Western Copper Corporation

Project Proposal

Carmacks Copper Project
Yukon Territory

Appendix M

Qualitative Risk Assessment Worksheets

Failure Scenario A2

Area:	Mine – Waste Rock Storage Area (WRSA)
Phase:	Construction/Operation/Closure
System/activity:	Construction/Operation/Closure of waste rock storage facilities
Failure Mode:	Physical Embankment Failure; Sediment or metals release to local drainages

Hazard Assessment

- Hazard Description and Qualitative Assessment

    - Hazards are materials movement and sediment (possibly heavy metals from waste rock itself) from local soils or permafrost failure.
    - WRSA cleared to promote permafrost thaw and drainage ditches to capture runoff.
    - Sediment control pond located down gradient of WRSA.
    - Contingency berm located below WRSA if required.
    - Maintenance and monitoring during operations.
    - Erosion/control and revegetation of bare surface.
    - It is expected that at most up to 100,000 tonnes of material and 2,000 mg/L of sediment can be released. Metals (copper) from waste rock would be 0.05 to 1 mg/L (low). Based on Table 7-13 this results in medium hazard for material and/or sediment release.

Exposure Assessment

- Possible Failure Mechanisms

    - Physical material release due to: permafrost degradation causing slope instability and slope raveling, failure of contingency berm.
    - Sediment release, under normal design flood (design/ construction error) or under runoff event exceeding design flood, due to: materials movement down gradient to watercourse; inadequate sedimentation capacity design; unprotected areas – no sediment control facilities constructed (human error); failure of sediment structures.
    - Metals release, under normal design flood (design/ construction error) or under runoff event exceeding design flood, due to: materials (waste rock) movement down gradient to watercourse; inadequate sedimentation capacity design; unprotected areas – no sediment control facilities constructed (human error); failure of sediment structures.

- Possible Initiating Events

    - Natural events – climate change, permafrost degradation and thaw, high precipitation event, or snow melt.
    - Site specific events – stripped surface causing slope instability; contingency berm failure; bare surfaces with no erosion control or sediment collection.

- Design, construction or maintenance events – inadequate capacity; poor construction, sediment dam filling up.

- Potential For Release

  - WRSA stripped prior to use to reduce physical failure from permafrost degradation.
  - Control ditches and sediment control pond in place.
  - Contingency berm in place to provide stability to WRSA if needed.
  - Low metals levels in non-acid generating waste rock.
  - WRSA construction with periodic slope grading to ensure stability.
  - Monitoring during operations.
  - During the construction phase it is expected that the potential of release will be low, assuming that good construction control is practiced.

- Magnitude of Release

  - Low because of construction practices. Waste rock with low metals. Permafrost soils provide sediment load, however WRSA set back from any North Williams Creek watercourse. Monitoring during operations.

- Duration of Release

  - Very short to days depending on precipitation events, quality of construction supervision and facility inspection.

- Pathways

  - Overland flow to North Williams Creek.

- Ecosystems at Risk

  - Forested drainages in the WRSA area with overland flow to surrounding creeks, or if major event, to nearby river. North Williams Creek very small stream with limited ability to transport materials down gradient. WRSA set back with buffer from the creek.

- Exposure Description and Qualitative Assessment

  - WRSA set back from North Williams Creek. Stripping of WRSA and contingency berm in place to ensure that materials and metals movement would be limited and not released directly to the stream. Materials would have to flow overland to impact aquatic ecosystems. There is a very low probability of a materials, sediment or metals release due to a significant precipitation event occurring coupled with poor construction practices or operational practices. Therefore, due to low potential of release it is not expected that the concentration of sediment will exceed 1,000 mg/L or metals at 1.0 mg/L. According to Table 7-13 there will be a low exposure.

Consequence Assessment

- Consequence Description and Qualitative Assessment

    - Possible consequences include materials movement down gradient below WRSA.
    - Materials not expected to effect local watercourse.
    - Contingency berm available to control and stabilize WRSA failure.
    - Slight sedimentation of streambeds causing habitat degradation and slight (<5%) reduction in fish productivity, only in lower reaches of Williams Creek.
    - Metals release to North Williams Creek causing slight habitat degradation in upper reaches, with no fish. Slight effects to lower stream reaches.
    - Based on Table 7-14 the consequences are therefore very low.

Risk Characterization

- Risk Description and Qualitative Characterization

    - The medium hazard posed by the materials and sediments and a low metals hazard combined with a low exposure will lead to very low consequences to the aquatic ecosystem. The overall risk therefore is very low (Table 7-15).

Project Specific Considerations

- EMS in final design phasing of project construction to prevent unprotected soil surfaces, construction of sediment collection structures.

- Mitigation and contingency planning for contingency WRSA toe berm.

- Monitoring of WRSA dump slopes for slope stability. Grade slopes to ensure stability or construct contingency berm if required.

- Careful scheduling and supervision during construction operations to construct sediment collection structures first, strip WRSA materials, remove sediment if structures fill up quickly, stabilize erodible surfaces and slopes and revegetate.

- Recommendations: practice good construction scheduling and control to eliminate areas unprotected by sediment or runoff control.

- Geotechnical instruments on WRSA and monitoring to determine need to construct contingency berm.

- Monitoring quality and quality of effects, and climate. Routine inspections and maintenance of WRSA and sediment control pond.

Failure Scenario A5

Area:	Mine
Phase:	Construction/Operation
System/activity:	Construction/Operation of onsite facilities
Failure Mode:	Sediment release to local drainages

Hazard Assessment

- Hazard Description and Qualitative Assessment
    - Hazards are sediments and possibly heavy metals.
    - Only small surface areas will be exposed during construction, heap leach pad already cleared.
    - Maintenance and monitoring to take place during operations.
    - Erosion control and revegetation of bare surface.
    - Expected that at most 2,000 mg/L of sediment will be released; based on Table 7-13 this results in medium hazard for sediment release.

Exposure Assessment

- Possible Failure Mechanism
    - Sediment release, under normal design flood (design/construction error) or under runoff event exceeding design flood, due to:
        1. Inadequate sedimentation capacity design.
        2. Unprotected areas – no sediment control facilities constructed (human error).
        3. Failure of sediment structures.
- Possible Initiating Events
    - Natural events – high precipitation event or snow melt.
    - Site specific events – bare surfaces with no erosion control or sediment collection.
    - Design, construction or maintenance events – inadequate capacity; poor construction; sediment dam filling up.
- Potential For Release
    - During the construction phase it is expected that the potential for release will be low, assuming that good construction control is practiced.
    - Maintenance and monitoring to take place during operations.
    - Potential during operations considered low/moderate.
- Magnitude of Release
    - Low, because of appropriate construction practices and the ongoing maintenance and monitoring that will take place during operations.

- Duration of Release
    - Very short to days depending on: precipitation event, quality of construction supervision and facility inspection.
- Pathways
    - Overland flow to Williams Creek.
- Ecosystems at Risk
    - Forested drainages in the mine area to aquatic ecosystems overland flow to surrounding creeks, or if major event, to nearby river.
- Exposure Description and Qualitative Assessment
    - Construction will take place near watercourses with buffer zones and any release of sediment could be directly discharged to the streams and overland flow could have some impact on aquatic ecosystems.
    - There is a very low probability of a sediment release due to a significant precipitation event occurring coupled with poor construction or operational practices. Therefore, due to low potential of release it is not expected that the concentration of sediment will exceed 1,000 mg/L. According to Table 7-13 there will be a low exposure.

Consequence Assessment

- Consequence Description and Qualitative Assessment
    - Possible consequences include slight sedimentation of streambeds causing habitat degradation and slight (<5%) reduction in fish productivity (only in lower reaches of creek). Based on Table 7-14 the consequences are considered very low.

Risk Characterization

- Risk Description and Qualitative Characterization
    - The low hazard posed by the sediments combined with a low exposure will lead to very low consequences to the aquatic ecosystem. The overall risk therefore is very low (Table 7-15).

Project Specific Considerations

- EMS in final design phasing of project construction to prevent unprotected soil surfaces, and include construction of sediment collection structures.
- Mitigation and contingency planning. Careful scheduling and supervision during construction and operations: construct sediment collection structures

first, remove sediment if structures fill up quickly, stabilize erodible surfaces and slopes, and revegetate.

- Recommendations: practice good construction scheduling and control to eliminate areas unprotected by sediment or runoff control.

- Monitoring quality and quantity of effects, and climate. Routine inspections and maintenance.

- Progressive reclamation and revegetation of disturbed areas.

Failure Scenario B5

Area:	Heap Leach Pad/Events Ponds
Phase:	Operation
System/activity:	Operation of onsite facilities
Failure Mode:	Metals and low pH release to local drainage

Hazard Assessment

- Hazard Description and Qualitative Assessment
    - Hazards are heavy metals, particularly copper and low pH. Possibly sediments due to the concentration of metals and pH of raffinate solutions. According to Table 7-13, the hazard is high.

Exposure Assessment

- Possible Failure Mechanism
    - Release of metals and low pH contaminated waters from heap leach facility, events ponds, emergency spillways, water management structures, sediment ponds, or process plant or water treatment plant and finally to creek.
    - Sediment release due to component structural failure or failure of sediment structure.
    - Metals release, under normal design flood or snowmelt (design/construction error or equipment malfunction) or under runoff event exceeding design flood or snowmelt event, due to:
        1. Inadequate solution capacity design in heap leach pad, events pond, process plant or water treatment plant.
        2. Pumping and redundant system failure (mechanical or human error).
        3. Liner leakage or tear (mechanical or human error).
        4. LDRS failure and seepage to groundwater.
        5. Failure of heap or events ponds embankments, diversion ditches, sediment pond, or emergency overflow structures.
- Possible Initiating Events
    - Natural events – high precipitation event, snowmelt, or earthquake.
    - Site specific events – heap, events pond, or sediment pond over topping and flowing through emergency spillway; embankment failures; solution pumping system or power system failure; pipe breakage; water treatment plant failure; process plant failure.
    - Design, construction or maintenance events – inadequate design (heap/ponds/treatment plant, ditches); inadequate capacity (heap/ponds/treatment plant); process system failure (power, pumping); poor construction or maintenance; human error; or vandalism.

- Potential For Release
    - The relative risk of a release is very low to low due to the proposed design of heap and events ponds for high consequence category; double liners systems with LDRS; provision for extreme event capacity (rain and snow melt); provision for redundant systems (power, pumping, piping, equipment and parts); provision for contingency water treatment system; and on site personnel providing care and maintenance and routine monitoring.
    - The QA/QC program will ensure good construction control is practiced.

- Magnitude of Release
    - Small under normal operating conditions and rapid response with redundant and contingency systems.
    - Large if extreme precipitation or earthquake event, however, a large event means natural dilution. Excess system storage events pond capacity, as it is not expected that all systems will fail at once. Climate and solution monitoring to predict and plan for process upsets.

- Duration of Release
    - Very short to days depending on site or release and type of precipitation event and lack of facility inspection.

- Pathways
    - Overland flow to Williams Creek. Creek with low aquatic production and small size. No fisheries resources in upper drainage, however, lower Williams Creek and receiving Yukon River sensitive with important fish species (juvenile Chinook salmon). Small stream has limited ability to dilute or complex metals or buffer pH. Treatment plant produces high hardness, decreased metals, and reduced toxicity. Yukon River large river with dilution.

- Ecosystems at Risk
    - Upper Williams Creek small creek, supports limited aquatic resources, however, no fish. Lower creek drains to important Yukon River and important aquatic ecosystem and wildlife habitat area. Spawning and rearing in Yukon River. No rare or unique terrestrial ecosystems near mine site.

- Exposure Description and Qualitative Assessment
    - There is a very low probability of an extreme event occurring and all redundant and contingency systems failing at the same time.
    - Facility design incorporates provision for extreme events.
    - Extreme events typically provide dilution and attenuation capability in the stream.

- A very low release over a short duration of untreated solution could increase pH slightly (pH 2-4 units) and reduce metals levels (Cu 1-10 mg/L) in the stream. Treated effluents have very low hazard. Due to a low potential for release, based on Table 7-13, there will be a medium exposure of untreated solutions.

Consequence Assessment

- Consequence Description and Qualitative Assessment

  - Possible consequences include loss of aquatic productivity in the upper stream reach with potential for fish kills and longer-term aquatic ecosystem harm in the lower reaches. Based on Table 7-14 the consequences are therefore medium to high.

Risk Characterization

- Risk Description and Qualitative Characterization

  - The high hazard posed by the release of untreated solutions and the medium exposure will lead to medium to high consequences to the aquatic ecosystem, particularly if the Yukon River is affected. The overall risk therefore is considered high (Table 7-15) if preventative engineering, system designs, and redundancy and contingency measures are not considered. However, the likelihood of extreme events exceeding design storage capacity and occurring in combination with the loss of all operating and redundant systems and contingency water treatment plant is considered very low. The risk characterization considering the likelihood of events is then considered very low to low.

Project Specific Considerations

- Preventative engineering and design measures including:
  - stand-by emergency power generation;
  - redundant systems (pumping, piping, equipment and power);
  - double liner with leak detection and recovery system constructed with construction quality assurance and quality control program;
  - contingency water treatment plant;
  - events ponds, sized to handle a combination of extreme events conditions and capacity to contain 100% of draindown in the first year of operation and for all winter of operations throughout the mine life;
  - sediment control ponds; and
  - operation plans that ensure that the events pond is empty in the fall, climate monitoring and solution water balance and inventory control.

- Final designs with construction QA/QC to ensure liner integrity and embankment and ditch construction.

- Contingency water treatment plant available during operations to treat effluent to meet MMER water quality and toxicity standards.

- Recommendations: construction QA/QC and Operation plans and system, and qualified personnel on site at all times to implement redundant and treatment systems as necessary.

- Monitoring quality and quantity of effects, and climate. Monitor LDRS and routine inspections and maintenance.

Failure Scenario B7

Area:	Heap Leach Pad/Events Pond Water Treatment Plant
Phase:	Operation/Closure
System/activity:	Operation of water treatment plant facilities
Failure Mode:	Accident/Equipment failure - metals and low pH release to local drainage

Hazard Assessment

- Hazard Description and Qualitative Assessment
    - Hazards are heavy metals particularly copper, and low pH. Due to the concentration of metals and pH of raffinate solutions, the hazard is high according to Table 7-13.

Exposure Assessment

- Possible Failure Mechanism
    - Release of metals, and low pH contaminated waters from water treatment plant and finally to creek. Release under normal design flood or snowmelt (design/construction error, or equipment malfunction) or under runoff event exceeding design flood or snowmelt event due to:
        1. Inadequate solution capacity design in the water treatment plant.
        2. Pumping and redundant system failure (mechanical or human error).
        3. Power outage (mechanical or human error).
        4. Failure of sediment pond or emergency overflow structures.
- Possible Initiating Events
    - Natural events – high precipitation event, snowmelt, or earthquake.
    - Site specific events – heap, events pond or sediment pond over topping and plant exceeding capacity; solution pumping system or power system failure; pipe breakage in water treatment plant failure or process plant failure.
    - Design, construction or maintenance events – inadequate water treatment plant design; inadequate capacity (treatment plant); process system failure (power, pumping); poor construction or maintenance; human error; or vandalism.
- Potential for Release
    - The relative risk of a release is low due to proposed design of heap and events ponds for high consequence category, provision for extreme event capacity (rain and snow melt) in heap and events pond, provision for redundant systems (power, pumping, piping, equipment and parts), on site personnel providing care and maintenance and routine monitoring.
    - The QA/QC program will ensure good construction control is practiced.

- Magnitude of Release

    - Small under normal operating conditions and rapid response with routine monitoring, redundant and contingency system.
    - Large if extreme precipitation or earthquake event, however, a large event means natural dilution. Excess system storage capacity and pond capacity, as all systems are not expected to fail at once. Sediment pond located down gradient provides an opportunity to minimize non-compliance release. Climate and solution monitoring to predict and plan for process upsets. Routine monitoring and inspection of facility.

- Duration of Release

    - Very short to days depending on site conditions, or release and type of precipitation event and lack of facility inspection.

- Pathways

    - Discharge from water treatment plant to sediment control pond and then controlled flow to Upper Williams Creek. Creek with low aquatic production and small size. No fisheries resources in upper drainage however lower creek reach and receiving Yukon River sensitive with important fish species (juvenile Chinook salmon). Small stream has limited ability to dilute or complex metals or buffer pH. Treatment in sediment pond as contingency. Yukon River large river with dilution.

- Ecosystems at Risk

    - Upper Williams Creek is a small creek, supports limited aquatic resources, however no fish. Lower creek drains to Yukon River and important aquatic ecosystem and wildlife habitat area. Spawning and rearing in Yukon River. No rare or unique terrestrial ecosystems near mine site.

- Exposure Description and Qualitative Assessment

    - There is a very low probability of an extreme event occurring and all redundant and contingency systems failing at the same time.
    - Extreme events typically provide dilution and attenuation capability in the stream.
    - Moderate probability of pump or equipment failure, however short term event.
    - Sediment pond located down gradient provides an opportunity to minimize non-compliance release (in situ treatment).
    - A very low release over a short duration of untreated solution could decrease stream pH slightly (pH 2-4 units) and increase metals levels (Cu 1-10mg/L) in the stream. Treated effluents have very low hazard. Due to a low potential for release, based on Table 7-13, there will be a medium exposure of untreated solutions.

Consequence Assessment

- Consequence Description and Qualitative Assessment

    - Possible consequences include loss of aquatic productivity in the upper stream reach with potential for fish kills and longer-term aquatic ecosystem harm in the lower stream reaches. Based on Table 7-14 the consequences are therefore medium to high.

Risk Characterization

- Risk Description and Qualitative Characterization

    - The high hazard posed by the release of untreated solutions and the medium exposure will lead to medium to high consequences to the aquatic ecosystem, particularly if the Yukon River is affected. The overall risk is therefore considered high (Table 7-15) if preventative engineering, system designs and redundancy and contingency measures are not considered. However the likelihood of extreme events exceeding design storage capacity and occurring in combination with the loss of all operating and redundant systems is considered very low. Any release as a result of equipment failure or accident is expected to be short-term thereby minimizing downstream exposure and resultant effects. Sediment control pond provides opportunity for contingency water treatment. The risk characterization considering the likelihood of events is then considered to be low.

Project Specific Considerations

- Preventative engineering and design measures including:
    - stand-by emergency power generation;
    - redundant systems (pumping, piping, equipment and power);
    - events ponds sized to handle a combination of extreme events conditions and capacity to contain 100% of draindown in the first year of operation and for all winter operations throughout the mine life;
    - sediment control ponds that provides an opportunity for controlled treatment; and
    - operation plans that ensure that the events pond is empty in the fall, climate monitoring and solution water balance and inventory control.

- Final designs with construction QA/QC to ensure proper plant construction and operation.

- Contingency water treatment plant available during operations to treat effluent to meet MMER water quality and toxicity standards.

- Recommendations: construction QA/QC and Operation plans and system, and qualified personnel on site at all times to implement redundant and treatment systems as necessary.

- Monitoring plant operations and effluent quantity and quality of effects, and climate monitoring. Routine inspections and maintenance.

- Spill Contingency Plan for emergency sediment control pond water treatment.

Failure Scenario C1 and C2

Area:	Transportation, Storage and Handling Facilities
Phase:	Construction/Operation/Closure
System/activity:	Transport and handling of hazardous materials to or on site
Failure Mode:	Hazardous materials release to ground and/or local drainages

Hazard Assessment

- Hazard Description and Qualitative Assessment

    - Hazards are petroleum products, sulphur, sulphuric acid, and other processing reagents.
    - Hazardous materials may be released to ground in a localized area or directly or indirectly to watercourse depending on event location.
    - Trained personnel only transport large volumes of materials.
    - Spill response planning and equipment available.
    - Maintenance and monitoring of road and traffic conditions during operations.
    - Quantities typically limited to shipping quantities: 5,000 to 50,000 liters. Based on Table 7-13 this results in a medium hazard for petroleum product release.

Exposure Assessment

- Possible Failure Mechanism

    - Hazardous material release due to:

        1. Equipment or tank failure or breach.
        2. Accident(s) or human error.
        3. Single or multiple vehicle accident.

- Possible Initiating Events

    - Natural events – high precipitation event, weather conditions – poor road conditions.
    - Site specific events – wildlife crossing or collision;
    - Design, construction or maintenance events – inadequate road maintenance or poor construction; improper training.

- Potential for Release

    - During the construction and closure phase it is expected that the potential for release will be lower than operations with reduced traffic.
    - Likelihood of an accident is high.
    - Road maintained, personnel trained, emergency response and spill contingency plan in place.
    - Monitoring of hazardous materials traffic.

- Magnitude of Release
    - Low magnitude as a spill is confined to local ground area and sorption to soils.
    - Possible release to watercourse indirectly or directly, however, limited stream crossings and major crossings with bridges.
- Duration of Release
    - Very short to days depending on: response time and precipitation event, and material clean up. Trained personnel and spill response equipment readily available.
- Pathways
    - On local soils, through to groundwater; overland flow to watercourse.
- Ecosystems at Risk
    - Forested drainages along the transportation corridor and at the mine area to aquatic ecosystems, overland flow to surrounding creeks, or if a major event, to nearby river.
- Exposure Description and Qualitative Assessment
    - Transport and storage or handling of hazardous materials will take place along defined road corridors and on the mine property.
    - Release expected initially to ground and potentially to a nearby watercourse, and some impact to terrestrial or aquatic ecosystems.
    - There is a moderate probability of an accident and/or materials release due to human error or accident.
    - For a single incident, the magnitude of the largest loss into the receiving environment would be restricted to the capacity of the largest load, be it fuel, reagents or ammonium nitrate.
    - A spill of hazardous material could contaminate soil and/or surface and groundwater.
    - Contaminated soils can be removed and treated.
    - Receptors affected by a spill would generally be the aquatic biota.
    - Due to moderate potential of release it is not expected that all transport volumes of hazardous materials will be released and exceed 50,000 liters. According to Table 7-13 there will be a low to medium exposure.

Consequence Assessment

- Consequence Description and Qualitative Assessment
    - Possible consequences include localized contamination of soils with possible release to watercourse if sorption capacity of soil is exceeded and materials flow into a watercourse.

- Likelihood of materials in watercourse is low. Slight habitat degradation and slight (<5%) reduction in fish productivity due to smaller stream in area of the Freegold road, mine access and mine site.
- Based on Table 7-14 the consequences are very low to low, depending on the type of watercourse affected.

Risk Characterization

- Risk Description and Qualitative Characterization

  - The medium hazard posed by the petroleum and processing products combined with a low to medium exposure will lead to very low consequences if released to soils and a low consequence if released to the aquatic ecosystem. The overall risk therefore is low (Table 7-15).

Project Specific Considerations

- Materials storage and handling located in protected areas designed to minimize potential for product release. Secondary containment of product storage on mine site.

- EMS with requirements for personnel training and emergency response for trucking and handling hazardous materials.

- Emergency Response and Spill Contingency Plan and procedures in place with appropriate equipment.

- Monitoring of road conditions and maintenance, highway signage, and posting of any wildlife crossings to minimize accident potential.

- Traffic scheduling and monitoring to control materials transport and track materials movement and arrival.

- Recommendations: practice emergency and spill contingency procedures; ensure equipment in good condition and trucks with spill containment equipment.

- Monitoring climatic and road conditions and restrict traffic during poor road conditions. Routine inspections and road maintenance.