and remediated before migration to the groundwater table could occur. No residual adverse effects on VCs are anticipated, and therefore no further effects assessment is required.

22.3.1.5 Seepage, Drainage and Water Collection System Failure

The drainage and water collection system will be designed to capture contact water and seepage from various Project components, such as the ore stockpiles and WRSAs, and would also collect leakage or spills from other Project components within the PDA such as the TMF pipelines through a perimeter collection system. The system will include eight sedimentation ponds and over 20 km of perimeter ditches. Seven ponds will hold water temporarily and provide primary treatment and storage, while one pond (M1) will be designed to provide centralized onsite storage for all mine contact water with controlled release to the Southwest Arm of Kenogamisis Lake following treatment through the effluent treatment plant as required.

A failure may occur as a result of water overtopping the berms of the collection ponds under an extreme precipitation event, or the inability to discharge from the collection ponds in the event of a pipeline blockage or rupture, or a pump failure. In addition, a breach of the TMF dam would result in a breach to the TMF seepage collection system, but the effects of such a breach are discussed as part of the TMF Dam Failure or overtopping assessment (Section 22.4.1).

A failure of the water management ponds may include overtopping depending on water quantities. TMF seepage collection may fail if there is a TMF dam failure. Failure of this system may result in a release to the environment of mine contact water, stormwater, or other chemicals associated with spills captured by the system, potentially affecting surface water, fish and fish habitat, or adjacent wetlands. Spills would have limited potential to affect groundwater (no groundwater is anticipated to be collected by seepage), as they would be confined to the soils within the timeframe of a cleanup response and appropriately contained and remediated before migration to the groundwater table could occur. Potential effects to fish and fish habitat may by extension also affect local land and resource uses, including traditional uses.

Based on the potential for residual adverse effects on a number of VCs, further effects assessment is provided in Section 22.4 below.
22.3.1.6 Fuel Spill

Diesel and LNG will be stored on site in tanks, and used to refuel mine equipment. Relatively small spills of petroleum products may occur during construction or operation during refueling of, or leaks from machinery. Tanks used to store fuel may also leak, causing the release of petroleum products to the environment.

Fuel storage and refueling activities will be limited to the PDA, and spills will be immediately cleaned up using spill kits. Fuel will be stored in double walled tanks on a concrete slab, and delivery trucks and mining equipment will park on the concrete slab for fuel transfer. Some large equipment may require refueling by fuel truck, but control devices and procedures will be put in place to prevent spills. No refueling will occur outside of the PDA. As a last resort, spilled fuel will be collected by the drainage and water collection system which routes collected mine water to a central pond. If fuel enters the pond pumping will cease, the spill will be contained by a boom and removed by a skimmer. Soils in the vicinity of the spill will be tested for hydrocarbons and treated as required, before migration to the groundwater table could occur. No releases to the environment or residual adverse effects on VCs are anticipated, and therefore no further effects assessment is required. Spills from vehicle collisions (including fuel) have been addressed separately below.

22.3.1.7 Hazardous Material Spill

Hazardous materials needed for mine operation will be transported to and stored at the site, and spills may result from leaks or during container handling. Mill reagents will be delivered to the site in accordance with Transportation of Dangerous Goods Regulations as appropriate. Some reagents will be delivered in bulk, such as lime, sodium hydroxide, elemental sulphur, and hydrochloric acid, while other reagents will be delivered in smaller quantities, depending on the application. Storage of hazardous material will occur within buildings, in secure and contained areas, and secondary containment and alarms will be used as appropriate. Storage facilities will be sited in locations that represent a relatively low risk and afford an opportunity for containment during emergency response.

The storage and handling of hazardous material will be limited to the PDA, and spills will be immediately cleaned up using appropriate absorbent materials or using collection trenches. As a last resort, hazardous material spills will be collected and treated by the drainage and water collection system which routes collected mine water to central treatment. Spills would have limited potential to affect groundwater, as they would be confined to the soils within the timeframe of a cleanup response and appropriately contained and remediated before migration to the groundwater table could occur. No releases to the environment or residual adverse effects on VCs are anticipated, and therefore no further effects assessment is required.
22.3.1.8 Open Pit Slope Failure

A Hardrock Mine Open Pit Feasibility Level Slope Design Recommendations report has been produced by Golder Associates (May 2015). This technical document presents the result of slope design investigations, the slope design recommendations and the slope design risk management plans (design and monitoring) for the Project.

The Golder Associates’ report states that the Hardrock Project will be developed in good to very good rock mass. Given the pit’s moderate overall slope height and good rock mass quality, rock mass failure is not a concern. Rather, the potential instability will involve structural controls, the most significant being the foliation control on bench face angle and the potential control of flat sets on bench rest back break angles. Locally, review of the geological interpretation indicates that potential instability may occur along banded iron formation layers, though laboratory strength testing and stability analyses indicate that sliding along iron formation folds may not occur if blast damage is limited. No major faults are identified that will adversely daylight on the ultimate pit. The location of the underground workings and whether they are filled or unfilled are well-understood. In addition, historical information on the underground workings confirms that water producing fractures, which had the potential to connect the underground operations to Kenogamisis Lake, were not an issue. Risks to safety and pit access due to the underground stopes must be mitigated through design and planning at all stages of the Project.

Follow-up analysis during operations, based on slope performance data, will be required to assess how stress concentration combined with the rock mass fabric orientations will control slope behavior for walls deeper than 400 m.

There remains a potential that open pit slope failure may occur at the open pit walls as a result of improper pit design, unanticipated geologic slip plane failures or operational procedures, such as blasting.

Slope failure could result in a loss of approximately 75 m from the pit crest toward the WRSAs located around the perimeter of the open pit (assuming 45 degrees rupture). This would cause slumping into the open pit.

Since the open pit is located within the PDA and is mostly surrounded by WRSAs, a failure of the pit wall may affect mine operations or infrastructure, but will not have a residual adverse effect on VCs, therefore no further effects assessment is required.

22.3.1.9 WRSA or Overburden Stockpile Slope Failure

Failure of the WRSAs and overburden stockpiles could occur as a result of inadequate allowance for lift settling, incorrect stockpile placement or grading, uncontrolled erosion, inappropriate design considerations and unknown soil/foundation characterization.
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The WRSAs are located along the edge of the PDA, stockpiles range from approximately 60 to 90 m in height with 2:1 slopes. Since the stockpiles will be located along the edge of the PDA, a failure could result in stored material discharging beyond the PDA, based on the height and slope of the stockpile, and the location of the failure. A Waste Rock Areas Stability Assessment (WRSAs A, B, C & D) has been completed by AMEC FW (2015b). This assessment is discussed further in Section 22.4.

Should a failure occur, a slump or slough of the stockpiles could result in material entering Kenogamisis Lake, the Goldfield Creek diversion, the Highway 11 realignment, the residential property boundary located in proximity (approximately 150 m) to WRSA A or the open pit, resulting in potential damage to infrastructure or a release of sediment or mine rock into surface water and fish habitat. Potential effects to fish and fish habitat may by extension also affect local land and resource uses, including traditional uses.

Based on the potential for residual adverse effects on a number of VCs, further effects assessment is provided in Section 22.4.

22.3.1.10 Loss of Stability of Historical Tailings

A portion of WRSA A and the Highway 11 realignment will be built over the existing historical Macleod high tailings and Hardrock tailings. The historical tailings deposits are approximately 10 m thick, and are comprised of loose sand and silt, which provides less stable geotechnical conditions than native overburden found elsewhere on the site. A failure may be caused by seismic activity, or if stability is upset during construction, blasting or placement of overburden during operation.

Geotechnical recommendations will be taken into account to maintain the stability of the Highway 11 realignment over historical tailings to address the potential for failure (Appendix H). Geotechnical considerations have also informed the design of the WRSAs; for example, the Macleod high tailings will likely be capped with a layer of waste rock and then used as an overburden stockpile instead of a WRSA (AMEC FW 2015b). Stability of the historical tailings has been considered in the Waste Rock Areas Stability Assessment (WRSAs A, B, C & D) completed by AMEC FW (2015b). Although the geotechnical recommendations will be followed, there is the unlikely potential for failure of the historical tailings, which would result in potential effects to surface water, fish and fish habitat, and groundwater. The potential also exists for effect on land and resource uses, including traditional uses.

Based on the potential for residual adverse effects on a number of VCs, further effects assessment is provided in Section 22.4.
22.3.1.11 Goldfield Creek Diversion Failure

The Goldfield Creek realignment will involve excavation and clearing along new and existing channels, and will be susceptible to erosive forces, especially during construction before the channel is stabilized. The creek diversion will also include a diversion dam separating seepage collection pond T2 from the creek diversion (seepage collection gradients are inward - towards the TMF). Failure of the realigned channel could result from a heavy precipitation or snowmelt event that exceeds the capacity of engineered controls, causing the partial or complete loss of channel form due to erosion forces, resulting in the movement of sediment. A failure of the flood control weir (diversion dam) during operation may exceed the design conveyance capacity of the floodway, resulting in localized erosion and sedimentation in the channel.

A failure of the Goldfield Creek diversion or related works would result in erosion of the constructed channel and sedimentation to downstream water bodies. This would result in potential adverse effects on surface water features and fish and fish habitat. The potential also exists for effects on land and resource uses, including traditional uses.

Based on the potential for residual adverse effects on a number of VCs, further effects assessment is provided in Section 22.4.

22.3.1.12 Blasting

Explosives are required for the development of the mine, and will be stored and prepared in a dedicated explosive plant. Blasting will be a regular part of the Project, occurring approximately twice weekly during construction for a duration of 12 months, and a few times per week during operation throughout the LOM. An uncontrolled explosion may occur as an unmanaged or inadvertent detonation. An unmanaged explosion would be related to open pit operations, where proper safety measures were not in place (e.g., blast mats not used), whereas an inadvertent explosion may be the result of error or malfunction.

The Explosives Safety and Security Branch (ESSB) of NRCan is responsible for administering the Explosives Act and regulations and pursuing the advancement of explosives safety and security technology. ESSB’s main priority is the safety and security of the public and the workers involved in the explosives industry in Canada. This includes providing necessary authorizations for any explosive that is to be imported into or manufactured, transported, possessed or used in Canada, and licensing for the acquisition, storage and sale of explosives. Blasting operations will be carried out by qualified and certified blasting personnel in accordance with strict operating procedures. Explosive components will be supplied by a distributor who is certified under Canadian regulations. In addition, the explosives facility will be located according to the guidelines set out in NRCan’s Quantity Distance Principles User’s Manual (NRCan 1995), which provides the minimum permissible distance between a site containing explosives and nearby sites requiring protection.
GGM will develop operating procedures to carry out blasting safely during mine operations. This will include standards related to employee responsibilities, notification, inspections, signage, clean-up and the safe use of materials and equipment.

Although an uncontrolled explosion would create a larger blast and more noise than a controlled explosion (since regular blasting in the open pit would be performed by drilling and blasting successive benches with appropriate controls in place), noise and vibration effects from an uncontrolled explosion would still be short in duration. Although blasting operations will be carried out in such a manner and in accordance with necessary regulations to limit the potential for an uncontrolled explosion, the PDA was developed to include a 500 m safety limit around the open pit to isolate VC's from the potential effects of flyrock, and the explosives facility will be located based on minimum distance requirements as noted above. No residual adverse effects on VC's are anticipated, and therefore no further effects assessment is required.

22.3.1.13  Fires

Project-caused fires may occur as a result of an accident associated with the activities of the Project including due to an equipment malfunction, human error, or uncontrolled explosion. Fires arising from non-Project causes such as lightning strikes or off-site forest fires due to undefined cause, and potentially affecting the Project, are assessed as an effect of the environment on the Project in Chapter 21.0.

Although a Project-related fire could spread beyond the PDA, all reasonable precautions will be taken to avoid fires and limit the potential spread of fires beyond the PDA. Employees will be trained in fuel handling, equipment maintenance, and fire prevention and response measures. Robust fire prevention and suppression systems will be maintained onsite, including water supplies, sprinklers, fire extinguishers and other firefighting equipment. Flammable material (such as fuels and explosives) will be carefully controlled within the PDA. Emergency response measures will also be in place for a timely and effective response to fires, and containment within the PDA.

No residual adverse effects beyond the PDA or adverse effects on VC's are anticipated, and therefore no further effects assessment is required.

22.3.1.14  Spills from Vehicle Collisions

The Project will generate vehicle traffic during all phases as a result of the movement of equipment, supplies, materials, and personnel to and from the Project site. A vehicle collision could occur on the road transportation network leading to or from the Project site (such as Highway 11), or within the Project site.

Fuel and other hazardous materials will be periodically transported to the mine site, and a vehicle collision could result in a spill of these materials. A spill within the PDA would be captured
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and treated by the drainage and water collection system around the perimeter of the PDA. Spills would have limited potential to affect groundwater, as they would be confined to the soils within the timeframe of a cleanup response and appropriately contained and remediated before migration to the groundwater table could occur. No releases to the environment or residual adverse effects on VCs are anticipated in the case of a vehicle collision within the PDA, and therefore no further analysis is required.

However, a vehicle collision outside the PDA would have the potential for a residual adverse effect. A spill on land would be localized to the soils and readily remediated, but if the collision takes place near a waterbody, there is a higher potential for parameters of potential concern to spread, which could affect surface water, and fish and fish habitat. Potential effects to fish and fish habitat may by extension also affect local land and resource uses, including traditional uses.

Based on the potential for residual adverse effects on a number of VCs, further effects assessment is provided in Section 22.4.

22.3.1.15 Summary of Accidents or Malfunctions Screened for Further Assessment

A total of six accident and malfunction events were identified to have a potential residual adverse effect on VCs, and will be assessed further in this Chapter. These include:

- Tailings Management Facility Dam Failure or Overtopping;
- Seepage, Drainage and Water Collection System Failure;
- Stockpile or Overburden Slope Failure;
- Loss of Stability of Historical Tailings;
- Goldfield Creek Diversion Failure; and
- Spills from Vehicle Collisions.

These events have the potential to affect the following VCs. Potential residual adverse effects on these VCs will be assessed where applicable for the selected accidents or malfunctions:

- Surface Water;
- Fish and Fish Habitat;
- Groundwater;
- Upland Vegetation and Wetlands;
- Wildlife and Wildlife Habitat;
- Land and Resource Use;
- Traditional land and Resource Use; and
- Community Services and Infrastructure.
22.4 EFFECTS ASSESSMENT OF SCREENED ACCIDENTS OR MALFUNCTIONS

22.4.1 Tailings Management Facility Dam Failure or Overtopping

22.4.1.1 Tailings Management Facility Dam Safety Measures

A feasibility level geotechnical and hydrologic design of the TMF was prepared by AMEC FW (Appendix K). The Project involves the production of approximately 128 Mt of gold-bearing ore, an allowance for 17 Mt of additional tailings has been included in the design of the TMF. The TMF is formed mostly using perimeter embankment dams raised in stages using mine rock with relatively low-porosity till forming an upstream core. The TMF design criteria are provided in Tables 1 through 3 of Appendix K.

The TMF is expected to cover 520 ha at final configuration. The maximum starter dam section is about 10 m high with the ultimate dams raised to a maximum section height of about 35 m.

The TMF will be constructed using proven design specifications in accordance with relevant guidelines and legislation. Containment structures will be designed in accordance with:

- site conditions – climate (precipitation, temperature) and seismic risk (refer to Appendix K);
- tailings operating data – production rate and discharge slurry density (refer to Appendix K);
- Technical Bulletin – Geotechnical Considerations for Dam Safety (CDA 2007); and

Tailings dams will be constructed to withstand the Probable Maximum Flood (which is the largest possible flood based on an analysis of the maximum possible precipitation in a given area) and maximum credible earthquake (which is the largest earthquake that is capable of occurring based on the tectonic characteristics of an area). The TMF dam will also be designed to hold the EDF, which is the maximum flood volume that must be contained within the storage capacity of the TMF so that any discharge over this level will be diluted enough to meet discharge requirements. An emergency spillway will pass flows in excess of the EDF to maintain dam stability while controlling releases to the environment to meet discharge requirements.

The perimeter dams are earth and rockfill embankments that will not depend on the support of deposited tailings for stability. The tailings deposition plan involves discharging tailings from the dams to displace the pond into the central portion of the TMF, so that the solid beaches will form against the perimeter of the TMF, and water will be stored in the center. For closure, the pond will be against natural ground at the west side of the TMF and the permanent closure spillways will be constructed on native ground, minimizing the amount of water stored against
constructed embankments, thereby reducing the risk of embankment failure. An objective of the final stages of deposition in in the TMF will be to minimize the size of the pond to reduce the risks and consequences of a potential dam failure.

Additional studies will be carried out as the Project design advances to fulfill the regulatory requirements and guidelines identified above, including the completion of a Failure Mode and Effect Analysis by qualified specialists to confirm the TMF embankment design and operating plan adequately address potential failure causes, and a Mechanisms and Dam Break and Inundation Study, which considers the potential volumes and flow rates of materials released, the path followed and extent of inundation.

The process of conducting site investigations, design, review, construction, operation, closure, and monitoring of a TMF in Canada is well established under guidelines developed by the CDA and by International Commission On Large Dams. The CDA Guidelines specify that qualified third-party engineering firms conduct site investigations, develop designs, monitor construction, and inspect ongoing operations to confirm the appropriate standards are met. For the Project, GGM will retain a qualified third-party engineering firm to verify these standards are met, including the following:

- design for geotechnical stability for the most significant earthquake loading relating to the largest applicable seismic event (known as the Maximum Design Earthquake);
- design for safe containment of rainfall and runoff resulting from the EDF at all times during operation;
- design for attenuation and safe passage of rainfall and runoff resulting from the IDF at all times during operation and closure;
- quality assurance and inspections by the design engineers during initial and ongoing construction of the TMF;
- An Operation, Maintenance and Surveillance (OMS) manual will be developed to facilitate training of staff for safe operation of the TMF dams. The manual will include guidelines for daily (including night shifts), weekly, monthly and quarterly inspection of the TMF by operational personnel;
- annual dam safety inspections will be performed by a qualified geotechnical engineer, with more thorough Dam Safety Reviews on a five year interval under the CDA conducted by a qualified geotechnical engineer independent of the design engineer to assess TMF performance and to identify conditions that differ from those assumed during the design;
- dam instrumentation to allow monitoring of the phreatic (seepage) and deformation conditions of the dams; and
- scheduled, ongoing inspections and audits of the facility by qualified geotechnical engineers during operation and after closure.
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Procedures for monitoring and routine surveillance will be set out in the OMS manual to provide the operators with background on the indicators and warning signs that could eventually lead to dam failure, if not responded to and acted upon. Per CDA guidelines, an Engineer of Record in support of activities related to dam safety will be defined by GGM to verify the timely and appropriate actions are initiated in response to all potential dam safety incidents.

TMF dams are also subject to permitting under LRIA by the MNRF. Authorizations under the LRIA (i.e., Location Approval and Plans and Specifications Approval) to construct the TMF dam requires the determination of the Hazard Potential Classification (HPC) for each TMF dam. The HPC is determined through an incremental assessment of dam failure effects arising from a wet weather breach event. Other breach scenarios assessed include a dry weather (sunny day) and seismically sourced dam failure events. The preliminary HPC for the TMF dams is set at very high, but dam HPCs will be finalized during detailed design and permitting with MNRF to provide additional detail on hazard potential, but a preliminary assessment is provided below.

The preliminary EDF has been set at 1:100 year return period hydrologic event. The TMF is designed to contain and store runoff events up to and including the EDF. The preliminary IDF has been set as the PMF. The IDF is the most severe inflow flood (peak, volume, shape, duration, timing) for which a dam and its associated facilities are designed (CDA 2007). The PMF is defined by the LRIA Technical Guidelines as having a return period of 1:1,000,000 years.

Based on the design criteria noted above, the TMF will be constructed to withstand extreme flood and earthquake events in the region. Due to the design measures in place to protect against these improbable events, the likelihood of a partial or complete failure of the TMF is considered very low.

22.4.1.2 Tailings Management Facility Dam Emergency Response Measures

The initial response in the event of a TMF dam failure or overtop will be to shutdown pumping of tailings to the TMF. Notification of authorities, emergency responders, local residents and Aboriginal communities will also promptly occur. The ERP will be initiated including evacuation procedures if required. The ERP will include emergency repairs, if safe to do so. The TMF could be pumped, if possible, to reduce the amount of released effluent during the emergency repair. The spill will be contained using temporary dams of earth or snow and silt fences, and through other available equipment or means.

Spilled tailings will need to be effectively contained to limit potential effects. This could mean that spilled tailings would be stabilized; for example, a cover could be engineered over the deposited material or tailings and soil beneath may be excavated and hauled back to the repaired TMF if feasible. Areas where tailings are removed would be restored to the extent practical. A surface water and groundwater monitoring program will be designed to monitor the movement of parameters that may infiltrate from spilled tailings and the success of rehabilitation measures.
22.4.1.3 TMF Dam Failure or Overtopping Effects Assessment

A TMF failure would result in the release of effluent containing a high concentration of metals and other hazardous chemicals and a portion of the contained solid material. A dam breach may affect a relatively large area, resulting in the destruction or temporary disturbance in order to stabilize or remove the tailings. A release of tailings water from overtopping would be caused by a wet weather event that dilutes parameters of potential concern that would result in flooding and sedimentation. However overtopping should be relatively limited as a result of the emergency spillway that forms part of the facilities design.

In the conservative case event of a TMF failure resulting in a complete breach of the tailings dam, the release of material should be limited based on the design of the facility (with solids settling against the perimeter of the facility to increase stability and prevent liquefaction, as well as the emergency spillway noted above). A portion of the solids may release in a plume originating at the breach location, and effluent contained in the facility would also be released.

In a conservative case scenario, a TMF failure would result in the release of TMF contact water and have a widespread effect that extends to surface water, fish and fish habitat, groundwater, upland vegetation and wetlands, and wildlife habitat. Effects on these VCs would also impede the use and access of land and water resources for recreational and traditional uses. The effect would have uncertain remediation due to the complexity of the potential release, and would therefore have a high consequence.

Surface Water

In a conservative case scenario, a TMF breach has the potential to affect nearby waterbodies including the realigned Goldfield Creek Tributary, the Southwest Arm of Kenogamisis Lake, Goldfield Lake, Lake A322 and A321, Marron Lake and the Kenogamisis River, depending on the location of the breach. Effects could also extend downstream from these waterbodies depending on the extent of the failure.

The Southwest Arm is relatively unaffected by historical tailings, with exceedances of the interim PWQO of 5 µg/L in 9% of samples, and exceedances of aluminum and copper in 3% of samples. The Goldfield Creek Tributary did not have exceedances of PWQOs. A TMF failure could lead to exceedances of PWQOs for a number of parameters. This effluent would extend in a pulse through the release of water. High concentrations of ammonia could also lead to algae blooms in Kenogamisis Lake.

Overtopping would cause environmental effects but would be quickly dissipated in the receiving environment due to dilution from precipitation and the assimilative capacity of receiving waters. A dam failure would result in higher concentrations of parameters of potential concern through the release of water and tailings, but such a release may be mitigated by...
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turbidity curtaining, isolating affected areas through the use of cofferdams, and removing and redepositing contaminated material in the TMF.

In a conservative case scenario, a release into the Southwest Arm of Kenogamisis Lake would occur which would increase water levels. The effects on the lake would result in a change in water quantity and quality. A release into adjacent watercourses would cause increased erosion prior to entering Kenogamisis Lake. Downstream effects may also occur depending upon the scale of the breach. There are two dams located downstream of the Project, the Kenogamisis and Long Lake dams. The dams may assist in reducing the geographic extent of the effects, however this would depend upon the scale of the breach.

A failure would also result in siltation, and the infilling of the watercourse or a portion of the lake with tailings and eroded material. The release of high volumes of water would result in local flooding and high erosion events.

Residual adverse effects on surface water would be of high magnitude, extending to the RAA, long-term and potentially irreversible.

Fish and Fish Habitat

A variety of habitats exist for fish within the waterbodies surrounding the TMF. Failure of the TMF into these waterbodies would result in changes in water quantity and quality as well as sedimentation and the potential infilling of existing fish habitat. The potential for effects on fish and fish habitat would vary with the location and magnitude of the overtopping or TMF dam failure.

Overtopping would likely result in short-term exceedance of surface water quality that may be acutely lethal to fish. Such an event would not likely result in a permanent alteration of fish habitat, and fish communities would likely recover naturally over time.

A catastrophic failure of the TMF dam would have greater potential to affect fish and fish habitat. Effects on fish and fish habitat would vary with the location and magnitude of the TMF dam failure. By example, if there were a partial dam failure on the northeast side of the TMF, tailings may be somewhat contained in an adjacent wetland and effects on fish and fish habitat may be limited to Watercourse M and the Southwest Arm Tributary. If, however, there were a catastrophic dam failure on the southeast side of the TMF, adjacent to Kenogamisis Lake or the Goldfield Creek Tributary, there would likely be a permanent reduction in the productivity of fish habitat in Kenogamisis Lake. The primary causes of effects would be the direct overprinting of natural substrates and changes in water quality. Tailings deposition in fish habitat could potentially smother existing fish eggs, if present, or cause a change in physical substrate characteristics that would render substrates unsuitable for spawning. There would be a loss of benthic and aquatic plant communities that would not likely fully recover without complete rehabilitation of disturbed areas. If tailings deposition in fish habitat were extensive, reductions in
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The productivity of fish and fish habitat may be observed at a lake-wide scale. In addition to these potential longer term effects, there is also potential for shorter term effects and localized chronic effects (i.e., surrounding the deposited tailings). Potential short-term effects may include the death of fish from acutely lethal water quality due to physical (e.g., concentration of suspended solids, water temperature) and chemical (e.g., arsenic concentration) changes. Long-term effects may result in sub-lethal effects on fish due to an alteration of food availability or chronic toxicity. Potential residual effects of such an event would be high in magnitude, could potentially extend into the RAA and would likely be long-term and irreversible.

Although the potential for effects on fish and fish habitat would vary with the location and magnitude of the overtopping or TMF dam failure, a conservative case scenario would result in residual adverse effects on fish and fish habitat that would be of high magnitude, extend to the RAA, long-term and irreversible.

**Groundwater**

A TMF failure has the potential to effect groundwater quality and would depend upon the size of the failure and the timeframe of a cleanup response. A failure of the TMF that requires multiple days for a clean-up response has the potential to effect groundwater quality. Topography and the horizontal hydraulic gradient in the area of the TMF slope towards the existing Goldfield Creek and Kenogamisis Lake and it is anticipated that the effect to groundwater quality, as a result of a TMF failure, would extend from the TMF and spill area towards existing Goldfield Creek and Kenogamisis Lake. Consistent with the residual adverse effect of the TMF on groundwater quality, a failure of the TMF could potentially result in select parameters of concern above baseline conditions.

Residual adverse effects on groundwater would be confined to the LAA, and mainly within the PDA, but would be considered high magnitude, long-term and potentially irreversible.

**Upland Vegetation and Wetlands**

The release of tailings would result in the infilling of surrounding vegetation and wetlands. This would cover or destroy existing vegetation, and may impede wetland function depending on the direction and extent of the release.

Depending on the chemical composition and concentrations of the tailings released, this may also result in the contamination of upland vegetation, as well as wetlands downstream of the release if the tailings reach flowing water supporting and connecting wetland communities.

A release of tailings along the northeast periphery of the TMF has the potential to affect the vegetated form and wetland function of a sensitive wetland community (Community B136-Sparse Treed Fen).
Any contamination of upland vegetation or wetlands would be addressed by the rapid implementation of spill containment measures, restoration of affected areas, and the cleanup of released material. Over time, vegetation in the portions of affected wetlands will re-establish through natural dispersion from unaffected portions of either the same community, or adjacent wetland communities, usually within one to two growing seasons; however, this would depend upon the scale of the TMF breach. The re-vegetation process will be monitored so invasive species (e.g., reed canary grass and/or phragmites) do not become established in the re-vegetated areas.

In a conservative case scenario, residual adverse effects on vegetation and wetlands would be confined to the LAA, and mainly within the PDA, but would be considered moderate to high magnitude, medium to long-term and potentially irreversible.

Wildlife and Wildlife Habitat

Effects on wildlife and wildlife habitat would depend upon the scale of the TMF breach. Wildlife presence is expected to be limited close to the PDA, due to the presence of humans and heavy machinery, which would reduce the risk of wildlife mortality as a result of TMF failure. The sustainability or abundance of regional wildlife populations would not be expected to be affected by a TMF failure.

A release of tailings along the northeast periphery of the TMF has the potential to affect a sensitive wetland community (Community B136- Sparse Treed Fen). In addition to being a sensitive wetland community, the fen also represents significant wildlife habitat as it supports taiga alpine (Erebia mancinus, an S3 (vulnerable in Ontario) species of butterfly. Rapid response measures are anticipated to limit the area affected and the duration of effects. Over time, wildlife habitat affected by a release will re-establish through natural dispersion.

In a conservative case scenario, residual adverse effects on wildlife and wildlife habitat would be confined to the LAA, and mainly within the PDA, but would be considered moderate to high magnitude, medium to long-term and potentially irreversible.

Land and Resource Use and Traditional Land and Resource Use

A release would limit the use of affected areas for recreational and traditional land uses such as hunting, gathering and fishing, if the affected area were used for such activities. Both land and water-based activities have the potential to be affected. A release of a chemical of potential concern may also affect human and ecological health.

Residual adverse effects on vegetation and wetlands, and wildlife and wildlife habitat may occur as a result of a TMF breach. A breach would predominantly affect the PDA and extend into the LAA under a conservative case scenario. Recreational and traditional activities are not
expected to be practiced regularly in the PDA during Project operation, given the ongoing disturbance from human activity and machinery nearby.

Residual adverse effects on fish and fish habitat would have potential to limit recreational and traditional uses through the destruction of areas used for fishing and effects on local fish populations. In a conservative case scenario, there is potential for destruction or permanent alteration of fish habitat that would result in a loss of fisheries productivity that can be measured at the lake-wide scale. This may result in reduced fish abundance, health or condition such that the quality of the recreational or Aboriginal fishery is diminished. Small to moderate TMF dam failures may be remediated, however it would be difficult to remediate or offset the destruction or alteration of fish habitat that would occur under a conservative case scenario. There may also be potential residual adverse effects on navigation of watercourses, for example smaller watercourses could be blocked or flows could change in watercourses.

Residual adverse effects on human and ecological health could occur as a result of exposure to a chemical of potential concern. Mitigation would be employed in terms engagement with recreational and traditional land uses, mitigation in the form of special advisories (such as fisheries advisories) may be required depending upon the scale of the event.

In a conservative case scenario, residual adverse effects on land and resource use and traditional uses would be of moderate to high magnitude, limited to the LAA, potentially extending into the RAA, medium- to long-term and potentially irreversible.

### 22.4.2 Seepage, Drainage and Water Collection System Failure

#### 22.4.2.1 Seepage, Drainage and Water Collection Safety Measures

Designs for perimeter ditching and seepage collection ponds around the Project components will take into account distances from nearby infrastructure and water features to minimize potential effects associated with breaches of the drainage collection system. This will include a minimum offset of 30 m from existing water bodies (such as, Southwest Arm and Kenogamisis Lake).

The drainage and water collection system has been designed to control runoff and to contain potential releases from infrastructure failures within the PDA to a 1:100 year return period storm event. In addition, each collection pond will be constructed with an emergency overflow spillway which will be designed to convey the regulatory storm event, which has a greater return period than the 1:500 year storm. Predictive models completed to assess the effects of extreme weather events and climate change on the Project in Chapter 21.0 have confirmed that the regulatory storm is considered a locally acceptable, long-term and permanent flood control design criteria. Since the emergency overflow spillway system will be designed to manage storm events greater than the 1:500 year storm, which would have a 0.2% chance of occurring in a given year, the likelihood of failure of this system is considered very low.
22.4.2.2 Seepage, Drainage and Water Collection Emergency Response Measures

Response measures to recover spilled material from a breach of the drainage and water collection system include:

- immediate response through use of absorbent materials and booms;
- physical reclamation of contaminated soils; and
- removal of contaminated soil and replacement with clean soil.

Cleanup of a major spill would also be accompanied by a monitoring program to detect residual adverse changes to soils and groundwater.

22.4.2.3 Seepage, Drainage and Water Collection Failure Effects Assessment

If the drainage and water collection system is breached, untreated mine contact water, stormwater runoff, or other effluent collected through spills within the PDA would be released. Water quality modelling results (Appendix F5) have confirmed that water quality in the collection ponds could exceed PWQOs for the following parameters: arsenic (up to 100x), antimony (up to 18.5x), cobalt (up to 4.7x), uranium (up to 4.6x), chromium (up to 2.1x), silver (up to 1.5x), thallium (up to 1.9x), and lead (up to 1.7x).

Since collection ponds have been constructed at topographic low points or former intermittent watercourses for gravity drainage, a release could enter Barton Bay or the Southwest Arm of Kenogamisis Lake, the Southwest Arm Tributary, or Mosher Lake, depending on the location of the breach.

A drainage and water collection system failure would have a localized effect on surface water, fish and fish habitat, and upland vegetation and wetlands. Effects on these VCs would also impede the use and access of land and water resources for recreational and traditional uses. The effect would be reliably remediated, and would therefore have a low consequence.

**Surface Water**

Water quality testing has confirmed that for Kenogamisis Lake, the concentration of arsenic and metals from historical tailings and industrial activities is highest in Barton Bay, with levels reducing through the Central Basin and Outflow Basin, with the Southwest Arm having few exceedances.

Surface water quality baseline data indicated that Barton Bay exceeded the Interim PWQO for Arsenic of 5 µg/L in 100% of samples, although there were no exceedances of the PWQO of 100 µg/L. Barton Bay also had PWQO exceedances for iron, copper, aluminum, and phosphorus (33%, 33%, 13%, and 9% of samples, respectively). The Central Basin exceeded the Interim PWQO for Arsenic in 86% of samples, and the PWQO for copper in 33% of samples. The Outflow Basin
exceeded the Interim PWQO for Arsenic in 79% of samples, and the PWQO for copper and aluminum in 4% of samples.

Arsenic levels within the Southwest Arm Tributary exceeded the interim PWQO in 88% of samples, and iron in 13% of samples, and had no other PWQO exceedances. Arsenic levels in Mosher Lake exceeded the interim PWQO in 100% of samples, but had no other PWQO exceedances.

Effluent from the drainage and water collection system would affect surface water quality if released into water bodies adjacent to the PDA, particularly related to already elevated levels of arsenic and some metals in the receiving waters. However, based on the short-term nature of the upset conditions following emergency response and the assimilative capacity of Kenogamisis Lake, parameters of potential concern that cannot be controlled through emergency response measures will disperse rapidly and will not degrade surface water that was previously compliant with PWQOs to such an extent that it exceeds those guidelines.

Residual adverse effects on surface water would be of moderate magnitude, localized to the LAA, short-term and reversible.

**Fish and Fish Habitat**

A variety of habitats exist for fish within the vicinity of seepage, drainage and water collection features. The release of arsenic and metals at a high enough concentration can result in fish mortality. However, metal concentrations from a drainage and water collection failure are not anticipated to be high enough to lead to fish mortality in the event of a drainage release. Arsenic concentrations may come close to the approximate limit for fish mortality of 550 µg/L; but, potential fish mortality would be expected to be localized near the release point and not affect an entire fish population within an ecological unit (i.e., stream or lake). It is anticipated that such failure would be at a small enough scale that potential effects on fish and fish habitat could be remediated. Potentially affected fish populations would likely reestablish within the affected area within one or two generations. Sedimentation could negatively affect fish including fish eggs, if present. Sedimentation of fish eggs could lead to the partial or total loss of a fish population cohort depending on the scale of the event and presence of eggs.

Residual adverse effects on fish and fish habitat would be of moderate magnitude, limited to the LAA, medium-term and reversible.

**Upland Vegetation and Wetlands**

A water collection system breach may release into wetlands adjacent to the PDA at the Southwest Arm Tributary, depending on the location of the breach. Depending on the concentrations of arsenic and metals in the water released, this may result in the contamination of wetland vegetation in the vicinity of the Southwest Arm. Contamination of wetlands in this area would be addressed by the restoration of affected areas, including the removal of
affected vegetation and soils. Over time, the communities will re-establish through natural dispersion from adjacent, unaffected vegetation communities, usually within one to two growing seasons. The revegetation process will be monitored so invasive species (e.g., reed canary grass and/or phragmites) do not become established in the revegetated areas. The measures to be employed to clean up a spill in a wetland will be selected based on the nature and extent of the wetlands affected, type of material spilled, and time of year.

Residual adverse effects on wetlands would be of moderate magnitude, localized to the LAA, short-term and reversible.

**Land and Resource Use and Traditional Land and Resource Use**

A failure of the water collection system would affect fishing for recreational and traditional purposes, if the affected area were used for such activities. Elevated arsenic levels and other metals could lead to fish mortality, affecting fishing activities near the failure site. However, potential fish mortality would be expected to be localized near the release point and not affect fish populations across an entire ecological unit. Sedimentation of fish eggs could also lead to the partial or total loss of a fish population cohort. Potentially affected fish populations would re-establish within the affected area within one or two generations, limiting the duration of effects. A release of a chemical of potential concern may also affect human and ecological health as a result of exposure. Mitigation would be employed in terms engagement with recreational and traditional land uses; mitigation in the form of special advisories (such as fisheries advisories) may be required depending upon the scale of the event.

Residual adverse effects on land and resource use and traditional uses would be of moderate magnitude, limited to the LAA, medium-term and reversible.

**22.4.3 WRSA or Overburden Stockpile Slope Failure**

**22.4.3.1 WRSA or Overburden Stockpile Slope Failure Safety Measures**

Waste rock material is very coarse grained and angular in shape providing high surface locking potential and high angle of repose, which increases slope stability. Side slope angles have been designed to provide long-term geotechnical stability and benches at regular intervals will be used to shorten slope run and the potential of a slope failure.

A Waste Rock Areas Stability Assessment (WRSAs A, B, C & D) has been prepared by AMEC FW (2015b). The WRSAs are located along the edge of the PDA, reaching heights up to 95 m with varying slope angles.

As noted by AMEC FW (2015b), the Project area is in a low seismic hazard area based on Natural Resources Canada’s seismic hazard map. The 2010 National Building Code of Canada seismic hazard calculator was used to calculate interpolated seismic hazard values for the Geraldton
area. Static liquefaction of foundation soils due to high rates of loading from waste rock dumping will be controlled by monitoring pore pressures and dump rates/bench heights in potentially susceptible areas. The dynamic liquefaction of the overburden soils due to seismic events is not considered to be a risk at the site.

Stripping of organics/peat along the perimeter of WRSAs was assumed for analysis to avoid creation of mud waves during waste rock placement as well as inherent stability and settlement issues of the WRSAs in the long term. Based on a sensitivity analyses it was determined that stripping organics along the perimeter of the WRSA footprint up to a minimum length of approximately 175 m measured from the toe of the WRSAs will be required, wherever organics are thicker than 0.3 m.

The central part of WRSA A is proposed to be built over historical Macleod tailings, which requires special design and construction considerations and was divided three segments namely the WRSA A’(west), WRSA ‘A’(central) and WRSA ‘A’(east). A description on the required foundation treatment for each WRSA, as described in the Waste Rock Area Stability Assessment (AMEC FW, 2015b) summarized below:

WRSA A (West): Generally located to the west of the Macleod historical tailings. The southern portion of this pile is anticipated at 2H:1V slopes, the northern portion of pile is anticipated at 3H:1V slopes. Staged construction with toe berms is proposed. A toe berm 70 m wide x 10 m high is recommended as there is no land constraint for this part of the pile. There is enough offset available for the berm from the Right of Way (ROW) for the realigned Highway 11.

WRSA A (Central): Generally located over the Macleod historical tailings. Owing to the liquefaction potential of the historical Macleod High tailings, a 2 to 3 m high toe berm is proposed extending 35 m from the pile toe. This berm will preclude dynamic liquefaction at the toe area of the WRSA by increasing the overburden pressure on the tailings. Slopes of 4H:1V are recommended to meet the target factors of safety under different loading conditions. The berm width was sized for stability in the post seismic condition considering elevated pore pressures within the non-liquefied tailings and liquefied tailings beyond the toe berm.

In view of the proximity of the realigned Highway 11 near WRSA ‘A’ (Central) it was considered necessary to estimate earthquake induced permanent deformations (vertical displacements). The preliminary estimates for earthquake induced permanent deformations of the WRSA (based on the simplified Makdisi-Seed analysis approach) indicate that permanent displacements in the WRSA of under 1 m could be expected during the 1:2,475 year seismic event. This level of deformation would not be expected to impact the serviceability of the relocated Highway 11.

WRSA A (East): Generally located to the east of the Macleod historical tailings. The majority of this pile is anticipated at 2H:1V slopes. Staged construction with toe berms is proposed. A small toe berm (50 m wide x 10 m high) with shear key (20 m wide) is recommended due to the proximity of
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Kenogamisis Lake. The shear key should extend down to an average depth of approximately 6 m to the base of the clay layer. The southern limit of the pile overlies the historical Hardrock tailings. These tailings will be excavated prior to placement of waste rock.

WRSA B: The majority of the pile is anticipated at 2H:1V slopes. A staged construction approach is recommended at this location due to the depth and thickness of the clayey silt layer. A small toe berm (50 m wide x 10 m high) with shear key (30 m wide) is recommended. The shear key should extend down to an average depth of approximately 3 m to 6 m to the base of the clay layer due to the proximity of Kenogamisis Lake.

WRSA C: Slopes of 3H:1V, staged construction with a toe berm 50 m wide x 10 m high will be required to meet the target factors of safety.

WRSA D: The majority of the pile is anticipated at 2H:1V slopes. A staged construction approach is recommended. A small toe berm (50 m wide x 10 high) with shear key (20 m wide) is recommended. The shear key should extend down to an average depth of approximately 4 m to the base of the clayey silt layer due to the proximity of Kenogamisis Lake.

An estimated 15,500 kt of overburden will be generated over the LOM. The primary overburden stockpile will be located over the portion of WRSA A that is located on top of the Macleod historical tailings. The slopes of the overburden pile are anticipated to be 4H:1V. In addition, a smaller overburden stockpile will be developed within contingency area for WRSA D near the TMF for temporary storage until required for rehabilitation of the TMF, beginning in Year 10. Once stockpiles are completed, they will be graded and seeded to prevent erosion.

A 30 m buffer will be maintained between Kenogamisis Lake and WRSA infrastructure (waste rock and drainage/seepage collection system). Small scale slumping or sloughing at the toe of the WRSA will not extend into the 30 m buffer and will be repaired without deposition beyond the PDA.

The design of the stockpile and overburden storage areas will account for the nature of the material being managed to provide long-term stability. However, the consistency of excavated material may deviate from the expected average composition. This may minimally affect the overall stability of small sections of the storage piles, but should not result in deviations significant enough to result in wide scale failure.

Specific designs including toe stability berms and shear keys in conjunction with toe stability berms have been developed as noted above. Further investigations and detailed design will be carried out prior to construction in critical areas. Ample dump space is available to allow placement in interior locations to allow for toe preparation works to be carried out. Construction quality assurance will be carried out by a qualified geotechnical engineer or designate in critical areas. Instrumentation to monitor performance within the design expectations will be installed as required.
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The likelihood of a failure that would extend beyond the protection measures that are in place (benching and setbacks) is very low.

22.4.3.2 WRSA or Overburden Stockpile Slope Failure Emergency Response Measures

Emergency preparedness measures will include maintaining access to determine if the weight of the toe stability berm can be increased if monitoring data indicates incipient failure. If a stockpile were to fail, the first response will be to stop work in the area to maintain worker safety. Material will be excavated and returned to the stockpile, or re-contoured in-place depending upon the scale of the failure. Silt fencing and monitoring may also be required depending upon the scale of the failure as well as repair of damaged infrastructure. Areas would be restored to the extent practical. A monitoring program will be designed to monitor the success of rehabilitation measures.

22.4.3.3 WRSA or Overburden Stockpile Slope Failure Effects Assessment

Failure of the stockpiles could result in slumping and release of either waste rock or overburden material into either the open pit, Kenogamisis Lake or the Southwest Arm Tributary. A failure to the north could also affect the realigned Highway 11 as well as a residential property located in proximity to WRSA A. Failures in other sections of the ore stockpiles and WRSAs would be limited by the location of Project infrastructure such as access roads.

Geochemical baseline studies (Appendix E6) have confirmed that overburden is non-potentially acid generating. Leachate quality may potentially exceed PWQO for arsenic, cobalt, and copper due to background soil and rock properties. Waste rock was sampled from a variety of lithologies. The majority of waste rock in non-potentially acid generating (less than 4% is PAG). Concentrations of arsenic and cobalt, may potentially exceed PWQO and antimony, aluminum and uranium the interim PWQO.

Stockpile and overburden slopes will be designed to maintain stability, so even a conservative case scenario failure should have a limited potential for release beyond the PDA; however there is potential for material to enter the LAA. A stockpile or overburden slope failure would have a localized effect on surface water and fish and fish habitat. Effects on these VCs would also impede the use and access of land and water resources for recreational and traditional uses. Community services and infrastructure, such as the realigned Highway, may also be affected by a stockpile or slope failure. The effect would be reliably remediated, and would therefore have a low consequence.

Surface Water

Waste rock or overburden material has the potential to affect surface water quality if released into water bodies adjacent to the PDA. However, based on the short-term nature of the upset conditions following emergency response and the assimilative capacity of Kenogamisis Lake,
parameters of potential concern that cannot be controlled through emergency response measures will disperse rapidly and will not degrade surface water that was previously compliant with PWQOs to such an extent that it exceeds those guidelines.

A release of overburden into surface water would also lead to localized increases in turbidity and suspended sediment, while suspended sediment from waste rock would be limited due to the coarse nature of the material. Long term leaching would be a greater concern for waste rock, but this material can also be more readily recovered in the event of a failure.

Following closure, the open pit will form a pit lake that will be stratified, with fresh water in the upper layer and denser water with elevated concentrations of various elements in the lower layer. A failure of overburden or waste rock into the open pit following closure would disturb this stratification, resulting in a mixing of the upper and lower layers of the lake. This could result in increased concentrations of select elements, potentially above applicable water quality objectives, being discharged to Kenogamisis Lake.

Residual adverse effects on surface water would be of moderate magnitude, localized to the LAA, short-term and reversible.

Fish and Fish Habitat

Water quality modelling results indicate that while elevated concentrations of arsenic are expected from WRSA runoff, the concentrations are well below thresholds that could lead to fish mortality.

A sudden increase in suspended solids in the water column has the potential to cause acute mortality in fish, with resulting sediment deposition potentially affecting spawning habitats. Death of fish would be a one-time event and not persist overtime. Although the loss of individual fish would be permanent, it is anticipated that fish communities would recover over time. Effects of sediment deposition would be short-term in duration.

Deposition of waste rock or overburden into surface water features (or material that is mobilized due to WRSA slope failure) affecting fish habitat would be removed/remediated if it is deposited in sufficient quantities to permanently alter the ecological function of fish habitat (e.g., if sediments could no longer support similar plant and benthic communities). However, safety measures and design features (as discussed above) will be in place to reduce the material that could be released in a conservative case scenario.

Residual adverse effects on fish and fish habitat would be of low to moderate magnitude, limited to the LAA, short-term and reversible.
Community Services and Infrastructure

A failure of one of the stockpiles to the north of the open pit has the potential to affect the realigned Highway 11. Depending on the size of the failure, a portion of the highway could be buried or damaged by the release. Effects on the highway would be addressed through cleanup and repairs as necessary, and would result in temporary traffic disruptions.

Residual adverse effects on community services and infrastructure would be of moderate to high magnitude, limited to the LAA, short-term and reversible.

Land and Resource Use and Traditional Land and Resource Use

A failure of the stockpile or overburden slopes would affect fishing for recreational and traditional purposes, if the affected area were used for such activities. Elevated arsenic levels and other metals could lead to fish mortality, affecting fishing activities near the failure site. However, concentrations of parameters of potential concern and release rates from leaching are not expected to be high enough to lead to fish mortality. Sedimentation of fish eggs could also lead to the partial or total loss of a fish population cohort, but would be localized to the failure site. Potentially affected fish populations would re-establish within the affected area within one or two generations, limiting the duration of effects.

Residual adverse effects on land and resource use and traditional uses would be of low to moderate magnitude, limited to the LAA, short-term and reversible.

22.4.4 Loss of Stability of Historical Tailings

22.4.4.1 Loss of Stability of Historical Tailings Safety Measures

Historical mine tailings are present along the shoreline of Barton Bay (McLeod High tailings) and the Central Basin (Hardrock tailings) of Kenogami Lake. McLeod and Hardrock historical tailing have low potential ARD. Groundwater within historic tailings exceeds MMER limits for arsenic, nickel, and zinc, with the highest values in the PAG material associated with the Hardrock tailings.

Placement of waste rock on the historical tailings will be staged to maintain stability. WRSAs over historical tailings will be built at a more gradual slope of 4:1 (instead of 2:1 for other waste rock storage areas) to account for the loose foundation material, with a maximum height of 45 m (instead of approximately 90 m) (AMEC FW 2015b). The majority of the WRSA located on the Macleod high tailings will be loaded with overburden instead of waste rock. Overburden placement will follow the same guidelines provided for waste rock placement above the historical MacLeod tailings (i.e., controlled placement rate with geotechnical instrumentation to monitor pore pressures and deformations). Analyses indicate 2 to 3 m of waste above the tailings is sufficient to preclude tailings liquefaction from dynamic (seismic) deformations during the
earthquake loading. Analyses indicate approximately 1 m vertical deformation of the waste rock pile. This level of deformation would not be expected to impact the serviceability of Highway 11.

As noted by AMEC FW (2015b), the historical Macleod high tailings are contained by a tailings perimeter berm. In accordance with Geocon (1996) the high tailings were developed over previously deposited older tailings called “Low Tailings”. The low tailings deposit is relatively thin. The realigned Highway 11 north of the WRSA A passes over the tailings perimeter berm, the Macleod High tailings and also through the Low Tailings area. The highway ROW corridor width is 110 m. No permanent structures will be allowed to be built within the Highway ROW. The distance between the toe of the WRSA A and the southern edge of the Highway 11 ROW varies from about 45 m to 120 m.

For the realigned Highway, embankments will be constructed based on geotechnical recommendations to maintain stability across historical tailings. Further investigations will be undertaken during detailed design of the Highway to confirm stability, and to meet the MTO Embankment Settlement Criteria, which set limits on the allowable amount of settlement which can occur after construction of a roadway (Appendix H).

Based on the geotechnical design considerations being applied for construction on top of historical tailings, the likelihood of a failure is considered very low.

**22.4.4.2 Loss of Stability of Historical Tailings Emergency Response Measures**

The first response will be to stop work in the area to maintain worker safety. Notification of authorities, emergency responders, local residents and Aboriginal communities will occur if required. The historical tailings will be contained to the extent possible using temporary dams of earth or snow and silt fences, and through other available equipment or means. A remedial action plan will be developed in consultation with appropriate government agencies. A surface water and groundwater monitoring program will be designed to monitor the movement of parameters that may infiltrate from historical tailings and affect the success of rehabilitation measures.

A third party reviewed stability assessment and monitoring plan will be implemented as part of the WRSA and overburden stockpiling plan which addresses the overall safety of the embankments that are to be founded on the historical tailings. If a stockpile were to fail as a result of the historical tailings failure, material will be excavated if safe to do so and returned to an appropriate stockpile location with appropriate remediation if required. Stockpiles may also be re-contoured in-place depending upon the scale of the failure.
22.4.4.3 Loss of Stability of Historical Tailings Effects Assessment

If construction or the placement of waste rock and overburden material on historical tailings results in the failure of the tailings, this could lead to localized slumping and the release of contaminated material. Since the historical tailings areas extend beyond the shore line of Barton Bay and the Central Basin of Kenogamisis Lake, there is the potential for historical tailings to be released directly to surface water. A failure has the potential to disrupt previously stable material in the tailings deposits, which may increase the infiltration of parameters of potential concern into groundwater. The effects associated with slumping of a WRSA as a result of loss of stability of historical tailings are discussed in Section 22.4.3.

The major parameter of concern in historical tailings is arsenic, although there are elevated levels of a number of metals as well. For the MacLeod tailings (north of the open pit), average values for the following elements in the groundwater within the tailings exceed the respective PWQOs: arsenic (2063x), iron (246x), cobalt (13x), nickel (~3x), lead (~2x) and chromium (1.4x). For the Hardrock tailings (east of the open pit), average values for the following elements exceed the PWQOs: free cyanide (2x), aluminum (4x), arsenic (2005), boron (1.5x), cadmium (4x), chromium (3.4x), cobalt (383x), copper (2.6x), iron (2659x), lead (3.5x), nickel (22x), silver (3.2x), thallium (3.2x), uranium (3.3x), and zinc (5.5x).

In a conservative case scenario, a failure of the historical tailings could have a widespread effect on surface water and fish and fish habitat, and a localized effect on groundwater. Effects on these VC*s would also impede the use and access of land and water resources for recreational and traditional uses. Remediation would be uncertain, and would therefore have a high consequence.

**Surface Water**

Surface water quality baseline data indicated that Barton Bay exceeded the Interim PWQO for Arsenic of 5 µg/L in 100% of samples, although there were no exceedances of the PWQO of 100 µg/L. Barton Bay also had PWQO exceedances for iron, copper, aluminum, and phosphorus (33%, 33%, 13%, and 9% of samples, respectively). Arsenic levels within the Southwest Arm Tributary exceeded the interim PWQO in 88% of samples, and iron in 13% of samples, and had no other PWQO exceedances. Arsenic levels in Mosher Lake exceeded the interim PWQO in 100% of samples, but had no other PWQO exceedances.

A release of historical tailings into Kenogamisis Lake would affect surface water quality, particularly related to already elevated levels of arsenic and some metals in the receiving waters. The potential for contamination would be limited by cleanup activities, with the greatest concern resulting from any remaining tailings deposited to the lake, which would release parameters of potential concern overtime. This would result in localized elevations of PWQOs that would disperse rapidly given the assimilative capacity of Kenogamisis Lake, and would not
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degradate surface water that was previously compliant with PWQOs to such an extent that it exceeds those guidelines.

Residual adverse effects on surface water would be of moderate magnitude, localized to the LAA, long-term and potentially irreversible.

Fish and Fish Habitat

Potential effects on fish and fish habitat due to loss of stability of historical tailings are the same as those identified for a catastrophic failure of the proposed new TMF (Section 22.4.1.3.2). Although the potential for effects on fish and fish habitat would vary with the location and magnitude of historical tailings failure, a conservative case scenario would result in residual adverse effects on fish and fish habitat that would be of high magnitude, extend to the RAA, and be long-term and irreversible.

Groundwater

A failure of the historical tailings has the potential to effect groundwater quality, if the tailings material shifts and results in increased infiltration to local aquifers. Groundwater is already affected by seepage from historical tailings; but an upset of existing stable conditions may result in the increased potential for releases beyond baseline conditions of arsenic and numerous metals.

The effect on groundwater would be confined to the LAA, and would be considered low magnitude, long-term and potentially irreversible.

Land and Resource Use and Traditional Land and Resource Use

A failure of the historical tailings would affect fishing for recreational and traditional purposes, if the affected area were used for such activities. Elevated arsenic levels and other metals could lead to fish mortality, affecting fishing activities near the failure site. Residual adverse effects on fish and fish habitat would have potential to limit recreational and traditional uses through the destruction of areas used for fishing and effects on local fish populations. In a conservative case scenario, there is potential for destruction or permanent alteration of fish habitat that would result in a loss of fisheries productivity that can be measured at the lake-wide scale. This may result in reduced fish abundance, health or condition such that the quality of the recreational or Aboriginal fishery is diminished. Small to moderate failures of historical tailings may be remediated, however it would be difficult to remediate or offset the destruction or alteration of fish habitat that would occur under a conservative case scenario. Residual adverse effects on human and ecological health could occur as a result of exposure to a chemical of potential concern. Mitigation would be employed in terms engagement with recreational and traditional land uses, mitigation in the form of special advisories (such as fisheries advisories) may be required depending upon the scale of the event.
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In a conservative case scenario residual adverse effects on land and resource use and traditional land and resource use would be of moderate to high magnitude, potentially extending into the RAA, be medium to long-term and potentially irreversible.

22.4.5 Goldfield Creek Diversion Failure

22.4.5.1 Goldfield Creek Diversion Safety Measures

The creek diversion will include a diversion dam separating collection pond T2 from the creek diversion. The collection pond will be maintained lower than the diversion head pond for hydraulic containment purposes (seepage collection gradients are inward – towards the TMF).

The principles of natural channel design will be used to guide the development of the new diversion channel. Natural channel design is based on the idea of using a functioning stream system near the site of the Project as a reference for the design of the new channel. The design is developed thorough an understanding of the geomorphic processes (e.g., flow regime, sediment regime, valley type) shaping the reference stream. Goldfield Creek will be used as the reference stream for the new diversion channel. The potential effects of climate change, such as significant precipitation events, will be addressed through the design of the channel and its associated floodplain. Risks associated with extreme events can be mitigated by designing a channel with the appropriate pattern, dimension and profile and by providing effective floodplain access.

There is no risk of failure during construction as the channel will be constructed offline, with no connection to watercourse or fish habitat. Nonetheless, erosion and sediment control measures (e.g., silt fence, sediment traps, sediment basins) will be included in the design to prevent sediment from leaving the construction site. Sediment control measures will be inspected on a regular basis, particularly before and after heavy precipitation events.

The diversion channel will be at the highest risk of failure immediately after construction and when the water is first diverted into the new channel. The potential for failure will be limited by implementing the natural channel design principles noted above, as well as by having the design engineer onsite during construction. This will help confirm that the instream and bank protection unique to natural channel design will be constructed properly. The potential for failure will be reduced as the vegetation planted on site matures and develops the root systems needed to stabilize the stream.

Some minor erosion would be expected as the channel makes minor adjustments, but regular (e.g., twice annually) inspections will confirm that the vegetation planted onsite is surviving in sufficient numbers to promote channel stability and surveys of the new channel will confirm that it is stable. Therefore the likelihood of a failure is very low.
22.4.5.2 Goldfield Creek Diversion Emergency Response Measures

In the event of a structural failure within the diversion channel, response measures will be implemented as described in the ERP.

There is a chance the diversion could jam with ice and the diversion dam could overtop into pond T2. In turn the pond T2 contents would mix with the inflow and then flow out after some time along the blocked diversion channel. Surveillance should indicate ice damming. It may also be possible to pump the combined areas in the TMF as a contingency. The diversion channel will be constructed offline with appropriate erosion and sediment measures in place, such as silt fences, earth/snow dams etc. This will significantly reduce the risk of silt laden water reaching natural waters or fish habitat. The realigned channel will be monitored on a regular basis and adaptive management will support long-term stabilization. If a breach occurs repairs will occur when it is safe to do so. In the event that a structural failure occurred and habitat was permanently damaged, compensation or offsetting measures may be required in accordance with relevant legislation.

22.4.5.3 Goldfield Creek Diversion Failure Effects Assessment

Minor areas of erosion are common during the first few years as the new channel makes some minor adjustments to its pattern, dimension and profile. But these areas of erosion are generally small and produce only minor increases in turbidity. In most cases, these areas of erosion heal themselves and are considered part of the natural geomorphic process.

In a conservative case scenario, a failure would extend several hundred metres, resulting in sedimentation to connecting waterbodies. A failure of the Goldfield Creek diversion would have a localized effect on surface water and fish and fish habitat. Effects on these VCs would also impede the use and access of land and water resources for recreational and traditional uses. The effect would be reliably remediated, and would therefore have a low consequence.

Surface Water

A failure of the Goldfield Creek diversion could result in a change in surface water quality in the Southwest Arm Tributary and Kenogamisis Lake. The highest potential for effects would be in the Southwest Arm Tributary, directly downstream of the diversion. This watercourse would experience the highest flow and sedimentation, potentially leading to further erosion beyond the extent of the constructed diversion. The volume of water and assimilative capacity of Kenogamisis Lake would reduce the effect of increased flow and sedimentation. High flows and sediment releases would be caused by a precipitation event, and would be expected to cease shortly following the storm. Following the sediment release, water quality of affected watercourse would return to pre-release conditions, as sediment is washed downstream and deposited in waterbodies.
Residual adverse effects on surface water would be of low magnitude, localized to the LAA, short-term and reversible.

**Fish and Fish Habitat**

A variety of habitats exist for fish within the Southwest Arm Tributary and Kenogamisis Lake. Sedimentation particularly if it is composed of fine sized particles, could negatively affect fish including fish eggs, if present. Effects on adult fish would likely be short-term in duration. Sedimentation of fish eggs could result in the partial or total loss of a fish population cohort if eggs are present. Habitat quality could negatively be affected. Adverse changes to the quality of fish habitat would be expected to reverse following the sedimentation event as the flow of the watercourse cleans away the sediment and leads to deposition downstream. Additional remedial measures may be required to restore the quality of fish habitat in the constructed channel. If fish habitat were destroyed as an effect of the failure, appropriate measures such as compensation or restoration would be applied to offset this effect.

Residual adverse effects on fish and fish habitat would be of moderate magnitude, limited to the LAA, short-term and reversible.

**Land and Resource Use and Traditional Land and Resource Use**

A release would limit the use of affected areas for recreational land and traditional land uses such as fishing, if the affected area were used for such activities. Effects on adult fish from sedimentation in the event of a failure of the Goldfield Creek diversion would be short in duration; however sedimentation of fish eggs could result in the partial or total loss of a fish population cohort. Adverse changes to the quality of fish habitat would be expected to reverse following the sedimentation event. Habitat quality could also be affected. If the Goldfield Creek diversion were being used for fishing at the time of failure, further use would be restricted until restoration efforts were completed.

Residual adverse effects on land and resource use and traditional uses would be of moderate magnitude, limited to the LAA, short-term and reversible.

**22.4.6 Spills from Vehicle Collisions**

**22.4.6.1 Spills from Vehicle Collision Safety Measures**

A number of traffic safety measures will be in place to reduce the potential for vehicle collisions to occur as a result of the Project. These include, but are not limited to, the following.

- Road, safety, and traffic control improvements that are required to accommodate the realignment of Highway 11 will be implemented based on a study that was conducted to
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- review current traffic conditions and analyze traffic forecasts during the Project (Appendix F9);
- the realignment of Highway 11 will be designed and constructed to applicable standards and adhere to the highest standard practices for highway construction;
- dedicated turning lanes will be implemented if and as required for safety;
- drivers will be required to adhere to posted speed limits;
- Project vehicles will be manually inspected on a regular basis to confirm there are no problems; and
- transported amounts of hazardous materials (e.g., fuel, cyanide, LNG, ammonia) will be limited to the amounts required by the Project, and transported by licensed contractors.

To reduce the likelihood of such an event, emphasis will be placed on safety and accident prevention.

Fuel will be transported to the Project site along the regional road network by tanker trucks. The tanker trucks will consist of single units that typically have a capacity of 7.5 kilolitres. Tanker trucks are generally compartmentalized, such that if there were to be an accident, only a portion of the load will be lost except in a catastrophic incident.

The traffic impact assessment indicates that traffic along Highway 11 is very low (less than 2,000 vehicles per day), and well within the capacity of the highway. A two lane highway that exhibits near capacity conditions would have daily traffic volumes near 15,000 vehicles per day. As a result, the vehicles generated by mine activities can be easily accommodated, resulting in a very low likelihood of a collision along existing routes. Further details are provided Appendix F9.

22.4.6.2 Spills from Vehicle Collision Emergency Response Measures

A detailed ERP will be developed and submitted to appropriate regulatory agencies for review prior to the initiation of Project activities. It will contain specific measures related to vehicle collisions, including:

- medical response;
- notification of regulatory authorities;
- spill containment;
- removal/cleanup of contaminated soils and water;
- monitoring of environment; and
- ongoing staff training to learn from any accidents.
22.4.6.3 Spills from Vehicle Collision Effects Assessment

In the event of a vehicle collision, a spill could result in the release of a number of different parameters of potential concern, depending on the contents of the vehicles. Mill reagents will be delivered in bulk, such as lime, sodium hydroxide, elemental sulphur, and hydrochloric acid, while other reagents will be delivered in smaller quantities, depending on the application. Diesel and LNG will also be delivered in tanker trucks.

The potential for effects would depend on the location of the collision and the nature of the materials being released. Volumes of hazardous material will be limited based on the needs of the Project.

Non-hazardous material transported to site will include sand/aggregates in approximately 50 t trucks.

In a conservative case scenario, a vehicle collision would have a localized effect on surface water and fish and fish habitat. Effects on these VCs may also impede the use and access of land and water resources for recreational and traditional uses. The effect would be reliably remediated, and would therefore have a low consequence.

Surface Water

A vehicle collision resulting in the release of fuel or hazardous material could have localized effects on surface water. If a vehicle collision were to occur outside the PDA, the response time to implement emergency measures may be longer, resulting in potentially increased effects. Depending on the location of the collision, this could include the release of fuel or hazardous materials into watercourses, which could extend contamination downstream before cleanup activities are started. Emergency response times should be sufficient to contain and remediate downstream effects, since hazardous materials would only be transported in limited quantities.

Residual adverse effects on surface water would be of moderate magnitude, short-term and reversible, but may extend downstream from the collision site.

Fish and Fish Habitat

If a vehicle collision resulted in a spill of fuel or hazardous material near fish habitat, this may lead to localized fish mortality. Based on the relative abundance and distribution of fish populations, it is anticipated that depending of the size of the spill and toxic materials spilled fish mortality could range from a few fish (not affecting the sustainability and productivity of a fishery), to larger scale levels of fish mortality (which could have a temporary effect on localized fish populations). It is anticipated fish populations would re-establish themselves one or two generations in larger events. Emergency response measures would include site cleanup to avoid lasting effects on fish habitat.
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Residual adverse effects on fish and fish habitat would be of moderate magnitude, short-term and reversible, but may extend downstream from the collision site.

Land and Resource Use and Traditional Land and Resource Use

A release from a vehicle collision would temporarily limit or affect the use of the area surrounding the accident site for recreational and traditional land uses such as fishing, if the affected area were used for such activities. However, fish populations affected by mortality from contaminated material would re-establish themselves within one or two generations. Emergency response measures would include site cleanup to avoid lasting effects on fish habitat. Residual adverse effects on human and ecological health could occur as a result of exposure to a chemical of potential concern. Mitigation would be employed in terms engagement with recreational and traditional land uses, mitigation in the form of special advisories (such as fisheries advisories) may be required depending upon the scale of the event.

Residual adverse effects on land and resource use and traditional uses would be of moderate magnitude, limited to the LAA, short-term and reversible.

22.5 RISK ANALYSIS

Once the potential effects associated with each accident or malfunction scenario were identified, the level of residual risk (after controls or safety measures have been applied) was determined based on the method described below. Risk is determined as a function of likelihood (frequency of occurrence) and severity (degree of consequence).

The likelihood and severity are based on experience and judgment of qualified professionals. Determinations of likelihood and severity consider the lifespan of each Project component (as required by the EIS Guidelines).

The potential likelihood of an event occurring has been defined as follows:

- **Very Low**: Doubtful to occur (<5%)
- **Low**: Unlikely to occur over (5% - 25%)
- **Moderate**: Could occur over (26% - 50%)
- **High**: Expected to occur over (51% - 75%)
- **Very High**: Almost certain to occur (>75%)

The severity or consequence of that event has been defined as follows:

- **Very Low**: localized effect; readily remediated, recovery within days or weeks
- **Low**: localized effect; predictably remediated, recovery within the life of the project
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- **Moderate**: widespread effect; predictably remediated, recovery within the life of the project
- **High**: widespread effect; uncertain remediation, not recoverable within the life of the project
- **Very High**: widespread effect; unlikely to be completely remediated, not recoverable within the life of the project, loss of a considerable portion of a VC.

The assessment of the potential risk of environmental effects resulting from accidents or malfunctions involves the use of a risk matrix (Figure 22-1), where the residual risk is determined based on the likelihood and consequence of that particular accident or malfunction. Risk levels are colour coded to provide a visual means of expressing risk, the definitions of which are provided in Figure 22-2. Where a range of risk ratings could occur for a particular accident or malfunction, a conservative approach was taken whereby the highest rating was considered. The results of the risk assessment are provided in Table 22-2.

![Figure 22-1: Risk Matrix](image-url)
<table>
<thead>
<tr>
<th>Legend</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>Risk is acceptable; no additional risk mitigation required</td>
</tr>
<tr>
<td>Low</td>
<td>Risk is tolerable; continue to monitor risk; no additional risk mitigation required</td>
</tr>
<tr>
<td>Moderate</td>
<td>Risk may be tolerable; more detailed review required; if warranted, additional mitigation may be required</td>
</tr>
<tr>
<td>High</td>
<td>Risk is unacceptable; appropriate risk mitigation needs to be applied</td>
</tr>
<tr>
<td>Very High</td>
<td>Risk is imminent; mitigation needs to be applied; long term risk reduction plan needs to be developed and implemented</td>
</tr>
</tbody>
</table>

**Figure 22-2: Risk Level Legend**
### Table 22-2: Summary of Accidents or Malfunctions Risk Analysis

<table>
<thead>
<tr>
<th>Accident/ Malfunction</th>
<th>In-design Safety Measures</th>
<th>Likelihood of Event</th>
<th>Parameters of Potential Concern Released (If Event Occurs)</th>
<th>Emergency Response Measures</th>
<th>Description of Residual Adverse Effects</th>
<th>Severity (Consequence) of Residual Event</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tailings Management Facility Dam Failure or Overtopping</td>
<td>Construct TMF (with emergency spillways) using safe and proven design specifications. Construct dam to withstand the Probable Maximum Flood and maximum credible earthquake. Design dam to hold the environmental design flood. Emergency spillway for excess flows. Deposition plan displaces the pond into the central portion of the TMF so that solid beaches will form against the perimeter of the TMF for added safety. Limits the size of the ponds to reduce risks. Conduct a Failure Mode and Effect Analysis and a Mechanisms and Dam Break and Inundation Study during detailed design. Meet Canadian Dam Association and International Commission on Large Dams standards. Monitoring and routine surveillance. Annual dam safety inspections.</td>
<td>Very Low</td>
<td>Tailings Heavy metals Suspended solids</td>
<td>Shutdown pumping of tailings to the TMF in the event of failure. Notify emergency responders and stakeholders. Initiate evacuation procedures if required. Implement emergency repairs, if safe to do so. Pump the TMF if possible to reduce the amount of released effluent. Contain the spill through temporary dams, silt fences and other means. A remedial action plan will be developed. Stabilize spilled tailings and haul back to TMF if feasible. Restore areas to the extent practical. Develop surface and groundwater monitoring plan.</td>
<td>In the event of a failure, a breach could result in effects to surface water, groundwater and fish and fish habitat, along with the destruction of upland vegetation and wetlands, and wildlife habitat. These effects may also affect resource use and traditional uses related to fishing, hunting and gathering if practiced in the affected area. In addition, a breach could result in changes to human and ecological health depending upon the scale of the event. Contamination from metals and other hazardous materials is a concern for local fish and wildlife, surface water, soils and groundwater. Depending upon the scale of the event, it may not be possible to contain or remove spilled tailings from a breach. In the conservative case scenario, the effects of a TMF failure could have a widespread effect and uncertain remediation.</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Seepage, Drainage and Water Collection System Failure</td>
<td>Designs for perimeter ditching and seepage collection ponds will take into account safe distances from nearby infrastructure and water features. Minimum offset of 30 m from existing water bodies (such as, Southwest Arm and Kenogamiis Lake). Design system to control runoff up to the 1:100 year return, with emergency overflow to 1:500.</td>
<td>Very Low</td>
<td>Process water/ effluent Suspended solids Ammonia</td>
<td>Immediate response through use of absorbent booms and pads. Liquids cleanup can be used to capture both fuels and groundwater near the site for removal and disposal. Physical reclamation of contaminated soils; removal of contaminated soil and replacement with clean soil. Monitoring program to detect residual changes to soils and groundwater.</td>
<td>Following a failure or breach of the drainage and water collection system, there may be a release that affects surface water, wetlands or fish and fish habitat, but the rapid implementation of emergency response measures would limit the extent of potential effects. These effects may also affect resource use and traditional uses related to fishing, if practiced in the affected area. In addition, a breach could result in changes to human and ecological health depending upon the scale of the breach. Effects would be localized and reliably remediated.</td>
<td>Low</td>
<td>Very Low</td>
</tr>
</tbody>
</table>
### Table 22-2: Summary of Accidents or Malfunctions Risk Analysis

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>WRSA or Overburden Stockpile Slope Failure</td>
<td>Waste rock stability assessment undertaken and foundations treatments, such as toe slope berms and shear keys identified. Side slope angles designed for long-term stability. Benches at regular intervals to shorten slope run and the potential of a slope failure. A minimum 30m buffer between the toe of slopes and waterbodies. Instrumentation installed to monitor performance.</td>
<td>Very Low</td>
<td>Suspended solids</td>
<td>Heavy metals</td>
<td>Maintaining access to determine if the height of the toe stability berm can be increased if monitoring data indicates incipient failure. First response will be to stop work in the area to maintain worker safety. Material will be excavated and returned to the stockpile, or re-contoured in-place depending upon the scale of the failure. Silt fencing and monitoring may also be required depending upon the scale of the failure as well as repair of damaged infrastructure. Areas would be restored to the extent practical. A monitoring program will be designed to monitor the success of rehabilitation measures.</td>
<td>A failure of the waste rock or overburden slopes may result in the release of this material into surface water and fish and fish habitat, increasing levels of parameters of potential concern and sedimentation. These effects may also affect resource use and traditional uses related to fishing, if practiced in the affected area. A failure towards the realigned Highway 11 could result in damage to the highway. Effects would be localized and reliably remediated.</td>
<td>Low</td>
</tr>
<tr>
<td>Loss of Stability of Historical Tailings</td>
<td>Stability assessment undertaken. Placement of waste rock on the historical tailings will be staged to maintain stability. Waste rock storage areas over historical tailings will be built at a more gradual slope of 4:1 with lower pile height (45 m). Piles will also consist of a small amount of waste rock covered by overburden. Construction of an initial waste rock bench and a toe berm to distribute material loads. Highway embankments will be constructed based on geotechnical recommendations to maintain stability.</td>
<td>Very Low</td>
<td>Tailings</td>
<td>Heavy Metals</td>
<td>First response will be to stop work in the area to maintain worker safety. Notification of authorities and stakeholders. The historic tailings will be contained to the extent possible using temporary dams of earth or snow and silt fences, and through other available equipment or means. A remedial action plan will be developed in consultation with appropriate government agencies. A surface water and groundwater monitoring program will be designed to monitor the movement of parameters that may infiltrate from historical tailings and the success of rehabilitation measures. Material will be excavated if safe to do so and returned to an appropriate stockpile location with appropriate remediation if required. Stockpiles may also be re-contoured in-place depending upon the scale of the failure.</td>
<td>A failure of the historical tailings may result in the release of this material into surface water and fish and fish habitat, increasing levels of parameters of potential concern and sedimentation. These effects may also affect resource use and traditional uses related to fishing, if practiced in the affected area. In addition, a failure could result in changes to human and ecological health depending upon the scale of the event. It may not be possible to contain all material released, which could have long-term effects on water quality. Loss of stability could disrupt existing hydrogeological characteristics, resulting in increased infiltration of parameters of potential concern into groundwater. Effects which would be widespread with uncertain remediation.</td>
<td>High</td>
</tr>
</tbody>
</table>
Table 22-2: Summary of Accidents or Malfunctions Risk Analysis

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</tr>
</thead>
<tbody>
<tr>
<td>Goldfield Creek Diversion Failure</td>
<td>Diversion dam will separate collection pond T2 from creek channel. Collection pond will be maintained lower than diversion head pond for hydraulic containment purposes. The principles of natural channel design will be used to guide the development of the new diversion channel. Potential effects of climate change, such as significant precipitation events, will be addressed through the design of the channel and its associated floodplain. Construct channel offline to avoid risk of failure during construction. Implement and regularly inspect erosion and sediment control measures (e.g., silt fence, sediment traps, sediment basins). Construct channel with design engineer present.</td>
<td>Very Low</td>
<td>Suspended solids</td>
<td>Surveillance with regard to potential ice dams. Response measures will be implemented immediately as described in the ERP. Compensation or offsetting measures may be applied in accordance with relevant legislation.</td>
<td>Changes to surface water quality resulting from an erosion or sedimentation event would be short in duration and reversible. As the flow in watercourses would clean away sediment deposited during an erosion or sedimentation control failure, changes to fish habitat would also be expected to be short-term in duration. These effects may also affect resource use and traditional uses related to fishing, if practiced in the affected area. Effects will be localized and reliably remediates.</td>
<td>Low</td>
<td>Very Low</td>
</tr>
<tr>
<td>Spills from Vehicle Collisions</td>
<td>Adhere to applicable standards and practices for highway construction. Implement dedicated turning lanes as required. Require drivers to adhere to posted speed limits. Regular vehicle inspections. Regular equipment maintenance. Limit the amounts of hazardous materials being transported.</td>
<td>Low</td>
<td>Fuel Oil Hazardous material</td>
<td>Notification of regulatory authorities, Spill containment. Removal/cleanup of contaminated soils and water. Monitoring of environment. Ongoing staff training to learn from accidents</td>
<td>A vehicle collision may result in the release of fuel or hazardous materials in areas with no surface water controls, thereby allowing materials to enter waterbodies with fish habitat. These effects may also affect resource use and traditional uses related to fishing, if practiced in the affected area. In addition, a spill could result in changes to human and ecological health depending upon the scale of the event. Emergency responses procedure can be implemented to clean up spills and limit the extent of potential effects. Effects will be localized and predictably remediates.</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
22.6 SUMMARY

Residual adverse effects on VCs are characterized in Section 22.4 with risk summarized in Section 22.5. Significance thresholds are presented for each VC in Chapters 7.0 through 19.0. As noted above, the Project is inherently designed to prevent accidents and malfunctions primarily through adherence to accepted design codes and standards. Most accidental events that could be expected to occur are small spills that are easily cleaned up onsite with little or no environmental consequences. Emergency response and contingency plans will be developed and implemented to effectively respond to accidents and malfunctions to reduce the magnitude and duration of adverse environmental and social effects. In the unlikely event of a major industrial accident at the site involving a large scale environmental release, a significant adverse effect is possible for those VCs assessed in this Chapter. The overall risk to VCs from Project-related accidents and malfunctions is summarized in Table 22-2 where some events, with mitigation, are predicted to be of potentially high consequence with low or very low probability. In summary, significant adverse residual effects from Project-related accidents and malfunctions are not likely.

22.7 REFERENCES


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