6. Accidents and Malfunctions

The following sections identify potential accidents and malfunctions that could occur during these phases, the potential environmental effects that may occur as a result of the accident or malfunction, and the mitigation measures implemented to minimize the risk of the accident or malfunction from occurring, and/or to the minimize the potential for negative effects in the event that such an accident or malfunction does occur.

6.1 Construction Period

The following sections provide an assessment of the potential adverse effects on the environment resulting from accidents and malfunctions during construction. These can include cofferdam failure and associated flooding of the work area, spills and accidental fires. The assessment also includes a discussion on the probability and extent of the incident.

6.1.1 Cofferdam Failure

6.1.1.1 Potential Effects

Cofferdams will be one of the primary structures that will retain water during construction of each of the proposed facilities. If any cofferdam were to fail, it would likely cause the work area to be flooded. Failure of the cofferdam would likely result in the downstream transport of fine impervious fill material from the cofferdam structure or result in mobilization of fine sediments and other debris from the area within the cofferdam, which would have an adverse effect on water quality, due to turbidity and suspended solids and on aquatic habitat due to sedimentation and infilling of the rocky channel bed with fine materials. In addition, cofferdam failure could have the potential for water coming into contact with potentially hazardous materials in the work area (e.g., fuels, oils, solvents, uncured concrete) and being transported downstream. This could also have an adverse effect on surface water quality, aquatic biota and habitat. Cofferdam failure could also jeopardize the safety of the workforce.

Adverse effects of cofferdam failure and associated flooding of the work area will vary depending on the severity of the failure (i.e., the amount of cofferdam material eroded and the amount of flow released into the area behind the cofferdam and subsequently back to the river) and the nature of the construction activities occurring within the cofferdam area at the time of failure.

6.1.1.2 Mitigation Measures

Given the potential negative environmental effects that could occur in the event of a cofferdam failure, the integrity of the cofferdam structure is important. In addition, since workers will be behind the cofferdams and failure could have impacts on human life, the Hazard Potential Classification (HPC) of the cofferdams is High. Accordingly, they will be designed by professional engineers to meet current MNR Dam Safety Guidelines. Cofferdams will be designed to be stable and not be overtopped at the 1 in 25-yr flow rate and an Emergency Preparedness Plan will be prepared to detail how to respond to potential accidents and malfunctions of the cofferdam structure. The proposed cofferdams will require approval under the LRIA, in which a detailed review of the engineering of the cofferdam structure will be conducted before an approval is issued. Accordingly, cofferdams are expected to have a very low probability of failure, consistent with industry experience.

A Job Safety Plan is to be prepared by the Contractor and distributed to the labour force on site, instructing them on how to safely work around water, including what to do in the event of a cofferdam failure.

Potentially hazardous materials (e.g., fuels and other hydrocarbons, will not be stored behind cofferdams.

6.1.1.3 Net Effects and Significance of Net Negative Effects

The net effects of a cofferdam failure would be dependent on the magnitude of the failure. However, it is anticipated that failure would result in negative effects on surface water quality (due to turbidity or contaminants such as hydrocarbons if present in the flooded work area), aquatic habitat and aquatic biota. The following identifies the significance of these net negative effects.

Value of Resource

River water quality, aquatic biota and aquatic habitat have a ***High*** value in the local area since fish are harvested by CLFN and members of the general public. Human life (i.e., the workforce working behind the cofferdam) also has a ***High*** value.

Magnitude of Effect

The magnitude of effect is dependent on the magnitude of failure. Assuming the worst case scenario of a complete failure, the magnitude of effect on surface water quality, aquatic biota and habitat would be ***Moderate***. It is assumed that cofferdam failure would occur during high flow periods, so the release of fine sediments from the cofferdam would be somewhat diluted at these high flow rates, thereby decreasing the overall magnitude. Magnitude of effect on human life could also be ***High*** under a worst-case scenario.

Geographic Extent of Effect

The geographic extent would likely occur >500 m from the Project Area, due to downstream transport of materials in the Kabinakagami River, therefore the geographic extent is ***High***.

Duration and Frequency of Effect

The effect would occur once immediately upon cofferdam failure, so the duration and frequency are considered to be ***Low***.

Reversibility of Effect

The effects on surface water quality are ***Reversible*** since they will eventually diminish to restore existing conditions. However, loss of life due to a cofferdam failure would be ***Non-Reversible***.

Ecological or Social Context

The area is determined to have ***Moderate*** fragility with respect to effects on surface water quality, aquatic habitat and biota due to cofferdam failure. The area has a ***Moderate*** fragility with respect to effects on human life (i.e. workers behind cofferdam).

Probability of Effect

The probability of a cofferdam failure is ***Low*** since it will be designed by a professional engineer to appropriate industry standards.

Overall Assessment

Given the low probability of this effect, this is considered to be ***Not Significant***.

6.1.2 Accidental Fires

6.1.2.1 Potential Effects

Accidental fires can be started by a number of incidents including careless smoking and sparks from construction equipment and electrical faults. The potential negative effects associated with an accidental fire in the Study Area depend on the nature and ultimate size of the fire. The effects of small, controllable fires in the work area would tend to be local in extent, minor in magnitude, short-term in duration; however, there is the potential for an event that could result in effects that are very large in magnitude, particularly if a large fire were to start in the surrounding forest during dry periods. Such a large fire may be hard to control and have the potential to spread into a large forest fire. Large wildfires could potentially have negative effects on public health and safety, wildlife and wildlife habitat, aquatic biota and habitat (due to ash deposition in watercourses), air quality (due to smoke) and surface water quality due to runoff from burned areas to waterbodies. Fires could also affect forestry and other resource extraction operations.

6.1.2.2 Mitigation Measures

The frequency of occurrence of fires due to construction is anticipated to be low given the requirements to monitor all activities that could result in a fire. Vegetation clearing operations conducted under approval of the *Crown Forest Sustainability Act* will be done in accordance with the requirements of MNR's Modifying Industrial Operations Protocol (MNR, 2008) to prevent wildfires from occurring.

The Contractor will prepare a Fire Prevention and Preparedness Plan which will outline the following, as required by MNR (2008):

- appropriate contacts (for Northland, the Contractor and MNR)
- the type of operations by risk category
- fire prevention planning
  - fire prevention programs and initiatives
  - fire prevention monitoring
- fire preparedness planning
  - fire suppression training
  - fire suppression equipment available
  - actions to be taken when a fire is detected
  - communications plan.

The Contractor will be required to have, on hand, fire suppression equipment in accordance with the *Forest Fires Prevention Act* and MNR (2008) and Regulations to develop communications, notifications and reporting protocols, as well as initial response procedures. Appropriate training will occur for any workers that will be expected to operate fire suppression equipment in the event of an accidental fire. All mechanical equipment shall be equipped as required by MNR and be kept free of any accumulation of flammable materials. Fire extinguishers will be included on or within 5 m of all mechanical equipment that is operating within forested area during construction. Other fire suppression equipment will be present on site in accordance with the requirements noted in MNR (2008). The implementation of measures described above would greatly reduce the risk of fire.

6.1.2.3 *Net Effects and Significance of Net Negative Effects*

The effects could vary depending on the severity of the fire but, assuming the mitigation noted above is sufficient to minimize the size and spread of the fire, effects would tend to be local in extent, minor in magnitude and short-term in duration. However, a large scale fire could have negative effects on a number of VECs and VSCs.

Value of Resource

Since a number of VECs and VSCs could be negatively affected by a fire, the value is considered to be ***High***.

Magnitude of Effect

The magnitude of effect is dependent on the magnitude of the fire. Assuming the worst case scenario of a large forest fire, the magnitude of effect on the environment would be ***High***. However, small controllable fires in the Project Area could have a ***Low*** effect.

Geographic Extent of Effect

The geographic extent is dependant on the magnitude of the fire. Large fires would likely occur >500 m from the Project Area, , therefore the geographic extent would be ***High***, while small fires could be contained to the Project Area, given effective mitigation.

Duration and Frequency of Effect

The effects of a large magnitude fire occurring during construction could potentially be present well into the operations period, so the duration and frequency of such a fire would be ***High***, although the duration of frequency of a small controllable fire would be ***Low***.

Reversibility of Effect

The effects on VECs and VSCs after a fire are generally ***Reversible*** since they will eventually diminish to restore existing conditions.

Ecological or Social Context

The area is determined to have ***High*** fragility with respect to effects of a forest fire.

Probability of Effect

The probability of a fire is ***Low*** given the mitigation proposed.

Overall Assessment

Given the low probability of effect, this is considered to be ***Not Significant***.

6.1.3 *Accidental Spills*

Spills could occur during construction as a result of one or more of the following events:

- discharge of sediment to aquatic environment
- release of petroleum hydrocarbons and/or other hazardous substances
- release of liquid concrete
- release of sewage.

6.1.3.1 *Potential Effects*

The potential environmental effects of accidental spills could potentially include:

- soil contamination
- groundwater contamination
- surface water contamination (including turbidity and suspended solids)
- adverse health effects or mortality of aquatic biota (fish and benthic invertebrates)
- adverse health effects on vegetation and wildlife
- adverse effects on socio-economic components including recreational water quality, angling and hunting success (if impacts on fish and wildlife populations occur). No surface water source in the Project area provides potable water with the exception of potable water at the Project's temporary construction camp, which will draw water from the Kabinakagami River and treat as necessary.

Activities during the construction phase that could potentially result in transport of these materials to the watercourse, with subsequent negative impacts on water quality, include:

- refuelling and maintenance (e.g., oiling, addition of hydraulic fluid) of equipment potentially resulting in, for example, accidental spills and improper disposal of waste fluids
- use of equipment containing fuels, lubricants or other materials within, or in the vicinity of the watercourse potentially resulting in, for example, leakage from machinery and washing of materials from surface of machinery
- storage of hazardous materials, including oils, gasoline and cement potentially resulting in, for example, accidental spills and, leaching and/or runoff of materials.

6.1.3.2 *Mitigation Measures*

Given the Erosion and Sediment Control Plan outlined in Section 5.4.1.1, and the spill mitigation measures outlined below, the potential for a spill of any type of material is considered to be low. The effects could vary depending on the severity of the spill but would tend to be local in extent, minor in magnitude, short-term in duration and generally mitigable through the implementation of emergency spill response procedures.

The Contractor is required to have an Emergency Spill Response Plan. Generally, in the event of a spill, it is anticipated that the following procedures would be implemented as part of that Plan:

- advise Environmental Representative, Northland Site Representative and MOE Spill Response Centre (as applicable) forthwith

- control/contain the spill
- clean up the spill immediately
- document actions taken.

The Plan will specify roles, responsibilities and appropriate procedures for chemical handling, spill response, reporting and cleanup, with reference to relevant legislative requirements. All site staff will be trained in proper implementation of the Plan.

There are a number of general mitigation/preventative practices to be followed by the Contractor during construction to minimize the potential for adverse environmental impacts associated with a spill resulting from the storage, use and disposal of fuels, lubricants and other hazardous materials. These include the following:

- Designated refuelling and maintenance areas will be established at least 30 m (if possible) from flowing watercourses and away from drainage ditches, channels or other wet areas. The refuelling of small equipment such as, compressors, generators and lighting will be undertaken on site (behind cofferdams) with a small service truck equipped with a spill kit.
- Designated hazardous material storage areas will be located at least 30 m away (if possible) from watercourses, for all hazardous materials to be stored outside. Storage areas should be above ground and enclosed by an impervious secondary containment structure (e.g., berm or container) capable of holding the entire volume of the stored material, as well as some additional volume of rainwater. The area should be equipped with a drain so that it can be cleared of any spilled material or accumulated rainwater, which would be disposed of in a suitable manner. Secondary containment areas should be monitored throughout the construction period to ensure their integrity.
- Where possible, storage of materials (e.g., small volumes) will occur in a covered area (e.g., Sea Cans). These will be located greater than 30 m from a watercourse.
- A barrier will be erected around the storage area to prevent accidental damage to containers (i.e., due to vehicular collisions).
- Only machinery/equipment that is clean and well maintained (e.g., no leaks) should operate in or near watercourses or drainage areas. No washing of equipment is to take place within or near watercourses.
- Provision of adequate spill clean-up materials/equipment (e.g., absorbents) on site. The Contractor must prepare a spill clean-up procedure/emergency contingency plan, prior to commencement of work at the site. All site staff should be trained in implementation of the procedure.

Monitoring will be conducted throughout the construction period to ensure that the Contractor is adhering to the terms and conditions of the ER and relevant permits and approvals and that mitigation measures are having the intended effects in preventing/minimizing the potential for spills and associated impacts.

6.1.3.3 *Net Effects and Significance of Net Negative Effects*

The net effects could vary depending on the location and magnitude of the spill, as well as the material spilled. Spills into water could have negative effects on surface water quality, aquatic habitat and biota, while spills on land could have negative effects on soil and groundwater quality, terrestrial habitat and biota.

Value of Resource

Since a number of VECs and VSCs could be negatively affected by a spill, the value is considered to be ***High***.

Magnitude of Effect

The magnitude of effect is dependent on the magnitude, location and nature of the spill. Assuming the worst case scenario of a large spill in water, the magnitude of effect on the environment would be ***High***. However, small controllable spills in the Project Area could have a ***Low*** effect.

Geographic Extent of Effect

The geographic extent is dependant on the magnitude and location of the spill. Large spills in water would likely have negative effects >500 m from the Project Area, , therefore the geographic extent would be ***High***, while small spills on land could be contained to the Project Area, given effective mitigation.

Duration and Frequency of Effect

The effects of a large magnitude spill occurring during construction could potentially be present into the operations period, so the duration and frequency of such a spill would be ***High***, although the duration of frequency of a small controllable spill would be ***Low***. However, in the event of a large spill, remediation would be implemented so it is not anticipated that effects would be present following completion of remediation efforts.

Reversibility of Effect

The effects on VECs and VSCs after a spill are generally ***Reversible*** over time since they will eventually diminish to restore existing conditions.

Ecological or Social Context

The area is determined to have ***High*** fragility with respect to effects of a spill.

Probability of Effect

The probability of a high magnitude spill is ***Low*** given the mitigation proposed. The probability of low magnitude spills is ***Moderate***.

Overall Assessment

Given the low probability of high magnitude effects associated with a large spill, or the low magnitude effects associated with a higher probability small spill, this is considered to be ***Not Significant***.

6.2 Operations Period

Potential occurrences of accidents and malfunctions during operations include dam failure, failure of the distribution system, accidental spills and accidental fires. All of these events are considered highly unlikely, particularly given the rigid design criteria applied to the development of the Project and the health, safety and emergency procedures to be implemented for operation of the facility.

Failure of one or more of the dams would an extremely unlikely event, but could result in a release of water downstream over a short period of time under a total failure scenario. Dam failure can theoretically happen at any time, but as part of a Dam Safety Assessment under the Ontario Dam Safety Guidelines, two scenarios are typically assessed, including high flow periods and low flow periods. The high flow period assessment results in the identification of HPC, which is then used to identify the Inflow Design Flood (IDF), which is the flood flow rate that the dam should be safety designed to pass. The selection of the IDF affects the design of the dam (e.g., spillway size) and footprint. A low flow assessment also results in the identification of a HPC for the low flow period. Low flow dam failures could potentially occur due to earthquakes, so the HPC for a low flow scenario guides the design of the dam with respect to earthquake resistance, but does not typically affect the footprint or overall design of the facilities. The potential for earthquakes of sufficient magnitude of have any effect on the dam structures in this area of Ontario is minimal.

6.2.1 Dam Failure – High Flow

The proposed dams were assessed under the Ontario Dam Safety Guidelines. An Incremental HPC was applied to each of the four facilities individually, and a dam break analysis was carried out to assess the potential for cascade failure in the event of a breach at the most upstream dam, Site 3 – Neeskah. The 1:100, 1:1000 and 1:10 000 flood events were simulated. Since the spillway at each site is designed to accommodate the 1:1000 event, none of the dams will be overtopped for events with a lesser annual exceedance probability. Additionally, it was determined, through hydraulic model simulation, that the 1:10 000 AEP flood would not overtop the dam at Site 3. A piping breach was therefore simulated at Neeskah and downstream dams were set to breach only if they were overtopped by the breach outflow from Site 3 – Neeskah. In addition to assessing the peak stage at each dam location, the hydraulic model was extended downstream so as to assess the affect of breach flood wave along the downstream reach. The furthest downstream cross section assessed in the model is located approximately 86 km downstream of Site 6 – Wapoose structure.

Based on the results of this study it was determined that the four facilities would be preliminarily classified as having a Moderate Incremental HPC. This assesses the potential for failure of the facilities to result in Loss of Life, Property Losses, Damage to the Environment and impacts on Cultural-Built Heritage features. The results and assessment of each are discussed in the following sections. The complete assessment will be included with the *Lakes and Rivers Improvement Act* application for the facilities. The HPC will have to be approved by MNR.

6.2.1.1 Potential for Loss of Life

The only downstream inhabited area was identified to be the camp at Mammamattawa, which is located just downstream of the confluence of the Kabinakagami River, Nagagami River and Kenogami River. It was determined that the incremental increases in water depth and flow velocity at the camp would not be sufficient to result in any Loss of Life.

Safety risks for any users on the water (e.g., recreational fisherman or boaters) would also be present in the event of a dam failure, if humans were present in the downstream reach. However, during a flood of the nature that would have the potential to cause a dam failure, human use of the river system would not likely be occurring. Therefore, this has not been considered to result in a potential for loss of life.

6.2.1.2 *Potential for Property Damage*

There is very little property along the river reach that would be significantly affected by incremental flooding, and of this, the property has no significant economic value. Thus, incremental damages would be well below the $300,000 limit for LOW HPC.

6.2.1.3 *Potential for Environmental Damage*

The main affects on the environment that can be attributed to a dam breach are incremental damages due to incremental flooding, incremental erosion of the river bed and banks, and deposition of materials from the breached dam.

In order for incremental flooding to cause damages of significance to the environment the amount flooding and the velocities must be quite high. For the 1-100-yr flood the incremental flooding was 0.09 m, and for the 1-1000-yr flood the incremental flooding was 0.59 m and the velocities in the flooded areas would be approximately 0.2 m/s. Neither of these scenarios would cause a significant increase in long term damages to the environment.

The river bed of the Kabinakagami River downstream from Site 6 – Wapoose is made up primarily of gravel, cobbles and bedrock sections. This type of river bed is very resistant to erosion and could only be disturbed by significant change in flow regime. In all dam breach scenarios the increase in flow is not likely to cause significant increases in erosion. Thus, incremental erosion damage to the river bed and banks caused by a dam breach of any of the dams are estimated to be insignificant.

It is difficult to assess what damages could occur due to deposition of materials from the dam. However, the materials used in the embankment dams will be smaller in size than the river bed materials. Thus, it is very likely that the embankment dam materials will be carried down river during spring freshet events. Thus, long-term damage is not expected to occur due to deposition of embankment dam materials. Concrete dams are not known to break into small enough parts to be transported downstream, thus the concrete could be easily removed from the river. However, given the significance of the downstream reach for providing critical fish habitat (spawning and benthic production/feeding areas) for important fish communities such as Lake Sturgeon, the dams were all rated as Moderate HPC for Environmental Losses for flood and sunny-day conditions.

6.2.1.4 *Cultural-Built Heritage Losses*

There is no known cultural or built heritage resources along the river reach that would be significantly affected by incremental flooding. Thus, incremental damages would be below the limit for a LOW HPC.

6.2.1.5 *Overall Hazard Potential Classification*

Based on these results, it was determined that the HPC for the proposed facilities was Moderate, resulting in an IDF of 1:100 years.

6.2.1.6 *Potential Effects of Dam Failure*

Should flows become higher than the IDF for the Project (a 1:100-yr flood), dam failure could result. However, the earth dam sections will be designed with adequate freeboard and the top of the earth dams will be at least 1.0 m higher than the IDF corresponding flood level. Additionally, the dam spillway has been designed to accommodate the 1:1000-yr storm event. The risk of a dam failure is very low and generally accepted in dam engineering practice.

Given the relatively small volume of the incremental amount of water retained in the head pond, the magnitude and duration of the dam break flood would be expected to be relatively minor. Effects could include mobilization of channel bed and bank sediments within the head pond and within the downstream area due to higher flow velocities associated with the increased flow being released from the head pond during failure. Such mobilization could result in temporarily impaired water quality and negative effects on aquatic habitat due to erosion as well as deposition within downstream reaches. Dam failure could also result in displacement of aquatic biota (e.g., fish and benthic invertebrates) which would result in temporary disturbance of these communities. Human safety risks would also be present in the event of a dam failure, if humans were present in the downstream reach. During a flood of the nature that would have the potential to cause a dam failure, human use of the river system would not likely be occurring.

A dam(s) failure of this sort would preclude full operation of the facility(ies) until the dam(s) could be replaced to reinstate the head pond(s) and fully submerge the intake. High flow events after a failure of this type would not pose any additional risk to the facilities, as it would be passed through the main river channel.

No maintenance activities are envisaged that will put the dam structures at risk.

6.2.1.7 *Mitigation Measures*

The mitigation to prevent or minimize the potential for a dam failure is to design the dams to appropriate safety standards in accordance with industry standard design practices.

6.2.1.8 *Net Effects and Significance of Net Negative Effects*

The net effects of a dam failure could vary depending on the magnitude of the failure. A dam failure could have negative effects on a number of VECs and VSCs.

Value of Resource

Since a number of VECs and VSCs could be negatively affected by a dam failure, the value of the resource potentially affected is considered to be ***High***.

Magnitude of Effect

The magnitude of effect is dependent on the magnitude of the dam failure. Assuming the worst case scenario of a large failure of all four facilities, the magnitude of effect on the environment would be ***High***.

Geographic Extent of Effect

The geographic extent of a dam failure is dependant on the magnitude of the failure. However, a failure would likely have negative effects > 500 m from the Project Area, therefore the geographic extent would be ***High***.

Duration and Frequency of Effect

The effects of a large magnitude dam failure could potentially persist for a long duration period so the duration and frequency of such a failure would be ***High***.

Reversibility of Effect

The effects on VECs and VSCs after a dam may be ***Reversible*** over time since they will eventually diminish to restore existing conditions.

Ecological or Social Context

The area is determined to have ***Moderate*** fragility with respect to effects of a dam failure.

Probability of Effect

The probability of a dam failure is ***Low*** given the proposed engineering design standards.

Overall Assessment

Given the low probability of a dam failure, this is considered to be ***Not Significant***.

6.2.2 *Dam Failure – Low Flow*

The hydraulic modeling to assess the low flow scenario will be completed as part of the *Lakes and Rivers Improvement Act* application for the facilities. For the purposes of the Class EA, the preliminary HPC has been estimated to assess the potential for negative effects on the environment as a result of a sunny day dam failure (low flow conditions). However, the preliminary HPC associated with sunny day failure will have to be approved by MNR.

The following sections identify the criteria used to assess the preliminary HPC for a sunny day dam failure and document the potential negative effects of such a failure. Based on the results of this study, it was determined that the four facilities would be preliminarily classified as having a High HPC for a sunny day failure. This assesses the potential for failure of the facilities to result in Loss of Life, Property Losses, Damage to the Environment and impacts on Cultural-Built Heritage features. The results and assessment of each are discussed in the following sections.

6.2.2.1 *Potential for Loss of Life*

The only downstream inhabited area was identified to be the camp at Mammamattawa, which is located just downstream of the confluence of the Kabinakagami River, Nagagami River and Kenogami River. Because the camp is located on high ground, it is expected that the water depth and flow velocity at the camp would not be sufficient to result in any Loss of Life.

Safety risks for any users on the water (e.g., recreational fisherman or boaters) would be present in the event of a sunny day dam failure because there is a probability that humans could be using the downstream reach for navigation or recreational purposes. The flood wave associated with a dam break during a sunny day conditions could potentially result in overturning of boats in the water, or sweeping away of humans along the shoreline area. Therefore, this has been considered to result in a potential for loss of life, or HIGH HPC.

6.2.2.2 *Potential for Property Damage*

There is very little property along the river reach that would be significantly affected by incremental flooding, and of this, the property has no significant economic value. Thus, incremental damages would be well below the $300,000 limit for LOW HPC.

6.2.2.3 *Potential for Environmental Damage*

The main affects on the environment that can be attributed to a dam breach are incremental damages due to the flood wave, erosion of the river bed and banks, and deposition of materials from the breached dam.

In order for the flood wave to cause damages of significance to the environment, the amount of water, water level and velocities must be quite high. A dam break under sunny day conditions would result in a flow rate that would be close to or in excess of normal or high flood flows on the Kabinakagami River, depending on the rate of discharge from the failed dam.

The river bed of the Kabinakagami River downstream from Site 6 – Wapoose is made up primarily of gravel, cobbles and bedrock sections. This type of river bed is very resistant to erosion and could only be disturbed by significant change in flow regime. Thus, incremental erosion damage to the river bed and banks caused by a dam breach of any of the dams are estimated to be insignificant.

It is difficult to assess what damages could occur due to deposition of materials from the dam. However, the materials used in the embankment dams will be smaller in size than the river bed materials. Thus, it is very likely that the embankment dam materials will be carried down river during spring freshet events. Thus, long-term damage is not expected to occur due to deposition of embankment dam materials. Concrete dams are not known to break into small enough parts to be transported downstream, thus the concrete could be easily removed from the river. However, given the significance of the downstream reach for providing critical fish habitat (spawning and benthic production/feeding areas) for important fish communities such as Lake Sturgeon, the dams were all rated as Moderate HPC for Environmental Losses for low flow conditions.

6.2.2.4 *Cultural-Built Heritage Losses*

There is no known cultural or built heritage resources along the river reach that would be significantly affected by incremental flooding. Thus, incremental damages would be below the limit for a LOW HPC.

6.2.2.5 *Overall Hazard Potential Classification*

Based on these results, it was determined that the HPC for the proposed facilities was High, given the potential for loss of life.

6.2.2.6 *Potential Effects of Dam Failure*

The dams will be designed to appropriate safety standards in accordance with industry standard design practices and subject to review and approval under the *Lake and Rivers Improvement Act*. Accordingly, the risk of a dam failure is very low and generally accepted in dam engineering practice.

Given the relatively small volume of the amount of water retained in the head ponds, the magnitude and duration of the dam break flood would be expected to be relatively minor. Effects could include mobilization of channel bed and bank sediments within the head pond and within the downstream area due to higher flow velocities associated with the increased flow being released from the head pond during failure. Such mobilization could result in temporarily impaired water quality and negative effects on aquatic habitat due to erosion as well as deposition within downstream reaches. Dam failure could also result in displacement of aquatic biota (e.g., fish and benthic invertebrates) which would result in temporary disturbance of these communities. Human safety risks would also be present in the event of a dam failure, if humans were present in the downstream reach. During sunny day conditions, it is probable that humans could be using the area downstream from the dam for navigational or recreational purposes. Therefore, there is potential that injury or loss of life could occur if humans were to get caught within the flood wave resulting from a dam failure.

No maintenance activities are envisaged that will put the dam structures at risk.

6.2.2.7 *Mitigation Measures*

The mitigation to prevent or minimize the potential for a dam failure is to design the dams to appropriate safety standards in accordance with industry standard design practices.

6.2.2.8 *Net Effects and Significance of Net Negative Effects*

The net effects of a dam failure could vary depending on the magnitude of the failure and the presence or absence of humans downstream from the structure. A dam failure could have negative effects on a number of VECs and VSCs.

Value of Resource

Since a number of VECs and VSCs, including human life could be negatively affected by a dam failure, the value of the resource potentially affected is considered to be ***High***.

Magnitude of Effect

The magnitude of effect is dependent on the magnitude of the dam failure. Assuming the worst case scenario of a large failure of all four facilities, the magnitude of effect on the environment would be ***High***.

Geographic Extent of Effect

The geographic extent of a dam failure is dependant on the magnitude of the failure. However, a failure would likely have negative effects >500 m from the Project Area, therefore the geographic extent would be ***High***.

Duration and Frequency of Effect

The effects of a large magnitude dam failure could potentially persist for a long duration period so the duration and frequency of such a failure would be ***High***.

Reversibility of Effect

The effects on VECs and VSCs after a dam may be ***Reversible*** over time since they will eventually diminish to restore existing conditions. However, if loss of life were to occur, this would be ***Non-Reversible***.

Ecological or Social Context

The area is determined to have ***Moderate*** fragility with respect to effects of a dam failure.

Probability of Effect

The probability of a dam failure is ***Low*** given the proposed engineering design standards.

Overall Assessment

Given the low probability of a dam failure, this is considered to be ***Not Significant***

6.2.3 Distribution Line/Power Failure

Failure of the distribution system would isolate the station from the grid, and require it to shut down until transmission line repairs were undertaken.

Should the station trip off, the turbines will immediately stop generating electricity although they will remain spinning and passing flow. The turbines are capable of passing up to 175% of their rated flow capacity. If this were to occur, it is anticipated that the turbines would pass all flow in the river until power is restored. Therefore, in this manner there would be no change in flow in the river due to a power outage. If a power outage were to occur when flows in the river are less than approximately 12 m^3/s, the intake gates will close to limit the amount of flow that is being passed by the turbine. The gates will close to a level such that a minimum flow of 5 m^3/s continues to flow downstream at all times. The remaining flow in the river will be used to fill the head pond to the level of the spillway crest, where spilling will commence. Once spilling occurs, the intake gate will be completely closed to stop all flow through the turbines and all flow will be spilling.

6.2.3.1 *Potential Effects*

If flow in the river is less than 12 m^3/s at the time of outage, there could be a short-term decrease in flow rate and water level downstream from the facilities. Given the small size of the head ponds, it is anticipated that the water level in the head pond would increase and spilling would commence in a relatively short duration of time, after which, natural water levels and flows would be restored. During this time period, there could be some decrease in water levels downstream from the facilities, which could result in mortality of benthic invertebrates and small fish if they are not able to mobilize out of the dewatered area, and alterations in habitat use. During such low flow periods, water levels in the Kabinakagami River will already be very low and fish will likely be using the deeper portions of the channel. Therefore, effects are anticipated to be relatively low.

If flows are >12 m^3/s, no change in river flow would occur due to the outage with all flow being passed through the turbines, therefore, no negative effects are anticipated to occur.

6.2.3.2 *Mitigation Measures*

Mitigation, in the event of an outage, is to continue passing all flow in the river through the turbines if flow is >12 m^3/s in the river. If flow is <12 m^3/s the facility cannot indefinitely pass this low amount, so a portion of the flow will be released downstream at all times, while the remainder is retained to fill the head pond to the level at which spilling commences, at which time, natural downstream river flows will be maintained.

6.2.3.3 Net Effects and Significance of Net Negative Effects

The net effects of a distribution line/power outage during low flow periods (< 12 m^3/s) would be a short-term reduction in flow rates downstream from the facility until the head pond is filled and spilling commences. There would be no net negative effects if a distribution line/power outage were to occur at higher flow rates, since all flow in the river will continue to be passed through the non-operating turbine.

Value of Resource

Surface water flows and levels and aquatic habitat and biota are highly valued by members of the CLFN and the general public since they support a valued fishery and other socio-economic uses of the Kabinakagami River (e.g., navigation),therefore, the value of the resource potentially affected is considered to be ***High***.

Magnitude of Effect

The magnitude of effect is considered to be ***Moderate***.

Geographic Extent of Effect

The geographic extent of reduced flows in the river would likely extend > 500 m from the Project Area, therefore the geographic extent would be ***High***.

Duration and Frequency of Effect

The effects of a power outage would be a short-term occurrence until the head pond fills to commence spilling so the duration and frequency of such an occurrence would be ***Low***.

Reversibility of Effect

The effects on water levels and flows would be ***Reversible*** since natural flow conditions would be restored once spilling commences or the power is restored to the plant.

Ecological or Social Context

The area is determined to have ***Moderate*** fragility with respect to decreased flow rates at low flow periods.

Probability of Effect

The probability of a power outage at some point in the life of the Project is ***High*** although the probability of an outage at flow rates less than 12 m^3/s is low.

Overall Assessment

Given the low probability of an outage at low flow periods, and the short duration time that the effect of reduced flows would occur, this is considered to be ***Not Significant***.

6.2.4 Accidental Fires

6.2.4.1 Potential Effects

Fires can occur during operation and maintenance activities when a flame is required, for example, when welding, or develops as a spark on mechanical equipment. Electrical fires could also occur within the powerhouses or at the switchyards or associated with the transmission lines. Fires could potentially result in loss of vegetation and wildlife, adverse effects on surface water quality due to ash-laden runoff and corresponding effects on aquatic biota. Large fires, although not anticipated to occur, could also present a human safety risk.

6.2.4.2 *Mitigation Measures*

The *Forest Fires Prevention Act* will apply to the operations of the proposed Project. Fire protection equipment will be installed in each of the powerhouses. An Emergency Response Plan will be developed to document the procedures to be followed at the facilities in response to a fire. The Plan will outline responsibilities and procedures to be followed by the observer, immediate supervisor, operator, and incident coordinator. The Plan will also identify personal protective equipment that should be worn when dealing with clean-up/ decontamination following fires.

The transmission line ROW will be maintained to minimize the potential for damage to the transmission line due to vegetation, which will also minimize the fire risk due to the transmission line.

6.2.4.3 *Net Effects and Significance of Net Negative Effects*

The effects could vary depending on the severity of the fire but, assuming the mitigation noted above is sufficient to minimize the size and spread of the fire, effects would tend to be local in extent, minor in magnitude and short-term in duration. However, a large scale fire could have negative effects on a number of VECs and VSCs.

Value of Resource

Since a number of VECs and VSCs could be negatively affected by a fire, the value is considered to be ***High***.

Magnitude of Effect

The magnitude of effect is dependent on the magnitude of the fire. Assuming the worst case scenario of a large forest fire, the magnitude of effect on the environment would be ***High***. However, small controllable fires in the Project Area could have a ***Low*** effect.

Geographic Extent of Effect

The geographic extent is dependent on the magnitude of the fire. Large fires would likely occur >500 m from the Project Area, therefore the geographic extent would be ***High***, while small fires could be contained to the Project Area, given effective mitigation.

Duration and Frequency of Effect

The effects of a large magnitude fire occurring during operations could potentially be present for a number of years, so the duration and frequency of such a fire would be ***High***, although the duration of frequency of a small controllable fire would be ***Low***.

Reversibility of Effect

The effects on VECs and VSCs after a fire are generally ***Reversible*** since they will eventually diminish to restore existing conditions.

Ecological or Social Context

The area is determined to have ***High*** fragility with respect to effects of a forest fire.

Probability of Effect

The probability of a fire is ***Low*** given the mitigation proposed.

Overall Assessment

Given the low probability of effect, this is considered to be ***Not Significant***.

6.2.5 Accidental Spills

6.2.5.1 Potential Effects

There are no operations and/or maintenance requirements anticipated that would result in a discharge of sediment into the aquatic environment, including sediment release from shoreline vegetation restoration. Monitoring of restored shoreline vegetation following construction, as identified in Section 11, will continue through operations and maintenance.

There are numerous activities during operations and maintenance that involve the use or transfer of petroleum hydrocarbons. These include, for example, use of fuels and other petroleum hydrocarbons by all vehicles, use removal and transfer of transformer oils and use of hydraulic fluids and cooling oils within the powerhouses and substation areas. Examples of potential spills include oil loss from failure of heat exchangers or runner hub seats.

Spills during operations could have similar adverse effects on the environment as those identified in Section 6.1.4 during construction.

6.2.5.2 Mitigation Measures

Mitigation measures to prevent accidental spills during operations include the following:

- Equipment should be refuelled or maintained at the maintenance facility, which is located a significant distance from the Kabinakagami River or any other watercourse.
- Hazardous materials should be stored within contained areas within the maintenance facility.
- Substation transformers should be enclosed by an impervious secondary containment structure (e.g., berm or container) capable of holding the entire volume of oil, as well as some additional volume of rainwater. The area should be equipped with a drain so that it can be cleared of any spilled material or accumulated rainwater, which would be disposed of in a suitable manner. Secondary containment areas should be monitored throughout the operational period to ensure their integrity.
- An oil-water separator should be installed in each powerhouse to contain oil in the event of an accidental spill within the powerhouse.
- Only machinery/equipment that is clean and well maintained (e.g., no leaks) should operate in or near watercourses or drainage areas. No washing of equipment is to take place within or near watercourses.
- Adequate spill clean-up materials/equipment (e.g., absorbents) on site need to be provided. Northland will have an Emergency Response Plan, which will include spill clean-up procedure/emergency contingency plan in place for the operational period. All site staff, including maintenance contractors, should be trained in implementation of the procedure.

Generally, in the event of a spill, the following procedures are to be followed:

- the operator/contractor must activate the Emergency Response Plan for spills
- control/contain the spill
- clean up the spill immediately
- advise Northland representative and MOE Spill Response Centre (as applicable) forthwith
- document actions taken.

For the most part, the occurrence of a spill is considered to have a low potential. The effects would be local in extent, minor in magnitude, short-term in duration and generally mitigable through the implementation of measures described above. The risk is considered minor.

Spills could also potentially occur due to accidental flooding of the powerhouse resulting from failure or human error of the water supply connections to the intake or within the powerhouse. In such an event, the powerhouse, including sump pumps would be shut down immediately. Water contained within the powerhouse, would be tested and then pumped out to an on-land location and treated as necessary (based on the results of testing) before being discharged away from the Kabinakagami River.

6.2.5.3 *Net Effects and Significance of Net Negative Effects*

The net effects could vary depending on the location and magnitude of the spill, as well as the material spilled. Spills into water could have negative effects on surface water quality, aquatic habitat and biota, while spills on land could have negative effects on soil and groundwater quality, terrestrial habitat and biota.

Value of Resource

Since a number of VECs and VSCs could be negatively affected by a spill, the value is considered to be ***High***.

Magnitude of Effect

The magnitude of effect is dependent on the magnitude, location and nature of the spill. Assuming the worst case scenario of a large spill in water, the magnitude of effect on the environment would be ***High***. However, small controllable spills in the Project Area could have a ***Low*** effect.

Geographic Extent of Effect

The geographic extent is dependent on the magnitude and location of the spill. Large spills in water would likely have negative effects >500 m from the Project Area, therefore the geographic extent would be ***High***, while small spills on land could be contained to the Project Area, given effective mitigation.

Duration and Frequency of Effect

The effects of a large magnitude spill could potentially be present for a number of years, so the duration and frequency of such a spill would be ***High***, although the duration of frequency of a small controllable spills would be ***Low***.

Reversibility of Effect

The effects on VECs and VSCs after a spill are generally ***Reversible*** over time since they will eventually diminish to restore existing conditions.

Ecological or Social Context

The area is determined to have ***High*** fragility with respect to effects of a spill.

Probability of Effect

The probability of a high magnitude spill is ***Low*** given the mitigation proposed. The probability of low magnitude spills during operations is also L***ow***.

Overall Assessment

Given the low probability of high magnitude effects associated with a large spill, or the low magnitude effects associated with a small spill, this is considered to be ***Not Significant***.