Inuvik to Tuktoyaktuk Highway: Fish and Fish Habitat Protection Plan

Final Draft

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Northwest Territories Transportation


Northwest
Territories Transportation

Executive Summary

This Fish and Fish Habitat Protection Plan (FFHPP) is one of three plans developed for the Inuvik to Tuktoyaktuk Highway (ITH) to protect fish and fish habitat. The FFHPP provides mitigation against activities such as accidental fuel spills, water withdrawal, and overpressures in waterbodies or watercourses related to the use of explosives. Measures include mitigation for the highway right-of-way, installation of watercourse crossing structures, highway maintenance, waste and fuel storage, accidental spills and conducting borrow pit operations.

The FFHPP should be used in combination with two other fisheries related plans; Sedimentation and Erosion Control Plan (SECP) and the Fisheries Management Plan (FMP). The SECP provides objectives and mitigation measures for erosion and sedimentation control during construction and operation of the ITH. The FMP provides management strategies and guidelines to prevent adverse effects on fish populations due to increased fishing pressure which may occur as a result of the ITH. These three fisheries related plans are a subset of the Environmental Management Plan, which contains a set of plans developed for the safe construction and operation of the ITH and will be used in conjunction with one or more of these other plans (e.g., Pit Development Plans). The FFHPP will be complementary to terms and conditions contained in all relevant permits and Authorizations.

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Appendices

Abbreviations

AANDC	Aboriginal Affairs and Northern Development Canada
AEMP	Aquatic Effects Monitoring Plan
BMP	Best Management Practice
DFO	Fisheries and Oceans Canada
FFHPP	Fish and Fish Habitat Protection Plan
EIRB	Environmental Impact Review Board
ILA	Inuvialuit Land Administration
ITH	Inuvik to Tuktoyaktuk Highway
kPa	kilopascal
NWT	Northwest Territories
SECP	Sedimentation and Erosion Control Plan

1 INTRODUCTION

1.1 Purpose

This Fish and Fish Habitat Protection Plan (FFHPP) was one of the conditions set forth by the Environmental Impact Review Board (EIRB) Panel and accepted by the Federal Government. The FFHPP was also a commitment of the Developer. The plan describes the objectives and mitigation measures to be used in the construction and operation of the Inuvik to Tuktoyaktuk Highway (ITH), including watercourse crossings right-of way construction, borrow pit operations, camps and routine maintenance not related to erosion and sedimentation control. The FFHPP is one of three fisheries related plans which also include the Sedimentation and Erosion Control Plan (SECP), and Fisheries Management Plan (FMP). These plans are a subset of the Environmental management Plan , which consists of a number of inter-related plans developed for the construction and operation of the ITH and will be used in conjunction with one or more of these plans (e.g., Pit Development Plans). The plan will be complementary to terms and conditions contained in all relevant permits and Authorizations.

1.2 Relevant Guidance

The FFHPP was prepared in accordance with guidance provided in the following best management practices (BMP) publications:

- Fisheries and Oceans Canada. 1993. *Land Development Guidelines for the Protection of Aquatic Habitat*
- Fisheries and Oceans Canada. 1995. *Freshwater Intake End-of-Pipe Fish Screen Guideline*
- Fisheries and Oceans Canada. 1998. *Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters*
- Fisheries and Oceans Canada. 2007. *Northwest Territories Operational Statement: Fish Timing Windows*
- Fisheries and Oceans Canada. 2007. *Operational Statement for Culvert Maintenance*
- Fisheries and Oceans Canada. 2007. *Operational Statement for Clear-span Bridges*
- Fisheries and Oceans Canada. 2007. *Operational Statement for Ice Bridges and Snow Fills*
- Fisheries and Oceans Canada. 2007. *Operational Statement for Temporary Stream Crossing*
- Fisheries and Oceans Canada. 2007. *Operational Statement for Bridge Maintenance*
- Fisheries and Oceans Canada 2010. P*rotocol for Winter Water Withdrawal in the Northwest Territories and Nunavut*;
- Fisheries and Oceans Canada. 2011. *Fish Screen Design Criteria for Flood and Water Truck Pumps*

- Indian and Northern Affairs Canada. 2003a. *Northern Land Use Guidelines Vol. 5: Access Roads and Trails*
- Indian and Northern Affairs Canada. 2003b. *Northern Land Use Guidelines Vol. 6: Camps and Support Facilities*
- Indian and Northern Affairs Canada. 2003c. *Northern Land Use Guidelines Vol. 7: Pits and Quarries*

1.3 Regulatory Approvals

The ITH is located wholly within the Inuvialuit Settlement Region, with the route crossing Inuvialuit 7(1) (a), 7(1) (b) and federal crown lands. The ITH was reviewed by the Environmental Impact Review Board (EIRB) Panel and recommended approval by the federal government. The recommendation included a number of conditions of which the development and implementation of a FFHPP was one of these conditions. The federal government accepted the EIRB Panel recommendation and the requirement for a FFHPP. The FFHPP supports applications for permits, licences, and Authorizations from the Northwest Territories Water Board, Inuvialuit Land Administration (ILA), Aboriginal Affairs and Northern Development Canada (AANDC), and Fisheries and Oceans Canada (DFO).

1.4 Timing of Construction

To avoid rutting and erosion in permafrost terrain, overland travel is not permitted during summer months and new highway construction should only take place during late fall or winter when the active layer is well frozen (Indian and Northern Affairs Canada 2003a). Therefore, construction of the highway and installation of the watercourse crossing structures and operation of the borrow sources will occur during winter. Additional construction and installation activities may be required at crossings structures and embankments during non-winter months; however, access will be on sections previously constructed along ITH right-of-way. All in-stream construction activities will fall within the allowable time frame between July 15 and September 15 as identified in the DFO Fish Timing Windows for the NWT.

1.5 Contractor Education

The FFHPP will be reviewed with the Contractor that will be completing the work. The purpose of this review is to ensure the Contractor understands the intent of the FFHPP, to gain buy-in for the plan, to obtain feedback on possible improvements, and to ensure the Contractor understands how to implement the plan. The contractor will be responsible for educating highway construction crews on the content of the plan and its importance to be implemented correctly.

2 WATERCOURSE CROSSINGS AND RIGHT OF WAY

2.1 Description

The ITH alignment will be a 2 lane granular highway, approximately 130 km in length and crossing 66 watercourses (Appendix A). The watercourses vary in size from ephemeral drainages, with only seasonal flow, to large permanent watercourses, which may flow year-round. Proposed crossing structures include large sized culverts, bridge sized culverts, and bridges. Table 2-1 provides fish and fish habitat information for each of the watercourses.

2.2 Riparian Areas

Vegetated areas immediately adjacent to a watercourse are referred to as riparian areas. These areas are valuable in maintaining fish habitat and stabilizing stream banks. Riparian areas can provide cover to fish, be a source of nutrients to the aquatic environment and moderate water temperatures. The following applies to all watercourse crossings; regardless of type or classification of the watercourse. Additional information can be obtained in Appendix B (Riparian Zone Preservation BMP 6).

- Riparian areas will be maintained. When practical, riparian vegetation at water crossings will be altered by hand. If machinery must be used, machinery will be operated on land and in a manner that minimizes disturbance to the banks of the water body.
- Removal of vegetation will be limited to the width of the right-of-way.
- When altering a tree or shrub that is located on the bank of a watercourse it will not be cut < 10 cm from the ground to allow the root structure soil stability to be maintained.
- Banks will be restored to original condition if any disturbance occurs.
- Grading of the stream banks for the approaches will not occur.
- If the stream bed and banks are steep or highly erodible (e.g., dominated by organic materials and silts), erosion and degradation are likely to occur as a result of equipment fording, then a temporary crossing structure or other practice (e.g., snow fill) will be used to protect these areas.
- Waste materials created by construction will be stabilized and removed from the work site to prevent them from entering the watercourse and potentially causing blockages to fish or the input of deleterious substances.
- A vegetated buffer strip will be maintained between the work site and water course, except at the actual crossing location.

Table 2-1 Fish presence and fish habitat use for ITH watercourses

Cross ID	Type	Hydro name	Class	Latitude	Longitude	Fish	Potential Fish	Habitat Potential
1	Bridge Sized Culvert	Unknown	Ephemeral	68.43240	-133.76495	No	No	None
2	Culvert	Unknown	Ephemeral	68.43524	-133.76445	No	No	None
3	Bridge	Unknown	Perennial	68.43967	-133.76501	No	Yes	Possible migration and rearing
4	Bridge Sized Culvert	Unknown	Perennial	68.44742	-133.76297	No	Yes	Possible migration and rearing
5	Culvert	Unknown	Perennial	68.45476	-133.76111	No	Yes	Possible migration and rearing
5a	Bridge Sized Culvert	Unknown	Ephemeral	68.45585	-133.76091	No	Low to Nil	Possible migration during high water periods
6	Culvert	Unknown	Ephemeral	68.47205	-133.75755	No	No	None
7	Culvert	Unknown	Perennial	68.47906	-133.76665	No	No	None
8	Bridge	Unknown	Ephemeral	68.48754	-133.76419	No	Yes	Possible migration during high water periods
9	Bridge Sized Culvert	Unknown	Ephemeral	68.49227	-133.76506	No	No	None
10	Culvert	Unknown	Ephemeral	68.49824	-133.76690	No	Low to Nil	Possible migration during high water periods
11	Bridge Sized Culvert	Unknown	Ephemeral	68.50145	-133.76553	No	No	None
12	Bridge Sized Culvert	Unknown	Perennial	68.51603	-133.77064	No	Yes	Provision of limited migratory and spawning habitat due to obstructions and high fines; good rearing habitat.
12a	Culvert	Unknown	Ephemeral	68.52499	-133.76516	No	Low to Nil	Possible migration during high water periods
12b	Culvert	Unknown	Ephemeral	68.53417	-133.76586	No	Low to Nil	Possible migration during high water periods
13	Culvert	Unknown	Ephemeral	68.53456	-133.76567	No	No	None
13a	Bridge Sized	Unknown	Perennial	68.56660	-133.74203	Stickleback	Yes	excellent migratory, rearing

Table 2-1 Fish presence and fish habitat use for ITH watercourses

Cross ID	Type	Hydro name	Class	Latitude	Longitude	Fish	Potential Fish	Habitat Potential
	Culvert							and spawning habitat.
14	Culvert	Unknown	Ephemeral	68.58045	-133.72064	No	Yes	Provision of limited migratory and rearing habitat.
15	Bridge Sized Culvert	Unknown	Ephemeral	68.60409	-133.69275	No	No	None
16	Culvert	Unknown	Ephemeral	68.61275	-133.69151	No	Low	Limited migratory habitat
17	Culvert	Unknown	Ephemeral	68.61573	-133.68772	No	No	None
17a	Bridge Sized Culvert	Unknown	Ephemeral	68.62363	-133.67210	No	Unknown	Unknown
18	Bridge	Unknown	Perennial	68.63238	-133.65187	No	Yes	Provision of good migratory, spawning and rearing habitat.
18a	Culvert	Unknown	Ephemeral	68.63398	-133.64099	No	Unknown	Unknown
19	Culvert	Unknown	Ephemeral	68.63461	-133.63629	No	No	None
20	Culvert	Unknown	Intermittent	68.63590	-133.61950	No	No	None
20a	Bridge Sized Culvert	Unknown	Ephemeral	68.63751	-133.61409	No	Unknown	Unknown
21	Bridge Sized Culvert	Unknown	Ephemeral	68.63914	-133.60601	No	Low to Nil	Unknown
21a	Culvert	Unknown	Ephemeral	68.65099	-133.58031	No	No	None
22a	Bridge Sized Culvert	Unknown	Perennial	68.66954	-133.56572	No	Low to Nil	Nil to low for all species
22b	Culvert	Unknown	Ephemeral	68.70950	-133.54851	No	Unknown	Unknown
23a	Bridge	Trail Valley Creek	Perennial	68.74064	-133.53617	No	Yes	Moderate for small bodied forage fish species -spawning, rearing and feeding and low for overwintering. Moderate for large bodied fish species (NRPK) -spawning, rearing, feeding and low spawning,

Table 2-1 Fish presence and fish habitat use for ITH watercourses

Cross ID	Type	Hydro name	Class	Latitude	Longitude	Fish	Potential Fish	Habitat Potential
								rearing and feeding for Arctic Grayling and nil to low for overwintering (NRPK, ARGR).
24a	Bridge Sized Culvert	Unknown	Perennial	68.75895	-133.54292	No	Low to Nil	Unknown
24b	Culvert	Unknown	Ephemeral	68.76142	-133.54076	No	No	None
25	Culvert	Unknown	Perennial	68.76756	-133.53755	No	Low to Nil	Unknown
26	Culvert	Unknown	Ephemeral	68.77976	-133.54688	No	No	None
27a	Culvert	Unknown	Intermittent	68.79393	-133.53578	No	No	None
27b	Culvert	Unknown	Ephemeral	68.80473	-133.53904	No	No	None
27b2	Culvert	Unknown	Ephemeral	68.81230	-133.54713	No	Unknown	Unknown
27c	Culvert	Unknown	Ephemeral	68.81958	-133.55849	No	Unknown	Unknown
28a	Culvert	Unknown	Perennial	68.84738	-133.54957	No	Yes	Low to moderate for small bodied forage fish species - spawning, rearing and feeding and nil to low for overwintering. Nil to low for large bodied fish species (Northern Pike, Arctic Grayling) -spawning, rearing, feeding and nil to low overwintering
29a	Bridge Sized Culvert	Unknown	Perennial	68.86286	-133.55329	No	No	None
30a	Bridge	Hans Creek	Perennial	68.86828	-133.54011	Whitefish sp., LSCS, ARGR, NRPK, LNSK,	Yes	High for small bodied forage fish species -spawning, rearing and feeding and nil to low for overwintering. Moderate to high for large bodied fish species (NRPK, ARGR) - spawning, rearing, feeding and nil to low for overwintering

Table 2-1 Fish presence and fish habitat use for ITH watercourses

Cross ID	Type	Hydro name	Class	Latitude	Longitude	Fish	Potential Fish	Habitat Potential
31	Bridge	Zed Creek	Perennial	68.94095	-133.41883	LKWF, ARGR, LKTR, forage	Yes	High for small bodied forage fish species -spawning, rearing and feeding and nil to low for overwintering. Moderate to High for large bodied fish species (NRPK, ARGR) - spawning, rearing, feeding and nil to low overwintering.
33a	Bridge Sized Culvert	Unknown	Intermittent	69.01228	-133.31336	No	No	None
33b	Culvert	Unknown	Intermittent	69.01225	-133.30728	No	No	None
34a	Culvert	Unknown	Ephemeral	69.02250	-133.25799	No	No	None
34a2	Culvert	Unknown	Ephemeral	69.04232	-133.20849	No	Unknown	Unknown
34b	Culvert	Unknown	Intermittent	69.04548	-133.19062	No	No	None
34c	Culvert	Unknown	Ephemeral	69.05742	-133.16046	No	Unknown	Unknown
34e	Culvert	Unknown	Intermittent	69.06618	-133.15006	No	No	None
35a	Bridge	Unknown	Perennial	69.07716	-133.10291	LKWF, ARGR, NRPK, STBK	Yes	High for small bodied forage fish species -spawning, rearing and feeding and nil to low for overwintering. High for large bodied fish species (NRPK, ARGR and Coregonids) - spawning, rearing, feeding and rearing and feeding for Burbot. Nil to low for overwintering
A13	Culvert	Unknown	Intermittent	69.08156	-133.09338	No	No	None
A12	Bridge Sized Culvert	Unknown	Perennial	69.10832	-133.08151	No	Yes	High for small bodied forage fish species -spawning, rearing and feeding and nil to low for overwintering. Low to moderate for large bodied fish

Table 2-1 Fish presence and fish habitat use for ITH watercourses

Cross ID	Type	Hydro name	Class	Latitude	Longitude	Fish	Potential Fish	Habitat Potential
								species for rearing, feeding and spawning (NRPK, BRBT). Nil to low for ARGR and Coregonid spawning and rearing. Nil to low for overwintering (large bodied fish species).
A11	Culvert	Unknown	Ephemeral	69.11134	-133.08012	No	No	None
A10	Culvert	Unknown	Intermittent	69.11619	-133.07513	No	No	None
A9	Culvert	Unknown	Perennial	69.12656	-133.04379	NRPK at entrance to watercourse maybe lake resident	Yes	Unknown
A8	Culvert	Unknown	Intermittent	69.14220	-133.03815	No	No	None
A3	Bridge	Unknown	Perennial	69.16820	-133.03671	Unknown	Yes	Possible migration and rearing
A2	Culvert	Unknown	Intermittent	69.18557	-133.00775	Unknown	Yes	Possible migration and rearing
A2a	Culvert	Unknown	Ephemeral	69.19962	-132.92631	Unknown	Unknown	Unknown
39a	Culvert	Unknown	Perennial	69.22026	-132.89179	ARGR	Yes	Excellent riffle-run migratory, spawning and rearing habitat for Arctic grayling.
39b	Culvert	Unknown	Ephemeral	69.24434	-132.90453	No	No	None
39c	Culvert	Unknown	Ephemeral	69.25046	-132.90083	No	No	None
39d	Culvert	Unknown	Ephemeral	69.26452	-132.91630	Unknown	Unknown	Unknown

Table 2-1 Fish presence and fish habitat use for ITH watercourses

Cross ID	Type	Hydro name	Class	Latitude	Longitude	Fish	Potential Fish	Habitat Potential
NOTES: Fish Code ARGR – Arctic grayling LKTR – Lake trout LKWF – Lake whitefish LNSK – Longnose sucker LSCS – Least cisco NRPK – Northern pike STBK – Ninespine stickleback								

2.3 Watercourse Crossing General Mitigation Measures

The following sections and mitigation applies to all watercourse crossings. Additional information can be obtained in Appendix C (Best Management Practices: Construction Practices, M1) and Appendix D (Northern Land Use Guidelines: Roads and Trails). Mitigation for sedimentation and erosion control is located in the SECP.

- Construction activities will be planned to minimize in-stream work.
- Disturbance of the natural banks will be kept to a minimum.
- In-stream work will be planned to occur as a single event at any one location.
- In-stream work will be restricted to low or no flow periods and abide by the DFO fish timing windows for the NWT.
- In-stream activities will be minimized as they may, restrict stream flow or divert the natural stream course.
- Dried or wet concrete and other deleterious materials will be prevented from entering the creek during construction;
- Formworks will be removed from the site after their removal from the abutments and retaining walls to prevent debris from entering the watercourse and causing blockages or alterations in stream flow and fish movements.
- Design of the bridge will prevent runoff from the bridge deck and side slopes and approaches will be directed to a vegetated area to prevent deleterious substances from entering the watercourse.
- Culvert size will be designed to allow passage of upstream movement of spawning sized fish (e.g., northern pike) with no more than a three day delay during a 1:10 year flow event.
- The culvert will be aligned parallel to the existing natural channel and located on a straight stream section.
- The culvert will be matched to meet normal flow velocities for all seasons.
- The channels from the equalization culverts will be sloped in such a manner to prevent fish stranding during high flow events.

2.4 Snow Fill/Ice Bridges

Snow fills involve compacting snow in the stream bed to create a road surface and are generally used for lighter types of traffic use. Ice bridges usually occur over larger watercourses and can be built-up to take heavy loads. Both types of temporary winter crossing methods may be used during the construction phase of the highway. The construction and use of snow fills and ice bridges will follow DFO's (2007) Operational Statement for Ice Bridges and Snow Fills (Appendix E).

- Ice bridges or snow fills must not obstruct the flow of water in a stream by causing it to freeze to the bottom.

- Prior to spring break-up, breach the ice bridge using physical means or create a v-notch in the middle of the ice bridge to allow it to melt from the center.
- Snow fills will not restrict water flow at any time.
- If water is being pumped from a lake or river to build up and maintain the ice bridge see Section 5, “Water Sources and Withdrawal” for mitigation.

3 EQUIPMENT MAINTENANCE, FUEL STORAGE, AND REFUELING

The construction and maintenance of the ITH requires the use of various forms of equipment from graders and trucks to water pumps and generators. The storage and use of fuels, hydraulic fluids and lubricants without proper mitigation could lead to the deposition of deleterious substances into watercourses or waterbodies. The following mitigation is designed to prevent these deleterious substances from entering aquatic systems.

- Fuels, lubricants and hydraulic fluids for equipment used will be carefully handled to avoid spillage, properly secured against unauthorized access or vandalism, provided with spill containment and disposed of in accordance with the Waste Management Plan.
- Fuel caches will be located on flat stable terrain or in natural depressions away from slopes to waterbodies.
- Fuel caches will be clearly marked and drums will be placed on their sides and spaced to allow for inspection.
- All fuel storage containers will have integrated 110% secondary containment
- Refuelling and servicing of machinery and storage of fuel and other materials for the machinery will occur, a minimum of 100 m away from any waterbody. Equipment used in or near water will be clean and free of oil, grease or other deleterious substances.
- All equipment will be inspected regularly to ensure it is free of leaks.
- Hydraulic fluids for machinery used for in-stream work will be biodegradable in case of accidental loss of fluid.
- Drip pans and drip trays will be placed under all equipment while not in use.
- The Spill Response Procedure and Spill Contingency Plan will be implemented if a spill occurs. Crews on site will be familiar with the Spill Contingency Plan; and any spillage of fuels, lubricants or hydraulic oils will be immediately contained and the contaminated material removed from the site and properly disposed of in an approved disposal facility.
- Any spills will be reported immediately to the **Northwest Territories Spill Line TEL: 867-920-8130**.

3.1 Waste Storage and Transportation

No waste is planned to be deposited into the environment.

- All camp waste will be handled, stored and disposed of in accordance with the Waste Management Plan.

- Wastes that are temporarily stored on site will be kept in secure containers at least 100 m from any waterbody.
- Waste oils and hydraulic fluids should be collected in leak-proof containers and removed from the site for proper disposal or recycling.
- All unused fuel and empty fuel and hazardous material containers will be removed from the camps and properly disposed of at approved facilities.
- Wastes will be back hauled by qualified personnel.

4 WATER SOURCES AND WITHDRAWAL

Water will be required for winter road construction, use in camps and for dust suppression. A majority of the water use is during the construction phase of the ITH and will only be taken from lakes. Lake systems used for water withdrawal during construction would be used for only one to two years as different lakes are utilized for water withdrawal as road construction progresses. Water use during the operation of the highway will primarily be for dust suppression. All water use activities will be regulated through a water licence.

- Waterbodies to be used for winter water withdrawal will be identified by following DFO's P*rotocol for Winter Water Withdrawal in the Northwest Territories* (Appendix F) and these waterbodies will be pre-approved by DFO before used.
- In one ice-covered season, total water withdrawal from a single waterbody is not to exceed 10% of the available water volume calculated using the maximum expected ice thickness of 1.5 m for below the tree line and 2.0 m for above the tree line.
- In cases where there are multiple users withdrawing water from a single waterbody, the total combined withdrawal volume is not to exceed 10% of the available water volume calculated using the appropriate maximum expected ice thickness as provided above.
- Only waterbodies with maximum depths that are ≥1.5 m than their corresponding maximum expected ice thickness will be considered for water withdrawal. Waterbodies with less than 1.5 m of free water beneath the maximum ice are particularly vulnerable to the effects of water withdrawal.
- Fish screens will be designed using the DFO (2011) Fish Screen Design Criteria for Flood and Water Truck Pumps (Appendix G).
- The screen should be keep clean and free of ice and debris.
- The screen should also be inspected for any damage prior to each withdrawal.
- If there is any evidence of fish impingement or entrainment the operator should immediately stop the pumping operation and relocate to a different water source.
- A second screen should be kept on hand as a backup that could be used if the primary screen is frozen due to icing or is damaged during operations.
- The withdrawal of any watercourse will not exceed 5% of the instantaneous flow, in order to maintain existing fish habitat.

5 BORROW SOURCES

Borrow sources have been identified for use during the construction and maintenance of the ITH. Specific pit development and management plans have been developed for each borrow source to mitigate potential environmental effects and support applications for permits from ILA and AANDC. The pit development and management plans describe the aspects of managing the borrow sources from the start of operations to final reclamation. The SECP provides mitigation on sedimentation and erosion control for the borrow sources. This section of the FFHPP provides mitigation for fish and fish habitat related potential effects from the:

- Use of explosives
- Melt water and run-off during spring and summer
- Site remediation and closure
- Temporary winter access roads

5.1 General Mitigation

Additional information can be obtained in Appendix B (Best Management Practices: Construction Practices, M1) and Appendix H (Northern Land Use Guidelines: Pits and Quarries).

- Borrow sites will primarily be operated during winter.
- Access trails and winter roads to borrow sources will only be constructed in winter
- All the material that was brought on-site, including structures, equipment, and all camp waste will be removed during borrow pit reclamation.
- At sites where the topography has been modified, the natural contours will be re-constructed to restore natural drainage patterns and re-vegetated upon closure.
- See Section 2.2 “Riparian Areas” of this plan for any work in or near riparian areas.

5.2 Permafrost

- Permafrost disturbance will be reduced by restricting pit operations to the winter months.
- At least 2 m of overburden or other suitable material will be placed on exposed ice surfaces to provide insulation.
- Positive drainage will be established and maintained to prevent the formation of an end-pit lake.

5.3 Explosives

- No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 50 kPa.
- After loading a charge in a hole, the hole is to be back-filled (stemmed) with sand or gravel to the level of the substrate/water interface or the hole collapsed to confine the force of the explosion to the formation being fractured.
- All “shock-tubes" and detonation wires are to be recovered and removed after each blast (when possible.
- The use of ammonium nitrate-fuel oil mixtures will not occur in or near water due to the potential production of toxic by-products (e.g., ammonia).

5.4 Winter Access Roads

Temporary winter roads and access trails will be required to access the borrow sources during construction and maintenance of the ITH. These winter roads will only be operational when the ground is sufficiently frozen and there is an adequate layer of snow to prevent damage to the ground by vehicles. Additional information can be obtained in Appendix C (Northern Land Use Guidelines: Roads and Trials). Snow fills or ice bridges constructed on access roads will follow the mitigation in Section 2.4 of this plan.

6 CAMPS

Temporary camps will be used to house workers during the construction of the ITH. Mitigation for sedimentation and erosion control related to camps is provided within the SECP.

- Sewage waste and greywater will be stored on-site before being transported to an approved disposal facility.
- All the material that was brought on-site, including structures, equipment, and all camp waste will be removed at camp closure.
- Camps during the winter period will be located on ice pads. Summer camps will be located on the constructed embankment. Construction of water and erosion control structures to prevent erosion will be completed if required (refer to the SECP).

7 HIGHWAY MAINTENANCE

Operating conditions for road use will be established to protect the integrity of the road and the safety of the users. To that end, regular maintenance will be required to keep the road in good and safe condition.

- Load limits will be implemented on roads to preserve the roadbed.
- During snow removal operations, care will be taken to not damage riparian vegetation near watercourse crossings.
- Snow from the road will be placed or ploughed off the highway in such a manner that during spring melt it drains into vegetated areas.
- Culvert maintenance will follow protocols set in the DFO *Operational Statement for Culvert Maintenance* (DFO 2007) provided in Appendix K; key mitigation measures include:
    - The removal of accumulated material (i.e., branches, stumps, other woody materials, garbage, ice build-up, etc.) should be conducted between the period of July 15 and September 15, as per DFO Fish Timing Windows for the NWT, unless there is immediate blockage of water or fish movement at which time removal can occur.
    - Emergency debris removal using hand tools or machinery (e.g., backhoe) can be carried out at any time of year. Emergencies include situations where carrying out the project immediately is in the interest of preventing damage to property or the environment, or is in the interest of public health or safety. DFO is to be notified immediately. You should follow all other measures to the greatest extent possible.
    - The proposed removal of materials, debris or ice while a watercourse is ice-covered requires a review and approval by DFO.
    - The removal of riparian vegetation, if necessary should be kept to a minimum.
    - The removal of accumulated material (i.e., branches, stumps, other woody materials, garbage, etc.) will be limited to the area within the culvert, immediately upstream of the culvert and to that which is necessary to maintain culvert function and fish passage.
    - Accumulated material and debris will be removed slowly to allow clean water to pass, to prevent downstream flooding and reduce the amount of sediment-laden water going downstream. Gradual dewatering will also reduce the potential for stranding fish in upstream areas.
    - Beavers may build structures in or at culvert locations. The removal of any beaver should be conducted in consultation with the nearest Hunter and Trappers Committee.

- Refer to the SECP, Section 2.11 for mitigation related to sedimentation and erosion control. Bridge maintenance will follow the DFO *Operational Statement for Bridge Maintenance* (DFO 2007) provided in Appendix L. Key mitigations include:
  - Unless the debris accumulation is an immediate threat to the integrity of the piers and abutments, the removal of debris will be conducted between July 15 and September 15 to avoid disruption of sensitive life stages of fish.
  - Ice build-up removal can be conducted at any time of year.
  - **T**he removal of material will be limited to that which is necessary to protect piers and abutments.
  - Debris will be removed by hand or with machinery operating from shore.
  - Emergency debris removal using hand tools or machinery (e.g., backhoe) can be carried out at any time of year. Emergencies include situations where carrying out the project immediately is in the interest of preventing damage to property or the environment, or is in the interest of public health or safety. DFO is to be notified immediately. A**ll** other measures will be followed to the greatest extent possible**.**
  - Shrouding will be used to trap and prevent concrete and other bridge materials from entering the watercourse during structural repairs and reinforcements.
  - The removal of riparian vegetation will be kept to a minimum and limited to the right-of-way of the bridge. If riprap requires repair, install riprap material at a similar slope to maintain a uniform stream bank and natural stream alignment.
  - Riprap will be placed so as not to interfere with fish passage or constrict the channel width.
  - Measures to prevent sedimentation and provide erosion control can be found in the SECP under Section 2.11.

8 MONITORING

Water quality and fish habitat monitoring will be conducted for a number of components of highway construction and operation, including the use of explosives, water withdrawal, and highway construction and maintenance. Monitoring measures for sedimentation and erosion are provided in the SECP. Monitoring from unplanned events such as spills is provided in the Emergency Spill Response Plan. Additional information on aquatic effects monitoring is provided in the Aquatic Effects Monitoring Plan (AEMP). Detail monitoring plans including sampling locations will be completed prior to construction and in collaboration with regulators.

8.1 Highway Alignment and Watercourse Crossings

During construction an environmental monitor will be on site at all watercourse crossings to ensure mitigation measures are being followed correctly and to respond to any problems which may arise by correcting the problem immediately or requesting immediate assistance from their provided contacts.

During highway operations, the structural integrity and performance of bridges and culverts along the road will be monitored during daily routine checks by DOT inspectors. Included in this monitoring is check that there are no obstructions to fish passage or unforeseen hydraulic changes to the channel downstream such as the formation of a hanging culvert, scour pool, or bank erosion.

Bridges and culverts will be cleaned as required. During winter, culverts will be checked daily for icing during routine inspection tours of the highway.

8.2 Water Withdrawal

The largest quantity of water used and drawn from lakes in winter will occur during the construction phase of the highway. Small amounts of water will be required during the open water season for dust suppression during both the construction and operational phases of the highway. Other monitoring includes:

- Daily recording of quantities of water withdrawn from lakes during the winter period.
- Measurement of water depth below ice at the beginning and end of winter water withdrawal from any given lake where water withdrawal occurs.
- Daily recording of quantities of water withdrawn from watercourses during the summer period.
- Periodic measurement of dissolved oxygen during ice-on periods.

8.3 Use of Explosives at Borrow Sources

Explosives using ammonium nitrate oil based mixtures will be used at borrow sites used for construction of the ITH. Although the release of ammonium or nitrate into the aquatic environment is not expected a

monitoring program will be established for those borrow sites that are within 200 m of waterbody or watercourse. Explosives will only be used in the winter period.

Winter monitoring will include:

- Transects and sampling stations will be set-up prior to the start of the use of explosives at borrow sources with a waterbody or watercourse within 200 m of a borrow site.
- Three transects will be established for each borrow site. One perpendicular (center) transect from the borrow site to the nearest waterbody or watercourse. The other two transects will be 45 degrees from each side of the perpendicular transect.
- Sampling of snow for ammonia, nitrate and pH will occur along each transect at 50 m, 100 m and 200 m from the edge of the borrow source.
- A surface water sample for ammonia, nitrate and pH will also be taken of the surface water under the ice of the potentially affected waterbody.
- Sampling of snow will be conducted again along the same transects and sampling stations after completion of the use of explosives in any given year at a borrow source.
- If elevated ammonia or nitrate levels exist after the use of explosives, additional lake samples will be taken to determine if potential increases in these compounds are measurable within the potentially affected lakes.

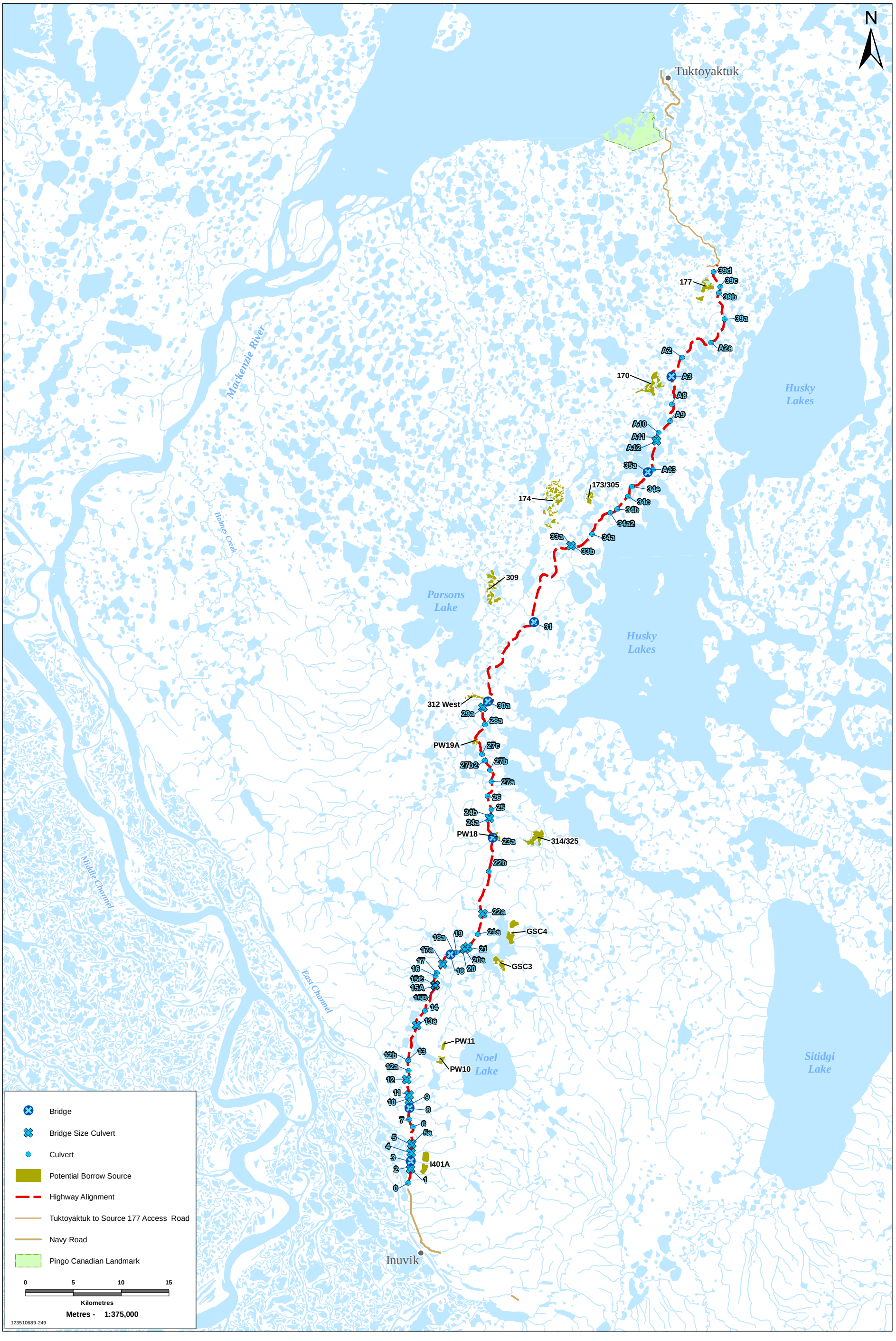
Summer monitoring will include:

- Surface water from the pit will be sampled once a month for ammonia, nitrate, pH and oil and grease.
- Samples will be taken inside the pit and on the edge of the pit as well as 50 m from the pit.

8.4 Reporting

An annual report of all monitoring activities related to fish and fish habitat protection will be prepared for the period of construction and first two years of highway operation. If additional monitoring is required other than routine inspections after the first two years of operation, reports will be prepared for these additional years. Reports will provide results of monitoring activities, indicate if any problems were identified, and describe how these problems were corrected.

APPENDIX A Highway Alignment and Watercourse Crossings



INUVIK TO TUKTOYAKTUK HIGHWAY OVERVIEW

ITH Alignment Watercrossings and Borrow Source Locations

Base Data: Government of Canada; Watersheds: Government of Canada.

PREPARED BY
Northwest Territories Transportation

PREPARED FOR
KAVIK-STANLEY

FIGURE NO.
Appendix A

Last Modified: September 4, 2013 By: jpetho

APPENDIX B Riparian Zone Preservation BMP 6

Riparian Zone Preservation Sediment Control and Erosion Control	B.M.P. #30

Description and Purpose

- Protection of existing plants and trees adjacent to all natural water bodies (riparian zones) adjacent to construction areas
- Existing vegetation acts as an effective vegetative buffer strip as a form of erosion and sediment control measure

Applications

- Permanent measure
- Existing established vegetation acts as an effective sediment control and erosion control buffer strip barrier to slow down flows and allow sedimentation filtration to occur
- May be used along property boundaries to minimize sediment transport off construction site despite non-presence of watercourse adjacent

Advantages

- Existing dense vegetation is more effective than any man-made structures or devices for sediment or erosion control, however, other forms of sediment and erosion control measures may be required on construction sites in addition to preserved riparian zones
- Any denuding of vegetation along steep valley slope with highly erodible soil will be detrimental and inducive to long-term sedimentation yield; it is important only to strip necessary areas along the footprint of construction. Preservation of riparian zone is mandatory along river valley slopes and along the edge corridor of waterbodies

Limitations

- Preservation of riparian zones may interfere with construction efficiency
- Careful planning is required to work around preserved riparian zones

Construction

- It is highly important to preserve an established vegetative buffer as freshly planted vegetation generally require substantial growth periods before they are as effective as established riparian zones
- Wherever possible, retain as much existing vegetation as possible between construction areas and sensitive zones (wetlands, marshes, streams, floodplains, etc.) to entrap sediment and to minimize sediment transport off of the construction site into the sensitive zones

Riparian Zone Preservation Sediment Control and Erosion Control	B.M.P. #30

- Define and delineate riparian zones to be preserved in Environmental Construction Operations Plan (ECO Plan) prior to commencement of construction
- Clearly mark riparian zones to be preserved in the field (with construction fencing, survey flagging, or other highly visible measure) so all personnel involved with construction operations can identify areas to be preserved

Construction Considerations

- Riparian zones must be fenced off immediately to minimize trespassing and to ensure effectiveness of riparian zone is maintained
- Do not allow equipment to enter areas not necessary to construction
- Based on site-specific situations established buffer zones of adequate width

Inspection and Maintenance

- Inspection frequency should be in accordance with the PESC and TESC Plans
- Maintain fences protecting riparian zones from trespassing

APPENDIX C

Construction Practices BMP 1

BEST MANAGEMENT PRACTICES

Construction Practices

M 1

FACTSHEET

DESCRIPTION AND PURPOSE

Work performed in and around water can potentially result in adverse effects on fish and fish habitat. These effects can be prevented by incorporating standard best management practices (BMP) into all work occurring in or near water. The BMP listed below should be used routinely for all watercourse crossing and maintenance projects.

GENERIC BEST MANAGEMENT PRACTICES

INSTREAM WORK

- Plan the project so that the amount of instream work is kept to a minimum
- Where possible, plan instream work to occur as a single event
- Restrict instream work to low flow periods where possible
- Limit machinery access to a single point on one bank
- Limit distance between machinery access point and work site
- Adhere to timing restrictions
- Minimize flow constriction
- Use instream pad built of washed gravel where instream equipment activity would generate excess sediment

RIGHT-OF-WAY

- Keep right-of-way for watercourse crossings as narrow as possible within the constraints of safety and construction requirements
- Limit removal of vegetation to the width of the right-of-way
- Clear vegetation from unstable or erodible banks by hand, avoiding the use of heavy machinery
- Develop sediment control plans and install sediment control measures before starting work
- Inspect sediment control measures regularly and make necessary repairs immediately after damage has been discovered
- Stockpile top soil removed from the right-of-way outside of the active floodplain and use measures such as silt fences and holding ponds to prevent stockpile runoff from entering the watercourse
- Minimize the length of time that unstable erodible soils are exposed
- Direct runoff containing sediment away from the stream into a vegetated area
- Construct suitably sized settling ponds to precipitate suspended sediment before water is discharged into the watercourse
- Stabilize erodible soils as soon as practical by seeding, spreading mulch or installing erosion control blankets
- Allow at least 4 weeks of growing season when using seeding to stabilize erodible soils
- Maintain a vegetated buffer strip between the work site and watercourse except at the actual crossing location

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Transportation

BEST MANAGEMENT PRACTICES

Construction Practices

M 1
FACTSHEET
2 of 3

GENERIC BEST MANAGEMENT PRACTICES (CONT'D)

MACHINERY

- Machinery should arrive on site in a clean, washed condition, free of fluid leaks
- Install stabilized entrances at vehicle and machinery access points
- Limit the amount and duration of instream work with heavy machinery. Work from the banks where possible
- Refuel machinery at locations well removed from the watercourse (maintain a minimum 100 m separation)
- Wash and service vehicles and machinery at locations well removed from the watercourse
- Work on instream pads composed of washed gravel to minimize sediment entrainment

POTENTIALLY TOXIC MATERIALS

- Use bio-friendly hydraulic fluids in equipment operating in or adjacent to watercourse
- Store fuel, lubricants, hydraulic fluid and other potentially toxic materials at locations well removed from the watercourse
- Isolate storage areas so that spilled fluids cannot enter the watercourse
- Prepare a spill contingency plan
- Report all spills:

AENV 24 Hour Spill Reporting Line: 1-800-222-6514

- Ensure creosote treated and pressure treated lumber is completely dry (no evidence of seepage of treatment materials) before use in or near watercourse
- Lumber used in construction should be treated and painted at a site well removed from the watercourse
- Use bridge skirts or other appropriate measures to prevent material from entering watercourse when painting, cleaning or resurfacing bridge deck and superstructures
- Do not use ammonium nitrate-fuel oil (ANFO) based explosives

COFFERDAMS AND BERMS

- Use cofferdams (earth fill, sheet pile or other proprietary designs) to separate instream work site from flowing water
- Use clean, washed material for construction and face berms with clean granular material
- Design cofferdams to accommodate the expected flows of the watercourse
- Limit cofferdams to one side of the watercourse at any one time and ensure that they block no more than one-third of the channel
- Restore the original channel bottom grade after removing cofferdams
- Treat all water pumped from behind the cofferdams to remove sediment before discharge

TEMPORARY DIVERSION CHANNELS

- Construct temporary diversion channels in the dry, starting from the downstream end
- Design temporary diversion channels to accommodate expected watercourse flow from storm events (generally 1 in 5 year event, though the 1 in 2 year event may be used for non-critical situations)
- Use erosion control methods where appropriate

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Transportation

- Leave the existing channels untouched until the temporary diversions are constructed

GENERIC BEST MANAGEMENT PRACTICES (CONT'D)

- Open diversion channels from the downstream end first
- Use clean, washed material to close existing channels and divert water to temporary diversion channels
- Use gradient controls to ensure that diversion channel slopes correspond to the existing channel gradients
- Protect unstable bends from erosion

PUMPED DIVERSIONS

- Used where a channel must be completely blocked to allow work 'in the dry'
- Must not be used where there are fish passage concerns
- Intakes must be sized and screened to prevent debris blockage and fish mortality
- Pumping system should be sized to accommodate expected watercourse flow from storm events (generally 1 in 5 year event, though the 1 in 2 year event may be used for non-critical situations)
- Discharge point should be armored with clean rock to prevent erosion

RECLAMATION AND SITE CLEANUP

- Begin reclamation and site cleanup as soon as construction has been completed
- Remove all waste material from the active floodplain
- Recontour, stabilize and revegetate disturbed areas to suit original conditions
- Remove all temporary facilities and structures
- Stabilize all slopes leading directly to the watercourse
- Seed exposed slopes immediately if there are at least 4 weeks remaining in the growing season. If this is not possible, slopes should be revegetated immediately in the next growing season

APPENDIX D

Northern Land Use Guidelines: Roads and Trails

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

VOLUME 05

NORTHERN LAND USE GUIDELINES

Access: Roads and Trails

Canada

Table of Contents

Preface

Indian and Northern Affairs Canada (INAC) has revised its popular land use guidelines series. It is designed to guide land use activity on Crown land in the Northwest Territories and Nunavut. Activities on land under private ownership (e.g., First Nations or Inuit-owned land)[1] and land under municipal or territorial control (e.g., Commissioner's land) require direction from the appropriate agency.

Guidelines apply to land use activities on Crown land only.

These guidelines will assist proponents and operators in planning proposed land use activities, assessing related environmental effects and minimizing the impacts of these activities. They should be supplemented by local research, traditional knowledge, engineering or other professional expertise specific to a proposal and advice from the appropriate regulatory agency. Although every attempt has been made during the preparation of these guidelines to use up-to-date information, it remains the operator's responsibility to obtain the most recent information related to northern resource development and to follow current regulatory requirements.

Guidelines do not replace acts, ordinances, regulations and permit terms and conditions.

[1] Aboriginal land refers to First Nations, Inuit, or Métis owned lands

Volumes in this series include:

- Vol. 01 Administrative Framework
- Vol. 02 Administrative Process
- Vol. 03 Applying Sustainable Development
- Vol. 04 Permafrost
- Vol. 05 Access: Roads and Trails
- Vol. 06 Camp and Support Facilities
- Vol. 07 Pits and Quarries
- Vol. 08 Mineral Exploration
- Vol. 09 Hydrocarbon Exploration
- Vol. 10 Other Land Uses
- Vol. 11 Abandonment and Reclamation

The series is available electronically at **www.publications.gc.ca**. Readers are encouraged to visit the site for updates and revisions to the series.

For further information concerning the subject matter contained in this guideline series, please contact:

OTTAWA

Manager, Land Programs, Natural Resources and Environment Branch
Indian and Northern Affairs Canada
Les Terrasses de la Chaudière
10 Wellington Street
Hull QC K1A 0H4
TEL: 819-994-7464 FAX: 819-997-9623
E-MAIL: NorthernLands@ainc-inac.gc.ca

NORTHWEST TERRITORIES

Land Administration
Indian and Northern Affairs Canada
P.O. Box 1500
Yellowknife NT X1A 2R3
TEL: 867-669-2671 FAX: 867-669-2713
E-MAIL: NWTLands@ainc-inac.gc.ca

NUNAVUT

Land Administration
Indian and Northern Affairs Canada
P.O. Box 100
Iqaluit NU X0A 0H0
TEL: 867-975-4275 FAX: 867-975-4286
E-MAIL: landsmining@ainc-inac.gc.ca

YUKON

NOTE: *Effective April 1, 2003, responsibility for Indian and Northern Affairs Canada's Northern Affairs Program (land and resource management) was transferred to the Government of Yukon. For information on land-use in the Yukon, contact the office below*:

Land Use—Lands Branch Department of Energy, Mines And Resources
Government of Yukon
Suite 320, Elijah Smith Building
300 Main Street
Whitehorse YT Y1A 2B5
TEL: 867-667-3173 FAX: 867-667-3214
E-MAIL: land.use@gov.yk.ca

Acknowledgments

In the 1980s, Indian and Northern Affairs Canada published a series of six guidelines in a handbook format, intended to help operators of small to medium-scale projects carry out activities in northern Canada in an environmentally sensitive manner. These handbooks, commonly called "The Blue Books," have been widely distributed and quoted. Their success is a tribute to the efforts of the original authors and contributors, and to the departmental steering committee that guided their preparation.

This new series of northern land use guidelines is, in part, an update of the earlier series. This work was directed by a steering committee made up of Northern Regional Office staff and Northern Affairs Program staff in Ottawa. Much of the information and many of the photographs presented in this series were obtained in consultation with land use administrators and resource managers in the Northwest Territories and Nunavut.

CHAPTER
01

Introduction

The purpose of this volume is to provide guidance on the construction and operation of roads and trails on Crown land in the Northwest Territories and Nunavut. If you are not operating on Crown land, it is your responsibility to contact the appropriate landowner for any land use guidelines that may be in place.

Due to the remote nature of the Northwest Territories and Nunavut, road construction is often required to conduct land use activities. This volume presents strategies for planning, constructing, operating and reclaiming roads in an efficient and environmentally responsible manner. Consultation with appropriate experts is recommended for specific engineering and geotechnical concerns.

CHAPTER
02

Northern Roads and Trails

Roads and trails are often used to access land use activity sites in northern Canada due to the high cost and seasonal restrictions associated with travel by air or water. Existing road infrastructure is limited and access routes must often be planned and constructed before a primary land use activity like mining can begin. Development of a new access route in a remote, inaccessible area can have positive economic effects; however, it can also have negative impacts on land, water and cultural resources. Mitigation techniques should be outlined during the planning stage of road development to minimize potential environmental impacts.

Cold climatic conditions lead to the use of unique road-building techniques in the Northwest Territories and Nunavut. Winter roads that are constructed on frozen bodies of water and on frozen ground protected by layers of snow and ice are frequently used. The presence of permafrost in northern Canada requires different construction practices as surface disturbance can lead to permafrost melting and subsequent ground subsidence.

2.1 Classification

Roads are classified by season of use, size and purpose (Table 2-1). An all-season access road has a durable, all-weather surface that can be used by vehicles at any time of the year without damaging the land surface. A winter road is only operational when the ground is sufficiently frozen and there is an adequate layer of snow to prevent damage to the ground by vehicles.

2.2 Permitting

Most road or trail developments require a land use permit from the appropriate land use regulator. The application should include environmental background information and a description of the type of access, design specifications and development schedule. The application should also explain how identified environmental impacts will be avoided or minimized during construction and operation. If camps, quarries or pits are required during construction, the land use permit application should include details about these developments.

Proponents should discuss their proposed development with local Aboriginal groups and area land users. INAC and other regulatory authorities strongly encourage community engagement prior to and during the land use permitting process.

Other authorizations may be required depending on the nature of the development. The purpose of and the responsible authority for these authorizations is outlined in Table 2-2. Regulatory authorities should be contacted before applying for permits so that proponents understand the requirements and time frames necessary to obtain required permits. For more information on regulatory processes and applicable legislation, consult the *Administrative Process* volume of this series.

Table 2-1. All-season and winter road classifications

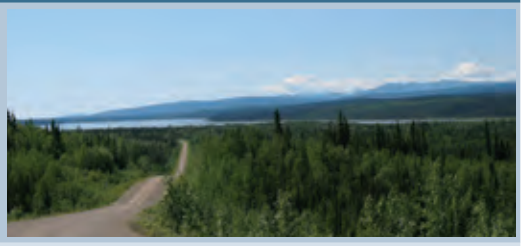
ALL-SEASON ROAD	CHARACTERISTICS	EXAMPLE
Haul Road (logging road, forest road, local road)	• Connects developed resource areas to highways or communities • Designed to carry heavy trucks at speeds of approximately 40 to 80 km/h	
Access Road (pioneer road, fire road, spur road, shoo fly)	• Provides initial access to resource areas for exploration • Requires minimal design work • Designed to carry low traffic volumes at low speeds	
Trail (push trail, cut line)	• Provides access for a limited duration • Degree of clearing varies from merely pushing down vegetation to clearing a narrow right-of-way	
WINTER ROAD	**CHARACTERISTICS**	**EXAMPLE**
Compacted Snow Road	• Winter use haul road • Constructed of compacted snow and/or ice	
Winter Access Road	• Constructed by dragging and levelling the surface to allow smoother travel • Water may be used to build up ice for the roadbed	
Winter Trail (push trail, cut line)	• Established for winter use by a single pass of a tracked vehicle using a blade, if necessary	

Table 2-2. Authorizations that may be required for road construction

PERMIT	PURPOSE	RESPONSIBLE AUTHORITIES
Land Use Permit	Use and occupation of land associated with a road	• Indian and Northern Affairs Canada (Inuvialuit Settlement Region) • Land and Water Boards (Mackenzie Valley – Northwest Territories) • Indian and Northern Affairs Canada (Nunavut)
Water Licence	Use of water or deposition of waste into water, for example, water used to build a winter ice crossing or deposit sewage from a road camp	• Northwest Territories Water Board (Inuvialuit Settlement Region) • Land and Water Boards (Mackenzie Valley – Northwest Territories) • Nunavut Water Board (Nunavut)
Quarrying Permit*	Obtain granular materials	• Indian and Northern Affairs Canada
Quarry Lease*	Long-term access to granular materials	• Indian and Northern Affairs Canada (Nunavut only)
Fisheries Authorization	Work in fish-bearing waters, for example, installation of a culvert	• Fisheries and Oceans Canada
Timber Permit	Clearing timber prior to road construction	• Government of the Northwest Territories • Government of Nunavut
Access Authorization	Access to and work on Aboriginal private lands	• Aboriginal private landowners
Access to a Public Highway Permit	Required prior to constructing a road that intersects a public highway	• Government of the Northwest Territories (NWT only)

*In Nunavut, quarrying activities on Inuit-Owned Land must be authorized by the appropriate Regional Inuit Association.

FIGURE 1. Contact your local INAC resource management officer to discuss project options prior to applying for a land use permit.

CHAPTER 03

Planning and Design

Proper planning will result in a road that uses the most suitable terrain, thereby reducing environmental impacts. A well-designed road will also result in efficient construction and operation.

Route selection is the first stage in the planning process and should be done before determining the type of access needed and associated road design. Existing and new environmental information must be gathered and used to determine what type of road is feasible and suitable given the environmental conditions. A systematic process should be followed for identifying alternative routes, evaluating these routes and choosing a preferred route based on consideration of all of the key planning issues.

The entire lifespan of the road should be considered during planning. For example, if a trail is likely to be upgraded to a haul road at a later date, the additional time spent finding a route with gentle grades, stable terrain and a minimum number of stream crossings will eliminate the need to construct an entirely new road in the future.

3.1 Site Conditions

3.1.1 Existing Information

Existing administrative and environmental information about the development area should be used to delineate the general area, the proposed location of the route and alternatives. Proponents are encouraged to identify and use existing roads where possible to reduce costs and the environmental footprint of the development.

Some examples of questions that can be answered using existing administrative and environmental information are listed below.

Administrative

- Who owns the land over which the proposed route will pass?
- Which land use regulators have authority over the land?
- Is the project within a region that has an approved land use plan?
- Who are other land users within the area (e.g. trappers, communities, tourism operators)?

Environmental

- What are the environmental and terrain conditions?
- Are there known environmental or terrain concerns within the area?
- Are land use, water quantity and water quality data available for the project area?
- Where is critical fish and wildlife habitat located within the area?

Some specific examples of information requirements and sources are outlined in Table 3-1.

Table 3 1. Information used for access route planning

INFORMATION CATEGORY	INFORMATION SUB-CATEGORY	SOURCES
Environmental	• Topography and drainage • Surface vegetation • Sensitive landforms (e.g. pingos or eskers)	• Aerial photographs and maps • Local INAC office • Appropriate resource managers or regulatory boards • Local operators and residents
	• Water management	• INAC Water Resources Division www.ainc-inac.gc.ca
	• Timber/forestry	• Government of the Northwest Territories, Environment and Natural Resources www.forestmanagement.enr.gov.nt.ca • Government of Nunavut, Department of Environment
	• Fish and wildlife habitat	• Fisheries and Oceans Canada www.dfo-mpo.gc.ca • Environment Canada www.ec.gc.ca • Territorial environment departments
Engineering	• Road design • Construction methods • Water crosssings and bridges	• Engineers • Examination of local roads • Field investigations • INAC resource management officer
Archaeological/cultural	• Location of archaeological sites and heritage resources • Traditional use areas (e.g. berry-picking sites, traplines, cabins)	• Prince of Wales Northern Heritage Centre (Northwest Territories) http://pwnhc.learnnet.nt.ca • Department of Culture, Language, Elders and Youth (Nunavut) www.gov.nu.ca/cley • Inuit Heritage Trust (Nunavut) www.ihti.ca • Field investigations
Reclamation	• Reclamation standards	• Local INAC office • Appropriate resource managers or regulatory boards • Territorial environment departments

3.1.2 Field Investigations

Once a general area for the route has been identified, field investigations should be conducted to collect more detailed information on environmental conditions so that the final configuration of the route can be chosen. A combination of on-the-ground assessments and aerial reconnaissance should be conducted along the entire proposed route during both summer and winter to delineate the full range of environmental conditions. The ground and aerial assessments should provide information on topography, hydrology, soils, permafrost, geotechnical properties, wildlife habitat, and heritage resources. Field investigations will also identify areas that should be avoided or that will require special management. Pre-development field investigations also provide a baseline record of environmental data that will help in setting reclamation goals. All field data collected should be included in the land use permit application.

If a pit or quarry is needed to obtain construction materials for the road, specific field investigations should be carried out to determine if a suitable site is located within the area of the proposed route. Further information on pit or quarry development is available in the *Pits and Quarries* volume of this series.

3.1.3 Stable Terrain

High, dry and flat ground is an ideal location for most roads as these areas are blown clear of snow during winter, leading to frozen and stable ground. When thawed, these areas are typically well drained. It is not always possible to locate a road in ideal terrain, but ground that is particularly susceptible to erosion or subsidence should be avoided. Areas to avoid include:

- unstable slopes and slide areas;
- deep valleys because they retain snow that inhibits ground freezing; and,
- wet areas such as peatlands, wetlands, seeps and springs.

Except for stream crossings, water bodies should be avoided to prevent erosion and sediment deposition into the water. To prevent sedimentation and erosion, vegetated buffer strips of at least 30 m width are required to be left between roads and water bodies.

In tundra areas, roads are often situated on or near eskers because they are well drained and stable; however, eskers also provide critical habitat for wildlife. Known denning areas should be avoided when planning development on or near an esker.

FIGURE 2. Determine if existing roads can be used. Proper planning may have prevented the network of roads shown in this photograph.

FIGURE 3. Field investigations should be conducted in both the summer and the winter to ensure that the road is built with consideration for the full range of climatic and hydrological conditions.

FIGURE 4. In permafrost terrain, avoid road construction on patterned ground.

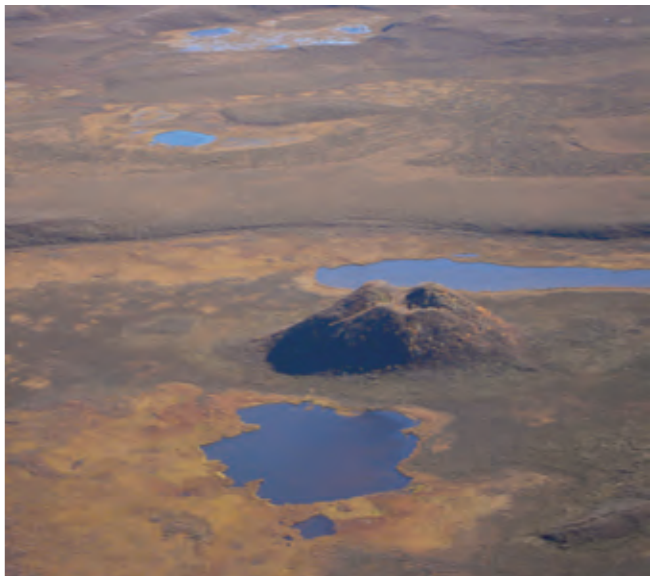


FIGURE 5. Pingos are ice cored hills that are unique to permafrost terrain. Vehicles and equipment are prohibited within 150 m of a pingo.

3.1.4 Permafrost

Some areas of perennially frozen ground contain significant amounts of ground ice. Disturbance of these areas should be avoided as they could melt and cause ground subsidence, potentially leading to soil erosion, instability of engineered structures and loss of habitat. Areas of ground ice are not always identifiable from surface features, so field investigations should be conducted to determine the extent and depth of permafrost and near-surface ground ice. In general, the following areas should be avoided in permafrost terrain due to high near-surface ground ice content:

- patterned ground;
- fine-grained soils, particularly clays; and
- sedge wetlands and peatlands.

Areas in permafrost terrain that have recently experienced a forest fire are prone to erosion, but a few years after the fire, once the ground ice has melted, these areas are more stable than older areas of unburned forest.

In discontinuous permafrost regions, it may be possible to avoid areas of permafrost altogether. Areas of black spruce trees or peatlands indicate the presence of ice-rich permafrost. Isolated patches of permafrost can also be cleared and allowed to melt prior to road construction. Further information on techniques to minimize permafrost disturbance is available in the *Permafrost* volume of this series.

3.2 Road Design

Once the location of the route has been determined, road design can be undertaken. Road design involves planning the road alignment, grades, embankments and surfaces, and requires an understanding of both local environmental conditions and transportation requirements, such as the purpose of the road, expected vehicle loads, frequency of use and duration of use.

The objective of road design is to construct a road that will be safe and minimize environmental disturbance. A well-designed road will be less prone to events that cause environmental disturbance and will require less maintenance to deal with issues such as wind-blown trees, blocked culverts, excessive rutting, washouts, ponding and bridge scouring.

For safety, road grades and curves must be suitable for all vehicles that will use the route. A wider right-of-way should be cleared on sharp curves to reduce the risk of accidents. Ideally, road grades should be less than six percent, which can often be accomplished by following the contours of the

FIGURE 6. Road grades and curves should be designed to be safe and minimize environmental disturbance. In this case, a wider curve and a lower grade would be safer and less prone to erosion.

land. Lower road grades will help reduce soil erosion and operating constraints as steeper grades often require large loads to be towed. In steep terrain, the use of lower road grades may increase the number of fills required and overall road length, so site-specific evaluations should be conducted to determine the best design.

The choice of proper road construction materials can also reduce operating and maintenance costs. Coarse-grained material should be used for road construction because it drains well and is less susceptible to frost heave. In wet areas, geotextiles can be used to distribute the bearing load and to prevent mixing of sub-grade materials with aggregates.

3.2.1 Drainage Control

Controlling drainage involves design aspects or structures that keep the road dry, including stream crossings. A detailed understanding of natural drainage patterns will assist in designing drainage control structures that will be appropriately sized for expected flows and will follow natural drainage courses. These measures will reduce erosion and ponding, resulting in lower long-term maintenance costs. The best time of the year to plan drainage control is during spring when all streams, seeps and springs are flowing. It is also important to understand high precipitation events during other seasons. If possible, a full year of observations is ideal. Important environmental factors to consider when determining expected flows and local drainage patterns include:

- total annual precipitation (rainfall and snowfall);
- high precipitation (storm) events;
- vegetation cover;
- topsoil and subsoil types; and,
- length of slopes.

Roads constructed in areas of soil with low infiltration rates, such as fine-textured silts and clays, will require more extensive drainage control measures as more water will be restricted to the surface. This is also the case in permafrost terrain where water is restricted to a thin active layer extending from the ground surface to the top of the permafrost. High precipitation events can lead to

erosive sheet flow. Rapid runoff from steep slopes is also a concern, especially on south- or west-facing slopes where snowmelt is more rapid. Non-forested areas may also be more susceptible to erosion.

Stream crossings are drainage control structures that should be particularly well planned as erosion and sedimentation into streams can affect water quality and fish habitat. A detailed watershed delineation should be completed for each stream crossing to determine the design requirements for a high flow, 100-year flood event. Once expected peak flows are understood, design considerations include:

- minimizing the number of stream crossings and using existing crossings where possible;
- selecting or constructing gently sloped approaches at right angles to the stream where the channel is straight, unobstructed and well defined, with a low bank height;
- locating stream crossings at sites with coarse-textured, well-drained material;
- locating stream crossings at least 500 m downstream of known fish habitat, such as spawning beds and rearing, feeding and overwintering sites; and,
- considering the high-water mark in the design of stream crossings.

Proponents should contact Fisheries and Oceans Canada and Transport Canada before conducting any stream crossing work to ensure compliance with regulations. More information on planning, constructing, operating and maintaining stream crossings can be found in the Canadian Association of Petroleum Producers' document *Pipeline Associated Watercourse Crossings* at www.capp.ca.

3.2.2 Visual Impacts

Where safety permits, the route should be designed to minimize its visual impact, especially in areas with high tourism or scenic value. The preferred mitigation technique is to avoid these areas; however, if avoidance is not possible, methods to reduce visual impacts include:

- minimizing long straight sections of road to reduce lines of sight; and,
- preserving a visual barrier between the route and public roads or streams by using buffer zones or doglegs.

3.3 Cultural, Subsistence and Recreational Values

Some areas of land are particularly valued for subsistence or recreational activities, such as traplines, hunting areas, canoe routes or tourism lodge sites. Aboriginal groups, territorial tourism departments, INAC resource management officers and local residents can identify sites of particular cultural, subsistence or recreational importance along a proposed route.

Representatives of existing interests, such as cabin owners or trappers, should be consulted during the planning phase so that their concerns can be addressed in the road design or alignment. The land use permit may also contain specific conditions to protect and minimize disruption to these existing interests.

FIGURE 7. Part of the planning process involves identifying and consulting with other land users near the proposed development.

3.4 Archaeological and Cultural Resources

Roads should be sited so that disturbance of archaeological and cultural sites is avoided. Archaeological and cultural sites should also be considered when constructing a winter road. The road corridor should be investigated during the summer prior to construction to identify potential archaeological or cultural sites. Territorial governments can provide information on documented sites through the Prince of Wales Northern Heritage Centre in the Northwest Territories and the Department of Culture, Language, Elders and Youth in Nunavut. Aboriginal

FIGURE 8. Verifying the route prior to construction can avoid unnecessary false starts such as this one

groups, communities and governments also have information on traditional-use areas.

If an archaeological or cultural site is discovered during construction, work in the area should be stopped immediately and the INAC resource management officer and territorial government notified. Signs of an archaeological site can include arrowheads, old encampments and evidence of buildings.

3.5 Verifying the Route

Once route planning has been completed and prior to applying for a land use permit, the entire route should be checked in the field and marked with flagging tape. Global Positioning System (GPS) coordinates should be recorded while in the field and provided to the INAC resource management officer. Verifying the route reduces the chance of building a road in an unsuitable area and the need to rebuild the road elsewhere, thereby reducing costs and minimizing the environmental footprint of the road. Marking the route with flagging tape before clearing begins also ensures that the clearing equipment operator can easily follow the intended route.

CHAPTER
04

All-Weather Road Construction

This section outlines surface preparation activities and all-weather road construction methods. Clearing and construction should be scheduled when the ground surface is strong enough to support equipment without rutting or erosion. The proponent should contact the local INAC resource management officer prior to commencing construction. Construction should be suspended when conditions could result in serious erosion, such as heavy rainfall or when sub-grade soils are saturated. To avoid rutting and erosion in permafrost terrain, overland travel is not permitted during summer months and road construction should only take place during late fall or winter when the active layer is well frozen.

Field conditions encountered during road construction may require changes to the plan that was provided in the application for a land use permit. Prior to making these changes, the proponent should consult with the INAC resource management officer and the land use regulator to determine if the modifications require regulatory approval.

4.1 Surface Preparation

Surface preparation for a road includes removal of trees, shrubs and ground cover along the right-of-way prior to road construction. Clearing should be restricted to the approved right-of-way and to the minimum width necessary to conduct safe operations. Rights-of-way should be wide enough to allow road surfaces to dry quickly. If the right-of-way is too narrow, the road surface will be shaded and wet or icy, resulting in unsafe operating conditions.

Clearing vegetation is discouraged in some areas, such as permafrost terrain where the shade provided by vegetation may prevent ground thaw. Vegetation may also be left to provide a visual barrier between the road and a public highway or other land use. Buffers of uncleared land must be left beside water bodies to prevent erosion of riparian areas and the deposit of sediment into streams and lakes.

4.1.1 Trees

In forested areas, trees should be felled onto the right-of-way to minimize disturbance of the adjacent forest. Trees should be felled away from water bodies to avoid blocking streams and impacting water quality. Where it is safe and practical, standing live or dead trees along the route that provide wildlife habitat should be saved.

When clearing with a dozer blade, ensure that trees break off at the ground surface and avoid uprooting trees as this can tear the surface organic layer,

FIGURE 9. Proper scheduling of road construction will avoid rutting and erosion.

FIGURE 10. Clear only the minimum width necessary for road use.

exposing and thawing ice-rich mineral soil beneath. It may be preferable to hand cut trees instead. Remaining trees that lean over the right-of-way or into the adjacent forest should also be removed as they pose safety hazards and can tear the surface organic layer if they fall. The use of U-blades for clearing trees and other vegetation is discouraged as it usually results in a high number of pushouts on the sides of the route, which may cover brush below, causing a fire hazard.

Land use permits may include conditions for saving and stacking merchantable timber. In general, trees larger than 12 cm in diameter should be saved. For more information, contact the Department of Environment and Natural Resources, Government of the Northwest Territories or the Department of Environment, Government of Nunavut.

4.1.2 Shrubs

Once trees have been removed from the site, shrubs can be cleared. However, clearing of ground cover and the surface organic layer is strongly discouraged as it protects permafrost from disturbance and prevents erosion in non-permafrost terrain.

One of the least intrusive methods of clearing shrubs is to "walk down" the vegetation with a bulldozer blade at a fixed height. Small trees and shrubs are pushed down by the blade and the weight of the machine compresses the felled vegetation. This method of clearing is common for trails, such as seismic lines, where conventional wheeled vehicles will not be used. Some shrubs that have been walked down may not break and may recover during the following season, which will help prevent soil erosion and enhance vegetation recovery at the end of operations.

FIGURE 11. Brush can be walked down using a bulldozer.

FIGURE 12. A brush cutter can be used to cut and dispose of brush.

4.1.3 Brush Disposal

Once trees and shrubs have been cleared, the resulting brush should be cleared off the right-of-way. The brush disposal method used depends on the size of the right-of-way and the type of vegetation. The land use permit will often specify how brush is to be disposed of but, in general, brush should be disposed of progressively as clearing proceeds and disposal should be completed along the entire route prior to expiry of the land use permit. Brush should not be disposed of in or near water bodies. In some cases, brush can be salvaged and used to control erosion along the route. For instance, stacked brush on the downhill side of a slope can slow and trap sediment.

The lopping and scattering technique is used when vegetation that was pushed down during clearing does not lie flat on the ground. Branches are removed and stems are cut into lengths so that the vegetation lies flat on the ground, enhancing decomposition.

Windrowing and compaction involve piling cut brush in long rows on the side of the right-of-way and compacting the piles using heavy equipment to increase decomposition. Windrows should be placed at least five metres away from standing timber to reduce the hazard of a fire. Breaks of approximately ten-metre width should be left in the windrow at approximately 300-metre intervals to allow wildlife passage.

Brush can be disposed of by mulching with a wood chipper or a brush cutter. The resulting wood chips can be scattered on the ground and will decompose more rapidly than windrowed brush. This method reduces the risk of fire and the accumulation of snow on the right-of-way in comparison with windrowing.

Complete disposal of brush by burning is often required within the first 100 m adjacent to the intersection of a public road or water body. Brush piles should be placed in the middle of the right-of-way to minimize the risk of fire spreading to surrounding vegetation. Set fires must be monitored at all times. Burning should not be conducted in permafrost terrain with high ground ice content as it could cause ground subsidence.

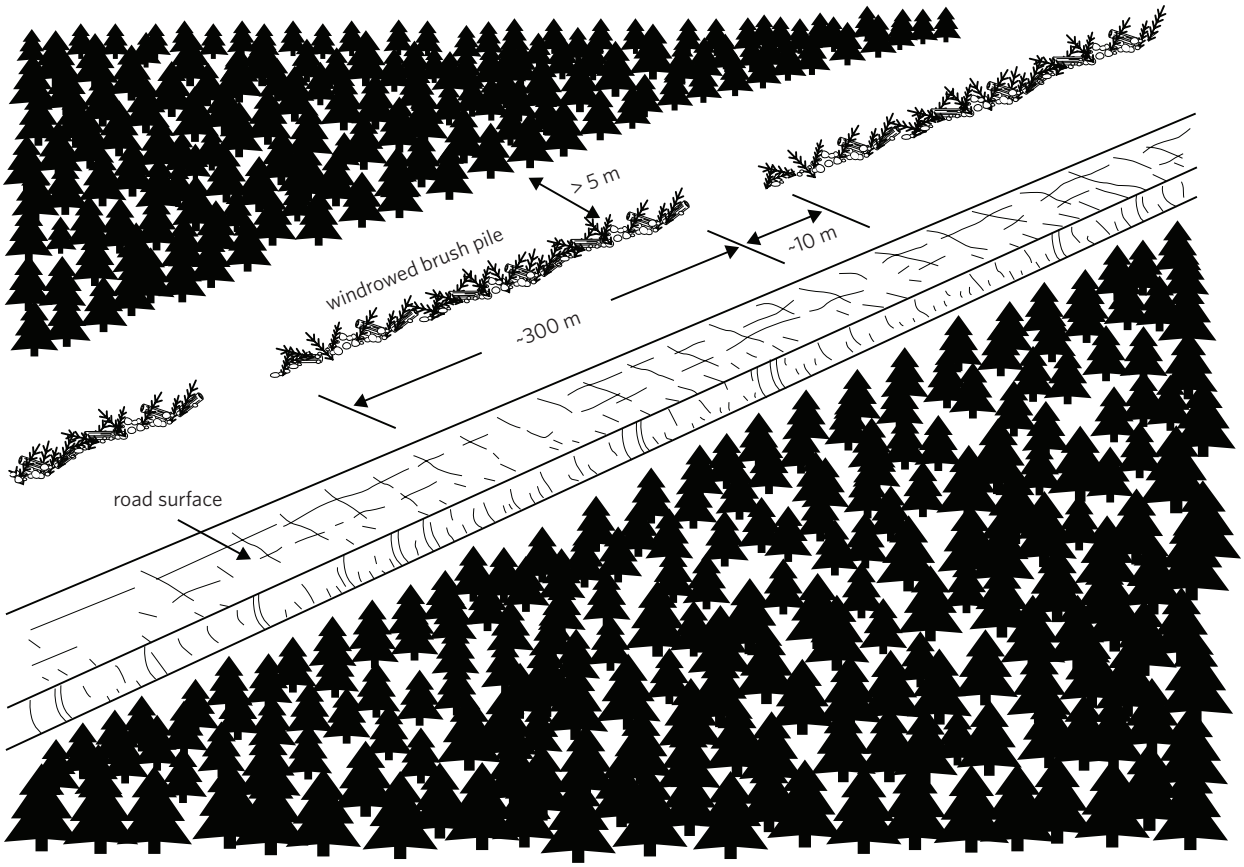


FIGURE 13. Openings of 10-m width left in windrows at 300-m intervals should ensure adequate passage for wildlife, and also reduce the fire hazard. Windrows placed at least 5 m away from standing timber reduce the risk of a fire. (1994 INAC Access Trails and Roads Guidelines)

4.1.4 Grubbing

Removal of stumps, roots and organic topsoil, known as grubbing, may be required to complete clearing for an all-weather road. Land use permits will often require the removal of tree stumps greater than 20 cm in diameter. To avoid erosion, grubbing should be minimized, particularly in areas of fine-grained soils or wet areas. If grubbing in fine-grained soils is unavoidable, it should be conducted during dry weather. Grubbing is not necessary for winter road construction or in areas where deeper fills will be used.

Disposal methods for grubbed material are the same as those for brush disposal, except for organic topsoil, which should be stockpiled separately from other materials for future reclamation use. Topsoil contains native plant seeds and organic matter that aid vegetation re-establishment. Stockpiles should be placed at a location that will not interfere with operations, will allow for the drainage of meltwater and will not be eroded by surface runoff.

FIGURE 14. Brush can be used as a sediment trap on steep slopes.

FIGURE 15. Improper disposal of brush in forest vegetation. Leaners should be cut down and brush windrowed.

4.2 Cuts and Fills

Cutting and filling is a road construction technique in which earth materials are excavated from one area and used to fill in an adjacent area to reduce the angle of a slope. Fills should use cut material from the upslope as cuts on the downhill side of a slope can lead to soil erosion. To ensure the stability of cuts and fills on slopes:

- Fill material should be compacted.
- The tops of cut slopes should be rounded.
- In unconsolidated material, the slope of the cut or fill should have a horizontal to vertical ratio of at least 2:1.
- Benches or breaks should be constructed on the slope to act as surfaces for revegetation.
- Rip-rap or cribbing should be used to slow surface runoff and erosion.
- Topsoil, seeds and mulch can be spread to enhance revegetation.

Cuts and fills should not be made on slopes in ice-rich permafrost terrain because they are prone to slumping. If a cut is unavoidable in permafrost terrain, the backslope should be nearly vertical to allow the ground to thaw and establish its own final position. A wide ditch at the base of the cut can contain the thawed material, which can be removed as required.

Fill from a borrow pit can also be used on level ground to protect areas prone to thawing and heaving, such as peatlands or other ice-rich permafrost terrain. To avoid disturbing the ground with road-building equipment, the fill should be end-dumped from an established roadbed.

4.3 Drainage and Erosion Controls

Drainage and erosion controls progress from relatively simple structures in flat terrain to more complex structures in steeper terrain. In flat areas, roads can be crowned so that runoff drains to either side of the right-of-way, leaving the surface dry. In areas with gentle slopes, roads should be outsloped so that the downslope side of the road is slightly lower than the upslope side to ensure effective drainage across the road. In steep or wet areas, water should be channelled into drainage control structures designed to carry greater volumes, such as ditches and cross drains.

FIGURE 16. The slope of this road has been reduced by fill excavated from the adjacent cut. Drainage and Erosion Controls

4.3.1 Drainage Control Structures

Parallel ditches are troughs that follow the road grade along the upslope side of the road to intercept water before it reaches the road. These are usually required for roads on steep slopes. To reduce erosion, parallel ditches should be constructed of coarse-grained material, and areas prone to erosion, such as ditch corners and discharge points, should be reinforced with geotextiles or rip-rap. To avoid sediment deposition into water bodies, ditches should drain into well-vegetated areas.

Cross ditches are shallow trenches that extend across the road in a downslope direction to drain ponded water from the uphill side or from the road surface. Cross ditches should extend beyond the right-of-way into vegetated areas to avoid scouring and soil erosion. The number of cross ditches required will depend on the length and slope of the particular road segment.

Berms are low mounds of earth fill that are constructed along the shoulder of a road in the path of flowing water to divert its direction and prevent erosion. Berms act as a dam and should be intercepted by cross ditches at regular intervals to allow water to flow away from the road.

Cross drains are pipes that extend through the roadbed to drain water from the uphill side of the road. These should be used on roads that are constructed of fill material with parallel ditches beside the road. To ensure that water will flow through them, cross drains should be located below the level of the parallel ditches. To prevent cross drain failure from frost heave, coarse-grained bedding materials should be used. The roadbed material should also be coarse grained and well packed to ensure that water does not erode around the cross drain. The cross drain should be properly sized and situated to accommodate the expected volume of water to prevent road washouts. The downstream end of a cross drain should not hang above the level of the ground as the resulting falling water will cause erosion below the outlet.

In areas of ice-rich permafrost, flowing water can lead to rapid thawing and erosion of the ground so water should be channelled under a road through cross drains rather than cross ditches on the surface. Cross drains can be stacked on top of each other to maintain drainage in the event that the lower cross drain freezes.

FIGURE 17. This cross drain is covered with coarse-grained granular material for frost protection.

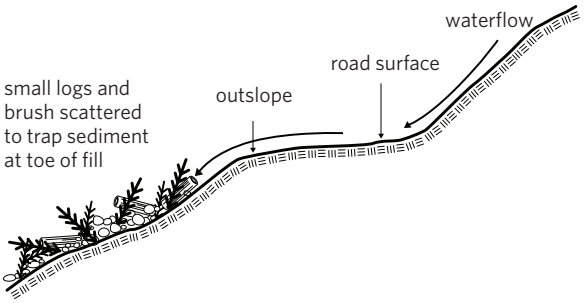


FIGURE 18. Sloping can be used to direct water off a road on a gentle slope. (modified from Hardy Associates (1978) Ltd., 1984)

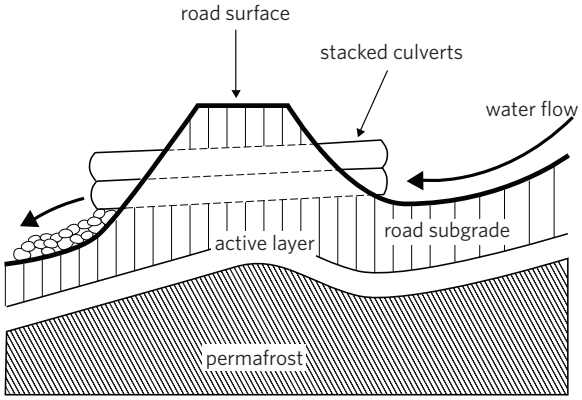


FIGURE 19. Stacked culverts can be used in permafrost terrain to ensure continuous drainage even if the bottom culvert becomes frozen. (modified from Hardy Associates (1978) Ltd., 1984)

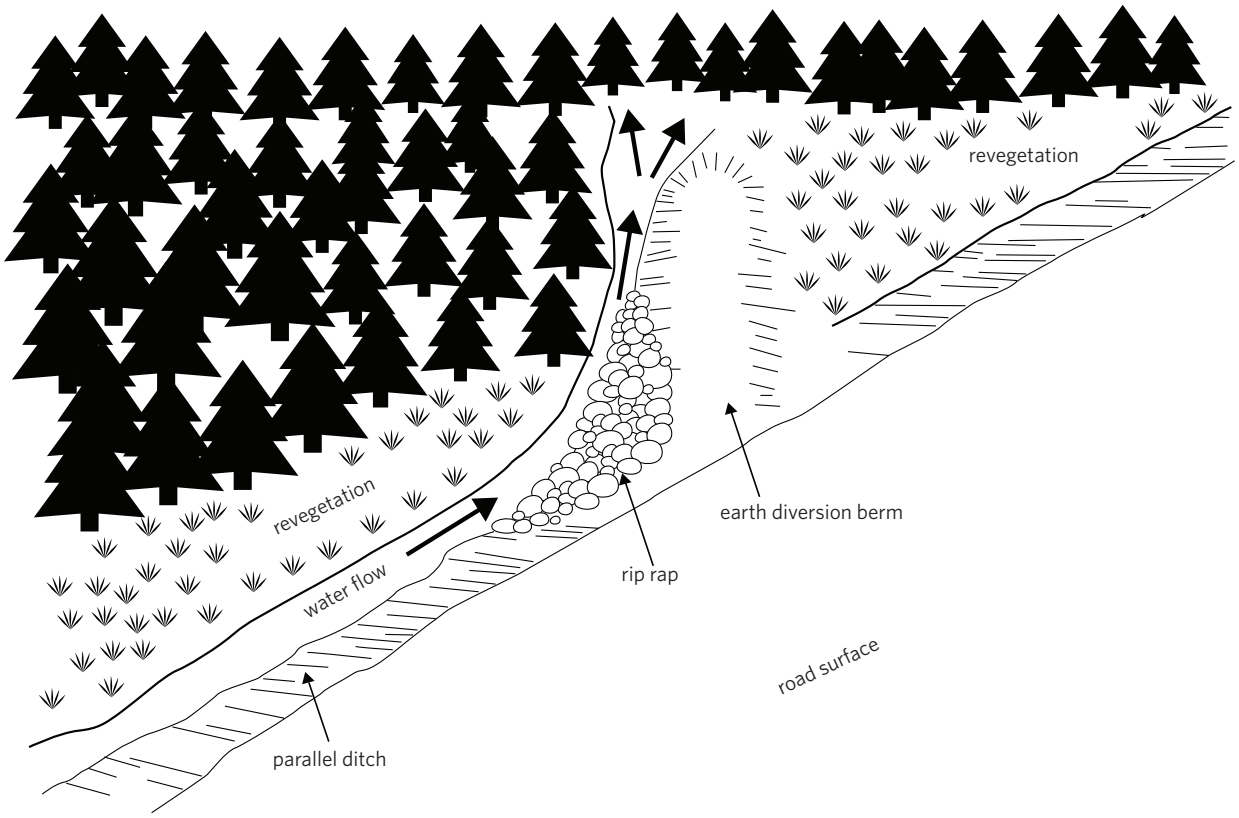


FIGURE 20. Diverting water away from the road and into a vegetated area at regular intervals will limit erosion and protect the roadbed. Directing runoff into a sedimentation pond is even more effective. (modified from Department of Transportation, Government of the Northwest Territories, 1993)

4.3.2 Erosion Control

Effective erosion controls, such as filter bags, silt fences or mats, can be used to slow runoff and reduce erosion where there is flowing water. In areas of higher velocity flow, such as ditches, ditch blocks can help control water speed and trap sediment. Ditch blocks are barriers to water flow that can be constructed of natural materials, including logs, cleared vegetation or rocks, or imported materials, such as sandbags. Spacing of ditch blocks should be determined by an engineer and will depend on the gradient and length of the ditch, soil texture and volume of runoff. Rip-rap should be used to armour the areas of highest velocity runoff, such as drainage channels and bridge abutments. Vegetation in ditches can also help control erosion and can be encouraged by seeding.

4.3.3 Drainage Icings

In cold weather, drainage control structures, particularly on slopes and at stream crossings, are prone to blockage by ice. Icings can also occur in flat terrain where areas of uneven snow removal or shading cause variable freezing of the active layer, forcing groundwater to the surface where it spreads and freezes. Pressure caused by icings can damage engineered structures and the build-up of ice on roads is a safety concern. If icings are observed, attempt to keep small channels thawed to promote continuous water movement.

Cross drains are particularly prone to icing. Methods to moderate this problem include:

- using open-ditch drainage;
- insulating cross drains;
- creating a frozen area above cross drains to block the winter flow of groundwater; and,
- installing a steam-circulating or electric-wire circuit in the cross drain to prevent freezing.

FIGURE 21. (Top) Ditch blocks and vegetation can be used to slow sediment movement in ditches parallel to the road.

FIGURE 22. (Middle) Silt curtains and matting can be used to control erosion near water bodies.

FIGURE 23. (Bottom) Icings can spread across a road and create a safety hazard.

4.4 Stream Crossings

Most roads will intersect several streams that will require various stream crossing methods. Stream crossings on all-weather roads can be temporary or permanent and include the use of fords, culverts or bridges. The use of logs for stream crossings is prohibited. The goal when building a stream crossing is to prevent erosion of riparian areas next to the stream and to avoid sedimentation into the stream as these situations could affect fisheries and wildlife habitat. There are several activities that should be avoided when constructing stream crossings:

- Minimize or eliminate in-stream activities as they tend to mobilize sediment, restrict stream flow or divert the natural stream course.
- Do not deposit soil or organic material into a stream.
- Avoid cutting stream banks to reduce the amount of sediment entering the stream.

Stream crossings should be located on stable ground at a narrow section of the stream with a gently sloped approach. Throughout construction, effective erosion controls, such as silt fences, should be used to prevent sediment from entering the stream. Engineered structures, such as culverts and bridges, should be installed progressively as construction of the road proceeds to eliminate the need for fording.

In-stream work may be required, for instance, to construct bridge abutments. While in-stream work is in progress, water-diversion channels or dams may be required to divert water from the stream bed. To allow fish passage, these structures should not block more than one third of the stream width and should be removed upon completion of construction. For more information on protecting fish and fish habitat while constructing stream crossings, refer to Fisheries and Oceans Canada at www.dfo-mpo.gc.ca.

4.4.1 Fording

Fording involves a vehicle travelling through a stream bed and may be acceptable under the following conditions:

- The crossing will not result in erosion and sedimentation into the stream or alteration (e.g. compaction or rutting) of the channel bed and banks.
- The stream bed is composed of non-erodible, coarse-grained material.
- Disturbance to riparian vegetation is minimized.

Fording should not be conducted in known fish-bearing streams, but if the crossing is unavoidable, fording should be restricted during spawning and migration periods. If sediment is inadvertently deposited into a stream, it must be removed immediately. The locations and proposed frequency of use of stream fords should be identified in the land use permit application.

FIGURE 24. Fording of this stream has resulted in rutting, sedimentation and erosion of the channel banks.

4.4.2 Culverts

Culverts are the most common stream crossing method for smaller streams. Professional engineering advice should be sought for installation of culverts to ensure that they are sized to accommodate the entire stream channel width and the highest annual flows. This will require a good understanding of local hydrology.

Culverts should be buried into the bed of the stream channel to a minimum of 20 percent of the culvert diameter at both the upstream and downstream

ends. This will promote the deposit of natural stream bed materials on the bottom of the culvert to maintain fish habitat and ensure that the water depth inside the culvert will be level with the water depth in the stream. Culvert alignment should approximate the existing stream channel alignment to mimic the natural stream flow, which will prevent bank erosion and channel scour. Culverts should extend a short distance beyond the toe of road fill material to prevent blockage at the end of the culvert by eroded soil. Granular material should be placed on top of the culvert to a minimum thickness of half the diameter of the culvert to prevent damage from vehicles travelling over.

In permafrost terrain, warm air circulating through culverts during summer may lead to thawing of permafrost in the roadbed and ground instability. To prevent thawing of permafrost, insulation can be placed around culverts during installation or flexible covers can be placed on the ends of large culverts to reduce the circulation of warm air. These covers should be removed in early winter to accommodate high water levels in the spring.

4.4.3 Bridges

Large, fast-flowing streams may require the construction of a bridge. Professional engineering advice should be sought for placement and construction of a bridge. Bridges should be high enough to permit the passage of water during periods of peak flow and ice during breakup. Sufficient clearance is also required in navigable waterways, and more information can be obtained from Transport Canada at www.tc.gc.ca. Bridge supports should be aligned to direct flow away from stream banks, but where this is not possible, banks should be armoured. Portable bridges are most appropriate for temporary roads because they can easily be removed, resulting in minimal disturbance to the stream.

FIGURE 25. (Top) A portable bridge is most appropriate for stream crossings on temporary access roads.

FIGURE 26. (Left) Incorrect sizing of culverts can lead to erosion and damage to the road.

FIGURE 27. (Right) Bridge abutments should be constructed out of the flood plain to avoid erosion and restricting stream flow.

CHAPTER 05

Winter Access

Roads and trails that are only used during winter, when the ground is frozen, are common in the North. Frozen ground is much harder than unfrozen ground and can withstand greater vehicle loads as the formation of ground ice increases soil strength. A surface layer of snow also protects the ground surface from rutting and the potential for thermokarst erosion. In winter, the frozen surfaces of lakes and rivers should be accessed, where possible, to reduce impacts on the land.

All-terrain vehicles and tracked vehicles can be used on all types of winter access routes but, because of their higher ground pressure, conventional wheeled vehicles should only travel on compacted snow or ice roads.

5.1 Surface Preparation

In some cases, it may be necessary to clear trees or brush from the route. Brush can be used as fill in wet areas. Brush can also be used to insulate permafrost terrain, but this technique should not be used for all-weather roads as decomposing vegetation can destabilize the roadbed.

Before winter road construction can proceed, the ground should be frozen and there should be sufficient snow cover to protect the ground surface from the tires or tracks of vehicles. The land use permit will specify the minimum snow depths and the timing of vehicle access to ensure the ground is frozen.

Once vehicles are permitted on the road, some surface preparation, such as snow clearing and packing, is usually required to enhance ground freezing and protect the ground surface. The amount of surface preparation required depends on weather conditions, size of vehicles using the road and frequency of vehicle use. A small-scale winter trail may not require any surface preparation if it is to be used by low ground pressure vehicles for only a few passes.

When clearing or packing snow, bulldozer blades should be raised off the ground using mushroom shoes or smear blades (Figure 34) to avoid cutting the tops of hummocks, tussocks or high spots, which can lead to ground thaw and subsidence during spring. The road should be allowed to settle for a few days after the first compaction before allowing traffic as compacted snow gains strength

FIGURE 28. A smear blade raises the bulldozer blade off the ground surface.

FIGURE 29. A low ground pressure vehicle, such as a snowcat, can be used for a first pass to compact snow on a winter road.

with time. Snow windrows on either side of the road created by snow clearing should have breaks at regular intervals to allow wildlife passage and drainage of meltwater in the spring.

To build a more durable road that can accommodate heavy vehicles, water can be sprayed on the road to create ice layers that build up the road surface and protect the ground. Alternatively, the strength of the snow layer can be enhanced by disaggregating the surface layer and then repacking it and allowing it to harden. Disaggregating snow by tilling or running it through a snow blower will result in a stronger road surface.

In areas where there is not enough snow to protect the ground surface and vegetation, snow can be hauled from nearby water bodies, captured using snow fences or manufactured using snow-making machines, then spread along the road and compacted. When there is a lack of snow over a wider area, an aggregate ice road can also be constructed. Blocks of ice can be mined from adjacent lakes and end-dumped to form the road base. Water can then be sprayed on the blocks to bond them together.

FIGURE 30. The road surface can be built up with ice using a water truck with a sprayer.

5.2 Scheduling

5.2.1 Opening

Commencement of winter road construction depends on air temperatures and snow conditions. The opening date is usually designated in the land use permit (generally November 15), but can be changed at the discretion of the INAC resource management officer depending on weather conditions. After the opening date, the road can be opened to lightweight tracked vehicles that will compact snow on the road surface to enhance ground freezing. Pre-packing the snow will also minimize disturbance to the ground surface associated with using drags or blades. There should be at least 10 cm of compacted snow on the road before heavier wheeled vehicles are permitted to operate.

5.2.2 Closing

Winter roads should be closed before the ground thaws and vehicle travel causes rutting. The closing date is usually designated in the land use permit (generally April 15), but can be changed at the

discretion of the INAC resource management officer depending on the road and weather conditions.

Melting usually occurs first on south-facing slopes, stream approaches and road sections with dark surfaces, and these are good indicators that road closure is imminent. Sufficient time should be allowed for road closure, including the removal of all equipment and stream crossings. As air temperatures approach 0˚C, the frequency of road inspections should be increased to ensure that the road is shut down before rutting occurs. With approval from an INAC resource management officer, road use may sometimes be extended a few days past the closing date by allowing vehicle travel at night when temperatures are below 0˚C.

FIGURE 31. (Top) Winter roads are not ready for use by heavy wheeled vehicles until there is at least 10 cm of packed snow. Visible grass on this road indicates that there is less than 10 cm of snow.

FIGURE 32. Ponded water and a lack of snow indicate that the ground is thawing and this winter road should be closed immediately.

5.3 Water Use

Roads used by heavy vehicles during winter months can be strengthened by applying successive layers of water. Applying many thin layers of water to the roadbed and allowing them to freeze will result in a harder surface than building a road using several deep layers of water. An ice road surface can provide the following benefits:

- a smoother road surface requiring less maintenance;
- better protection of the ground surface; and
- a longer road life.

If water is required for winter road construction, a water licence may be required and water withdrawal protocols prescribed by Fisheries and Oceans Canada should be followed.

5.4 Ice Roads on Water Bodies

Ice road construction on bodies of water can be easier, more cost effective and have less environmental impact than winter road construction on land. The Government of the Northwest Territories' *A Field Guide to Ice Construction Safety* provides guidelines for appropriate ice thicknesses for winter roads on bodies of water.

5.5 Stream Crossings

Stream crossings for winter roads range from simple fills to engineered structures, including snow fills, ice bridges, culverts and bridges. All crossings should be located along gently sloped stream banks to minimize soil erosion. Ice and snow thickness should be sufficient to protect the stream banks from erosion (minimum 10 cm). Clean snow should be used to construct approaches to crossings and fills to ensure that debris does not enter the stream during spring.

Snow fills are the smallest scale winter stream crossing and involve compacting snow in the stream bed to create a road surface. They should only be used in streams that freeze to the bottom and should be removed, or notched, in the spring so that they do not impede stream drainage.

For streams that develop a solid ice cover, but do not freeze to the bottom, an ice bridge can be built to cross the stream. An ice bridge can be built by removing snow from the ice surface to increase the

FIGURE 33. A well-constructed snow fill located adjacent to a new bridge.

FIGURE 34. A poorly constructed snow fill consisting of mixed brush and snow.

FIGURE 35. An ice bridge built over a large stream channel.

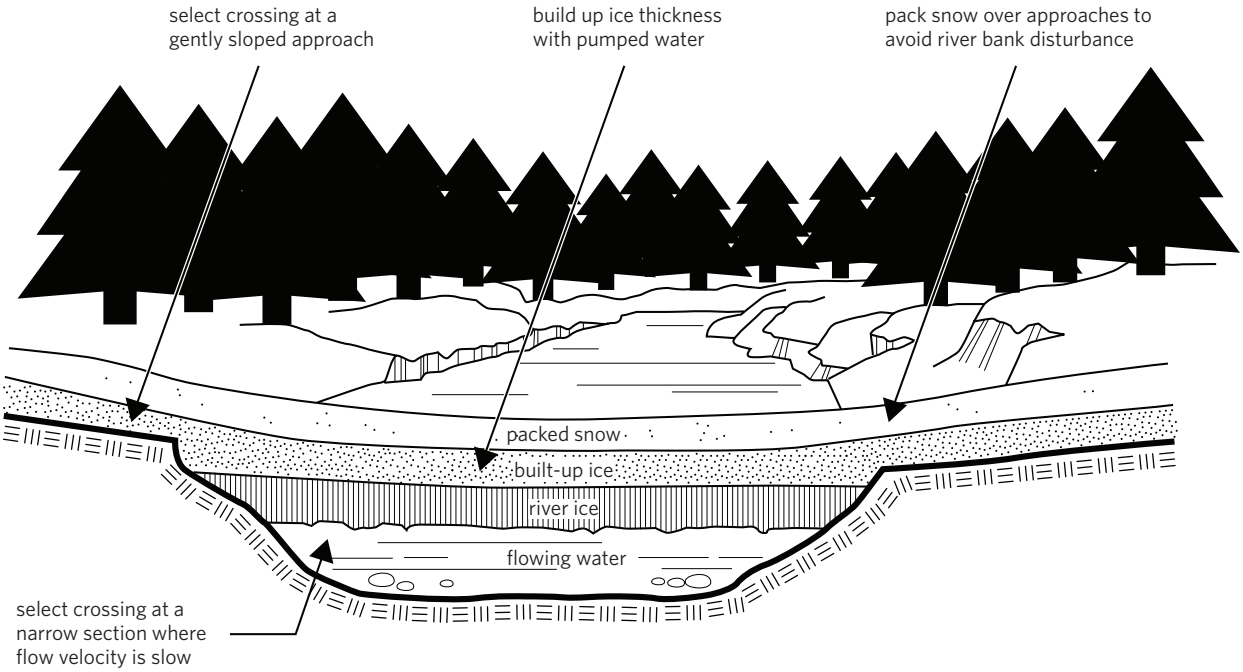


FIGURE 36. Typical ice bridge location and construction. (modified from Deparment of Transportation, Government of the Northwest Territories, 1993)

ice thickness. Water can then be used to increase the ice thickness in successive shallow layers. The Government of the Northwest Territories' *A Field Guide to Ice Construction Safety* recommends appropriate ice thicknesses for stream crossings.

Ice bridges must not obstruct the flow of water in a stream by causing it to freeze to the bottom. The resulting dam could create an icing that would spread beyond the stream banks, damaging both vegetation and the road. Overwintering fish and aquatic mammals would also be negatively affected. More information on protecting fish and fish habitat while constructing a snow fill or ice bridge is available from Fisheries and Oceans Canada at www.dfo-mpo.gc.ca.

As an alternative to ice bridges, pipe culverts can be placed in streams that do not develop a solid ice cover. Culvert installation must be preplanned and carried out during summer as described in Section 4.4.2. For fish-bearing streams, however, bridges or arch culverts, are preferable to the use of pipe culverts to maintain fish habitat. These bridges retain the natural stream bottom and slope.

All snow, ice and other construction materials associated with a stream crossing, including culverts, must be removed from the stream bed in the spring before freshet to allow free passage of water and fish. Removal of stream crossings should occur progressively along the right-of-way as the winter road is closed to minimize in-stream work. In some cases, a v-shaped notch cut into the middle of the stream crossing will allow for the passage of water and result in removal of the rest of the snow or ice during the spring freshet.

CHAPTER 06

Operations

Operations include the establishment of operating conditions that protect the route, such as weight restrictions, and regular monitoring and maintenance that ensure the route continues to function with minimal impact on the environment.

6.1 Operating Conditions

Operating conditions for road use, such as appropriate vehicle loads and operating times, should be established to protect the integrity of the road and the safety of its users.

During wet periods, roads can become soft and rutting is more likely to occur. To preserve the roadbed, vehicles should keep off road shoulders and out of parallel ditches. In extremely wet conditions, the road should be closed to traffic.

Load limits can be implemented on roads to avoid rutting and should be based on road engineering specifications and local experience. On all-weather roads, limits are commonly used during spring when the road is saturated and its load-bearing capacity is at a minimum. Limits should account for vehicle speed, weight and frequency of vehicle loads. Load limits on winter roads may be based on the depth of the snow cover. For winter roads that cross over water bodies, limits can also be based on the ice thickness, how the ice formed and water pressure below the ice.

Dust suppressants are used to maintain visibility on roads during the summer months. Where possible, water should be used as a dust suppressant and the use of water may require a water licence.

Dust suppressants should only be used with the approval of the appropriate land use regulator, territorial environment department and INAC resource management officer. Proponents may be required to notify the public and property owners in the area. For more information on dust suppression techniques, review the Government of the Northwest Territories' *Guidelines for Use of Dust Suppressants on Commissioner's Land in the Northwest Territories* or the Government of Nunavut's *Environmental Guideline for Dust Suppression*.

6.2 Monitoring and Maintenance

Regular monitoring of a road will allow for continual assessment of its performance and quick identification of areas that need to be repaired. The frequency of monitoring depends on the size of the road, its use, and potential risks to users and the environment. Typical monitoring activities include observation of drainage and erosion control structures, and stream crossings. Observations should also include current weather conditions and their effect on the route.

Regular maintenance is required to protect the structural integrity of the road and the cleared right-of-way, maintain drainage control structures and minimize erosion. Regular maintenance activities include:

- cleaning or repairing drainage and erosion control structures;
- grading the road surface to minimize rutting, potholes or channelling of water;

FIGURE 37. Regular monitoring will identify areas prone to erosion that may need to be redesigned.

- removing vegetation that overhangs the road to enhance drying and visibility; and
- maintaining vegetation or revegetating slopes and ditches to minimize erosion.

Well-documented monitoring and maintenance logs can be used to identify long-term trends and problem areas along the road that may need to be redesigned.

6.2.1 Drainage Control Structures

The performance of drainage control structures should be monitored after their installation, particularly during periods of high runoff, such as the spring freshet or heavy rainfall events. Scouring, flooding and displacement of rip-rap in ditches and berms are indicators that the structure is inadequate and should be upgraded as soon as possible. In some areas, natural drainage patterns may not be noticeable until after the road has been constructed and erosion or ponding occurs. In these areas, drainage structures will need to be added as problems are identified.

The structural integrity of bridges and culverts along the road should be assessed regularly. The morphology of the stream channel should also be monitored as any changes may affect bridge or culvert performance. Bridges and culverts should be inspected and cleaned regularly. During winter, culverts should be checked regularly for icing.

6.2.2 Permafrost Terrain

Drainage patterns in flat permafrost terrain are difficult to delineate because of gentle slopes and low precipitation rates. During summer, groundwater is confined to a thin active layer above the permafrost and may drain laterally across a road surface. Due to these difficulties in planning for drainage, post-construction monitoring of drainage control structures is particularly important in permafrost terrain to determine if more drainage structures are required.

Filled areas built on ice-rich permafrost can be subject to uneven thawing of the foundation soil, especially if they are constructed of fine-grained soil. Differential settling can lead to significant lateral spreading, cracking or sloughing of the embankment side slopes. Regular monitoring and maintenance are required to identify, fill and level affected areas.

FIGURE 38. Culverts should be monitored and cleaned regularly to ensure that they continue to function properly.

FIGURE 39. Regular monitoring will identify areas where drainage controls are inadequate and need to be redesigned.

6.2.3 Snow

Clearing fallen or wind-blown snow is a routine maintenance activity required to allow the passage of vehicles. Best practices for clearing snow include:

- staking or flagging culverts and berms to avoid damaging them;
- creating breaks in snowbanks at regular intervals to allow wildlife passage; and
- removing snowbanks before freshet to allow the road to drain.

Normal traffic use of a road during winter will eventually cause washboarding, which can increase vehicle wear and damage. This can be prevented by grading and dragging the snow.

Throughout winter, and especially during spring, the entire road surface should be kept covered with white snow because soil on the road surface absorbs heat, accelerates ground thawing and reduces the length of time the road can be used during spring. Bare spots should be covered with snow as soon as possible. Soil should not be mixed with snow for use as fill.

6.3 Access Management

At times, it may be necessary to restrict or manage access to a road or trail, particularly if there are health, safety or wildlife concerns. Further information on access management strategies can be obtained from the local INAC resource management officer.

FIGURE 40. Differential settlement can occur in ice-rich permafrost terrain.

FIGURE 41. Clearing snow is part of routine winter road maintenance.

CHAPTER 07

Spills

Spills can involve chemicals, hydrocarbons or other hazardous materials. Spills of reportable quantities must be reported immediately to the 24-hour spill line at 867-920-8130. A list of immediately reportable spill quantities is available in INAC's *Guidelines for Spill Contingency Planning* at www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/SCP-eng.asp

7.1 Spill Contingency Plan

A spill contingency plan must be in place during all phases of road construction and operation, and must be submitted with the land use permit application. Unexpected spill events do occur and a plan will help operators respond to them quickly and effectively. The spill contingency plan should be implemented immediately after a spill event. The plan outlines a logical order of how operators should respond to a spill, resources available on-site for spill response, and agencies and individuals that need to be notified. All personnel working on the site should be aware of and understand the plan so that they can respond effectively to a spill. A spill contingency plan template is provided in INAC's *Guidelines for Spill Contingency Planning*.

7.2 Spill Prevention

Hydrocarbon spills from equipment are a major source of environmental damage and are often preventable. Equipment should be properly maintained and in good working condition to minimize potential leaks from hydraulic hoses and other working components. Drip trays can be placed under equipment when it is not in use to catch hydrocarbon drips.

7.3 Spill Response

Spill response includes stopping, containing and reporting a spill event. A well stocked spill response kit should be available on-site. Once a spill has been contained and reported, photographs should be taken of the spill area, the extent of the spill should be delineated and a cleanup strategy should be developed. Ensure that there is never an ignition source in the vicinity of spilled flammable products.

FIGURE 42. Unexpected spill events do occur and a spill contingency plan will ensure that all operators are prepared to respond to them quickly and effectively.

CHAPTER 08

Closure and Reclamation

8.1 Reclamation Goals

The key question that should be considered when defining the reclamation goals for a road is whether it will be used in the future for a different purpose or whether it will be permanently decommissioned. The route should be designed with the final end use in mind. Reclamation goals will require the approval of the appropriate regulators, and should be discussed with community members and Aboriginal groups.

Reclamation goals will form the core of the closure and reclamation plan that will be required by the applicable land use regulator for roads that are being decommissioned. These plans are not usually required for trails. Reclamation requirements will be specified in the land use permit.

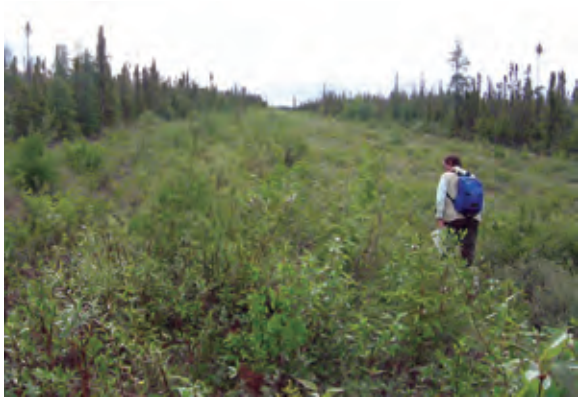


FIGURE 43. A reclamation goal could be to return the land to a stable condition by revegetating the site.

8.2 Reclamation Activities

Progressive reclamation should be conducted throughout construction and operation to reduce soil erosion and the length of time a site is disturbed. This can include activities such as revegetating ditches and reclaiming unused sections of roads, quarries and shoo flys. Reclamation of the cleared right-of-way adjacent to the road can be helped by leaving tree roots and shrubs in place during clearing and scattering brush to create micro-sites for native seeds.

Final site reclamation will occur when the road is no longer required. Monitoring after reclamation activities are complete will determine if reclamation has met the goals specified in the closure and reclamation plan. Monitoring the performance of progressive reclamation efforts during operations may shorten final reclamation monitoring requirements if they are found to be successful.

8.2.1 Remove Structures, Equipment and Garbage

During reclamation or extended shutdown of operations, all garbage, petroleum products and equipment should be removed from the road. For final reclamation, buildings should also be removed. If the road is being permanently decommissioned, culverts should be removed carefully to avoid sedimentation, and the stream bed and banks should be re-established. Where culverts are removed, cross ditches should be constructed across the road to maintain drainage.

FIGURE 44. This reclaimed site is well contoured and revegetated, but the culvert should be removed.

FIGURE 45. Erosion control can include the use of mats and planting willow cuttings.

8.2.2 Erosion Control

Areas that are not prone to erosion generally require minimal contouring and can be left to revegetate naturally. For instance, on flat sections of the route, stockpiled organic topsoil can be replaced evenly on the road surface and the surface can be scarified to provide sites for natural re-seeding.

On steep slopes, adequate cross drainage is required across the reclaimed road using cross ditches or berms. For slopes where soil erosion is a greater concern, active revegetation by seeding or planting should be conducted to achieve soil stability and restore the natural appearance of the site. The INAC resource management officer and territorial environment department should be contacted for information on approved seed mixes. Further erosion control measures include:

- planting shrub cuttings, such as willows;
- mulching and spreading;
- erosion control mats;
- soil binders;
- rock or gravel blankets; and
- creating terraces.

8.2.3 Restrict Access

Public use of reclaimed roads may disturb erosion control structures. To prevent public use of reclaimed roads, barriers can be constructed at their intersection with public roads. An effective method is to spread slash and debris on the right-of-way near the intersection.

8.3 Reclamation Monitoring

Monitoring will be required for several years after reclamation activities are completed to assess whether the closure objectives have been met. Monitoring requirements will usually be specified in the land use permit. Post-closure monitoring should attempt to answer the following questions:

- Are erosion control structures performing as designed?
- Are water management techniques effectively controlling water on and adjacent to the right-of-way?
- Has vegetation been re-established to predicted levels?

If monitoring demonstrates that some reclamation techniques have been unsuccessful, additional reclamation work may be required. When the land use regulator is satisfied that the site is stable and the reclamation objectives have been met, a letter of final clearance will be issued indicating that the permit holder is no longer responsible for the road or trail.

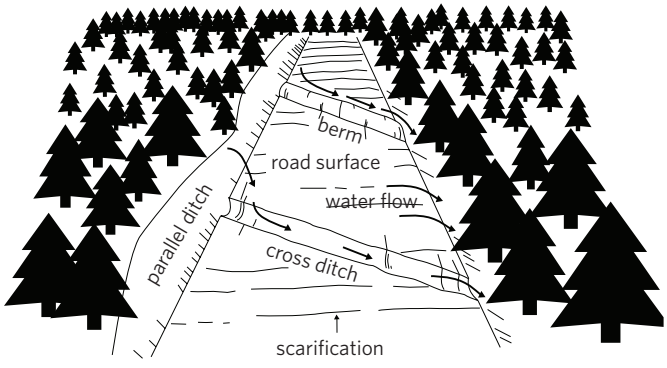


FIGURE 46. Berms and cross drains can be installed along the right-of-way to deflect water into surrounding vegetation and to control access. (1994 INAC Access Roads and Trails Guidelines)

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Glossary

Berm

Low earth mound constructed in the path of flowing water to divert its direction.

Binder

Substance that encourages the adherence of soil particles, such as a chemical mat.

Borrow pit

Pit created to provide earth materials to be used as fill at another site.

Buffer strip

Area of land left untouched to provide a natural barrier between a development area and an adjacent area. Buffers can be used to protect important ecosystem components, such as wildlife habitat or water bodies, or they can be used to provide a visual barrier between a development area and an area of human use.

Cross ditch

Shallow trench excavated across a road to drain water in the downslope direction.

Cross drain

Pipe that extends through the roadbed to drain water from the uphill side of the road.

Cut and fill

Construction practice in which earth materials are excavated from part of an area and used as fill in adjacent areas.

Cribbing

Support structure usually built of timbers or logs, but can be of concrete or steel.

Ditch block

Barrier constructed within a ditch to control water speed and trap sediment, which could include logs, cleared vegetation or rocks.

Dogleg

Sharp change in the direction of a road. Designed to conceal the road from view for aesthetic purposes.

Dragging

Method of smoothing a road surface by pulling a heavy object behind a moving vehicle.

End dumping

A method of road building where material is dumped onto the ground surface, spread, and graded. Construction continues by driving to the end of the road and dumping another load.

Esker

Long, narrow ridge of coarse gravel and granular materials deposited by glacial meltwater.

Fording

Crossing a stream by driving a vehicle through it.

Freshet

Rapid rise in stream flow due to runoff from snowmelt during spring.

Ground ice

Ice present in ground materials. It dominates the geotechnical properties of the material and can cause terrain instability if it melts.

Grubbing

Removal of stumps, roots, brush and excess organic matter from the route.

Heritage resources

Historic, cultural or natural resource that has been identified by a community, territory or the federal government as being representative of the history or culture of an area.

Hummock

Small mound of mineral soil, largely silt and clay, formed by differential frost heave that makes the ground irregular.

Parallel ditch

Trough that runs beside the road.

Peatland

Poorly drained organic terrain characterized by a high water table and the presence of permafrost.

Permafrost

Ground frozen for at least two consecutive years. Continuous permafrost is defined as an area where at least 90 percent of the land area is underlain by permafrost. Discontinuous permafrost is defined as an area where 10 to 90 percent of the land area is underlain by permafrost.

Progressive reclamation

Action that can be taken during operations before permanent closure to take advantage of cost and operating efficiencies by using resources available from ongoing operations. Enhances environmental protection and shortens the time frame for achieving reclamation objectives.

Pushouts

Trees that have been pushed down, off the right-of-way, as a result of clearing.

Riparian

Area of land adjacent to a stream, river, lake or wetland containing vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas.

Rip-rap

Layer of large stones or broken rock placed on an embankment for erosion control and protection.

Rutting

Depressions in soil, soil erosion and ponding that are the result of repeatedly operating heavy equipment on wet, unfrozen soils.

Shoo fly

Temporary access road built around a steep or difficult section of a right-of-way so that equipment can traverse the area without damaging the ground.

Slash

Woody debris, such as branches, logs and brush, that remains on the ground after clearing has been completed.

Subsidence

The gradual sinking or downward settling of the earth's surface in response to geologic or man-induced causes.

Thermokarst

Terrain characterized by pits and depressions caused by permafrost degradation and melting of ground ice.

Tussock

Thick clump of grass or sedge that can be up to 1 m in height formed by the accumulation of dead vegetation.

Watershed

Area of land that drains water into a particular stream, river or lake.

Windrow

Woody debris that has been piled into a long, continuous row.

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APPENDIX E

DFO Operational Statement for Ice Bridges and Snow Fills

ICE BRIDGES AND SNOW FILLS

Fisheries and Oceans Canada
Northwest Territories Operational Statement

Version 3.0

Ice bridges and snow fills are two methods used for temporary winter access in remote areas. Ice bridges are constructed on larger watercourses that have sufficient stream flow and water depth to prevent the ice bridge from coming into contact with the stream bed or restricting water movement beneath the ice. Snow fills, however, are temporary stream crossings constructed by filling a stream channel with clean compacted snow.

Ice bridge and snow fill crossings provide cost-effective access to remote areas when lakes, rivers and streams are frozen. Since the ground is frozen, ice bridges and snow fills can be built with minimal disturbance to the bed and banks of the watercourse. However, these crossings can still have negative effects on fish and fish habitat. Clearing shoreline and bank vegetation increases the potential for erosion and instability of the banks and can lead to deposition of sediments into fish habitat. There is also potential for blockage of fish passage during spring break-up.

Fisheries and Oceans Canada (DFO) is responsible for protecting fish and fish habitat across Canada. Under the *Fisheries Act* no one may carry out a work or undertaking that will cause the harmful alteration, disruption or destruction (HADD) of fish habitat unless it has been authorized by DFO. By following the conditions and measures set out below you will be in compliance with the subsection 35(1) of the *Fisheries Act*.

The purpose of this Operational Statement is to describe the conditions under which it is applicable to your project and the measures to incorporate into your project in order to avoid negative impacts to fish habitat. You may proceed with your ice bridge or snow fill project without a DFO review when you meet the following conditions:

- your planned work is not located in a critical area, as identified in a NWT Community Conservation Plan or other applicable land use plan,
- ice bridges are constructed of clean (ambient) water, ice and snow,
- snow fills are constructed of clean snow, which will not restrict water flow at any time,
- the work does not include realigning the watercourse, dredging, placing fill, or grading or excavating the bed or bank of the watercourse,
- materials such as gravel, rock and loose woody material are NOT used,
- where logs are required for use in stabilizing shoreline approaches, they are clean and securely bound together, and they are removed either before or immediately following the spring freshet,
- the withdrawal of any water will not exceed 10% of the instantaneous flow, in order to maintain existing fish habitat,
- water flow is maintained under the ice, where this naturally occurs,
- this Operational Statement is posted at the work site and is readily available for reference by workers, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when Constructing an Ice Bridge or Snow Fill* listed below in this Operational Statement.

If you cannot meet all of the conditions listed above and cannot incorporate all of the measures listed below then your project may result in the violation of subsection 35(1) of the *Fisheries Act* and you could be subject to enforcement action. In this case, you should contact the DFO office in your area if you wish to obtain DFO's opinion on the possible options you should consider to avoid contravention of the *Fisheries Act*.

You are required to respect all local, municipal, territorial or federal legislation that applies to the work being carried out in relation to this Operational Statement. The activities undertaken in this Operational Statement must also comply with the *Species at Risk Act* (**www.sararegistry.gc.ca**). If you have questions regarding this Operational Statement, please contact the DFO office in your area (see Northwest Territories DFO office list).

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Northwest Territories Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the DFO office in your area. This information is requested in order to evaluate the effectiveness of the work carried out in relation to this Operational Statement.

Measures to Protect Fish and Fish Habitat when Constructing an Ice Bridge or Snow Fill

1. Use existing trails, winter roads or cut lines wherever possible as access routes to limit unnecessary clearing of additional vegetation and prevent soil compaction.

2. Construct approaches and crossings perpendicular to the watercourse wherever possible.

3. Construct ice bridge and snow fill approaches using clean, compacted snow and ice to a sufficient depth to protect the banks of the lake, river or stream. Clean logs may be used where necessary to stabilize approaches.

4. Where logs are used to stabilize the approaches of an ice bridge or snow fill:

   4.1. The logs are clean and securely bound together so they can be easily removed.
   4.2. No logs or woody debris are to be left within the water body or on the banks or shoreline where they can wash back into the water body.

   Note: The use of material other than ice or snow to construct a temporary crossing over any ice-covered stream is prohibited under section 11 of the *Northwest Territories Fishery Regulations*, unless authorized by a Fishery Officer. Please contact the nearest NWT DFO office.

5. While this Operational Statement does not cover the clearing of riparian vegetation, the removal of select plants may be necessary to accommodate the road. This removal should be kept to a minimum and within the road right-of-way.

6. Install sediment and erosion control measures before starting work to prevent the entry of sediment into the watercourse. Inspect them regularly during the course of construction and decommissioning activities and make all necessary repairs if any damage occurs.

7. Operate machinery on land or on ice and in a manner that minimizes disturbance to the banks of the lake, river or stream.

   7.1. Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks.
   7.2. Wash, refuel and service machinery and store fuel and other materials for the machinery away from the water to prevent any deleterious substance from entering the water or spreading onto the ice surface.
   7.3. Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.
   7.4. Restore banks to original condition if any disturbance occurs.

8. If water is being pumped from a lake or river to build up the bridge, follow DFO's *NWT Winter Water Withdrawal Protocol* (available from the DFO offices listed below), and ensure that the intakes are sized and adequately screened to prevent debris blockage and fish mortality (refer to DFO's *Freshwater Intake End-of-Pipe Fish Screen Guideline* (1995) available at **www.dfo-mpo.gc.ca/Library/223669.pdf**).

9. Crossings do not impede water flow at any time of the year.

10. When the crossing season is over and where it is safe to do so, create a v-notch in the centre of the ice bridge to allow it to melt from the centre and also to prevent blocking fish passage, channel erosion and flooding. Compacted snow should be removed from snow fills prior to the spring freshet.

11. Stabilize any waste materials removed from the work site to prevent them from entering the lake, river, or stream. This could include covering spoil piles with biodegradable mats or tarps or planting them with grass or shrubs.

12. Vegetate and stabilize (e.g., cover exposed areas with erosion control blankets or tarps to keep the soil in place and prevent erosion) any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses. Cover such areas with mulch to prevent erosion and to help seeds germinate. If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site should be stabilized using effective sediment and erosion control measures. In areas with permafrost, care should be exercised to ensure these measures do not cause thawing or frost heave.

    12.1. Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

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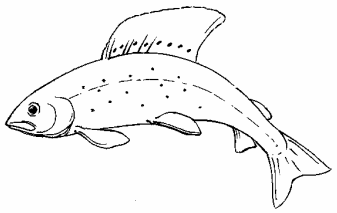
Aussi disponible en français

http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/epmp-pmpe/index_f.asp

DFO/2007-1329

APPENDIX F

DFO's Protocol for Winter Water Withdrawal in the Northwest Territories and Nunavut



DFO Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut

Rationale

In the Northwest Territories and Nunavut, winter activities such as access road construction, exploratory drilling and camp operations often require large amounts of water. Excessive amounts of water withdrawn from ice-covered waterbodies can impact fish through oxygen depletion, loss of over-wintering habitat and/or reductions in littoral habitat. The potential for such negative impacts to over-wintering fish and fish habitat has made winter water withdrawal a critical issue for Fisheries and Oceans Canada (DFO) in the Northwest Territories and Nunavut. To mitigate impacts to fish from water withdrawal from ice-covered waterbodies, and to provide standardized guidance to water users, including volume limits for certain water source types, DFO has developed this protocol in conjunction with industry and other regulators.

For the purposes of this protocol, a **waterbody** is defined as any water-filled basin that is potential fish habitat. A waterbody is defined by the ordinary high water mark of the basin, and excludes connecting watercourses.

This protocol will **not** apply to the following:

- Any waterbody that is exempted by DFO (e.g. Great Bear Lake, Great Slave Lake, Gordon Lake, and others as and when determined by DFO), and;
- Any waterbody from which less than $100m^3$ is to be withdrawn over the course of one ice-covered period.

In order to establish a winter water withdrawal limit for a given waterbody, the following criteria must be adhered to:

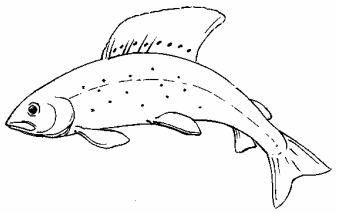
1. In one ice-covered season, total water withdrawal from a single waterbody is not to exceed 10% of the available water volume calculated using the appropriate maximum expected ice thickness provided in Table 1.
2. In cases where there are multiple users withdrawing water from a single waterbody, the total combined withdrawal volume is not to exceed 10% of the available water volume calculated using the appropriate maximum expected ice thickness provided in Table 1. Therefore, consistent and coordinated water source identification is essential.
3. Only waterbodies with maximum depths that are ≥1.5m than their corresponding maximum expected ice thickness should be considered for water withdrawal (Table 1). Waterbodies with less than 1.5m of free water beneath the maximum ice are considered to be particularly vulnerable to the effects of water withdrawal.
4. Any waterbody with a maximum expected ice thickness that is greater than, or equal to, its maximum depth (as determined from a bathymetric survey) is exempt from the 10% maximum withdrawal limit (Table 1).

To further mitigate the impacts of water withdrawal, water is to be removed from deep areas of waterbodies (>2m below the ice surface) wherever feasible, to avoid the removal of oxygenated surface waters that are critical to over-wintering fish. The littoral zone should be avoided as a water withdrawal location. Water intakes should also be properly screened with fine mesh of 2.54 mm (1/10") and have moderate intake velocities to prevent the entrainment of fish. Please refer to the *Freshwater Intake End-of-Pipe Fish Screen Guideline* (DFO, 1995) which is available upon request, or at the following internet address: www.dfo-mpo.gc.ca/Library/223669.pdf.

In order to determine the maximum water withdrawal volume from an ice-covered waterbody, and thereby conform to this protocol, the following information must be provided to DFO for review and concurrence prior to program commencement.

Water Source Identification

1. Proposed water sources, access routes, and crossing locations clearly identified on a map, with geographical coordinates (latitude/longitude and/or UTMs) included.
2. Any watercourse connectivity (permanently flowing and/or seasonal) between the proposed water source and any other waterbody or watercourse.



DFO Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut

3. Aerial photos or satellite imagery of the water sources.
4. Estimated total water withdrawal requirement for work or activity and estimated total water withdrawal per water source (in m^3).

Bathymetric Survey Results

1. For all waterbodies: One longitudinal transect, connecting the two farthest shorelines, is to be conducted regardless of waterbody size. Note: a longitudinal transect may be straight or curved in order to accommodate the shape of a lake (see Figure 1).
2. For waterbodies equal to or less than 1 km in length: a minimum of one longitudinal transect and two perpendicular transects are to be conducted. Perpendicular transects should be evenly spaced on the longest longitudinal transect, dividing the lake into thirds (Figure 1).
3. For lakes greater than 1 km in length: a minimum of one longitudinal transect is to be conducted. Perpendicular transects (minimum of 2) should be evenly spaced on the longest longitudinal transect at maximum intervals of 500 m.
4. Additional transects should be run as required to include irregularities in waterbody shape such as fingers or bays (Figure 1).
5. All longitudinal and perpendicular transects are to be conducted using an accurate, continuous depth sounding methodology, such as open water echo sounding or ground penetrating radar (GPR), that provides a continuous depth recording from one shore to the farthest opposing shore (Figure 1). Any alternative technology should be reviewed by DFO prior to implementing for bathymetric surveys.

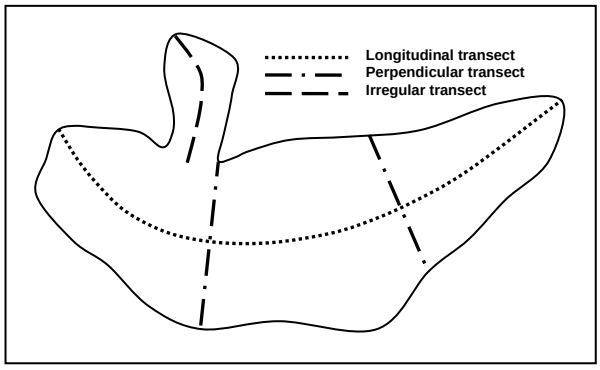
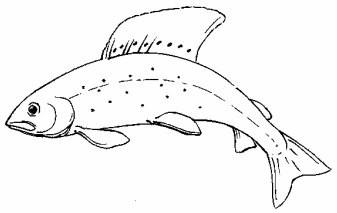


Figure 1. Minimum transect layout for a lake that is less than 1 km in length, with an irregularity.

Volume Calculations

1. Document the methods used to calculate surface area. If aerial photos or satellite imagery were used, provide the date (day/month/year) taken, as surface area may change depending on the time of year. If maps were used, provide the year that they were surveyed.
2. Detail the methods used to determine the total volume of free water, incorporating the relevant bathymetric information.
3. Calculate the available water volume under the ice using the appropriate maximum expected ice thickness, i.e. *Total Volume* $_{lake}$ *– Ice Volume* $_{max\ thickness}$ *= Available Water Volume* (see Table 1 for maximum ice thickness).
4. For programs where ice-chipping is used, the total ice volume to be removed from the waterbody should be converted to total liquid volume and incorporated into the estimate of total water withdrawal requirement per water source.



DFO Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut

Table 1. Maximum expected ice thickness, and corresponding water depth requirements, for different regions in the Northwest Territories.

Area	Maximum Expected Ice Thickness (m)	Minimum Waterbody depth Required for 10% Water Withdrawal (m)
Above the Tree Line	2.0	≥3.5
Below the Tree Line - North of Fort Simpson	1.5	≥3.0
Deh Cho –South of Fort Simpson	1.0	≥2.5

A brief project summary report documenting and confirming total water volume used per water source and corresponding dates should be submitted to DFO within 60 days of project completion. Information should be provided in the following format (this information would also be useful as part of the project description):

Lake ID	number and/or name
Coordinates	latitude and longitude and/or UTM coordinates
Surface area	in ha
Total Lake Volume	in m^3
Under Ice Volume	in m^3 (based on max ice thickness for region)
Max expected ice thickness value used	in m
Calculated 10% Withdrawal volume	in m^3
Total required water volume extracted	in m^3
Aerial photographs of waterbody	PDF format
Bathymetric Map(s) of waterbody	PDF format

Any requests deviating from the above must be submitted to DFO and will be addressed on a site-specific basis.

Beaver and Muskrat

Many species of animals are highly sensitive to water fluctuations. In areas where beaver and muskrat may occur, the appropriate agencies or organizations should be consulted to determine if harmful effects will result from your activities, and whether these effects can be successfully mitigated through modifications to your plans including best management practices.

Please note that adherence to this protocol does not release the proponent of the responsibility for obtaining any permits, licenses or authorizations that may be required.

For more information contact DFO at (867) 669-4915.

APPENDIX G

DFO Fish Screen Design Criteria for Flood and Water Truck Pumps

Fisheries and Oceans Canada | Pêches et Océans Canada

Fish Screen Design Criteria for Flood and Water Truck Pumps

Fisheries and Oceans Canada

Overview

Development is ever increasing in the north, with many associated activities occurring in the winter months when access to remote locations is facilitated by seasonal winter roads made of snow and ice. The construction and maintenance of winter roads often require large quantities of water that is withdrawn from ice-covered lakes, ponds, streams, and rivers. The duration and frequency of water withdrawals for access construction is limited at a given water source compared to more permanent structures such as a municipal or permanent camp water intake.

During construction or maintenance, water is used to strengthen or repair sections of the roadway. Water can be applied to the surface of the ice road using a flood pump or a water truck. Flood pumps are used to pump water directly from an auger hole to the surrounding surface area, and are used when a larger volume of water is required and a source of water is available at the site (Figure 1). Water trucks also need to extract water though holes augured through the ice, but have the ability to transport and distribute water over a larger area including portages (overland sections between waterbodies).

Fig.1. Flood Pump and the flood pump in use.

As with any water intake that operates in fish bearing waters, protection of fish from entrainment (i.e. fish drawn into the water intake) or impingement (i.e. fish held in contact with the intake screen and cannot escape) is required. The objective of this document is to

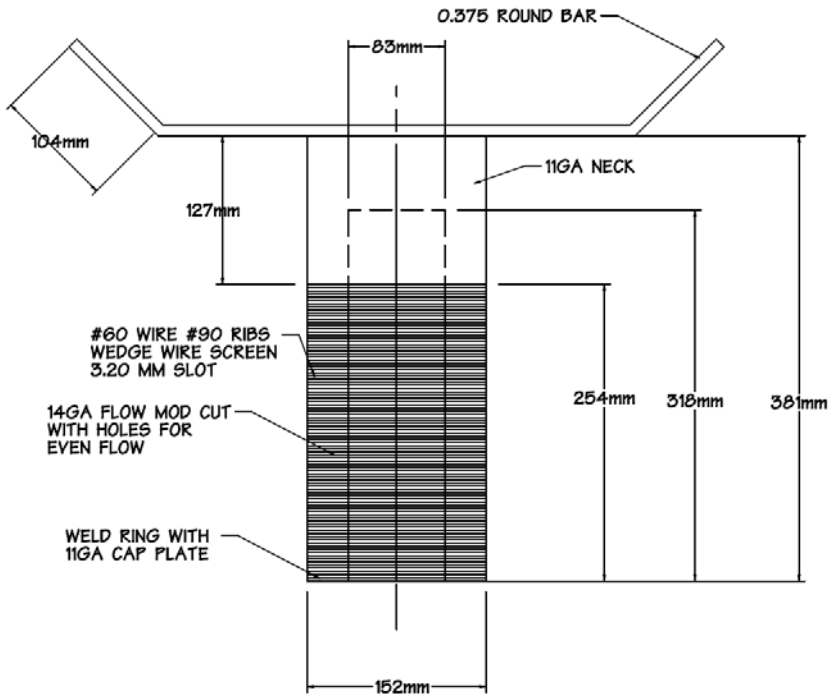
supplement the existing Department of Fisheries and Oceans (DFO) Freshwater Intake End-of-Pipe Fish Screen Guideline (hereafter "the DFO intake guideline) by providing fish screen design criteria to address the unique requirements and challenges of protecting fish at water intakes that are mobile, temporary and extract water through ice.

Design criteria for fish screens that are to be used for winter access construction need to take into consideration a number of factors including: the diameter of the auger hole, operating conditions, the potential for ice build-up and freezing of screens. The size and shape of the fish screen is constrained by the auger hole dimensions and ice thickness. The most common auger diameter used is eight inches, and ice thickness can exceed one meter.

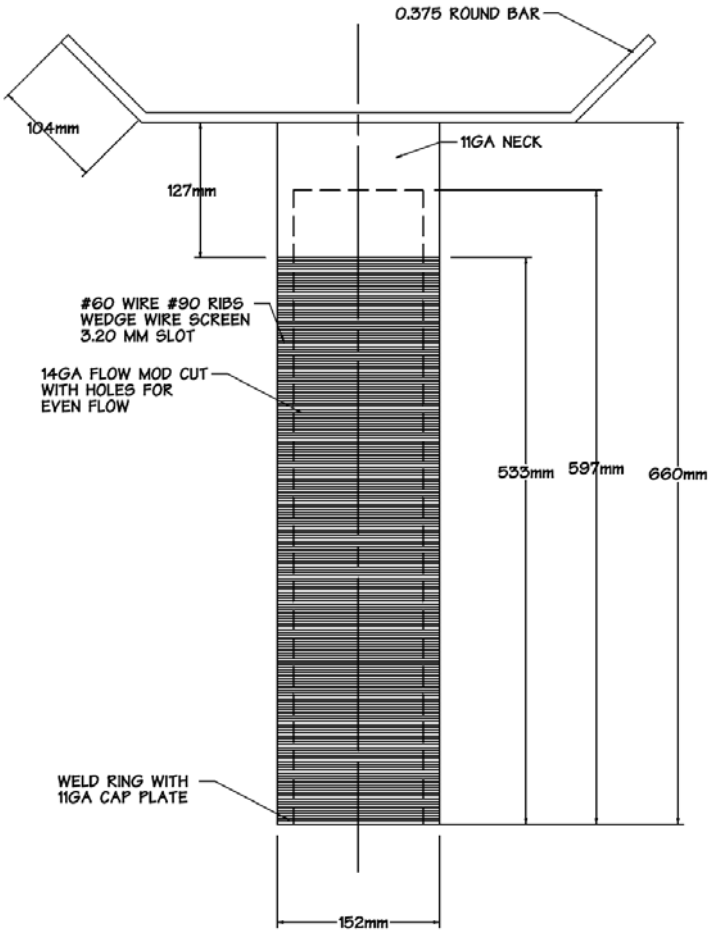
Based on a series of recent field tests of various fish screen designs, done in collaboration with DFO, the Tibbitt to Contwoyto Winter Road Joint Venture, and Nuna Logistics, the hanging basket screen design (Figure 2) with 3.20mm (0.125 inch) mesh without a baffle tube has been adopted as the design standard for flood pumps and water trucks

Fig. 2. Hanging basket screen design for water trucks (a) and flood pumps (b) © www.screen services.com. Note that baffle tubes (flow modulators) are shown in the figure but were later removed from the final design to improve pumping capacity.

a)



b)



Hanging Basket Fish Screen Design Criteria and Rational

- Design criteria aimed to balance the potential risk to fish (based on consideration that water withdrawals are typically limited and short term and are taken from ice-covered temporary water sources using small pumps) and the operating constraints of winter road operations.
- Designed for ease of use, where handling time and effort requirements are minimized to reflect the difficult and potentially hazardous working conditions (e.g. extreme cold, and isolated location).
- Fish protection is based on limiting the approach velocity in front of the intake screen to values that are within the swimming ability of fish species/ life stages likely present in

the area. Swimming ability is measured in terms of swimming speed and endurance time (the time that a fish can maintain a given swimming speed). Approach velocity is a function of the water withdrawal rate and the size (gross area) of the intake screen. The larger the screen area the lower the approach velocity.

  - The DFO intake guideline contains a summary of required screen area sizes for the two groups of fish species, anguilliform (fish that swim like eels) and subcarangiform (swim like trout) species for a range of water withdrawal rates up to 125 L/s (2000 US gpm). For more information on the approach velocity design criteria please refer to the DFO intake guideline (see link to this document under References).
  - Prototype hanging basket screens were developed for both water trucks and flood pumps and tested during the winter road field season (Table 1 and Fig. 2). Based on an assessment of the potential fish species that were at risk during the field tests, the subcarangiform group was selected as the design species. The surface area size for the screens was obtained from Table 2 in the DFO intake guideline based on the required pumping rate. The prototype basket screens were designed for 8 inch diameter boreholes.

- The hanging basket screen design was found to be most practical in terms of balancing fish protection needs with the challenges of winter water withdrawal, based on the reduced risk of entrainment and impingement due to the relatively short pumping time (less than 10 minutes at a given location), limited space between the screen and the auger hole for fish to be in, and noise levels from flood pumps which are in close proximity to where the water is being extracted acting as a potential deterrent for some fish species.

  - Both of the prototype basket screens used in testing were initially equipped with baffle tubes to ensure an even velocity distribution across the face of the screen. Testing of the flood pump with the basket screen resulted in a significant decrease in pumping capacity due to the head loss of the screen within the confines of the auger hole. The pumping capacity of the flood pump improved significantly when the baffle tube was removed from the screen. While the baffle tube did not significantly affect the pumping capacity of the water truck, the added protection to fish while the basket screen was in the auger hole was minimal and therefore it was removed.

Fig. 3. Hanging basket screen in use with water truck and flood pump.

- The recommended 3.20mm (0.125 inch) mesh size is based on a risk assessment that included fish species present and timing of the water withdrawal, location of the screens and as mitigation for potential icing effects. This differs from the design criteria for open water conditions which should use the maximum design opening recommended in the DFO intake guideline of 2.54 mm (0.10 inch) for the default 25 mm fish size.
- Screen openings may be round, square, rectangular or any combination thereof, but should not have any protrusions that could injure fish.
- The fish screen should be constructed of materials that can withstand the extreme winter temperatures and handling requirements of winter water withdrawals.
- Potential debris loading of the hanging basket screen is expected to be low because pumping time is short, the basket is positioned above the bed of the water source and sediment levels in the water column are generally lower in the winter.
- The hanging basket fish screen design could also be adapted for use in open water conditions by suspending the basket at the water surface with the use of a float or other support where water depth is sufficient to maintain the screen elevated above the bed of the water source
- **Please Note:** The recommended design where the screen is within the auger hole does not include a baffle tube. However, any proposed alternative that result in the screen being below the auger hole should include a baffle tube to produce an equal velocity distribution along the screen face to eliminate high velocity zones. A baffle tube would be required for any screen design used in open water conditions.

Table 1. Pump capacity and corresponding fish basket sizing criteria for pumps that were used during the winter road field test.

Pump Type		Pumping Capacity		Screen Size		
		L/s	US gpm	Area (m^2)	Length	Diameter
Water Truck		12.62	200	0.121	254 mm	152 mm or (6 inches)
Flood Pump		27.32	433	0.255	533 mm	152 mm or (6 inches)

Note: L/s = litres per second & US gpm = US gallons per minute

Screen Operation Criteria

- The screen should be keep clean and free of ice and debris.
- The screen should also be inspected for any damage prior to each withdrawal.
- If there is any evidence of fish impingement or entrainment the operator should immediately stop the pumping operation and relocate to a different water source.
- A second screen should be kept on hand as a backup that could be used if the primary screen is frozen due to icing or is damaged during operations.

Concluding Remarks

Properly designed fish screens for water intakes used in fish bearing waters will reduce the risk potential of injury or death to fish during the water extraction process and is a requirement under Section 30 of the *Fisheries Act*.

The hanging basket fish screen design presented in this document was developed based on the specific flood and water truck pumps used during the ice road construction field tests. The lower risk potential to fish based on the use of temporary water sources and the limited duration and frequency of water withdrawals at these sources and the operational challenges were factors in the selection of the basket screen design.

Please let us know how the screens are working as we are developing this guidance in conjunction with you, the operator. If fish are encountered, please document as much information as possible such as species, numbers, location, and water depth. Provide comments and/ or fish information to DFO by email at Bruce.Hanna@dfo-mpo.gc.ca or by phone at (867) 669-4931).

Acknowledgments

This document was prepared by Rick Gervais and Bruce Hanna, Fisheries and Oceans Canada. We would like to thank everyone who was involved in the design, construction and testing of the fish screens. In particular we would like to acknowledge Erik Madsen – Tibbitt to Contwoyto Winter Road Joint Venture; Alan Fitzgerald and the field crew from NUNA Logistics for their time, effort and commitment; Pete Cott, Fisheries and Oceans Canada and Charity Clarkin, BHP Billiton for reviewing and providing input on this guidance document; and Paul Whitham, Screen Services for designing and manufacturing the screens that were used in the field test..

References

Department of Fisheries and Oceans (DFO) 1995. Freshwater Intake End-of-Pipe Fish Screen Guideline. Department of Fisheries & Oceans Publication DFO/5080. Available at: www.dfo-mpo.gc.ca/Library/223669.pdf

APPENDIX H

Northern Land Use Guidelines: Pits and Quarries

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

VOLUME 07

NORTHERN LAND USE GUIDELINES

Pits and Quarries

Canada

Table of Contents

Preface

Indian and Northern Affairs Canada (INAC) has revised its popular land use guidelines series. It is designed to guide land use activity on Crown land in the Northwest Territories and Nunavut. Activities on land under private ownership (e.g., First Nations or Inuit-owned land)[1] and land under municipal or territorial control (e.g., Commissioner's land) require direction from the appropriate agency.

Guidelines apply to land use activities on Crown land only.

These guidelines will assist proponents and operators in planning proposed land use activities, assessing related environmental effects and minimizing the impacts of these activities. They should be supplemented by local research, traditional knowledge, engineering or other professional expertise specific to a proposal and advice from the appropriate regulatory agency. Although every attempt has been made during the preparation of these guidelines to use up-to-date information, it remains the operator's responsibility to obtain the most recent information related to northern resource development and to follow current regulatory requirements.

Guidelines do not replace acts, ordinances, regulations and permit terms and conditions.

[1] Aboriginal land refers to First Nations, Inuit, or Métis owned lands

Volumes in this series include:

- Vol. 01 Administrative Framework
- Vol. 02 Administrative Process
- Vol. 03 Applying Sustainable Development
- Vol. 04 Permafrost
- Vol. 05 Access: Roads and Trails
- Vol. 06 Camp and Support Facilities
- Vol. 07 Pits and Quarries
- Vol. 08 Mineral Exploration
- Vol. 09 Hydrocarbon Exploration
- Vol. 10 Other Land Uses
- Vol. 11 Abandonment and Reclamation

The series is available electronically at **www.publications.gc.ca**. Readers are encouraged to visit the site for updates and revisions to the series.

For further information concerning the subject matter contained in this guideline series, please contact:

OTTAWA

Manager, Land Programs, Natural Resources and Environment Branch
Indian and Northern Affairs Canada
Les Terrasses de la Chaudière
10 Wellington Street
Hull QC K1A 0H4
TEL.: 819-994-7464 FAX: 819-997-9623
E-MAIL: NorthernLands@ainc-inac.gc.ca

NORTHWEST TERRITORIES

Land Administration
Indian and Northern Affairs Canada
P.O. Box 1500
Yellowknife NT X1A 2R3
TEL: 867-669-2671 FAX: 867-669-2713
E-MAIL: NWTLands@ainc-inac.gc.ca

NUNAVUT

Land Administration
Indian and Northern Affairs Canada
P.O. Box 100
Iqaluit NU X0A 0H0
TEL: 867-975-4275 FAX: 867-975-4286
E-MAIL: landsmining@ainc-inac.gc.ca

YUKON

NOTE: *Effective April 1, 2003, responsibility for Indian and Northern Affairs Canada's Northern Affairs Program (land and resource management) was transferred to the Government of Yukon. For information on land-use in the Yukon, contact the office below*:

Land Use—Lands Branch Department of Energy, Mines And Resources
Government of Yukon
Suite 320, Elijah Smith Building
300 Main Street
Whitehorse YT Y1A 2B5
TEL: 867-667-3173 FAX: 867-667-3214
E-MAIL: land.use@gov.yk.ca

Acknowledgements

In the 1980s, Indian and Northern Affairs Canada published a series of six guidelines in a handbook format, intended to help operators of small to medium-scale projects carry out activities in northern Canada in an environmentally sensitive manner. These handbooks, commonly called "The Blue Books," have been widely distributed and quoted. Their success is a tribute to the efforts of the original authors and contributors, and to the departmental steering committee that guided their preparation.

This new series of northern land use guidelines is, in part, an update of the earlier series. This work was directed by a steering committee made up of Northern Regional Office staff and Northern Affairs Program staff in Ottawa. Much of the information and many of the photographs presented in this series were obtained in consultation with land use administrators and resource managers in the Northwest Territories and Nunavut.

CHAPTER
01

Introduction

The purpose of this volume is to provide guidance to pit and quarry operators when operating on Crown land in the Northwest Territories and Nunavut. If you are not operating on Crown land, it is your responsibility to contact the appropriate landowner for any land use guidelines that may be in place.

Granular resources are a strategic and valuable resource, and it is important that they be used in a sustainable way. This volume presents land use techniques and current industry best practices that can be used by operators to minimize land disturbances and environmental impacts. The guidelines are general in nature and should be supplemented, on a site-specific basis, by engineering and other expertise.

Northern Granular Resources

The term granular resources describes a wide range of materials, from silts to sands, gravel and cobbles. These are vital for the construction of a wide range of northern developments, including roads, pipelines, mines and community infrastructure. Granular materials can also be used for smaller scale activities, such as carving. Access to granular materials is often a challenge in the North because development activities are commonly located in remote areas with limited infrastructure. The availability of granular resources is often an important factor in determining how and if a proposed development can proceed.

Pit and quarry development requires that vegetation, topsoil and overburden be removed before drilling and blasting are used to excavate granular material. In order to minimize environmental effects and prevent wasting granular resources, proper land use techniques and extraction methods should be used.

Pits and quarries are defined by the type of granular material extracted and the method of extraction (Table 2-1).

Table 2 1. Definitions of pits and quarries

QUARRY	PIT
• Extraction of rock materials by digging, cutting or blasting • Quarries usually yield large stone that may then be crushed • Commonly quarried materials include limestone and granite	• Excavation of finer grained fill material, such as gravel, sand, clay, marl and topsoil • At a smaller borrow pit, the material is normally used at a nearby site
	

2.1 Evaluating Granular Deposits

Different types of granular resources have different uses. The proponent must evaluate the source material to ensure that it has the characteristics required for its intended use. Higher quality material should be reserved for those uses that require it, not for uses satisfied by lower quality material. Each material and deposit has unique characteristics that will require a slightly different approach to development.

The feasibility of using an existing pit or quarry should be assessed as this can be more economical and better for the environment. For example, the proponent should identify if a suitable source already exists within 10km of the site where the material is needed. Use of an existing source would reduce hauling costs and the environmental footprint associated with the creation of a new quarry or pit.

If a new granular source must be developed, site investigations should be conducted to verify the:

- type, extent and geology of the granular deposit;
- grade and quality of the deposit;
- structural and chemical properties of the rock; and
- extent of ground ice in the material.

If results from these investigations show that the granular material is suitable for its intended use, the proposed development is ready to proceed through the four phases of land use activity:

1. Planning and Design
2. Site Development
3. Operations and Monitoring
4. Closure and Reclamation

2.2 Permitting Requirements

In the Northwest Territories and Nunavut, quarrying activities on federal Crown land require a quarry permit and will often require a land use permit. Other authorizations may be required depending on the nature of the development. The purpose and responsible authority for these authorizations are outlined in Table 2-2. Contact regulatory authorities early to understand the requirements and time frames necessary to obtain required permits. For more information on regulatory processes and applicable legislation, consult the *Administrative Process* volume of this series.

2.2.1 Quarrying Permit/Quarry Lease

Quarrying permits are issued by INAC under the Territorial Quarrying Regulations. Quarrying permits and quarry leases specify how operations will be conducted and reporting requirements for materials that are used. Examples of quarrying permit applications for the Northwest Territories and Nunavut are presented in Appendix A. In Nunavut, a quarry lease may be applied for instead of a quarrying permit if longer term tenure is desired.

Applications for quarrying permits are assessed by INAC to determine:

- the need for a new pit or quarry, and the availability of an existing one;
- if potential reserves of the granular material are adequately identified and assessed; and
- if the application and proposed development plan maximize appropriate use of granular resources, especially in areas where these materials are scarce.

Extraction of granular materials from water bodies and shorelines is not normally allowed unless there are no alternatives. A water licence and fisheries authorization will also be required.

Under Section 10 of the Territorial Quarrying Regulations, residents of the Northwest Territories and Nunavut are allowed to take up to 38 m^3 (50 cubic yards) of sand, gravel or stone per calendar year for their own personal use without having to obtain a quarrying permit or pay any fees. This does not apply if any interest in the surface rights of lands has been licensed, leased or otherwise disposed of by the Crown.

Table 2-2. Authorizations that may be required for quarrying operations

PERMIT	PURPOSE	RESPONSIBLE AUTHORITIES
Quarrying Permit	Obtain quarry materials	Indian and Northern Affairs Canada
Quarry Lease	Long-term access to quarry materials	Indian and Northern Affairs Canada (Nunavut only)
Land Use Permit	Use and occupation of land associated with site investigations, geotechnical work and quarrying	Indian and Northern Affairs Canada (Inuvialuit Settlement Region) Land and Water Boards (Mackenzie Valley)
Water Licence	Use of water or deposition of waste into water, for example, water use for gravel washing, pit dewatering, or building structures that affect watercourses, such as culverts	Northwest Territories Water Board (Inuvialuit Settlement Region) Land and Water Boards (Mackenzie Valley) Nunavut Water Board
Fisheries Authorization	Work in fish-bearing waters, for example, installation of a culvert	Fisheries and Oceans Canada
Timber Permit	Clearing timber prior to quarrying	Government of the Northwest Territories (NWT only)
Explosives Authorizations	Possession, transportation and use of explosives	Natural Resources Canada Workers' Safety and Compensation Commission
Quarry Authorization/ Access Authorization	Access and work on Aboriginal private lands	Aboriginal private landowners
Land Access Permits	Inuit Owned Lands	Regional Inuit Associations (Nunavut)

2.2.1.1 Quarrying Fees

Royalty fees for granular material vary depending on the type and are specified in the Territorial Quarrying Regulations. Fees, based on an estimate of the amount of material required, must be submitted with the quarrying permit application. Outstanding balances will be returned if the amount of material used is less than estimated. During operations, the amount of quarried material must be tracked by monthly reporting of quarry returns to the local INAC office. A final plan, detailing the total volume of material used, is required when the total volume has been quarried or the quarrying permit expires.

For a quarry lease in Nunavut, fees are required as per the schedule in the lease.

2.2.2 Land Use Permit

If quarrying activities include the use of equipment that exceeds the thresholds of applicable land use regulations, a land use permit is required. Site investigation techniques conducted prior to quarrying that exceed thresholds of applicable land use regulations will also require a land use permit. Land use permits include specifications dealing with how operations must be conducted. More information can be obtained from the appropriate resource managers or regulatory boards, or by consulting applicable legislation and regulations. In Nunavut and the Inuvialuit Settlement Region, land use permits are issued under the *Territorial Lands Act*; in the Mackenzie Valley, they are issued under the *Mackenzie Valley Resource Management Act*.

Aboriginal rights must be respected when planning and conducting quarrying activities. INAC and other regulatory authorities strongly encourage community engagement as part of the permitting process. For example, proponents should contact local Aboriginal groups and communities to discuss their proposed development plans well in advance of submitting permit applications. Proponents can contact the applicable land use regulator in their region for more information on requirements for community engagement.

Site development can proceed once all applicable permits are issued. INAC is responsible for regular inspection and enforcement of quarrying and land use permit conditions on Crown land in both the Northwest Territories and Nunavut.

2.3 Carving Stone in Nunavut

In Nunavut, proponents are required to understand and follow provisions outlined in the Nunavut Land Claims Agreement (Article 19) respecting Inuit rights to carving stone on Crown land. Inuit have a largely unrestricted right to harvest carving stone, defined as serpentinite, argillite or soapstone, that is suitable for carving. The stone has both cultural and economic importance for Inuit.

Proponents must immediately report discoveries of carving stone in pits and quarries on Crown land to the local INAC district office. The Designated Inuit Organization then has the right to obtain an exclusive quarry lease if the deposit is significant or acquire title to the land containing the deposit through a land exchange process.

An Inuk has the right to remove up to 38 m^3 of carving stone per calendar year from Crown land without having to obtain a quarrying or land use permit as long as no significant damage is done to the land and it does not interfere with use and enjoyment of the land.

CHAPTER
03

Planning and Design

Proper planning is critical to conducting an efficient and environmentally responsible pit or quarry operation. The development objective is to maximize the use of granular resources while minimizing negative environmental impacts. To do this, the proponent should gain a thorough understanding of the site by collecting detailed site information during the early stages of the proposed development. The proponent should also create a complete plan for how the development will proceed from initial clearing through reclamation, called a pit/quarry development plan. This information will be required by regulatory authorities during the permitting process.

FIGURE 5. Ground truthing of site conditions is accomplished by field investigations.

3.1 Site Conditions

Pit or quarry development should include an assessment of site conditions as these will often dictate how and where development can proceed. Site assessment should take into consideration the quantity of material required, the duration of the operation and the mitigation of the environmental impacts. A review of existing information, such as aerial photographs, granular resource reports and existing land uses, should be conducted to identify suitable sites for further field investigations. There are a number of information sources that can be used to determine site conditions when planning and designing a granular resources operation. Some examples of information needs and sources are outlined in Table 3-1.

3.1.1 Field Investigations

Once a suitable site has been identified, field reconnaissance should be conducted to confirm interpretation of existing data and local environmental conditions. At the exploration stage, sensitive areas, such as slopes that are prone to erosion or areas of ice-rich permafrost, should be identified so that they can be avoided during the development stage. Overburden and granular materials should be tested for acid rock drainage or metal leaching potential and, if found, these areas should be avoided.

Non-intrusive geophysical surveys, using electronic instruments, can be conducted to delineate granular resources with little environmental disturbance.

Type and thickness of vegetation, overburden and interburden should also be assessed to determine the preparatory work required to access the deposit, and to ensure the deposit has adequate volume to meet user needs.

Advanced exploration of the granular deposit may be required to further understand the geological properties and size of the deposit. Activities such as drilling, test pitting or blasting, to obtain surface and shallow-depth granular samples, often include the use of equipment that exceeds the thresholds of applicable land use regulations, and will require a land use permit. Quarries for large-diameter armour stone require a more detailed field assessment to confirm that suitable material exists and that its extraction is feasible.

3.1.2 Permafrost

Continuous and discontinuous permafrost are present throughout the Northwest Territories and Nunavut. Assessment of a potential granular resources site should include observations of local

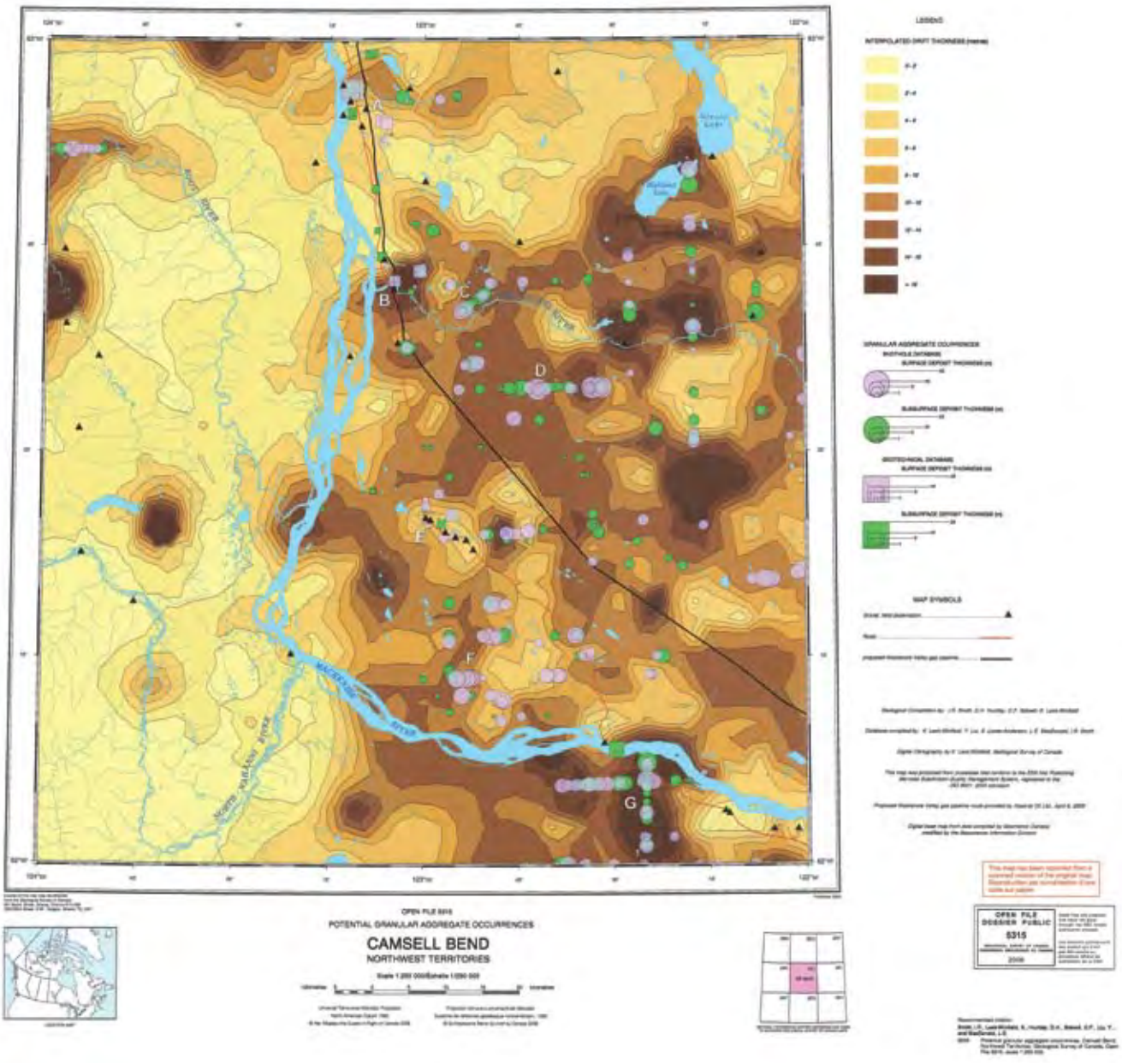


FIGURE 4. Existing granular information. (Natural Resources Canada)

Table 3 1. Information used for pit and quarry planning

INFORMATION TYPE	INFORMATION NEEDS	INFORMATION SOURCES
Surficial geology	• Type, extent and grade of deposit • Soil and overburden • Acid rock drainage or metal leaching potential • Extent of permafrost and ground ice	• Local INAC office • Northern Granular Resources Inventory www.ainc-inac.gc.ca • Northwest Territories Geoscience Office www.nwtgeoscience.ca • Nunavut Geoscience www.nunavutgeoscience.ca • Natural Resources Canada, Geoscience Data Repository www.gdr.nrcan.gc.ca • Local operators • Applicable land use plans
Environmental	• Topography and drainage • Surface vegetation • Sensitive landforms (e.g. pingos or eskers)	• Aerial photographs and maps • Local INAC office • Appropriate resource managers or regulatory boards • Local operators and residents
	• Water management	• INAC Water Resources Division www.ainc-inac.gc.ca
	• Timber/forestry	• Government of the Northwest Territories, Environment and Natural Resources www.forestmanagement.enr.gov.nt.ca
	• Fish and wildlife habitat	• Fisheries and Oceans Canada www.dfo-mpo.gc.ca • Environment Canada www.ec.gc.ca
Archaeological/cultural	• Location of archaeological sites • Traditional use areas (e.g. berry-picking sites, traplines, cabins)	• Prince of Wales Northern Heritage Centre (Northwest Territories) http://pwnhc.learnnet.nt.ca • Department of Culture, Language, Elders and Youth (Nunavut) www.gov.nu.ca/cley • Inuit Heritage Trust (Nunavut) www.ihti.ca
Existing land uses	• Existing pits and quarries, access roads and disturbances • Other land users	• Local INAC office • Appropriate resource managers or regulatory boards

permafrost conditions because ice-rich permafrost is prone to subsidence and slumping when it thaws, which can negatively impact quarrying operations.

In permafrost regions, field investigations should determine the extent, depth and ice content of permafrost at a proposed pit or quarry site before proceeding with development. Early identification of ice-rich permafrost will ensure that measures can be implemented to mitigate its degradation, or an alternative location can be developed where permafrost is absent.

If ice-rich permafrost cannot be avoided, measures to mitigate its degradation include conducting work during the winter and replacing the organic layer prior to spring thaw to provide an insulating layer between the permafrost and warm air temperatures. If ice-rich material is excavated, it should be piled in rows and allowed to melt and drain before use. More information on land use operations in permafrost areas is available in the *Permafrost* volume of this series.

FIGURE 6. (top) Permafrost can be ice-rich as demonstrated by this exposed ice wedge.

FIGURE 7. Melting of ice-rich permafrost can cause subsidence and erosion.

3.2 Site Design

Consideration of site design prior to development will result in an efficient operation with minimal environmental disturbance. A goal of site planning should be to minimize the area of disturbed land; however, there should be enough room to conduct all phases of development safely. For example, there should be adequate room to pile overburden during site development and granular materials during operations.

Site design for a quarry is usually more complex than for a pit because of safety concerns associated with blasting, and pit wall and bench design. Territorial mine safety legislation dictates how a quarry must be designed and developed. Land use permit conditions may also specify some design criteria, but the site design should be well defined at the time permit applications are submitted. This section outlines specific factors that should be considered during the planning phase of pit and quarry development.

3.2.1 Access

To reduce the area of land used in pit or quarry development, existing access routes, including roads, trails and seismic lines, should be used where available and safe. If a new access route is required, it should be kept to the minimum width necessary for safety. Ideally, only a single access route is required to enter and exit the pit or quarry, with vehicles turning around within the pit or quarry. Further information on access planning is available in the *Access: Roads and Trails* volume of this series.

3.2.2 Buffer Strips

Buffer strips are areas of land that are left untouched to provide a natural barrier between the development and an adjacent area. Buffers can be used to protect water quality by leaving riparian areas adjacent to water bodies intact, and they can be used to provide a visual barrier between the development and an area of human use. To ensure their stability and safety, buffers should be designed to resist damage from prevailing winds. When possible, buffer strips should also be designed to block road surfaces from direct sun exposure because direct sunshine can cause unsafe glare-ice conditions on road surfaces.

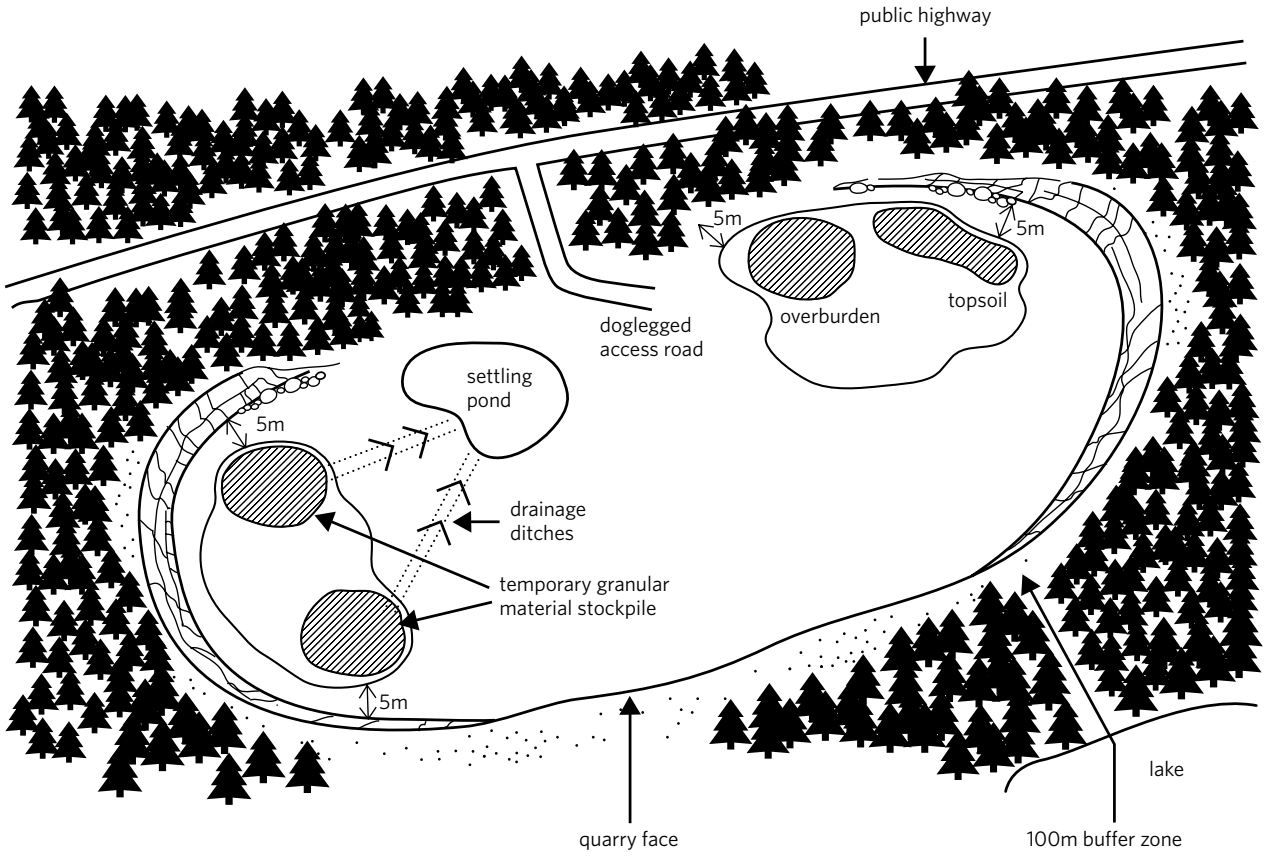


FIGURE 8. A well-designed quarry.

In the Mackenzie Valley, buffer strips of at least 100 m width, extending from the ordinary high water mark, are required between quarry developments and water bodies. In the Inuvialuit Settlement Region and Nunavut, buffer strips adjacent to water bodies are required to be at least 30 m wide.

3.2.3 Visual Impacts

Minimization of visual impacts to areas of human use, such as a highway, should be considered when designing a pit or quarry site. Land use permits may have specific conditions regarding the appearance of a development site. Recreation sites should be avoided, along with areas of heavy public use and highly visible locations.

If areas of public use cannot be avoided, creating adequate buffers between the pit or quarry and other users is the most effective means of mitigation. Buffers can include a vegetated strip or a constructed earth berm. A pit or quarry may also be eliminated from view by locating it on the downhill side of a road or creating a doglegged access road.

3.2.4 Noise and Dust

Noise and dust from pit or quarry operations can be a nuisance in areas with other land users nearby. Excessive dust can also be an occupational hazard for those working on-site, and can also affect wildlife. To minimize noise and dust, consider prevailing winds when designing the site and orient quarry faces to direct noise and dust away from other land uses. If this is not possible, consider constructing an earth berm to block noise and dust.

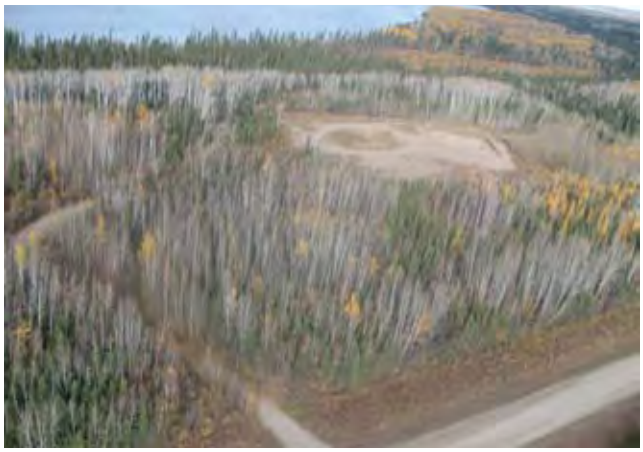


FIGURE 9. A well-designed pit with a doglegged access and vegetated buffer zones

3.2.5 Progressive Reclamation

The pit or quarry should be designed with eventual reclamation of the site in mind and how this work will be carried out progressively throughout operations to minimize the impact of the pit or quarry on the environment. For example, a depleted quarry face can be reclaimed using overburden and soil from land that is to be cleared for the next face. This will reduce the amount of time that the land is disturbed and will increase the length of time the proponent will have to evaluate the success of reclamation techniques. There is also an economic advantage to progressive reclamation during operations as machinery and resources are already on-site.

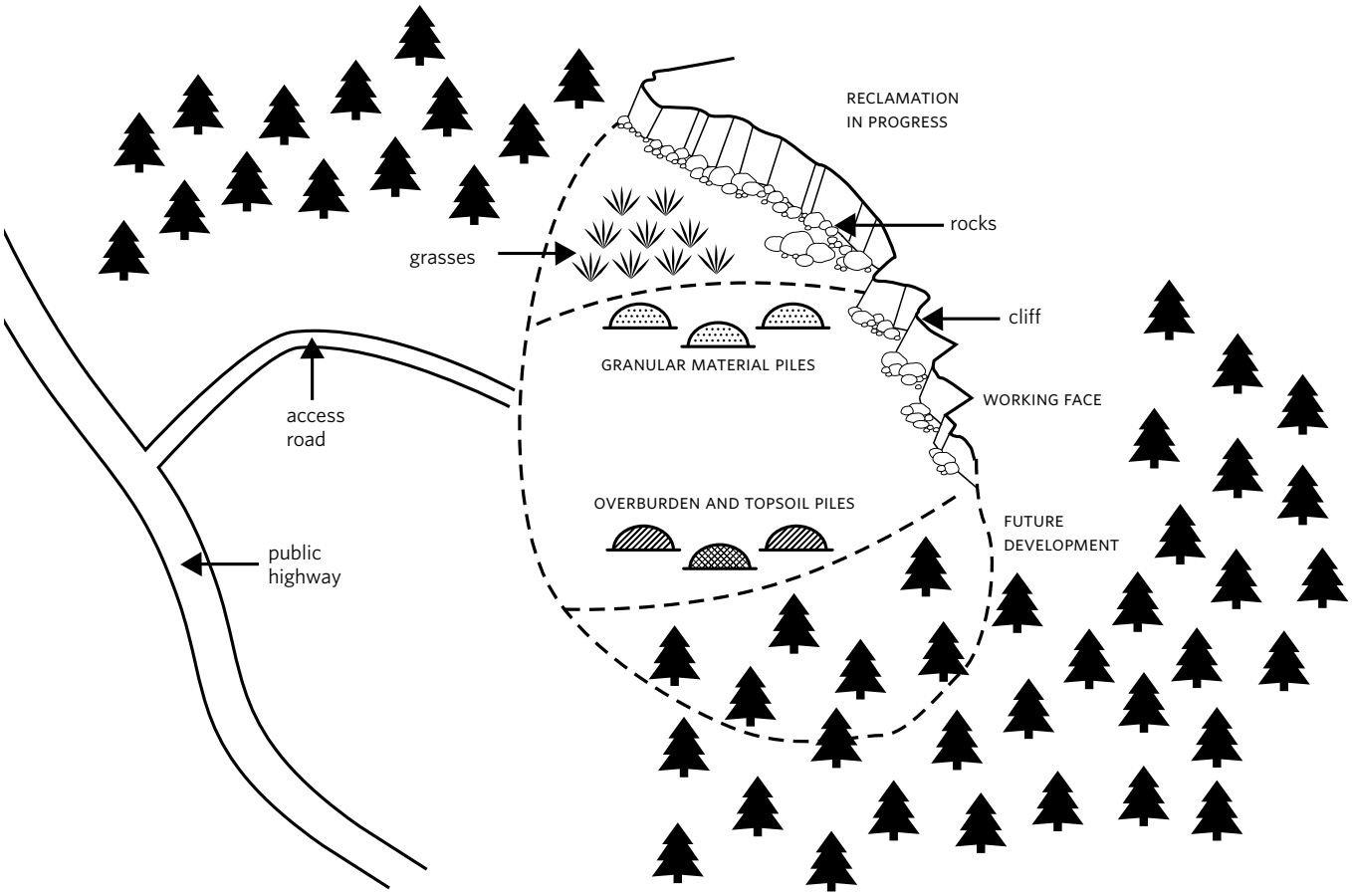


FIGURE 10. A pit that is being progressively reclaimed during operations.

3.3 Water Management

The flow of water into and out of a proposed pit or quarry site should be minimized to enhance the efficiency of operations, limit the effects of sedimentation on water quality and prevent permafrost degradation. Water management planning should consider both water quantity and quality. For instance, removal of vegetation and overburden will influence local water quantity by increasing the volume and rate of recharge into the groundwater system. Water quality may be affected by acid rock drainage or metal leaching from piles and the pit walls, or blasting residue, such as ammonia. Important changes to drainage characteristics due to pit or quarry development include:

- changes to natural drainage patterns;
- impermeable surfaces, such as clay layers, may inhibit drainage;
- steeper slopes may become unstable and contribute to erosion; and
- changes on adjacent properties may impact drainage at the pit or quarry site.

To avoid problems associated with operating in water, proponents should not excavate the pit or quarry below the water table, and seasonal and storm-related fluctuations in groundwater levels should be accounted for in the planning stage. The proponent should have an understanding of the maximum expected water flow in the project area, and plan water management structures to accommodate for peak periods of thaw and precipitation. Information on water levels may be obtained from Environment Canada, INAC Water Resources Division and local operators.

In permafrost areas, ponded water in low-lying areas of a pit can lead to permafrost degradation. Proper drainage can be promoted by sloping the pit floor away from the pit face, and installing drainage ditches or channels. In non-permafrost areas, water within a pit or quarry should be directed to a low-lying area within the pit or quarry where ground infiltration or evaporation can occur.

Pit or quarry water cannot be discharged to surface waters without obtaining an appropriate water licence that will specify water quality discharge limits. Treatment may be required before discharge

FIGURE 11. (top) Drainage ditches can be used to direct water to a settling pond within the pit.

FIGURE 12. (middle) Settling ponds can be used to manage pit water.

FIGURE 14. (bottom) Vehicular access to northern developments is often best accomplished during the winter.

to the environment. If dewatering of the pit or quarry is required, it should be directed to a holding pond or ditch that is well away from the top of a slope where erosion could occur.

Measures should be taken to prevent migration of silt into water bodies. Spreading slash or constructing shallow benches on an eroding slope can slow down runoff and erosion. Settling ponds or impoundments can be constructed to control surface runoff. Erosion control supplies, such as erosion control mats and blankets and silt curtains, should be kept on hand to respond to slope destabilization caused by water erosion.

3.4 Development Timing

Development timing is an important consideration in the North as many sites are more easily accessible by winter road when the ground is frozen, thereby minimizing land disturbance. Surface disturbance is more likely when the ground is saturated, particularly during spring breakup. In northern Canada, spring breakup generally occurs between March and April, and fall freeze-up occurs between October and November. Different stages of pit or quarry development should be scheduled at the most appropriate time of the year as suggested in Table 3-2.

3.5 Pit/Quarry Development Plan

To document the results of the planning stage, a pit or quarry development plan should be developed that outlines the entire project life cycle, including site conditions and design, planned operations and reclamation. The size and duration of the operation will determine the scope and level of detail required in the plan. A pit/quarry development plan template is presented in Appendix B.

At a minimum, the plan should include a 1:5000 scale site map illustrating the proposed layout of the operation, including the area of identified granular resources and proposed quarrying, existing access or clearing, the proposed overburden storage area, blasting locations and other infrastructure, such as camps. In addition, a description of proposed mitigation measures to address all identified environmental concerns should be included. Table 3-3 outlines common environmental concerns that may be encountered during site development or operations phases and related mitigation options, which are discussed further in subsequent sections of this volume.

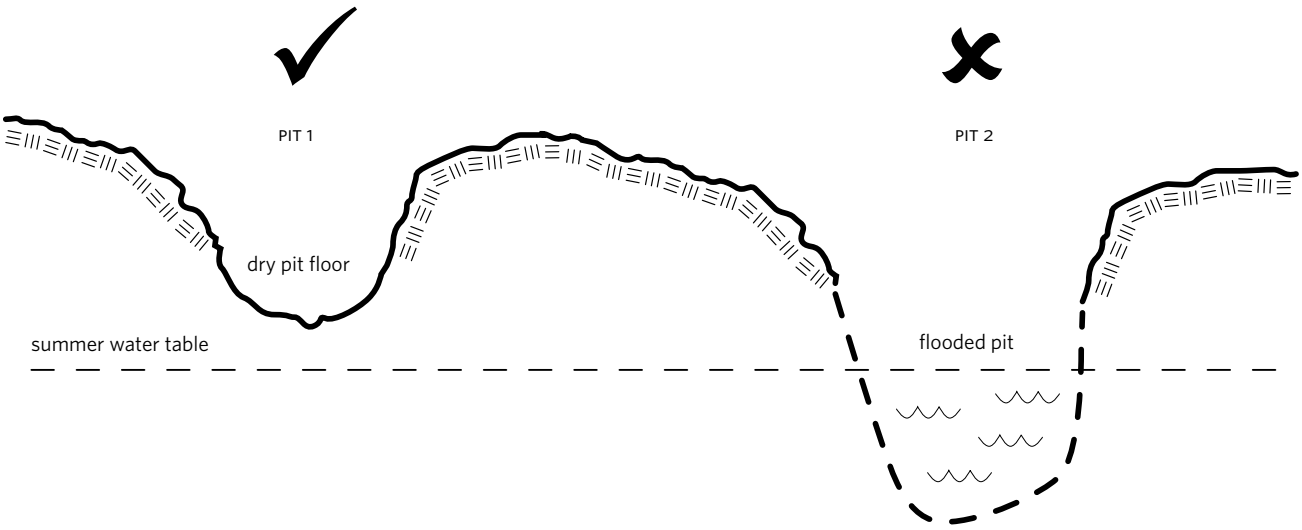


FIGURE 13. Ensure pit excavation is well above the summer water table. (Redrawn from Robertson and Brandt, 1997, p. 31.)

Table 3-2. Suggested timing for development activities

ACTIVITY	SUGGESTED TIMING
Exploration	Vehicular access and test drilling are more appropriate during the winter when the ground is frozen, but sampling activities that require unfrozen ground, such as test pitting, must be conducted during the summer.
Access	Vehicular access requires winter roads, unless construction of an all-season road is planned.
Operations	To avoid rutting and surface disturbance, operations may need to be limited during the spring melt period. Critical life stages for fish and wildlife may limit operations during the spring and fall. To avoid disturbance of permafrost in ice-rich areas, work should be conducted during the winter.
Closure and reclamation	Recontouring slopes for drainage, and replacing overburden and topsoil are best done during the summer when the ground has thawed and is well drained. Active revegetation, such as seeding, can be done during the fall so that the winter snow layer can provide plants with a water source the following spring.

Table 3-3. Pit and quarry environmental concerns and mitigation techniques

DEVELOPMENT PHASE	ACTIVITIES	ENVIRONMENTAL CONCERNS	POSSIBLE MITIGATION TECHNIQUES
Site design and development	• Timber and vegetation clearing • Overburden removal	• Habitat loss • Soil erosion • Sediment deposition	• Minimize project footprint • Identify and avoid environmentally sensitive areas • Locate the development in a well- drained area • Maintain natural drainage patterns • Retain vegetation buffer zones to maintain slope stability and protect water bodies • Construct ditches to direct runoff away from the site • Salvage and properly store organics, topsoil and overburden for use during reclamation
Operations and monitoring	• Blasting • Excavating • Crushing • Piling material • Access road maintenance	• Soil erosion • Sediment deposition	• Limit sediment movement using erosion controls (e.g. silt fence) • Use rip-rap to reinforce drainage channel corners and water discharge points • Use settling ponds before discharging water • Revegetate where required to stabilize slopes
		• Fuel spills • Blasting residue	• Use proper fuel containment and explosives-handling techniques
		• Permafrost degradation	• Limit pit or quarry depth to the active layer • Minimize in-pit water by directing surface water away from the site • Thaw ice-rich material at a location where meltwater will not re-enter the pit
		• Dust generation	• Use water and dust skirts on conveyors to minimize dust

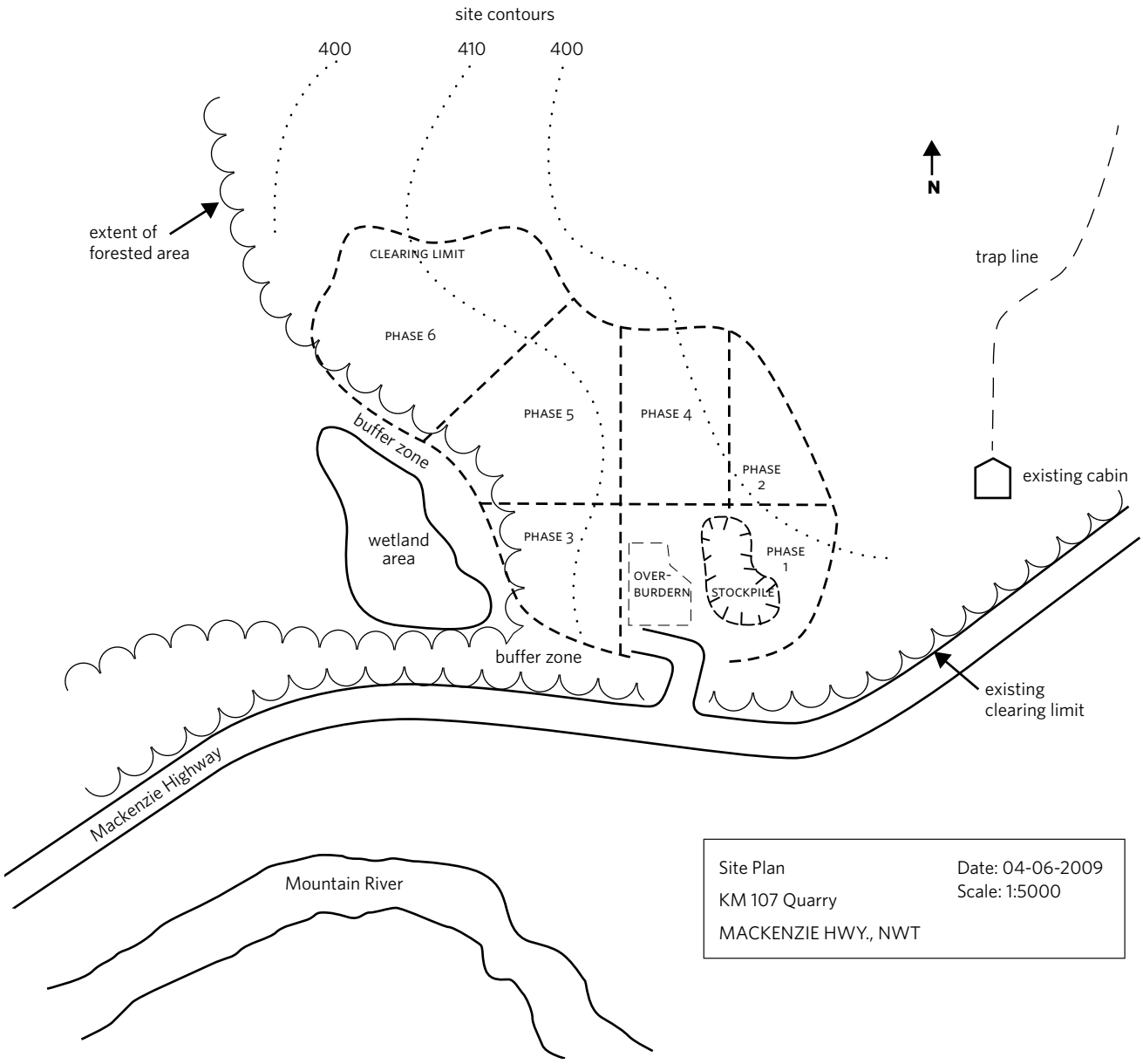


FIGURE 15. Site design diagram to be submitted with a pit/quarry development plan. (Redrawn from Robertson and Brandt, 1997, p. 64.)

In pits or quarries on federal Crown land where multiple users are anticipated, an overall management plan will be developed by INAC. Each proponent will be required to provide a pit/quarry development plan detailing how they will operate within the constraints outlined in the overall management plan.

CHAPTER
04

Site Development

Development of a pit or quarry site should proceed in an orderly sequence to ensure that erosion of soils and deposition of sediment into water bodies are minimized, and that materials overlying the granular resource are properly segregated and stored for future use during reclamation. This section outlines measures that should be used in the development of a pit or quarry site.

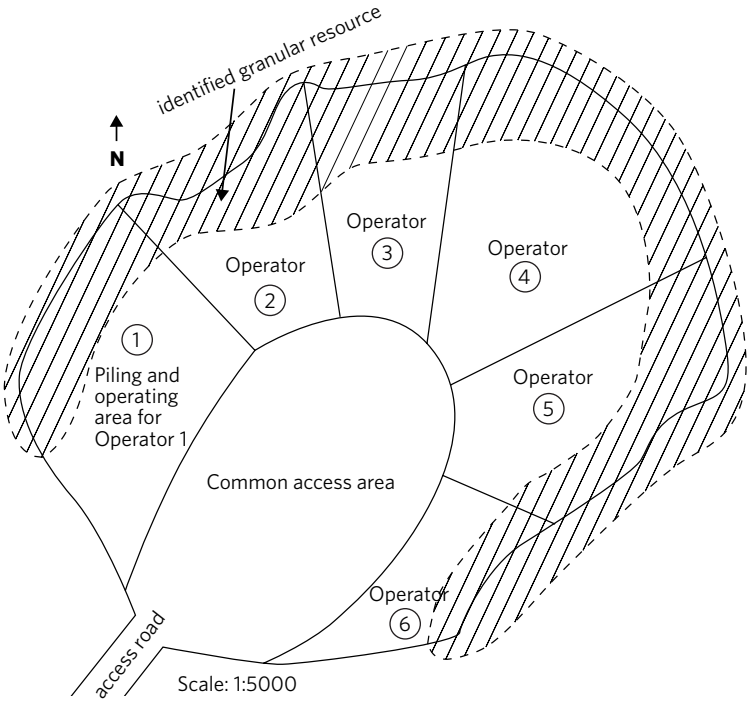


FIGURE 16. Planned site layout for a multiple-user pit.

4.1 Clearing

Clearing of vegetation has both a visual and an environmental impact, and it is good practice to avoid clearing a larger area than is necessary for the development. The pit or quarry boundaries should first be flagged to delineate the project area and restrict the project footprint. If applicable, the next step is to clear trees and shrubs within the project area. To reduce the length of time a site is disturbed, clearing should normally commence just prior to extraction. However, in areas of ice-rich permafrost, where winter operations will be conducted, it may be more effective to clear the site in the preceding fall. Clearing ice-rich sites during the summer should be avoided as this will expose the soil to direct sunlight and lead to ground-ice melting and subsidence.

Trees should be cut flush with the ground, unless clearing takes place when there is snow cover. In either case, tree stumps should extend no more than a maximum of 20 cm from the ground surface. Leaning trees should be cut down and made to lay flat on the ground to avoid damaging adjacent trees and for safety. Trees may also be mulched into wood chips that can be useful for stabilizing disturbed permafrost by insulating the ground. Land use permits may include conditions for saving and stacking merchantable timber. In general, trees larger than 12 cm in diameter should be saved. For more information, contact the Department of Environment and Natural Resources, Government of the Northwest Territories.

FIGURE 17. Merchantable timber can be saved and stacked for transport.

FIGURE 18. Leaning trees should be cut down and stacked into windrows.

Handling of cleared brush will be specified in the land use permit, or by an INAC resource management officer, and may be burned or piled for future use during site reclamation. Burning of brush is best accomplished in the fall or winter to minimize the risk of losing control of the fire. Brush can be compacted into long windrows that should be at least 5 m away from standing timber to reduce the hazard of a fire. Breaks of approximately 10 m width should be left in the windrow at approximately 300 m intervals to reduce blockage of wildlife movement.

In some cases, trees or shrubs can be saved and stored during site development for later use during reclamation to anchor the soil or to blend in with the surrounding landscape.

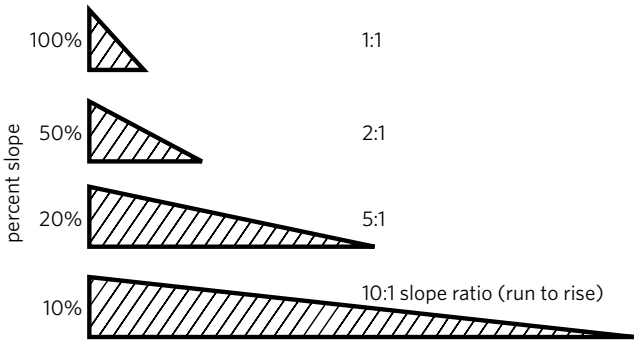


FIGURE 21. Slopes can be expressed as a ratio of the horizontal run over the vertical rise, or as a percentage. (Redrawn from Robertson and Brandt, 1997, p. 47.)

4.2 Soil and Overburden

The next step in site development is removal and piling of soil and rock overburden for future use during site reclamation. In many areas of northern Canada, soil layers are very thin or non-existent and this step may not be required. Organic topsoil, mineral soil and rock overburden layers should be stripped and piled separately to minimize mixing as they will have different functions during site reclamation. Rock overburden and mineral soil will be used for landscape reconstruction, whereas organic topsoil will be replaced on the surface to act as a natural native seed bank to support revegetation (see Section 7.4).

Soil and overburden piles should be located where they will not interfere with pit operations, and should be at least 5 m away from standing timber so that there is working space behind them. It is also important that the piles be placed in a location that will not interfere with surface runoff, and will allow for drainage of meltwater from ground ice. Organic topsoil can dry out quickly and can easily blow away or erode, so piles should be gradually sloped and rounded to minimize wind and water erosion. Structures to collect and treat runoff from piles may be required if the water has a high silt content. For safety, soil and overburden piles should be sloped to have a horizontal to vertical ratio of 2 horizontal to 1 vertical or greater.

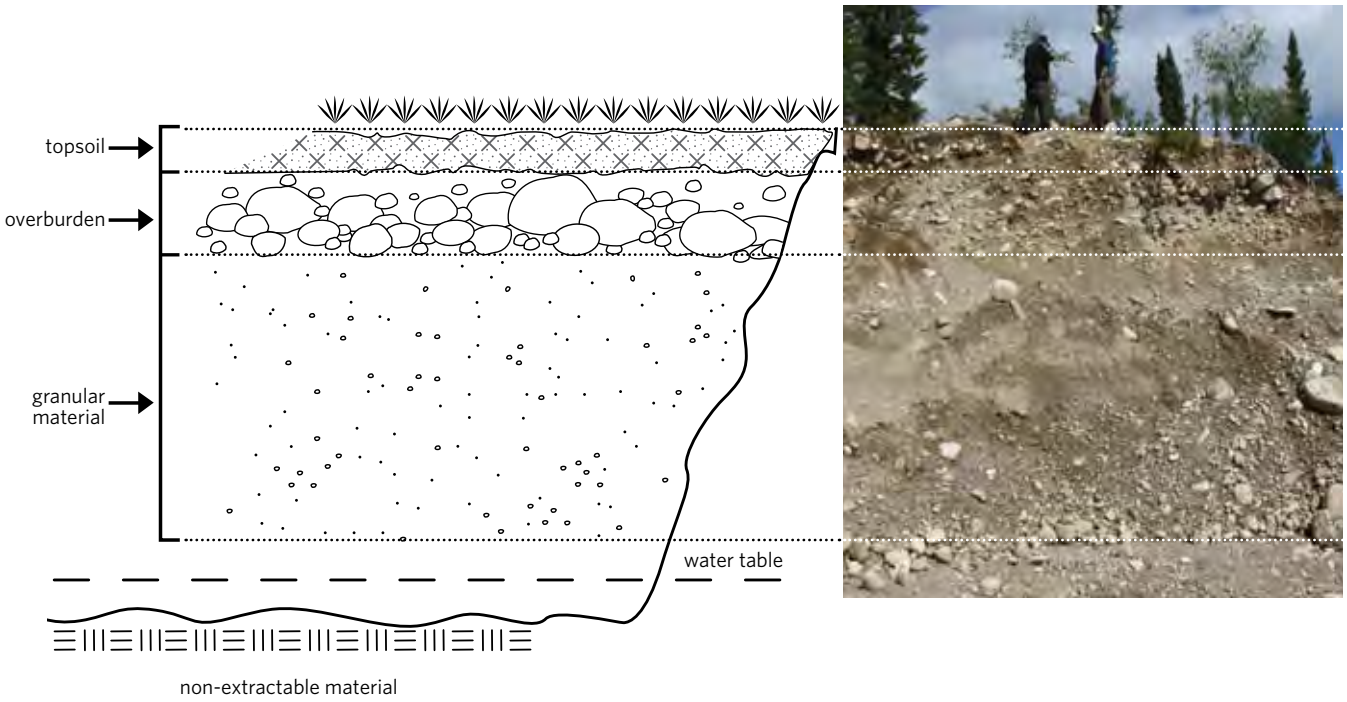


FIGURE 19. Typical stratigraphy of a pit or quarry site showing topsoil and overburden layers over granular material.

FIGURE 20. Overburden and woody debris should not be mixed, and piles should be at least 5 m from standing timber.

CHAPTER 05

Operations

The operations phase of quarrying includes extraction and processing of granular material at the site. Throughout operations, monitoring should be conducted to determine if the measures chosen to mitigate environmental concerns are working, and maintenance should be adaptive to ensure that mitigation techniques continue to work or are replaced. Operations must be conducted in accordance with approved management plans associated with the land use permit. Major changes in operations may require amending the land use permit or obtaining additional permits.

5.1 Resource Extraction

The method used to excavate granular material will depend on the nature of the material, the equipment available, and, in permafrost terrain, the extent and nature of the permafrost. Safe slope angles, wall heights and bench widths are determined by territorial mine safety legislation.

Temporary granular material piles stored in the pit should have stable slopes with a horizontal to vertical slope ratio of at least 2:1. If excavated material contains ground ice, it should be stored at a location within the pit where it can thaw and drain. Placing the material in small piles will allow it to thaw during a single summer season by exposing a larger surface area to direct sunlight.

Interburden waste material encountered within the desired granular material should be piled in a depleted section of the pit, and can be handled in the same way as overburden (see Section 4.2).

5.2 Resource Processing

Processing granular material usually requires an area of intensive heavy equipment activity, including crushers, screens, wash plants, generators and conveyors, and should be carried out on hard and stable ground within the pit. Each processing step requires an accessible area within the pit to carry out the operation, pile the processed material and allow trucks safe access to haul the material out of the pit.

Processing activities can generate considerable noise and dust, so it may be appropriate to restrict these operations during sensitive times for other land users or wildlife. Dust suppression controls, such as watering, using a dust skirt and minimizing the drop height when releasing material from a conveyor, are recommended to protect worker health and safety, and the environment.

Screening frozen material often leads to wastage caused by the presence of large frozen blocks. Wastage can be much reduced by waiting until the material has thawed. Alternatively, frozen material should be crushed before it is screened. Oversized materials, such as boulders that are rejected for resource use, should be stored and used for future reclamation activities.

Operations that require washing of granular materials may require a water licence for the use and disposal of wash water. Treatment of water from washing operations may be required to meet water quality objectives.

FIGURE 22. Extraction of rock involves drilling and blasting.

FIGURE 23. Excessive dust caused by crushing operations can be mitigated by spraying water or using dust skirts on conveyors.

5.3 Monitoring and Maintenance

The site should be monitored throughout operations to confirm that measures chosen to mitigate environmental concerns are working, to assess the performance of engineered structures, and to ensure that local regulations and conditions specified in the land use permit are being followed. Monitoring should be conducted regularly so that problems can be identified quickly. Early detection of a problem should trigger the appropriate response or contingency plan, and notification of the INAC resource management officer.

Regular monitoring should determine if environmental mitigation measures are achieving their goals, and should answer the following questions:

- Are the water management strategies effective?
- Are noise and dust mitigation measures effective?
- Is permafrost degradation occurring?
- Are spill-management plans being followed?

Regular maintenance of the site and infrastructure will ensure that environmental mitigation measures continue to be successful. In particular, the site and access roads should be regularly maintained to minimize erosion, sediment deposition and dust emissions. Potholes, washboarding and frost heaves should be promptly repaired to minimize dust generation and equipment wear.

5.4 Site Security

For safety and security, access to a pit or quarry site should be limited. Contact an INAC resource management officer for more information on appropriate access control methods.

5.5 Intermittent Operations

If a pit or quarry is to be closed seasonally, the proponent should inform regulatory authorities before operations are suspended. The pit or quarry must be stabilized before the operation is shut down by backfilling, contouring and reclaiming areas where extraction of granular resources is complete. Proper drainage must be in place to prevent flooding of the pit or quarry. If site conditions do not allow for positive drainage, intermittent operations may be impractical (this should be identified at the planning stage). If the proponent plans to store machinery, buildings or other materials at the site for future use, the proponent should request a storage authority from the local INAC office.

CHAPTER 06

Spills

Spills can involve chemicals, hydrocarbons or other hazardous materials. Spills of reportable quantities must be reported immediately to the 24-hour spill line at 867-920-8130. A list of immediately reportable spill quantities is available in INAC's *Guidelines for Spill Contingency Planning* (http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/SCP-eng.asp).

6.1 Spill Contingency Plan

A spill contingency plan must be in place during all phases of pit or quarry development, and must be submitted with the land use permit application. Unexpected spill events do occur and a plan will help operators respond to them quickly and effectively. The spill contingency plan should be implemented immediately after a spill event. The plan outlines a logical order of how operators should respond to a spill, resources available on-site for spill response, and agencies and individuals that need to be notified. All personnel working on the site should be aware of and understand the plan so that they can respond effectively to a spill. A spill contingency plan template is provided in INAC's *Guidelines for Spill Contingency Planning*.

6.2 Spill Prevention

Hydrocarbon spills from equipment are a major source of environmental damage and are often preventable. Equipment should be properly maintained and in good working condition to minimize potential leaks from hydraulic hoses and other working components. Drip trays can be placed under equipment when not in use to catch hydrocarbon drips.

6.3 Spill Response

Spill response includes stopping, containing and reporting the spill event. A spill response kit should be available on-site that is well stocked with materials that can be used to contain a spill. Once a spill has been contained and reported, photographs should be taken of the spill area, the extent of the spill should be delineated and a cleanup strategy should be developed. Ensure that there is never an ignition source in the vicinity of spilled flammable products.

CHAPTER 07

Closure and Reclamation

The final phase of pit or quarry development is closure and reclamation. The overall reclamation objective is to return the disturbed area to a stable, useable condition. Where several future land use options exist, the highest and most productive use should be chosen. Environmental limitations, nearby communities, land users, site visibility and existing regional land use plans will all influence the reclamation objectives that will be determined by the land use regulator. The overall reclamation objective for the majority of pit or quarry sites in the Northwest Territories and Nunavut is to return the site to a natural condition that blends in with the existing topography and surrounding landscape.

A closure and reclamation plan is required under the conditions of the land use permit. This plan should be developed with input from local communities and land users, regulatory authorities and the INAC resource management officer. Land use permits may also contain specific conditions regarding reclamation.

Once a closure and reclamation plan is approved, progressive reclamation may be conducted during operations at areas of the site that are no longer used. This will reduce the amount of reclamation required when operations are completed, will allow for evaluation of reclamation techniques, and could reduce reclamation costs at the end of operations by using equipment and resources that are already on-site.

When operations are complete, the site must be reclaimed as per the reclamation objectives outlined in the closure and reclamation plan. Monitoring will be required for several years after the reclamation work was conducted to ensure that the reclamation objectives are being met. If the reclamation objectives are not being met, proponents will be required to return to the site to carry out further reclamation work. Once the land use regulators are satisfied that the site is stable and the reclamation objectives have been met, a letter of final clearance will be issued indicating that the permit holder is no longer responsible for the pit or quarry site.

FIGURE 24. This pit has been recontoured and left to revegetate naturally.

7.1 Site Cleanup

At the end of operations, all materials and debris must be removed from the site, including buildings, machinery, fuel containers, garbage, blasting materials, granular material, overburden and soil piles. If hydrocarbon-contaminated soils are to be remediated on-site, the appropriate regulatory agency should be contacted to determine the method of cleanup (this must be documented in the closure and reclamation plan).

FIGURE 25. All waste must be removed from the site at closure.

7.2 Landscape Reconstruction

Most pit or quarry sites will require some landscape reconstruction for safety, to prevent erosion, and to reduce visual impacts. Loose material should be removed from pit walls by scaling cliff faces and removing overhang at the top of the wall.
The tops of excavated slopes should be rounded to reduce the chance of slumping, except in areas of continuous permafrost where they should be left to avoid disturbing the permafrost. For safety, a reclaimed pit slope should have a slope ratio of at least 2:1, or the natural angle of repose, whichever is greater, and steep slopes should be stepped.
A geotechnical engineer should be consulted for contouring of any slope higher than 5 m.

Rock overburden and mineral soil that were removed and stored at the beginning of operations should be used to contour the site. Use of frozen material for reconstruction activities is not recommended as the ground ice it contains may melt and cause subsidence. If sufficient overburden is available, gentle slopes and rounded shapes are visually preferable to straight lines. Rock overburden can be spread over the bottom of the pit and used to reconstruct slopes. It will provide an insulating layer to prevent further permafrost degradation. Mineral soil can be placed above the overburden for site grading and contouring.

Once site contouring is completed and the ground surface has stabilized, stored topsoil should be placed on the surface to promote revegetation. Topsoil contains native seeds and organic material that expedite vegetation growth. For most land uses, topsoil should be spread over as much of the surface of the disturbed area and as close to the original depth as possible. Depending on closure objectives, however, differing depths of topsoil can result in a greater diversity of natural vegetation, and there may be situations where an undulating or irregular terrain is preferred for wildlife, wetland or recreational use. In steeply sloping areas where soil erosion may occur, topsoil should not be used.

If the soil is compacted, its ability to support plant growth is greatly reduced. During spreading of overburden and topsoil, use of rubber-tired equipment should be minimized as this can compact soils and destroy soil structure.
Soils should not be handled when they are wet and most susceptible to severe soil compaction. After spreading, the ground surface should be roughened to provide micro-sites suitable for revegetation. If soils become compacted, a combination of soil-ripping techniques and soil amendments can be used to loosen the soil and restore soil structure.

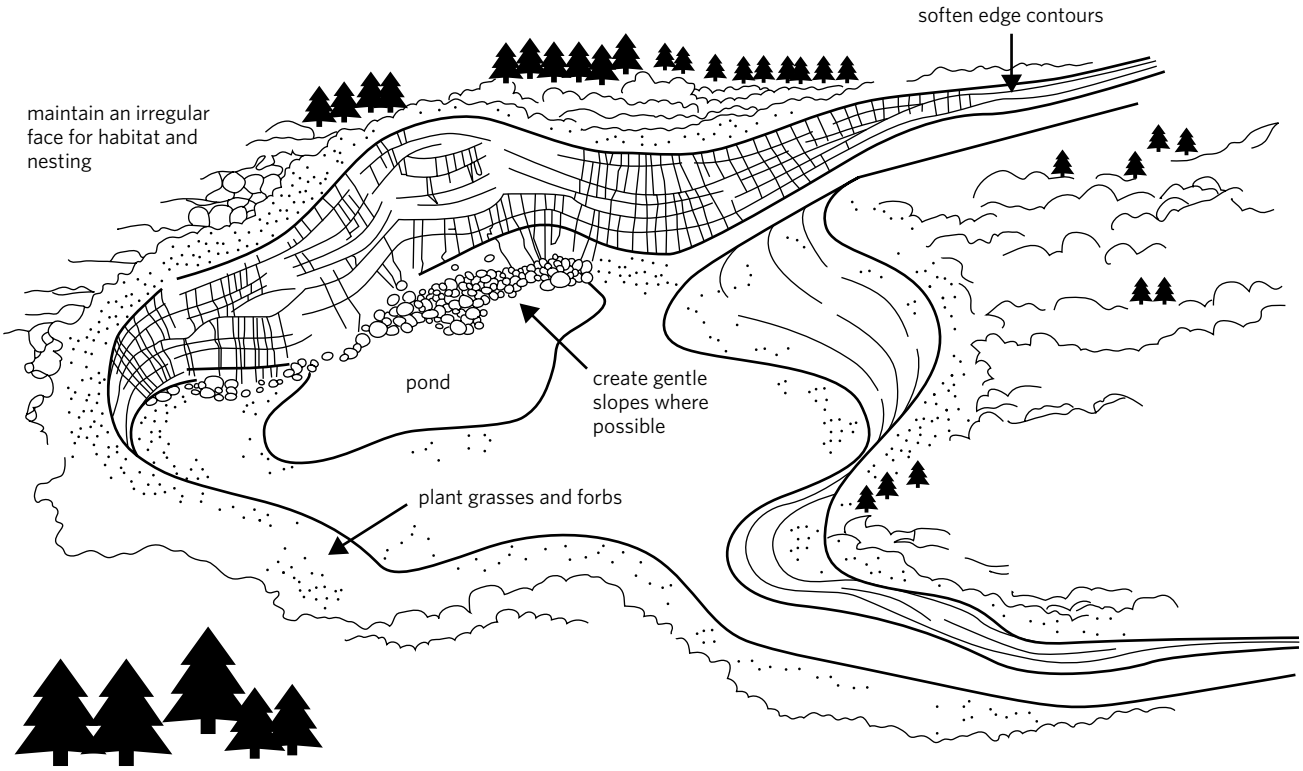


FIGURE 27. Closure and reclamation planning. (Redrawn from Robertson and Brandt, 1997, p. 20.)

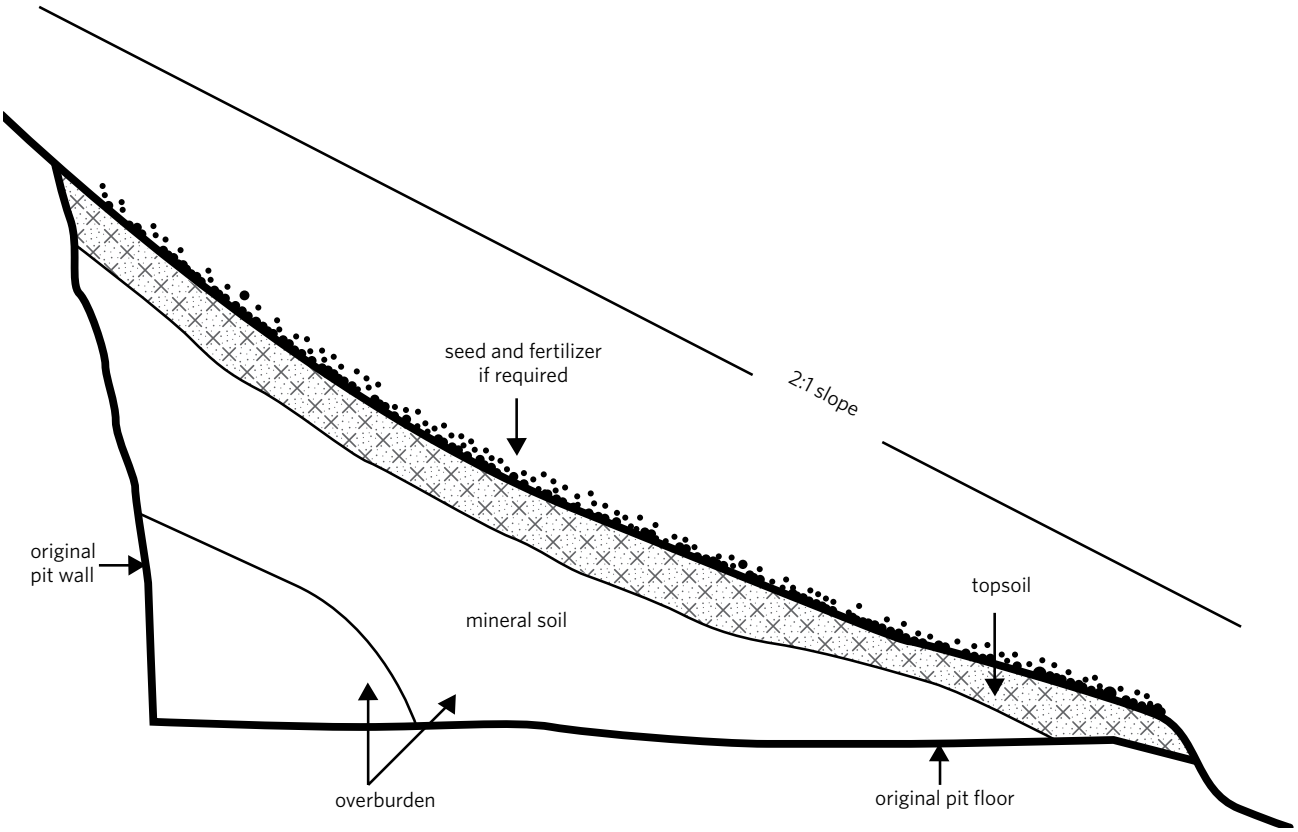


FIGURE 28. Proper placement of overburden, mineral soil and topsoil for reclamation. (Redrawn from Robertson and Brandt, 1997, p. 42.)

7.3 Drainage and Erosion Control

Successful reclamation includes well-designed surface drainage to control erosion. Site recontouring should not block or divert natural drainage patterns on the site as reclaimed areas are susceptible to erosion while vegetation and soil stability become re-established. Roughening exposed soil surfaces using horizontal grooves can improve drainage and minimize water ponding.

Slope grading and revegetation will, in most cases, serve to control erosion in the pit. However, at sites with greater surface flow, for instance, in permafrost terrain, additional drainage control measures may be necessary. These measures may include:

- constructing a berm or swale at the top of the slope to direct water away from or around the pit;
- laying brush across the slope to slow runoff and trap sediment; and
- directing runoff to the bottom of the slope through a drainpipe or ditch.

Drainage ditches should have adequate grade and capacity to divert runoff from the reclaimed site without eroding adjacent material. Rip-rap or boulders may be required to armour drainage ditch corners and discharge areas to prevent erosion from runoff. Construction and repair of drainage ditches should be performed during dry weather to avoid adding sediment to the water.

7.4 Revegetation

Revegetation objectives should be discussed with land use regulators, and will be specified in the closure and reclamation plan. The selected option should be based on the end land use, compatibility with the surrounding landscape and limiting factors such as climate, the surface material and the moisture-holding capacity of the surface material.

Allowing establishment of natural vegetation over time is preferred to seeding as it limits the introduction of invasive plant species that may be inadvertently included in seed mixes, and native plants are often more successful over the long term as they are adapted to northern growing conditions. Salvaged topsoil often contains seeds from native plants and organic matter that aid in establishment of natural vegetation. However, when slope erosion, dust or immediate aesthetic values are a concern, seeding of grass or legume species and the use of fertilizer may be desired to achieve revegetation objectives more quickly than would otherwise be possible through natural regeneration. Revegetation can also include planting trees or shrubs that were saved and stored when the pit was developed. Woody vegetation can anchor the soil and blend in with the surrounding landscape.

Where seeding is required, native seed mixes should be used to lower the risk of invasive species. Unfortunately, there is currently no commercial source of grass and legume seeds indigenous to the Northwest Territories or Nunavut. Instead, similar agronomic cultivars from Yukon, southern Canada, Alaska or continental United States must be used. Prior to using any seed mixes or fertilizers, or for more information on appropriate seed mixes and fertilizers, contact the local INAC office.

Seeding of non-native cultivars can be conducted in a way that encourages invasion of native species. Some seeded species will grow quickly and anchor the soil, but will eventually die back and provide a nutrient base for native species that invade the area.

FIGURE 30. This small borrow pit has been reclaimed as a pit lake.

7.5 End-Pit Lake

In permafrost terrain, the presence of a large body of water will lead to warming and subsidence of the ground, so allowing surface water to flood a pit and create a lake is not an acceptable closure objective. Positive drainage should be used to divert water away from the pit area to prevent formation of a lake.

If permafrost is not present, an end-pit lake may be an acceptable closure option. All economically viable granular material should be removed from the pit before flooding. The shoreline and slopes should be armoured or contoured so that they remain stable. Potential lake water quality, lake levels and connectivity with other water bodies should be considered in the reclamation planning stage. Proponents planning an end-pit lake should contact Fisheries and Oceans Canada.

7.6 Reclamation Monitoring

Site monitoring will be required for several years after reclamation activities are completed to assess whether the closure objectives have been met. Monitoring requirements will usually be specified in the land use permit. Post-closure monitoring should attempt to answer the following questions:

- Are erosion control structures performing as designed?
- Are water management techniques effectively controlling water going into and out of the pit?
- Has vegetation been re-established to predicted levels?

If monitoring demonstrates that some reclamation techniques have been unsuccessful, additional reclamation work may be required. When the land use regulator is satisfied that the site is stable and the reclamation objectives have been met, a letter of final clearance will be issued indicating that the permit holder is no longer responsible for the pit or quarry site.

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Glossary

Acid rock drainage/metal leaching

Outflow of acidic water or water high in dissolved metals from areas where the earth has been disturbed, such as mines. Acid rock drainage or metal leaching also occurs naturally within some environments as part of the rock weathering process.

Active layer

Layer of ground above permafrost that seasonally freezes and thaws.

Angle of repose

Maximum angle at which a slope can remain stable.

Armour stone

Stones or broken rock of larger size than rip-rap that are placed on an embankment for erosion control and protection.

Cultivar

Variety of a plant developed from a natural species and maintained under cultivation.

Dogleg

Sharp change in the direction of a road. Designed to conceal the road from view for aesthetic purposes.

Dust skirt

Sheet that surrounds the outlet of a crusher to contain and minimize dust emissions.

Ground ice

Ice present in ground materials. Important because it dominates the geotechnical properties of the material and can cause terrain instability if it melts.

Interburden

Waste material encountered within a granular resource.

Overburden

Rock or soil of little or no value located above the granular resource deposit. Must be removed prior to quarrying.

Permafrost

Ground frozen for at least two consecutive years. Continuous permafrost is defined as an area where at least 90 percent of the land area is underlain by permafrost. Discontinuous permafrost is defined as an area where 10 to 90 percent of the land area is underlain by permafrost.

Rip-rap

An erosion-resistant ground cover of large, loose, angular stones used to stabilize slopes and protect soil from the erosive forces of runoff.

Riparian

An area of land adjacent to a stream, river, lake or wetland containing vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas.

Windrow

Woody debris that has been piled into a long, continuous row.

Appendix A: Pit/Quarry Development Plan Template

A pit/quarry development plan should cover the following topics:

1. 1:5000 scale site map

2. Description of proposed mitigation measures to address all identified environmental concerns

3. Site Conditions
   - full delineation of granular resource
   - contours, elevations and drainage features
   - environmentally sensitive areas (e.g. streams, wildlife habitat)
   - extent of permafrost and ground ice
   - adjacent land uses

4. Site Design and Development
   - adequate room for all activities
   - topsoil, overburden and granular pile locations
   - proposed site development techniques (e.g. clearing trees, windrowing brush)
   - proposed or existing access routes
   - proposed or existing infrastructure (e.g. camps, refuelling areas)
   - design for water management and erosion control
   - design for progressive reclamation

5. Operations
   - resource extraction and processing techniques
   - single-season or multi-year operation
   - spill contingency plan
   - monitoring and maintenance plans
   - contingencies if changes to the original development scenario are required

6. Reclamation
   - closure objectives
   - removal of all garbage, debris, equipment and buildings
   - overburden replacement for site contouring
   - re-establishment of natural drainage
   - replacement of all salvaged topsoil
   - revegetation activities
   - reclamation of access roads

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APPENDIX I

DFO Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters

Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters

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1998

Canadian Technical Report of Fisheries and Aquatic Sciences 2107

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ABSTRACT

Wright, D.G., and G.E. Hopky. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107: iv + 34p.

The federal *Fisheries Act* includes provisions for the protection of fish, shellfish, crustaceans, marine mammals and their habitats. The detonation of explosives in or adjacent to fish habitat has been demonstrated to cause disturbance, injury and/or death to fish and marine mammals, and/or the harmful alteration, disruption or destruction of their habitats, sometimes at a considerable distance from the point of detonation.

Within the context of the guidelines and procedures outlined in this report, an explosive is defined as a chemical compound which, when detonated, creates a compressional wave having an almost instantaneous rise time to a very high peak pressure followed by a decay to below ambient pressure by either rapid oxidation or the breaking of high-energy chemical bonds.

The purpose of this report is to provide information to proponents who are proposing works or undertakings that involve the use of confined or unconfined explosives in or near Canadian fisheries waters, and to which the *Fisheries Act*, Sections 32 and 35 in particular, may apply. Guidelines are provided on methods and practices for the conservation and protection of fish, marine mammals, and fish habitat from impacts arising from the destructive forces of explosives. The report describes the suggested application and review procedures and processes for proponents whose use of explosives may result in the destruction of fish, or the harmful alteration, disruption or destruction of fish habitat.

RÉSUMÉ ANALYTIQUE

Wright, D.G. et G.E. Hopky. *Lignes directrices concernant l'utilisation d'explosifs à l'intérieur ou à proximité des eaux de pêche canadiennes,* rapport technique canadien des sciences halieutiques et aquatiques 2107, 1998, iv + 34 p.

La *Loi sur les pêches* fédérale renferme des dispositions relatives à la protection du poisson, des mollusques, des crustacés, des mammifères marins et de leur habitat. Il a été prouvé que la détonation d'explosifs dans l'habitat du poisson ou à proximité perturbe, blesse ou tue des poissons et des mammifères marins ou encore entraîne la détérioration, la destruction ou la perturbation de leur habitat. Il arrive parfois que les dommages se fassent sentir à une distance considérable du point de détonation.

Aux fins des lignes directrices et des procédures énoncées dans le présent rapport, on entend par explosif un composé chimique qui, lorsqu'il explose, crée une vague de compression entraînant presque instantanément un pic de pression extrêmement élevé suivi d'une décroissance sous la pression ambiante soit par oxydation rapide ou par la rupture des liaisons chimiques à haute énergie.

Le présent rapport a pour but de fournir de l'information aux promoteurs qui proposent des ouvrages ou des entreprises nécessitant l'utilisation d'explosifs confinés ou non confinés à l'intérieur ou à proximité des eaux de pêche canadiennes et auxquels la *Loi sur les pêches,* plus précisément les articles 32 et 35, pourraient s'appliquer. Il renferme des lignes directrices concernant les méthodes et pratiques de conservation et de protection du poisson, des mammifères marins et de leur habitat contre les effets découlant de la force destructrice des explosifs. On y décrit les procédures de présentation des demandes et d'examen pour les promoteurs qui prévoient l'utilisation d'explosifs de nature à entraîner la destruction du poisson ou la détérioration, la perturbation ou la destruction de son habitat.

SCOPE AND RATIONALE

The federal *Fisheries Act* includes provisions for the protection of fish, shellfish, crustaceans, marine mammals and their habitats. The detonation of explosives in or adjacent to fish habitat has been demonstrated to cause disturbance, injury and/or death to fish and marine mammals, and/or the harmful alteration, disruption or destruction of their habitats, sometimes at a considerable distance from the point of detonation. Therefore, the Department of Fisheries and Oceans (DFO) has prepared this document to provide information to proponents on the conservation and protection of fish, marine mammals, and their habitat from impacts arising from the use of confined or unconfined explosives in or near Canadian fisheries waters. The guidelines, and application and review procedures and processes outlined in this document apply in the context of the legislative and policy framework summarized below.

APPLICABLE LEGISLATION AND POLICY

Fisheries Act

A number of sections of the *Fisheries Act* and its attendant regulations are applicable to the conservation and protection of fish and fish habitat from the destructive forces of explosives.

- Section 2 defines “Canadian fisheries waters" as meaning all waters in the fishing zones of Canada, all waters in the territorial sea of Canada and all internal waters of Canada.

- Section 2 defines “fish" as including shellfish, crustaceans, marine animals and the eggs, sperm, spawn, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

- Section 32 prohibits the destruction of fish by any means other than fishing, except as authorized by the Minister of Fisheries and Oceans or under regulations made by the Governor in Council under the *Fisheries Act*.

- Subsection 34(1) defines “fish habitat” as meaning spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.

- Subsection 35(1) prohibits any person from carrying on any work or undertaking that results in the Harmful Alteration, Disruption or Destruction (HADD) of fish habitat.

- Subsection 35(2) provides for the alteration, disruption or destruction of fish habitat by any means or under any conditions authorized by the Minister of Fisheries and Oceans or under regulations made by the Governor in Council under the *Fisheries Act*.

- Subsection 36(3) prohibits the deposit of a deleterious substance into waters frequented by fish, unless otherwise permitted by regulation.

- Subsection 58(1) of the *Fishery (General) Regulations* provides for anyone proposing to carry on any work or undertaking likely to result in the HADD of fish habitat, to apply to have the means or conditions of that work or undertaking authorized by the Minister under Subsection 35(2) of the *Fisheries Act*, using the form set out in Schedule VI. Schedule VI includes a section for the applicant to provide details on the proposed use of explosives.

- Subsection 58(2) of the *Fishery (General) Regulations* provides the means for the Department of Fisheries and Oceans to issue Authorizations under Subsection 35(2) of the *Fisheries Act*, using the form set out in Schedule VII.

- Section 7 of the *Marine Mammal Regulations* prohibits disturbance of marine mammals except when fishing for them.

In addition, the Department of Fisheries and Oceans has developed a policy framework to assist in the interpretation and application of the applicable legislation. The most relevant documents are as follows:

- The **Policy for the Management of Fish Habitat** (1986) provides policy direction for interpreting the broad powers mandated in the *Fisheries Act* in a way that is consistent with the concept of sustainable development. To achieve the Policy's goal of fish habitat conservation when reviewing project proposals with the potential to affect fish habitat, DFO's habitat managers apply the No Net Loss (NNL) guiding principle. Under this principle, the Department strives to maintain the existing productive capacity of fish habitats, such that the fish habitat is able to sustain the production of fish suitable for fisheries purposes.

  In summary, in order to meet the NNL guiding principle, the habitat manager's first preference is to avoid or reduce the project's potential for a HADD of fish habitat through the application of appropriate mitigation measures. Avoidance measures, such as project relocation or redesign, can be effectively applied at the project design stage. Failing that, impacts may be further reduced by application of specific mitigation measures, such as use of timing windows during the construction phase. If a HADD is still expected to occur, unavoidable - i.e. residual - losses in habitat productive capacity may be compensated on a case-by-case basis if the manager concludes that compensation is acceptable and feasible.

- The **Directive on the Issuance of Subsection 35(2) Authorizations** (1995) clarifies the circumstances when an Authorization under Subsection 35(2) may be issued, and on providing proponents with letters of advice suggesting means of avoiding HADD of fish habitat.

- The **Habitat Conservation and Protection Guidelines** (1998) is a document for use by DFO's staff in administering the habitat provisions of the *Fisheries Act*. It outlines a standard approach to habitat conservation and protection through the application of the NNL guiding principle.

Canadian Environmental Assessment Act

A decision to issue an Authorization under Section 32 or Subsection 35(2) of the *Fisheries Act* triggers an environmental assessment under the *Canadian Environmental Assessment Act* (CEAA).

IMPACTS

The use of explosives may result in a number of adverse impacts on fish and marine mammals, and their habitats.

Effects on Fish

The detonation of explosives in or near water produces post-detonation compressive shock waves characterized by a rapid rise to a high peak pressure followed by a rapid decay to below ambient hydrostatic pressure. The latter pressure deficit causes most impacts on fish.

The primary site of damage in finfish is the swimbladder, the gas-filled organ that permits most pelagic fish to maintain neutral buoyancy. The kidney, liver, spleen, and sinus venous also may rupture and haemorrhage. Fish eggs and larvae also may be killed or damaged (Wright 1982).

Studies (Wright 1982) show that an overpressure in excess of 100 kPa will result in these effects. The degree of damage is related to type of explosive, size and pattern of the charge(s), method of detonation, distance from the point of detonation, water depth, and species, size and life stage of fish.

Vibrations from the detonation of explosives may cause damage to incubating eggs (Wright 1982, Wright in prep.). Sublethal effects, such as changes in behaviour of fish, have been observed on several occasions as a result of noise produced by explosives. The effects may be intensified in the presence of ice and in areas of hard substrate (Wright 1982, Wright in prep.).

The detonation of explosives may be lethal to marine mammals and may cause auditory damage under certain conditions. The detonation of explosives in the proximity of marine mammals also has been demonstrated to induce changes in behaviour (Wright in prep.).

The number of shellfish and crustaceans killed by the detonation of explosives is believed to be negligible, however, few data are available. Sublethal effects of explosives on

shellfish and crustaceans including behavioural modifications are little known or understood (Wright 1982, Wright in prep.).

Effects on Fish Habitat

The use of explosives in and near fish habitat may also result in the physical and/or chemical alteration of that habitat. For example, sedimentation resulting from the use of explosives may cover spawning areas or may reduce or eliminate bottom-dwelling life forms that fish use for food. By-products from the detonation of explosives may include ammonia or similar compounds and may be toxic to fish and other aquatic biota (Wright in prep.).

GUIDELINES, AND APPLICATION AND REVIEW PROCESSES

The following sections have been prepared to guide proponents proposing works or undertakings that involve the use of confined or unconfined explosives in or near Canadian fisheries waters, and to which the *Fisheries Act*, Sections 32 and 35 in particular, may apply. Confined explosives are those that would be used within a substrate, including ice, while unconfined explosives are those that would be used in open water, or not within a substrate.

Note that the information and guidance provided in these sections pertains to the conservation and protection of fish and fish habitat in the context of the *Fisheries Act*, and to the CEAA requirements that may result. There is no intent to relieve the proponent of responsibilities under any other federal, provincial or municipal legislation. Proponents are encouraged to contact other appropriate regulatory agencies to ensure that the proposed work or undertaking is carried out according to their requirements.

GUIDELINES

This section provides guidelines on methods and practices which, if incorporated into a project proposal, are intended to prevent or avoid the destruction of fish, or any potentially harmful effects to fish habitat that could result from the use of explosives. Implementation of these measures, for this purpose, is at the discretion of the proponent. Use of these guidelines should not be taken to imply approval of the proposed project in accordance with the *Fisheries Act*. Note that should the proponent proceed with the project and the use of explosives results in the destruction of fish and/or the HADD of fish habitat as a result of a change in plans, or failure to implement the measures, contravention of Section 32 and/or Subsection 35(1) of the *Fisheries Act* could occur.

1. Proponents considering the use of explosives are encouraged to consult the appropriate DFO Regional/Area authorities (Appendix I) as early as possible in their planning process to identify possible alternatives to the use of explosives, the biological resources and their habitats at risk, and/or effective mitigation measures.

2. Where provincial or territorial resource management agencies, or aboriginal resource management boards undertake the administration of fisheries, the proponent is encouraged to consult with the relevant authorities.

3. The use of confined or, in particular, unconfined explosives in or near Canadian fisheries waters is discouraged, and proponents are encouraged to utilize other potentially less destructive methods wherever possible.

4. No use of ammonium nitrate-fuel oil mixtures occurs in or near water due to the production of toxic by-products (ammonia).

   Note:

   - The deposit of deleterious substances into waters frequented by fish is prohibited under Section 36(3) of the *Fisheries Act*, unless otherwise permitted by regulation. There is no regulation pursuant to the *Fisheries Act* that permits the deposit of by-products resulting from the use of ammonium nitrate-fuel oil mixtures.

5. After loading a charge in a hole, the hole is to be back-filled (stemmed) with angular gravel to the level of the substrate/water interface or the hole collapsed to confine the force of the explosion to the formation being fractured. The angular gravel is to have a particle size of approximately 1/12th the diameter of the borehole.

6. All “shock-tubes" and detonation wires are to be recovered and removed after each blast.

7. No explosive is to be knowingly detonated within 500 m of any marine mammal (or no visual contact from an observer using 7x35-power binocular).

   Note:

   - Upon review of a proposal, the DFO Regional/Area authority may impose a greater avoidance distance, depending on the size of the charge or other project specific or fishery resource conditions.

8. No explosive is to be detonated in or near fish habitat that produces, or is likely to produce, an instantaneous pressure change (i.e., overpressure) greater than 100 kPa (14.5 psi) in the swimbladder of a fish.

   Notes:

   - For confined explosives, setback distances from the land-water interface (e.g., the shoreline), or burial depths from fish habitat (e.g., from under the riverbed) that will ensure that explosive charges meet the 100 kPa overpressure

guideline are shown in Table 1. Equations to derive these relationships have been adapted from Nicholls et al. (1971) and Anon (1980). The equations are described in Appendix II, and should be used for weights of explosives not covered in Table 1. Sample calculations and examples are illustrated in Appendix III.

- If a confined explosive is to be detonated close to the substrate-water interface (such as in trenching or demolition), the set-back distance closely approximates the theoretical lethal range within which 50% of the fish may be killed or injured. Consequently, the 100 kPa guideline is not likely to be met in those situations where, because of the design constraint's of the project, it is also likely not possible or practical to 'adjust' the setback distance as a means to meet the 100 kPa guideline. For example, preparation of a trench for a pipeline crossing typically requires no more than a below grade burial depth of about 2m. Therefore, the weight of explosive charge per delay will have to be adjusted in an effort to meet the 100 kPa guideline. A sample calculation to illustrate a trenching example is given in Appendix III.

- For unconfined explosives, proponents are encouraged to contact the appropriate DFO Regional/Area authorities (Appendix I) for further guidance.

9. No explosive is to be detonated that produces, or is likely to produce, a peak particle velocity greater than 13 $mm \cdot s^{-1}$ in a spawning bed during the period of egg incubation.

Note:

- For confined explosives, setback distances or burial depths from spawning beds that will ensure that explosive charges meet the 13 $mm \cdot s^{-1}$ guideline criteria are shown in Table 2. Equations to derive these relationships have been adapted from Nicholls et al. (1971) and Anon (1980) and are described in Appendix II. Sample calculations and examples are illustrated in Appendix III.

- For unconfined explosives, proponents are encouraged to contact the appropriate DFO Regional/Area authorities (Appendix I) for further guidance.

APPLICATION AND REVIEW PROCESSES

Proponents planning to use an explosive that is likely to destroy fish and/or cause a HADD of fish habitat are subject to certain legal obligations under the *Fisheries Act*, as identified in the preceding 'Applicable Legislation and Policy' section. This section discusses these obligations with respect to the proposed use of explosives, and suggests to proponents how to fulfil them.

Proponents should contact the DFO Regional/Area authorities (Appendix I) as early as possible in their planning process. The purpose is to find out whether the proposed use of

explosives is likely to affect a Canadian fisheries water and whether its use is likely to destroy fish and/or cause a HADD of fish habitat. Depending on the outcome, DFO may also discuss potential issues, specific information requirements, or the next steps and possible outcomes in a further review of the proposal. For example, as summarized in the subsequent 'Review and Decision-making Process' section, possible next steps could include a request for further information, or a recommendation that the proponent seek an authorization pursuant to Section 32 and/or Subsection 35(2). Possible outcomes may include the provision of written advice, the issuance of (an) authorization(s) subject to completion of a CEAA review, or, refusal to issue (an) authorization(s).

Proponents should contact DFO before irrevocable commitments (such as contracts for equipment/services) are made, in order to avoid any unnecessary delays in the application and review process. Note that DFO may become aware of your proposed project through its participation in co-operative arrangements with other governments, agencies, boards, etc.

The following 'Application Procedures' section provides information to assist the proponent in deciding if it should seek Authorization to destroy fish by means other than fishing, and/or Authorization to harmfully alter, disrupt or destroy fish habitat, through the use of explosives and, if so, provides information on procedures for filing, etc.

Note that application for Authorization under Section 32 and/or Subsection 35(2) is voluntary. Proponents are not prohibited from going ahead with their use of explosives without Authorization. But, if as a result of the use of explosives, fish are destroyed and/or there is a HADD of fish habitat, contravention of Section 32 and/or Subsection 35(1) of the *Fisheries Act* could occur and the proponent is liable to prosecution.

Application Procedures

1. Proponents unable to meet the overpressure or peak particle velocity guideline values identified, respectively, in measures 8 or 9 of the preceding 'Guidelines' section, should complete and submit an application for Authorization under Section 32 of the *Fisheries Act*, to destroy fish by means other than fishing. The recommended application form is shown in Appendix IV. However, the proponent should contact the appropriate DFO Regional/Area authority (Appendix I) to verify that this is the appropriate application form to use and/or to identify information requirements.

2. Proponents who wish to file for Authorization under Subsection 35(2) of the *Fisheries Act* should complete and submit a separate application in accordance with the form prescribed pursuant to Subsection 58(1) of the *Fishery (General) Regulations* (Appendix V). Assistance on filing the application form, and related procedures, may be obtained by contacting the appropriate DFO Regional/Area authorities (Appendix I).

3. Proponents seeking Authorization under both Section 32 and Subsection 35(2) should complete and submit both Section 32 (Appendix IV) and Subsection 35(2) (Appendix V) applications. However, to minimize duplication, the proponent may choose to cross-reference those sections that are the same in each application form, and is expected to only submit one set of the documents requested in the forms, unless otherwise requested by the DFO Regional/Area authority. Contact the appropriate DFO Regional/Area authorities (Appendix I) for further information and assistance.

4. In seeking Authorization, the proponent will be expected to provide the information requested in the application forms. Doing so will expedite the review process.

   In general, the proponent is expected to provide all plans, specifications, studies, procedures, samples or other information required to permit an assessment of the potential impact of the proposed use of explosives on fish and fish habitat, and the mitigation and/or compensation measures proposed to alleviate impacts and/or to compensate for any loss of productive capacity of habitat to produce fish. Typically, the fish and/or fish habitat information requirements include, but may not necessarily be limited to the items summarized below:

   a) A description of the project and the expected effects resulting from the use of explosives on the fisheries resources (including marine mammals) and/or fish habitat, including:

      i) A description of fish and marine mammal species and their habitats likely to be affected by the detonation;
      ii) A description of whether the fish, marine mammals and their habitats contribute, or have the potential to contribute, directly or indirectly, to a fishery - subsistence, commercial or recreational;
      iii) The timing of any seasonal migration of fish and marine mammals;
      iv) The theoretical lethal range (i.e., the range, or distance, over which the overpressure exceeds 100 kPa) of the explosives to be used (from equations provided in Appendix II);
      v) An assessment of potential impacts arising from the proposed use of explosives and a description of proposed mitigation and/or compensation measures; and
      vi) Other matters, such as the proposed contingency plan and monitoring and follow-up program.

   b) The proponent's mitigation plan should include discussion of the following measures that are particularly relevant to alleviating the potential impacts of explosives:

      i) The work or undertaking should be undertaken at the time of least biological activity or biological sensitivity. Proponents should consult with DFO Regional/Area authorities to determine the appropriate timing;

ii) If multiple charges are required, time-delay detonation initiators (blasting caps) should be used to reduce the overall detonation to a series of discrete explosions. Time delays for discrete explosions should be greater than 25 ms; and,
iii) If possible, large charges should be subdivided into a series of smaller discrete detonations or explosions using time-delay detonation initiators (a procedure known as decking) to reduce the overall detonation to a series of smaller discrete detonations or explosions.

In addition to these measures, the proponent should also consider additional mitigation measures including, but not limited to the following:

iv) Deployment of bubble curtains/air curtains to disrupt the shock wave;
v) Deployment of noise generating devices, such as an air compressor discharge line, to scare fish away from the site; or,
vi) Removal or exclusion of fish from the work area before the blast occurs.

5. Proponents should be aware that subsequent to filing the application, DFO may request additional information concerning fish and fish habitat, the mitigation and/or compensation plans, the contingency and monitoring and follow-up programs, and other matters as required to complete the *Fisheries Act* review. If the appropriate information is not already available, it is the proponent's responsibility to provide it and, also, to assure DFO that the proposed mitigation and/or compensation measures will be effective. Should it be necessary to conduct an environmental assessment of the project pursuant to the CEAA, then additional information will be required in order to meet the requirements of the CEAA.

6. The Department of Fisheries and Oceans will undertake to: respond to requests for review, or to referrals, of project proposals or activities; issue Authorizations or provide advice; and/or complete environmental assessments in a manner consistent with Departmental service standards. Generally, DFO will respond to requests for review or to referrals within 30 working days of notification. Timeframes required for the issuance of Authorizations or advice will be discussed with proponents. Proponents should be aware that the length of time required to complete a review can vary greatly, often depending on the type and complexity of project proposed, the fish and fish habitat issues involved, and whether or not an environmental assessment under the CEAA is required. Once again, proponents are encouraged to contact the appropriate DFO Regional/Area authorities (Appendix I) to discuss these issues.

7. If an unforeseen need to use explosives arises, Departmental service standards may be waived and a review completed as expeditiously as possible so as not to unduly delay a project. Further, Departmental service standards are waived in the event of an emergency where lives and/or property are threatened. In such cases, the amount of information required may be reduced due to the urgency of the

situation. Any verbal request for an emergency Authorization will be accepted only on the condition that it is followed by a written confirmation of the project details.

8. If applicable, proponents may be required by the Department of Fisheries and Oceans, Canadian Coast Guard, to issue a "Notice to Mariners" and/or a "Notice to Fishers". The appropriate DFO Area/Regional authorities (Appendix I) are prepared to assist the proponent with contacting the Canadian Coast Guard.

9. Resource management agencies of other governments, departments, or boards that have been established under some aboriginal land claim settlements, may have aquatic resource review requirements and service standards that are different than those described in this document. Proponents should contact those agencies to ensure compliance with any requirements they may have.

Review and Decision-making Process

This section summarizes the approach taken by the Department of Fisheries and Oceans in the review of referrals and of applications for Authorization. Included is a description of the key decisions possible from a review, and the criteria used in making decisions. There is also a brief summary of the linkage between Section 32 and/or Subsection 35(2) Authorizations and the responsibilities of the Department of Fisheries and Oceans to undertake environmental assessments pursuant to the *Canadian Environmental Assessment Act* (CEAA).

Fisheries Act

DFO will review the proponent's application in accordance with the *Fisheries Act* and its supporting policy framework, including this document. Upon receipt of information, notice, a referral, or application for Authorization concerning works or undertakings where the use of explosives is proposed, DFO will normally take the following steps in its review of the proposal:

1. Determine the adequacy of the information provided by the proponent.

2. Using the information provided, assess the extent of risk or potential damage to fish and marine mammals and/or fish habitat and the acceptability of this level of damage in context with the level of protection required.

3. Determine the probable success of proposed mitigation and/or compensation measures and, as appropriate the acceptability of any residual impacts.

4. Where relevant, consult with the appropriate provincial or territorial resource management agencies, and/or aboriginal resource management boards.

5. Note that prior to finalizing its review of the proposal DFO may, among other matters, advise the proponent of the need for more information, re-assess a revised project proposal, suggest that the proponent seek authorization, etc. The

review of a proposal is often an iterative process depending on a number of factors, such as the type of referral received by DFO, is completeness, its potential impacts on fish and/or fish habitat and the potential to mitigate and/or compensate for such impacts. Proponents should discuss this and related aspects of the review process with the relevant DFO/Regional area authority (Appendix I).

6. After examination of the proposal, DFO will make a decision regarding the proponent's application.

- **With respect to Section 32, DFO will either,**

  ⇒ upon determining that implementation of mitigation measures by the proponent is expected to prevent or avoid the destruction of fish, advise the proponent by letter that if such measures are incorporated into the project, Section 32 is not expected to be contravened. A letter of advice should not be taken to imply approval of the project pursuant to the habitat provisions of the *Fisheries Act*, or any other legislation. Note, if the destruction of fish occurs as a result of a change in the plans for the proposed project, or failure to implement the measures identified in the letter of advice, contravention of Section 32 of the *Fisheries Act* could occur.

  OR

  ⇒ upon determining that even with the implementation of mitigation measures the destruction of fish is still expected to occur **and**, because this mortality is acceptable within the context of the fisheries resource, issue a Section 32 Authorization using a letter format.

  OR

  ⇒ upon determining that even with the implementation of mitigation measures the destruction of fish is still expected to occur **but**, because this mortality is not acceptable within the context of the fisheries resource, reject the proposal, and notify the proponent that DFO will not issue a Section 32 Authorization and that a contravention of the *Fisheries Act* could occur should the proponent still choose to proceed as proposed.

- **With respect to Section 35, DFO will either,**

  ⇒ upon determining that implementation of mitigation measures by the proponent is expected to prevent or avoid a HADD of fish habitat, advise the proponent by letter that if such measures are incorporated into the project, Subsection 35(1) is not expected to be contravened. A letter of advice should not be taken to imply approval of the project pursuant to the habitat provisions of the *Fisheries Act*, or any other legislation. Note, if a

HADD of fish habitat occurs as a result of a change in the plans for the proposed project, or failure to implement the measures identified in the letter of advice, contravention of Subsection 35(1) of the *Fisheries Act* could occur.

OR

⇒ upon determining that even with the implementation of mitigation measures a HADD of fish habitat is still expected to occur **and**, because the proposed compensation for the unavoidable net loss of productive capacity of fish habitat is acceptable to DFO, issue a Subsection 35(2) authorization using the form provided in Schedule VII of Subsection 58(2) of the *Fishery (General) Regulations*.

OR

⇒ upon determining that even with the implementation of mitigation measures a HADD of fish habitat is still expected to occur **but**, because the proposed compensation for the unavoidable net loss of fish habitat productive capacity is not acceptable, reject the proposal, and notify the proponent that DFO will not issue a Subsection 35(2) Authorization and that a violation of the *Fisheries Act* could occur should the proponent still choose to proceed as proposed.

Notes:

- The Department of Fisheries and Oceans, in arriving at one of the above noted determinations, will also consider the following criteria:
    - Whether the use of explosives is the only technically feasible means by which to attain the desired objective; and
    - Whether the use of explosives is required to alleviate an emergency situation threatening human safety and/or property.
- Section 32 and/or Subsection 35(2) authorizations come with conditions attached, which among others may include:
    - The proponent may be required to develop, undertake and report on a monitoring program at its expense, typically, to monitor compliance and evaluate effectiveness of the mitigation and/or compensation measures.
    - If, during the course of the works or undertakings, the adverse effects of the explosives were significantly greater than anticipated, the proponent may be required to immediately cease all further use of explosives,

pending review of the situation with Department of Fisheries and Oceans personnel.

- Additional, site-specific terms and conditions as may be required in order to satisfy fishery resource and/or fish habitat protection requirements. For example, the conditions may be more stringent than the measures identified in the preceding 'Guidelines' section.

Canadian Environmental Assessment Act

Section 32 and Subsection 35(2) are included in the *Law List Regulation* of the *Canadian Environmental Assessment Act* (CEAA). Consequently, the Department of Fisheries and Oceans as the Responsible Authority must conduct an environmental assessment of the relevant proposed works or undertakings before an Authorization can be issued. If the result of the environmental assessment is that the work or undertaking will, after taking into account the appropriate measures, not likely result in significant impact that cannot be justified, then authorization(s) will normally be issued pursuant to Section 32 and/or Subsection 35(2) of the *Fisheries Act*. Procedures for coordinating the CEAA review with provincial and aboriginal government review processes vary. Proponents are strongly advised to contact the DFO Regional/Area authorities (Appendix I) to obtain additional information on environmental assessment procedures and requirements.

UPDATING

These guidelines will be reviewed and updated as necessary.

ACKNOWLEDGEMENTS

Many individuals and governmental and non-governmental organizations were consulted in the development of these guidelines. We gratefully acknowledge their interest and contributions. In particular, input from D. Haché, K. Fisher, K. Broughton and R. Drolet, from DFO, and L. Macanuf (Golder-VME) and R. Morin (Explotec Engineering Ltd) is appreciated.

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Table 1. Setback distance (m) from centre of detonation of a confined explosive to fish habitat to achieve 100 kPa guideline criteria for various substrates.

The data in this table is incorrect and should not be used.

Substrate Type	Weight of Explosive Charge (kg)							
	0.5	1	2	5	10	25	50	100
Rock	3.6	5.0	7.1	11.0	15.9	25.0	35.6	50.3
Frozen Soil	2.3	3.2	4.5	7.2	14.3	16	22.6	32
Ice	1.5	2.1	3.0	4.7	6.6	10.5	14.8	21
Saturated Soil	1.5	2.1	3.0	4.8	6.7	10.0	15.1	21.3
Unsaturated Soil	0.7	1.0	1.4	2.2	3.1	4.9	6.9	9.8

Erratum:

Wright, D.G., and G.E. Hopky. 1998. Guidelines for the use of explosives in or near Canadian fisheries waters. Can Tech. Rep. Fish. Aquat. Sci. 2107: iv + 34p.

Page 15: Table 1 should be replaced by the following Table:

Table 1. Setback distance (m) from centre of detonation of a confined explosive to fish habitat to achieve 100 kPa guideline criteria for various substrates.

Substrate Type	Weight of Explosive Charge (kg)							
	0.5	1	2	5	10	25	50	100
Rock	3.6	5.0	7.1	11.0	15.9	25.0	35.6	50.3
Frozen Soil	3.3	4.7	6.5	10.4	14.7	23.2	32.9	46.5
Ice	3.0	4.2	5.9	9.3	3.2	20.9	29.5	41.8
Saturated Soil	3.0	4.2	5.9	9.3	13.2	20.9	29.5	41.8
Unsaturated Soil	2.0	2.9	4.1	6.5	9.2	14.5	20.5	29.0

Table 2. Setback distance (m) from centre of detonation of a confined explosive to spawning habitat to achieve 13 mm•sec^{-1} guideline criteria for all types of substrate.

	Weight of Explosive Charge (kg)						
	0.5	1	5	10	25	50	100
Setback distance (m)	10.7	15.1	33.7	47.8	75.5	106.7	150.9

Appendix I
DFO Regional/Area Authorities

Newfoundland Region

Habitat Evaluation Engineer,
Habitat Management Division
Fisheries and Habitat Management Branch
PO Box 5667
St. John's, NF A1C 5X1
Voice: (709) 772-6157
Fax: (709) 772-4525

Maritime Region

New Brunswick and Prince Edward Island

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Nova Scotia

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Laurentian Region

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Fish Habitat and Environmental Science
Maurice-Lamontagne Institute
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Central and Arctic Region

Ontario

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Fisheries Management Branch
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Fax: (905) 336-6437

Manitoba, Saskatchewan and Alberta

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Fax: (204) 984-2402

Appendix I (concluded)
DFO Regional/Area Authorities

Central and Arctic Region (continued)

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Western Arctic

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Fisheries Management Branch
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Yukon

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Appendix II
General Equations to Determine Setback Distance for Confined Explosives to Meet Guideline Criteria of 100 kPa

Equation (A)

Equation (A) describes the transfer of shock pressure from the substrate to the water.

$$P_W = \frac{2(Z_W / Z_R)P_R}{1+(Z_W / Z_R)}$$

where:

P_W = pressure (kPa) in water
P_R = pressure (kPa) in substrate
Z_W = acoustic impedance of water
Z_R = acoustic impedance of substrate

Equation (B)

Equation (B) describes the relationship between acoustic impedance and the density and velocity of the medium through which the compressional wave travels.

$$Z_W/Z_R = \frac{D_W C_W}{D_R C_R}$$

where:

D_W = density of water = 1 g•cm^{-3}
D_R = density of the substrate in g•cm^{-3}
C_W = compressional wave velocity in water
= 146,300 cm•s^{-1}
C_R = compressional wave velocity in substrate in cm•s^{-1}

Appendix II (concluded)
General Equations to Determine Setback Distance for Confined Explosives to Meet Guideline Criteria of 100 kPa

Equation (B) (continued):

The following values are used for D_R and C_R for various substrates:

Substrate	D_R ($g \cdot cm^{-3}$)	C_R ($cm \cdot s^{-1}$)
Rock	2.64	457,200
Frozen Soil	1.92	304,800
Ice	0.98	304,800
Saturated soil	2.08	146,300
Unsaturated soil	1.92	45,700

Equation (C)

Equation (C) describes the relationship between the peak particle velocity (V_R) and the pressure, density and compressional wave velocity in the substrate.

$$V_R = \frac{2P_R}{D_R C_R}$$

Equation (D)

Equation (D) represents the scaled distance relationship and is used to equate the peak particle velocity to charge weight and distance.

$$V_R = 100\,(R/W^{.5})^{-1.6}$$

where:

V_R = peak particle velocity in $cm \cdot s^{-1}$
R = distance to the detonation point in m
W = charge weight per delay in kg

Appendix III
Sample Calculations and Examples for Confined Explosives

SAMPLE CALCULATIONS

Sample Calculation 1: Calculation of Setback Distance Required for a 100 kg Charge Set in Rock to Meet the 100 kPa Guideline.

1. From Equation (B):

$$Z_W/Z_R = \frac{D_W C_W}{D_R C_R}$$

$$= \frac{(1g \bullet cm^{-3})(146{,}300cm \bullet s^{-1})}{(2.64g \bullet cm^{-3})(457{,}200cm \bullet s^{-1})}$$

$$= 0.1212$$

2. From Equation (A):

$$P_W = \frac{2(Z_W / Z_R)P_R}{1+(Z_W / Z_R)}$$

$$P_W = \frac{2(0.1212)P_R}{1+(0.1212)}$$

$$P_W = 0.22\ P_R$$

3. To limit P_W to 100 kPa ($kg \bullet m \bullet s^{-2} \bullet m^{-2}$):

$$P_R = \frac{P_W}{0.22}$$

$$P_R = \frac{100\ kPa}{0.22}$$

$$P_R = 455\ kPa$$

$$P_R = 4.55 \times 10^2\ kPa$$

Appendix III (continued)
Sample Calculations and Examples for Confined Explosives

4. Convert kPa to dynes ($g \cdot cm \cdot s^{-2}$):

$$\text{dynes} = \text{kPa} \times 10^4$$

$$P_R = 4.55 \times 10^2 \times 10^4$$

$$P_R = 4.55 \times 10^6 \text{ dynes } (g \cdot cm \cdot s^{-2})$$

5. From Equation (C):

$$V_R = \frac{2P_R}{D_R C_R}$$

$$V_R = \frac{(2)\left(4.55 \bullet 10^6 \ g \bullet cm \bullet s^{-2}\right)}{\left(2.64 \ g \bullet cm^{-3}\right)\left(457{,}200 \ cm \bullet s^{-1}\right)}$$

$$V_R = 7.54 \ cm \bullet s^{-1}$$

6. From Equation (D):

$$V_R = 100(R/W^{.5})^{-1.6}$$
$$R = (W^{.5})(V_R/100)^{-0.625}$$
$$R = (100kg)^{.5}(7.54cm \bullet s^{-1}/100kg \bullet cm \bullet s^{-1} \bullet m)^{-0.625}$$
$$R = 50.3 \text{ m}$$

Therefore, a 100 kg charge of explosives detonated in rock requires a setback of 50.3 m from fish habitat in order to reduce the overpressure produced by the detonation to less than 100 kPa.

Now, the calculation of the set-back distance required for a 100 kg charge set in rock to meet the peak particle velocity guideline of 13 $mm \bullet sec^{-1}$ is as follows:

Appendix III (continued)
Sample Calculations and Examples for Confined Explosives

From Equation (D):

$$R = (W^{.5})(V_R/100)^{-0.625}$$

When

V_R = 13 mm•sec^{-1} = 1.3 cm•sec^{-1}

and W = 100 kg

$$R = (100^{.5})(1.3/100)^{-0.625}$$
$$R = 150.9 \text{ m}$$

Therefore, a 100 kg charge of explosives detonated in rock requires a setback of 150.9 m from a spawning area in order to reduce the peak particle velocity produced by the detonation to less than 13 mm•sec^{-1}.

Sample Calculation 2: Simplified Calculation of Setback Distance from Fish Habitat.

The calculations to determine the required setback distance to meet the 100 kPa guideline may be simplified. Since the weight of the charge and the distance from the charge to fish habitat are the only variables in the equations, a factor can be developed for substitution in Equation (D).

From Equation (D):

$$V_R = 100(R/W^{.5})^{-1.6}$$
$$R = (W.5)\ (V_R/100)^{-0.625}$$

Therefore:

$$R = W^{.5}(K)$$

By working through the equations of Appendix II and solving for V_R for each substrate

Appendix III (continued)
Sample Calculations and Examples for Confined Explosives

type, the following results are obtained:

SUBSTRATE TYPE	K
Rock	5.03
Frozen Soil	3.2
Ice	2.1
Saturated Soil	2.13
Unsaturated Soil	0.98

Therefore, to determine the setback distance required to meet the peak pressure guideline of 100 kPa, multiply the square root of the charge weight by the appropriate "K" factor.

Sample Calculation 3: Simplified Calculation of Setback Distance from Fish Spawning Habitat.

Similarly, to determine the set-back distance required to meet the peak particle velocity (V_R) guideline of 13 mm•sec^{-1}, a constant can be developed for substitution in Equation (D):

From Equation (D):

$$V_R = 100(R/W^{.5})^{-1.6}$$

$$R = (W^{.5})(V_R/100)^{-0.625}$$

where:

$$V_R = 13 \text{ mm•sec}^{-1} = 1.3 \text{ cm•sec}^{-1}$$

$$R = (W^{.5})(1.3/100)^{-0.625}$$

$$R = (W^{.5})(15.09)$$

Therefore, to determine the setback distance required to meet the peak particle velocity (V_R) guideline of 13 mm•sec^{-1}, multiply the square root of the charge weight by a factor of 15.09.

Appendix III (continued)
Sample Calculations and Examples for Confined Explosives

EXAMPLES

Example 1: On-shore Setback Distance from Fish Habitat.

A proponent wishes to use explosives to break rock in a quarry near a stream. What is the minimum setback distance from the stream required in order to limit the overpressure in the stream to less than 100 kPa?

Calculate the required set back distance for a 35 kg charges set in rock.

W		=	35 kg
$K_{(rock)}$	=	6.75	
R		=	$(W^{.5})(K)$
R		=	$(35^{.5})$ (5.03)
R		=	29.8 m

Note: It is assumed that the rock formation being quarried extends under the stream. Therefore the K factor for rock is used.

Therefore, the proponent would be required to maintain a set back distance of at least 29.8 m in order to meet the DFO guideline criteria of 100 kPa.

Example 2: Buried Charges for Geophysical Exploration.

A proponent wishes to conduct a geophysical survey beneath a shallow lake. Because of the shallow depth of the lake, it is not possible to use an air gun or other similar non-explosive energy source. To what depth must explosive charges (5 kg) be buried in order to limit the overpressure to less than 100 kPa?

W	=	5 kg
$K_{(sat.\ soil)}$	=	2.13
R	=	$(W^{.5})(K)$
R	=	$(5^{.5})$ (2.13)
R	=	4.8 m

Note: It is assumed that the charges are buried in un-consolidated sediments. Therefore the K factor for saturated soil is used.

Therefore the proponent would be required to bury the charges to a depth of at least 4.8 m below the substrate-water interface in order to limit the overpressure at the interface to less than 100 kPa.

Appendix III (continued)
Sample Calculations and Examples for Confined Explosives

Example 3: In-stream Trench Excavation.

A proponent wishes to use explosives to assist in the excavation of a trench for a pipeline across a trout stream. The right-of-way is located in a cobble bottom riffle area that is used as a feeding area. There is a potential spawning bed located 75 m upstream of the right-of-way. The explosives' parameters are as follows:

Weight of individual charges: 15 kg
# of holes detonated/delay: 5
Weight of charge/delay: 75 kg

Does the proposal meet the DFO guideline criteria for overpressure and peak particle velocity?

a) For the Overpressure Criteria:

$W = 75$ kg
$K_{(rock)} = 5.03$
$R = (W^{.5})(K)$
$R = (75^{.5})\ (5.03)$
$R = 43.6$ m

Note: Since explosives must be used to excavate the trench, it is assumed that the substrate consists of rock or strongly consolidated sediments. Therefore the K factor for rock is used.

Therefore the detonation of 75 kg of explosives could kill or injure fish within a radius of 43.6 m of the right-of-way.

b) For the Peak Particle Velocity Criteria:

To determine the setback distance required to meet the peak particle velocity (V_R) guideline of 13 mm•sec^{-1} in a spawning area, multiply the square root of the charge weight by a factor of 15.09.

$R = (W^{.5})(15.09)$
$R = (75^{.5})\ (15.09)$
$R = 130.7$ m

Therefore, the detonation of 75 kg of explosives would exceed the DFO Guideline for peak particle velocity of 13 mm•sec^{-1} in a spawning bed.

Appendix III (concluded)
Sample Calculations and Examples for Confined Explosives

Therefore, the application for an authorization to use explosives would be denied and major changes in the explosives program would be required in order for the project to be acceptable to DFO.

For example:

If the weight of explosive/delay were reduced to 5 kg by increasing the number of holes in the pattern and detonating each hole separately with 25 msec delays between each hole, the zone of overpressure exceeding 100 kPa would be:

$W = 5$ kg
$K_{(rock)} = 5.03$
$R = (W^{.5})(K)$
$R = (5^{.5})\ (5.03)$
$R = 11.2$ m

Similarly, the distance at which the peak particle velocity in the substrate would not exceed 13 mm•sec^{-1} would be:

$R = (W^{.5})(15.09)$
$R = (5^{.5})\ (15.09)$
$R = 33.7$ m

Therefore, if the weight of explosives per delay were reduced to 5 kg, the spawning area would be protected, as it is further than 33.7m from the detonation area. However, the detonation would still produce over-pressures exceeding 100 kPa to a distance of 11.2 m. Additional mitigation such as undertaking the project at a time of least fish activity or by removing/excluding fish from the area by either physical exclusion or scare tactics may be required.

Appendix IV
Application Form for Authorization to Destroy Fish by Means Other Than Fishing

¾ ¾

APPLICATION FOR AUTHORIZATION TO DESTROY FISH BY MEANS OTHER THAN FISHING

I, the undersigned, hereby request authorization to carry out the works or undertakings described on this application form. I understand that the approval of this application, if granted, is from the Department of Fisheries and Oceans standpoint only and does not release me from my obligation to obtain permission from other concerned regulatory agencies.

If an authorization is granted as a result of this application, I hereby agree to carry out all activities relating to the project within the designated time frames and conditions specified in the authorization.

Applicant's Name (Please Print) _____

Applicant's Business Address _____

_____

_____

_____

Applicant's Telephone Number _____

Applicant's Facsimile Number _____

Applicant's E-Mail Number _____

Date of Application _____

I solemnly declare that the information provided and facts set out in this application are true, complete and correct, and I make this solemn declaration conscientiously believing it to be true and knowing that it is of the same force and effect as if made under oath. This declaration applies to all material submitted as part of this application.

Applicant's Signature _____

Appendix IV (continued)
Application Form for Authorization to Destroy Fish by Means Other Than Fishing

¾ ¾

APPLICATION FOR AUTHORIZATION TO DESTROY FISH BY MEANS OTHER THAN FISHING (continued)

Location Details

Name of watercourse or waterbody (including co-ordinates)

_____

_____

Nearest Community _____

County _____

Province/Territory _____

Provide details of proposed activity including reasons as to why explosives must be used (attach additional information as required)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix IV (continued)
Application Form for Authorization to Destroy Fish by Means Other Than Fishing

¾ ¾

APPLICATION FOR AUTHORIZATION TO DESTROY FISH BY MEANS OTHER THAN FISHING (continued)

Schedule of Operations

Proposed starting date (D/M/Y) _____

Proposed completion date (D/M/Y) _____

The following documents will assist in assessing your application and help expedite its approval. Please check which documents you have attached.

Map indicating location of project	[ ]
Engineering specifications	[ ]
Dimensional drawings	[ ]
Assessment of fish and marine mammal resources	[ ]
Assessment of potential effects of project on fish and marine mammals	[ ]
Measures proposed to mitigate potential damage to fish and marine mammals	[ ]
Other	[ ]

Appendix IV (concluded)
Application Form for Authorization to Destroy Fish by Means Other Than Fishing

¾ ¾

APPLICATION FOR AUTHORIZATION TO DESTROY FISH BY MEANS OTHER THAN FISHING (concluded)

Explosives Contractor (If different from applicant)

Name _____

Address _____

_____

_____

Telephone number _____

Facsimile number _____

Details of Explosives

Type (including trade name) _____

Total weight of explosive to be used (kg) _____

Weight of individual shots/
Weight per delay _____

Shot pattern _____

Detonation depth _____

Delay period (msec) _____

Method of detonation _____

APPENDIX V
Application Form to Harmfully Alter, Disrupt or Destroy Fish Habitat

SCHEDULE VI/ANNEXE VI

(*Subsection 58(1)/paragraphe 58(1)*)

Fisheries and Oceans

Pêches et Océans

_____

Application No./N° de la demande

APPLICATION FOR AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT
DEMANDE D'AUTORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

I, the undersigned, hereby request authorization to carry out the works or undertakings described on this application form. I understand that the approval of this application, if granted, is from the Minister of Fisheries and Oceans standpoint only and does not release me from my obligation to obtain permission from other concerned regulatory agencies.

Je soussigné, demande par les présentes l'autorisation d'exploiter les ouvrages ou entreprises décrits dans la formule. Je comprends que l'approbation de cette demande, le cas échéant, porte sur ce qui relève du ministre des Pêches et des Océans et ne me dispense pas d'obtenir la permission d'autres organismes réglementaires concernés.

If an authorization is granted as a result of this application, I hereby agree to carry out all activities relating to the project within the designated time frames and conditions specified in the authorization.

Si la demande est approuvée, je consens par les présentes àexécuter tous les travaux relatifs àce projet selon les modalités et dans le laps de temps prescrits dans l'autorisation.

Applicant's Name (Please Print) _____ Nom du requérant (lettres moulées)

Applicant's Business Address _____ Adresse d'affaires du requérant

_____

_____

Applicant's Telephone No./ N° de téléphone du requérant _____ Date_____

I solemnly declare that the information provided and facts set out in this application are true, complete and correct, and I make this solemn declaration conscientiously believing it to be true and knowing that it is of the same force and effect as if made under oath. This declaration applies to all material submitted as part of this application.

Je déclare solennellement que les renseignements fournis et les faits énoncés dans cette demande sont véridiques, complets et exacts, et je fais cette déclaration solennelle, la croyant consciencieusement vraie et sachant qu'elle a la même force et le même effet que si elle était faite sous serment. Cette déclaration s'applique àtout document qui est présenté dans le cadre de cette demande.

_____ _____

Applicant's Signature (and corporate seal)

Signature du requérant (et sceau de la société)

Name of watercourse or waterbody (give coordinates)
Cours d'eau ou plan d'eau (donner les coordonnées) _____

This watercourse is a tributary of (where applicable)
Cours d'eau tributaire de (le cas échéant)

_____

Nearest community Localité la plus proche	County Comté	Province Province
_____	_____	_____

APPENDIX V
Application Form to Harmfully Alter, Disrupt or Destroy Fish Habitat (continued)

SCHEDULE VI-Continued/ANNEXE VI (suite)

Fisheries and Oceans
Pêches et Océans

Application No./N° de la demande

APPLICATION FOR AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT
DEMANDE D'AUTORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

Type of Activity/Genre d'activité

[ ] Bridge Pont	[ ] Stream Realignment Alignement de cours d'eau	[ ] Gravel Removal Enlèvement du gravier	[ ] Stream Traverse Traversée de cours d'eau
[ ] Culvert Ponceau	[ ] Channelization Canalisation	[ ] Obstruction Removal - Bypass Enlèvement ou contournement d'obstacle	[ ] Seismic Survey Levé sismique
[ ] Dam Barrage	[ ] Wharf - Break water Quai - Brise-lames	[ ] Stream Utilization - Recreation Utilisation récréative du cours d'eau	[ ] Agriculture
[ ] Stream Diversion Dérivation de cours d'eau	[ ] Dewatering Assèchement	[ ] Erosion Control Lutte contre l'érosion	[ ] Other (specify) Autres (préciser)
[ ] Mining Activité minière	[ ] Aquaculture	[ ] Flood Protection Protection contre les inondations	

List of Agencies (Federal, Provincial or Municipal) contacted or notified, or who have initiated contact with the applicant.
Liste des organismes (fédéraux, provinciaux ou municipaux) contactés ou qui ont pris contact avec le requérant.

PROVIDE DETAILS OF PROPOSED ACTIVITY INCLUDING REASONS FOR THE PROJECT AND TYPES OF EQUIPMENT TO BE USED
DONNER DES PRÉCISIONS SUR LES TRAVAUX PROJETÉS Y COMPRIS LA JUSTIFICATION DU PROJET ET LE TYPE D'ÉQUIPEMENT À UTILISER

APPENDIX V
Application Form to Harmfully Alter, Disrupt or Destroy Fish Habitat (continued)

SCHEDULE VI-Continued/ANNEXE VI (suite)

Fisheries and Oceans
Pêches et Océans

Application No./N° de la demande _____

APPLICATION FOR AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT
DEMANDE D'AUTORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

SCHEDULE/CALENDRIER

	D/J	M/M	Y/A
Proposed Starting Date Date prévue du début des travaux	_____	_____	_____
Proposed Completion Date Date prévue de l'achèvement des travaux	_____	_____	_____

Approximate Timing of Work in shoreline, foreshore, tidal zone, or underwater areas.
Période approximative des travaux sur le rivage et les estrans ainsi que dans les zones àmarées et les zones sous-marines.

	D/J	M/M	Y/A		D/J	M/M	Y/A
From/De	_____	_____	_____	To/A	_____	_____	_____

The following documents will assist in assessing your application and help expedite its approval. Please check which documents you have attached.	**Les documents suivants faciliteront l'évaluation de votre demande et permettront d'accélérer son approbation. Veuillez cochez les documents vous avez joints àvotre demande.**
Map indicating location of project	[ ] Carte indiquant l'emplacement du projet
Engineering Specifications	[ ] Spécifications techniques
Scale Drawings	[ ] Dessins àl'échelle
Dimensional Drawings	[ ] Plans cotés
Assessment of Existing Fish Habitat Characteristics	[ ] Évaluation des caractéristiques existantes de l'habitat du poisson
Assessment of Potential Effects of Project on Fish Habitat	[ ] Évaluation des répercussions possibles sur l'habitat du poisson
Measures Proposed to Offset Potential Damage to Fish Habitat	[ ] Mesures proposées pour compenser les ventuels dommages àl'habitat du poisson
Other	[ ] Autres

ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS CONSIDERATIONS	**CONSIDIRATIONS CONCERNANT LE PROCESSUS D'IVALUATION ET D'EXAMEN EN MATIORE D'ENVIRONNEMENT**
NOTE: All applications pursuant to section 35 of the Fisheries Act will be assessed in accordance with applicable federal environmental assessment requirements.	REMARQUE : Toute demande en vertu l'article 35 de la Loi sur les pêches sera soumise aux exigences fédérales applicables àl'évaluation environnementale.

APPENDIX V
Application Form to Harmfully Alter, Disrupt or Destroy Fish Habitat (concluded)

SCHEDULE VI-Concluded/ANNEXE VI (fin)

Fisheries and Oceans
Pêches et Océans

Application No./N° de la demande _____

APPLICATION FOR AUTHORIZATION FOR WORKS OR UNDERTAKINGS AFFECTING FISH HABITAT
DEMANDE D'AUTORISATION POUR DES OUVRAGES OU ENTREPRISES MODIFIANT L'HABITAT DU POISSON

COMPLETE ONLY IF USE OF EXPLOSIVES IS INTENDED
A REMPLIR SEULEMENT EN CAS D'UTILISATION D'EXPLOSIFS

EXPLOSIVES CONTRACTOR (IF DIFFERENT FROM APPLICANT)/RESPONSABLE DES EXPLOSIFS (SI AUTRE QUE LE REQUIRANT)

Name/Nom : _____

Address/Adresse : _____

_____

Telephone No./N° de téléphone : _____

	D/J	M/M	Y/A		D/J	M/M	Y/Y
Anticipated Starting Date Date prévue du début des travaux	_____	_____	_____	Completion Date Date d'achèvement	_____	_____	_____

DETAILS OF EXPLOSIVES/PRÉCISIONS SUR LES EXPLOSIFS

Type (including trade name)
Genre (y compris la marque _____

_____

Weight and configuration (where applicable) _____
Poids et forme (le cas échéant)

_____

_____

Weight of individual shots and shot pattern where multiple charges are used
Poids des coups individuels et déploiement des coups, en cas de charges multiples

_____

_____

Detonation depth (in the rock; note also the depth of water, if applicable)
Profondeur de détonation (dans le roc; indiquer aussi, la profondeur de l'eau, s'il y a lieu)

_____

_____

Method of detonation
Méthode de détonation _____

_____

_____

APPENDIX J

Northern Land Use Guidelines: Camps and Support Facilities

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

VOLUME 06

NORTHERN LAND USE GUIDELINES

Camp and Support Facilities

Canada

Table of Contents

Preface

Indian and Northern Affairs Canada (INAC) has revised its popular land use guidelines series. It is designed to guide land use activity on Crown land in the Northwest Territories and Nunavut. Activities on land under private ownership (e.g., First Nations or Inuit-owned land)[1] and land under municipal or territorial control (e.g., Commissioner's land) require direction from the appropriate agency.

Guidelines apply to land use activities on Crown land only.

These guidelines will assist proponents and operators in planning proposed land use activities, assessing related environmental effects and minimizing the impacts of these activities. They should be supplemented by local research, traditional knowledge, engineering or other professional expertise specific to a proposal and advice from the appropriate regulatory agency. Although every attempt has been made during the preparation of these guidelines to use up-to-date information, it remains the operator's responsibility to obtain the most recent information related to northern resource development and to follow current regulatory requirements.

Guidelines do not replace acts, ordinances, regulations and permit terms and conditions.

[1] Aboriginal land refers to First Nations, Inuit, or Métis owned lands

Volumes in this series include:

- Administrative Framework
- Administrative Process
- Applying Sustainable Development
- Permafrost
- Access: Roads and Trails
- Camp and Support Facilities
- Pits and Quarries
- Mineral Exploration
- Hydrocarbon Exploration
- Other Land Uses
- Closure and Reclamation

The series is available electronically from the INAC website: **www.ainc-inac.gc.ca.** Readers are encouraged to visit the site for updates and revisions to the series.

For further information concerning the subject matter contained in this guideline series, please contact:

OTTAWA

Manager, Land Programs, Natural Resources and Environment Branch
Indian and Northern Affairs Canada
Les Terrasses de la Chaudière
10 Wellington Street
Hull QC K1A 0H4
TEL.: 819-994-7464 FAX: 819-997-9623
EMAIL: NorthernLands@ainc-inac.gc.ca

NORTHWEST TERRITORIES

Land Administration
Indian and Northern Affairs Canada
P.O. Box 1500
Yellowknife NT X1A 2R3
TEL.: 867-669-2671 FAX: 867-669-2713
EMAIL: NWTLands@ainc-inac.gc.ca

NUNAVUT

Land Administration
Indian and Northern Affairs Canada
P.O. Box 100
Iqaluit NU X0A 0H0
TEL.: 867-975-4275 FAX: 867-975-4286
EMAIL: landsmining@ainc-inac.gc.ca

YUKON

NOTE: *Effective April 1, 2003, responsibility for Indian and Northern Affairs Canada's Northern Affairs Program (land and resource management) was transferred to the Government of Yukon. For information on land-use in the Yukon, contact the office below*:

Land Use—Lands Branch Department of Energy, Mines And Resources
Government of Yukon
Suite 320, Elijah Smith Building
300 Main Street
Whitehorse YT Y1A 2B5
TEL.: 867-667-3173 FAX: 867-667-3214
EMAIL: land.use@gov.yk.ca

Acknowledgements

In the 1980s, Indian and Northern Affairs Canada published a series of six land use guidelines in a handbook format, intended to help operators of small to medium-scale projects carry out activities in northern Canada in an environmentally sensitive manner. These handbooks, commonly called "The Blue Books," have been widely distributed and quoted. Their success is a tribute to the efforts of the original authors and contributors, and to the departmental steering committee that guided their preparation.

This new series of northern land use guidelines is, in part, an update of the earlier series. This work was directed by a steering committee made up of Northern Affairs Organization and Northern Regional Office staff. Much of the information and many of the photographs presented in this series were obtained in consultation with land use administrators and resource managers in the Northwest Territories and Nunavut.

CHAPTER
01

Introduction

This volume is written for proponents, operators and regulators of temporary camps in northern Canada. Temporary camps service land use projects of limited duration, such as mineral or hydrocarbon exploration. When the project is completed, the camp is generally dismantled. Camp support facilities include airstrips, roads, and fuel and waste storage areas.

This volume presents environmental issues and mitigation techniques associated with the life cycle of a camp from planning to reclamation. Use of proper mitigation techniques can protect the environment and lead to cost-efficiencies in construction, operation and maintenance of camp and support facilities.

Camp operators should note that these guidelines are subordinate to all relevant acts, regulations and permit requirements. When planning, proponents should also be aware of approved land use plans in their area. The guidelines are general in nature and site-specific conditions may require expert advice. Specifically, the guidelines should be supplemented by local research, traditional knowledge, engineering expertise, guidance from INAC land management staff and other appropriate authorities. It is the proponent's responsibility to be aware of and apply the most current and best available environmental mitigation practices.

FIGURE 1A & 1B. Temporary camps range in size and type of support facilities required.

CHAPTER
02

Planning and Design

This volume describes the four phases of camp development, as outlined in Table 1, and best practices for development at each stage. The entire life cycle of a camp, from construction through operations and reclamation, should be considered before development begins. Proper planning saves time and money as a camp that is well planned prior to construction will minimize project delays and reduce the risk of adverse environmental impacts.

To minimize new land disturbance, proponents should assess the possibility of having a community-based operation or use an existing camp. Once a location is chosen, existing environmental, administrative, social and cultural information should be collected (Table 2). Information gaps can then be filled by conducting field investigations. A baseline environmental study will identify sensitive environmental conditions that may require special attention. Undisturbed site conditions can also be recorded for use during closure and reclamation. Baseline information can include soil, permafrost, vegetation, surface water and groundwater quality, and fish and wildlife habitat. All of this information will enable the proponent to provide a complete land use permit application to the appropriate land use regulator.

Table 1. Four phases of camp development.

1 PLANNING AND DESIGN →	2 CAMP CONSTRUCTION →	3 OPERATIONS AND MAINTENANCE →	4 CLOSURE AND RECLAMATION
• Gather and analyze information • Select a site • Conduct a baseline study • Plan operations • Consider reclamation • Apply for a land use permit	• Plan construction • Carry out construction	• Implement maintenance programs • Conduct regular inspections • Identify and correct problems	• Prepare closure and reclamation plan • Progressive reclamation • Conduct closure and reclamation activities • Closure monitoring

2.1 Permitting

Most temporary camp developments on Crown land require a land use permit from the appropriate land use regulator before activity can proceed. Permitting thresholds applicable to temporary camps include the number of person-days, the amount of fuel storage, building construction and clearing of land. Thresholds are listed in the Mackenzie Valley Land Use Regulations *(www.laws.justice.gc.ca/eng/SOR-98-429/index.html)* for the Mackenzie Valley and Territorial Land Use Regulations *(www.laws.justice.gc.ca/eng/C.R.C.-c.1524/page-3.html)* for the Inuvialuit Settlement Region and Nunavut.

Each land use regulator has specific requirements for permit applications. Generally, an application should include environmental background information, a description of the planned camp and the development schedule. The application should also explain how identified environmental impacts will be avoided or minimized during construction and operation of the camp.

Authorization for water use may be required from the appropriate regulatory board. Permitting thresholds for camp water use and deposition of waste are listed in Northwest Territories Waters Regulations *(www.laws.justice.gc.ca/eng/SOR-*

Table 2. Information used for planning a temporary camp.

INFORMATION CATEGORY	INFORMATION SUBCATEGORIES	SOURCES
Environmental	• Topography and drainage • Surface vegetation • Sensitive landforms (e.g. pingos or eskers)	• Maps, aerial photos, satellite imagery • Territorial Geoscience Office (www.nwtgeoscience.ca and www.nunavutgeoscience.ca) • Natural Resources Canada (www.nrcan-rncan.gc.ca) • Local INAC office • Appropriate resource managers or regulatory boards • Local operators and residents
	• Water management	• Local INAC office • INAC Water Resources Division (www.ainc-inac.gc.ca) • Appropriate resource managers or regulatory boards
	• Timber/forestry	• Government of the Northwest Territories, Environment and Natural Resources (www.enr.gov.nt.ca)
	• Fish and wildlife habitat	• Fisheries and Oceans Canada (www.dfo-mpo.gc.ca) • Environment Canada • Territorial environment departments
Engineering	• Construction methods • Camp access: roads or trails	• Engineers • Field investigations • INAC resource management officer
Archaeological/ cultural	• Location of archaeological sites and heritage resources • Traditional-use areas (e.g. berry-picking sites, traplines, cabins)	• Prince of Wales Northern Heritage Centre - Northwest Territories www.pwnhc.learnnet.nt.ca) • Department of Culture, Language, Elders and Youth, Nunavut (www.gov.nu.ca) • Inuit Heritage Trust, Nunavut (www.ihti.ca) • Field investigations and local residents
Reclamation	• Reclamation standards	• Local INAC office • Appropriate resource managers or regulatory boards • Territorial environment departments

93-303/index.html). Camp water supply is also addressed in the *Public Health Act* of the Northwest Territories and Nunavut. The local Environmental Health Officer should be contacted to discuss water supply prior to camp development (N.W.T.: *www.hlthss.gov.nt.ca;* Nun.: *www.gov.nu.ca/health*).

Other authorizations may be required depending on the scope and nature of camp development. The purpose of and responsible authority for authorizations that are commonly required for camp development are outlined in Table 3. For more information, consult the Administrative Process volume of this series.

Table 3 Authorizations that may be required for camp development.

PERMIT	PURPOSE	RESPONSIBLE AUTHORITIES
Land Use Permit	Use and occupation of the camp site	• Indian and Northern Affairs Canada (Inuvialuit Settlement Region) • Land and Water Boards (Mackenzie Valley – Northwest Territories) • Indian and Northern Affairs Canada (Nunavut)
Water Licence	Use of water or deposition of waste, for example, treatment of camp sewage	• Northwest Territories Water Board (Inuvialuit Settlement Region) • Land and Water Boards (Mackenzie Valley – Northwest Territories) • Nunavut Water Board (Nunavut)
Fisheries Authorization	Work in fish-bearing waters, activities that may harm fish habitat	Fisheries and Oceans Canada
Quarrying Permit	Obtain granular materials	Indian and Northern Affairs Canada
Quarry Lease	Long-term access to granular materials	Indian and Northern Affairs Canada (Nunavut only)
Timber Permit	Clearing timber prior to camp construction	Government of the Northwest Territories (NWT only)
Quarry Authorization/ Access Authorization	Access and work on Aboriginal private lands	Aboriginal private landowners
Land Access Permit	Inuit-Owned Lands	Regional Inuit Associations (Nunavut)

2.2 Environmental Conditions

The location of a camp should be selected with care to avoid terrain that could lead to future problems. All camp structures, including fuel caches and greywater sumps, must be located at least 31 m from the high water mark of a water body to reduce the risk of impacting water quality.

2.2.1 Area

Proponents should first consider sites in previously cleared areas and in natural clearings to minimize new land disturbance.

The size of a camp and the area required to support it will be determined by the following:

- purpose of the camp;
- number of occupants and length of their stay;
- seasons during which the camp will operate; and
- type of support facilities (e.g., fuel storage, airstrip, roads).

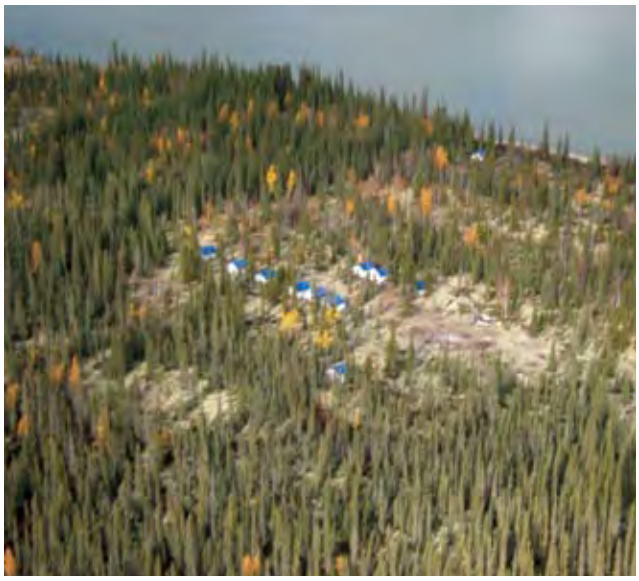
An increase in project activities may require camp expansion. To simplify future site changes, the chosen site should be large enough to accommodate expansion.

2.2.2 Durable Surface

Camps should be constructed on a durable surface, such as gravel or sand, that is consolidated and can withstand repeated, heavy use. This applies especially to camps operating during the summer, when a poorly located camp can erode and become very muddy. In more sensitive areas, elevated boardwalks can be built between camp facilities to reduce the impact of repeated use. Winter camp operations can be located on built-up snow pads and the site can be watered down to provide a durable base of ice.

2.2.3 Slope

A gently sloping site is preferable for camp construction and operations because surface water will easily drain from the site and vehicles will be able to access the site without rutting the surface. If a more steeply sloping site is chosen, slopes facing south or west may be preferable as they are usually warmer and drier.



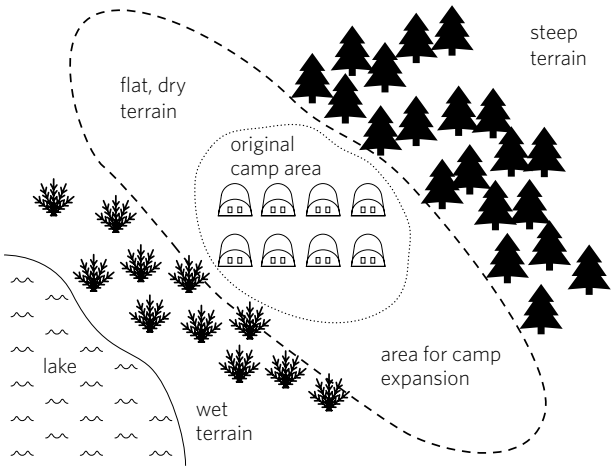


FIGURE 2. (top) Camps should be located in existing clearings to minimize new land disturbance.

FIGURE 3. (middle) Camps should be located where there is room for potential expansion.

FIGURE 4. (bottom) Camps should be constructed on durable surface material.

2.2.4 Vegetation

Vegetation stabilizes the soil with its roots and reduces surface runoff by evapotranspiration through leaves. Removal of vegetation can lead to soil erosion and increased surface water flow. In permafrost terrain, removal or disturbance of vegetation that shades the ground can lead to ground thaw and subsidence.

Boardwalks built between camp buildings can reduce damage to vegetation on high-traffic footpaths. Heavily used footpaths can also be marked using stakes and flagging tape to ensure that impacts to vegetation are confined to a small area.

In the High Arctic, plants grow slowly and are slow to recover from disturbance. In this dry environment, camps should be located in areas with minimal ground cover.

Land use permits may include conditions for saving and stacking merchantable timber in forested areas. For more information on timber management, contact the Department of Environment and Natural Resources, Government of the Northwest Territories.

2.2.5 Permafrost

Permafrost underlies the ground throughout many areas of the Northwest Territories and most of Nunavut. Many areas of perennially frozen ground contain significant amounts of ground ice in the near surface. Disturbance of these areas should be avoided as the ground ice could melt and cause the ground to subside, potentially leading to soil erosion and instability of camp infrastructure. Areas of ground ice are not always identifiable from surface features, so field investigations should be conducted at the campsite to determine the extent and depth of permafrost and near-surface ground ice.

In general, the following areas should be avoided in permafrost terrain due to high near-surface ground ice content:

- patterned ground;
- fine-grained soils, particularly clays; and
- sedge wetlands and peatlands.

FIGURE 5. (top left) Surface disturbance can be reduced by building boardwalks between camp structures.

FIGURE 6. (top right) The pathway is marked and streams are crossed by bridges to reduce impacts to vegetation and water.

FIGURE 7. (bottom left) Avoid locating a camp on patterned ground.

FIGURE 8. (bottom right) Probing for permafrost depths on a raised peatland.

Heat radiating from camp buildings may thaw permafrost, so all heated camp structures should be elevated above the ground surface to allow air circulation. Engineering advice should be obtained when establishing campsites in permafrost terrain. See the Permafrost volume of this series for additional information.

2.2.6 Wind Exposure

Campsites should be planned so that there are no long stretches of recently cleared, fine-grained soils exposed to the wind as these soils are easily eroded. Natural clearings are more resistant to wind because ground cover and root systems are already well developed. Sites that are cleared by hand can be more wind resistant as tree roots may still be intact.

North of the treeline, camps should be located on high ground to avoid accumulation of wind-drifted snow. In the absence of obstacles such as trees, snow is blown into low-lying areas, so a camp located on low ground would require frequent snow removal.

FIGURE 9. On the tundra, camps located on high ground require less snow removal.

2.2.7 Wildlife Habitat

Construction and operation of temporary camps and support facilities have the potential to alter or damage wildlife habitat. Proponents should identify species at risk that could be encountered or affected by the development and consider potential adverse effects of the project on those species and their habitat. If species at risk are encountered, the primary mitigation measure is to avoid disturbing them and their habitat. To discuss issues related to species at risk and for further information, proponents should contact the Canadian Wildlife Service *(www.ec.gc.ca/nature/default.asp?lang=En&n=FB5A4CA8-1)*. Information on species at risk is also available at the Species at Risk Public Registry *(www.sararegistry.gc.ca)* and in Species at Risk in the Northwest Territories *(www.enr.gov.nt.ca)*.

Proponents should also be aware of the presence of migratory birds in the development area. If migratory bird nests are present, the preferred mitigation measure is to clear the area during the nesting period. Information on migratory birds can be obtained from the Canadian Wildlife Service.

2.3 Social and Cultural Values

Social and cultural values should be considered when planning a camp. Local residents should be contacted to identify values, including the area's traditional and recreational usage and cultural significance.

2.3.1 Subsistence and Recreational Values

Community members, resource users and Aboriginal groups should be contacted early during the planning process to identify sites of particular cultural, subsistence or recreational importance in the area of interest. Existing uses can include traplines, cabins, hunting areas, canoe routes or tourism. Concerns can be addressed by the proponent in the choice of camp location and design. The land use permit may also contain specific conditions to protect and minimize disruption of existing interests.

The presence of a camp may detract from the scenic appeal of a landscape, especially in areas of high tourism or recreational value. Camps should be located and designed to minimize their visual impact. The preferred mitigation measure is to avoid highly valued areas; however, if avoidance is not possible, a visual barrier should be considered.

2.3.2 Archaeological Resources

Avoid archaeological and cultural sites when choosing a camp location. Information on documented sites can be obtained from the Prince of Wales Northern Heritage Centre in the Northwest Territories and the Department of Culture, Language, Elders and Youth in Nunavut. Aboriginal groups, communities and governments can also provide information on traditional-use areas. Field investigations should be conducted at the proposed location during the summer prior to camp construction to identify potential archaeological or cultural sites.

If an archaeological or cultural site is discovered at any stage of camp development, work in the area must be stopped immediately and the local INAC resource management officer, territorial government and regulatory board must be notified. Artifacts suggesting the presence of an archaeological site include arrowheads, old encampments or buildings.

FIGURE 10. Contact and engage stakeholders early during the planning process.

2.4 Access

Camp accessibility should be considered during the planning stage. Due to the remoteness of most northern camps, access is often by air. Chosen methods of access should be technically, environmentally and economically feasible.

2.4.1 Roads and Trails

Roads or trails can be used to access a camp. Environmental impacts should be minimized during road construction and operation. See the *Access: Roads and Trails* volume of this series for additional information.

2.4.2 Aircraft

Camps that are supported by fixed-wing aircraft can have airstrips located on land or use nearby water bodies. Where an airstrip is required on land, an existing airstrip or topographic feature capable of accommodating a plane should be utilized before constructing a new airstrip.

Camps that rely on helicopter support should be located in an open area that is large enough to build a helipad nearby.

2.4.3 Docks

For camps located near water bodies, a dock may be required for boat and float plane access. When determining the location and design of a dock, refer to the Department of Fisheries and Oceans' Dock and Boathouse Construction Operational Statement (*www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/nt/os-eo08-eng.htm).*

FIGURE 11. (top) During winter, a nearby frozen lake provides air and road access to this camp.

FIGURE 12 (BOTTOM) A dock should be located in a sheltered area with a gentle shore and adequate water depth for float planes and boats.

CHAPTER 03

Construction

Best construction practices can save time and money by minimizing future reclamation costs. Construction plans should address site-specific environmental, social and cultural conditions identified during the planning and design phase. Specific construction activities will vary according to the purpose, size and duration of the camp; terrain conditions; local weather conditions; and permit requirements. The proponent is responsible for adhering to all permit and regulatory requirements during and following the construction phase.

3.1 Development Timing

A key component of successful camp construction is the proper timing of activities. Winter projects should be scheduled between the average dates of fall freeze-up and spring breakup for the region, allowing adequate time for annual variability.

FIGURE 13. Deep rutting and soil erosion can occur if operations continue too late in the spring.

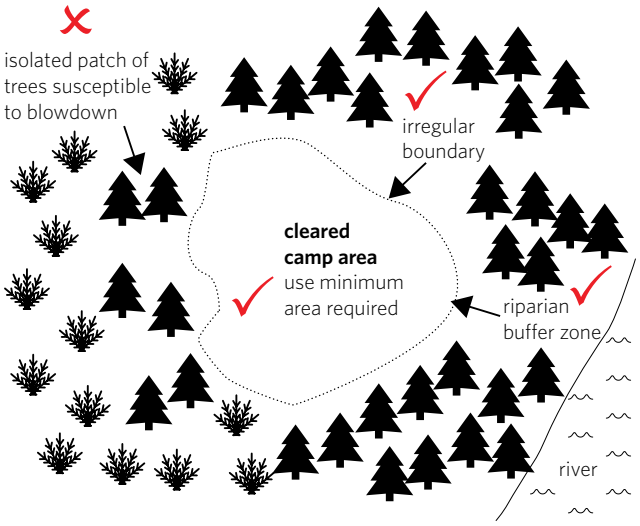
Sufficient time should be set aside for camp demobilization as serious environmental impacts can occur in late spring as the ground is thawing. Contact the local INAC resource management officer for typical freeze-up and breakup dates.

3.2 Clearing

The objective of clearing is to remove vegetation to allow for camp construction without disturbing the ground surface. For small areas, hand clearing is an effective, low-impact method. Clearing can also be undertaken with a machine, such as a dozer, but care should be taken to avoid uprooting vegetation so that roots are left in place to prevent soil erosion. Dozers can be equipped with mushroom shoes or a smear blade to prevent tearing the surface organic layer. Camp area boundaries should be irregular and follow natural edges to reduce the risk of high winds blowing down isolated patches of trees.

Cleared brush should be disposed of in a manner that minimizes fire hazards and allows for wildlife movement. Acceptable brush disposal methods depend on the amount and type of vegetation cleared, and will be specified in the land use permit. Brush should not be disposed of in or near water bodies, or left leaning against standing timber.

Lopping and scattering is used when vegetation that was pushed down during clearing does not lie flat on the ground. Branches are removed and stems are cut into lengths so that the vegetation lies flat on the ground, enhancing decomposition.



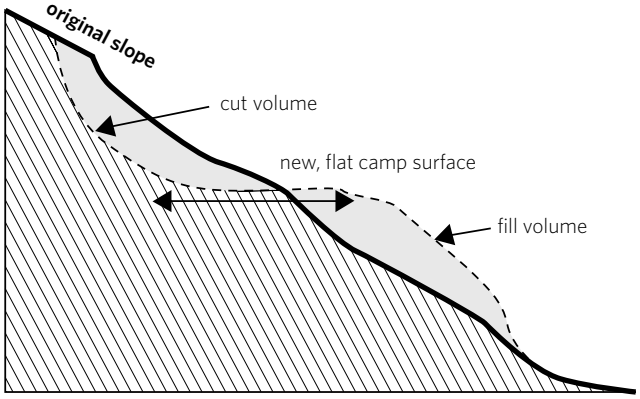


FIGURE 14. (top) Examples of clearing techniques.

FIGURE 15. (middle) Clearing brush with a skidder blade.

FIGURE 16. (bottom) Cut-and-fill technique for grading a sloped campsite.

Windrowing and compaction involves piling cut brush into long rows to the side of the clearing and compacting the piles using heavy equipment to increase decomposition. Windrows should be placed at least five metres away from standing timber to reduce the risk of fire. Breaks of approximately 10-metres width should be left in the windrow at approximately 300-metre intervals to allow wildlife passage.

Brush can also be disposed of by mulching with a wood chipper or a brush cutter. Resulting wood chips can be scattered on the ground, decomposing more rapidly than windrowed brush. This method reduces the risk of fire to a greater degree than windrowing.

Brush can also be completely disposed of by burning. Brush piles should be placed in the middle of the clearing to minimize the risk of fire spreading to surrounding vegetation. Set fires must be monitored at all times. Burning should not be conducted in permafrost terrain with high ground ice content as it could cause ground subsidence.

3.3 Site Grading

When there is no suitable flat terrain, the camp area may require site grading. However, site grading should be avoided in permafrost terrain to prevent ground melting and subsidence. In permafrost terrain, fill from another area may be required to create a flat building site.

Before any site excavation, organic topsoil should be stripped from the surface and stockpiled separately for later reclamation use. Material should be stored well away from water bodies to protect aquatic life. In addition:

- leave a setback of 31 m between the clearing and a water body;
- use sediment- and erosion-control measures during and after construction to prevent entry of sediment into water;
- retain as much riparian vegetation as possible; and
- stabilize stockpiled materials to prevent erosion.

On a slope, a cut-and-fill technique can be used to create a flat site. Materials are excavated from the top of a slope to be used as fill lower on the slope. However, since the excavated materials are highly susceptible to erosion, this technique should only be used if there are no other options, and should

never be used in permafrost terrain to avoid ground thaw and subsidence. Erosion-control measures should be placed on both the cut and fill areas immediately after excavation.

For winter-only camp operations, the preferred site-grading method is to level the camp surface with snow. The site can then be watered down to provide a durable base of ice.

3.4 Drainage Control

Controlling surface water drainage on the campsite will reduce soil erosion and sedimentation into streams. Drainage control is particularly important at campsites that have been graded because natural drainage patterns have been disturbed.

Drainage control options depend on the size of the site and the amount of surface runoff. The simplest method to control drainage is to construct the camp area on a gradient so that water runs away from the camp and into the surrounding terrain. Structures to slow surface runoff, such as sediment curtains or straw bales, can be used for areas with high surface runoff.

Regular maintenance is required to ensure drainage control structures remain effective. For example, trapped sediment should be regularly removed and properly disposed of to ensure that the structure continues to effectively filter sediment.

FIGURE 17. Sediment curtains used for drainage control at the edge of a clearing.

CHAPTER
04

Operations and Maintenance

Operating maintenance and monitoring procedures should be developed during the planning phase. The proponent is responsible for ensuring that these procedures meet applicable regulatory requirements. Procedures should be reviewed and, if necessary, revised before the camp is commissioned to reflect changes that may have occurred during construction.

Maintenance should be performed on camp infrastructure on both a routine and an as-needed basis. For example, a weekly schedule to remove water from fuel containment areas can be established to maintain their storage capacity, but in the event of a large precipitation event these areas should be emptied immediately. Camp infrastructure should also be monitored on a regular basis to identify problems at an early stage before there is an environmental impact. For example, daily inspections of heating fuel drums and fittings can prevent a spill.

Problems identified while using, maintaining or inspecting the camp should be promptly addressed. An action plan for correcting problems and monitoring outcomes should be developed and implemented. For example, if solid food wastes that attract wildlife are often found in the greywater sump, filters can be installed on kitchen drains, and a monitoring schedule can be developed to determine the success of the filters in removing the solid wastes.

4.1 Fuel and Hazardous Materials

Fuel and hazardous materials have the potential to cause environmental damage at campsites if spilled. In addition to hydrocarbon-based fuels, common hazardous materials at a campsite include explosives, fertilizer, reagents for chemical analyses and glycol antifreeze. Proper storage and handling techniques reduce the risks associated with having these materials on-site.

4.1.1 Fuel and Hazardous Material Storage

On federal Crown land, storage of petroleum products in tanks with a capacity greater than 230 L and associated piping and equipment is regulated by Environment Canada's Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations *(www.laws.justice.gc.ca/eng/SOR-2008-197/index.html)*. The purpose of these regulations is to reduce the risk of contaminating soil and groundwater due to spills and leaks of petroleum products from storage tank systems. Land use permit and water licence conditions also address fuel storage location and handling.

Location

Fuel and hazardous materials must be stored on land at least 100 m above the high-water mark to reduce the risk of fuel spills into water unless expressly authorized in the land use permit or in writing by the INAC resource management officer. Fuel caches should be located on flat, stable terrain, or in a natural depression, away from slopes

FIGURE 18. Secondary containment structures can also be used for fuel drum storage.

leading to water bodies. During camp construction, temporary storage of mobile fuel facilities on frozen water bodies may be allowed by the appropriate land use regulator.

The location and content of all fuel caches must be reported in writing to the land use regulator as soon as they are established. This also includes small fuel caches of more than 410 L (two barrels of fuel) but less than 4000 L, which do not require a land use permit. The notification should include the cache location, a description of the fuel, when the fuel will be used and when the empty barrels will be removed.

Some materials are incompatible for storage with others. Operators should maintain a current inventory of the types and quantities of fuels and hazardous materials on-site, and understand how these materials may interact. Incompatible materials should be stored in separate areas (e.g., acids and bases, or flammable and oxidizing materials). Explosives should be stored separately from all other materials. To promote employee awareness of fuel and hazardous materials, a map should be posted within the camp depicting storage locations and their contents.

Secondary Containment

Secondary containment refers to any impermeable storage structure surrounding fuel containers that has the capacity to contain the fuel in the event of a spill. Secondary containment is required for stationary fuel containers with a capacity greater than 230 L. The capacity of the secondary containment structure should be 10 percent greater than the capacity of the largest fuel container within it. Double-walled fuel tanks provide secondary containment. Engineered bermed structures are another method of containment. Berms should be of sufficient height or depth to contain the wave resulting from a major breach of a large container. Large secondary containment areas may require an oil/water separator. If possible, tanks in fuel storage areas should be elevated so that leaks can easily be spotted.

To reduce the chance of spillage, tanks with fill and dispense pipes located on the top of the tank are preferable. Valves and fittings for fuel storage tanks are often sources of leaks and should also be located within a containment area. For small fuel containers, such as drums, secondary containment is a relatively low-cost option to reduce the risk of a spill. Fuel drums used for heating camp tents should be elevated on stands and drip trays should be placed under the fittings and valves.

4.1.2 Fuel and Hazardous Material Handling

All fuel and hazardous material containers, full or empty, should be handled with care to avoid spills.

Fuel transfer areas should be stocked with adequate spill-response supplies. An impermeable liner can be placed under the fuel transfer area to confine contamination in the event of a spill. A common cause of spills is a lack of attention during fuel transfer. The transfer of fuel should always be closely supervised by trained personnel. Larger

operations can designate an employee to conduct refuelling and oversee care of the fuel transfer area. When not in use, fuel nozzles should be placed in containers to prevent drips.

Fuel drums should be kept sealed to prevent fuel from leaking. Caches with multiple fuel drums should be spaced in rows to allow for leak inspections. Fuel drums should be stored on their side with bungs at the 9 and 3 o'clock positions to prevent leakage. Drums should be raised above the ground surface to prevent rust if they are to be stored for longer than six months. All drums must be clearly marked with the operator's name so that they are easy to identify.

Fuel and hazardous material storage areas and fuel lines should be clearly marked with signs or flagging to avoid accidental breaks and punctures. These areas should be kept clear of debris and snow to facilitate routine inspections for leaks. Valves should be clearly marked so that it is apparent which valve opens which fuel tank or fuel line.

Monitoring is a critical aspect of handling and storing fuel and hazardous materials. Camp personnel should be designated to monitor storage and use of hazardous materials and to routinely inspect storage containers, containment areas, drip trays, valves and conveyance lines for leaks and punctures. Inspection records should note the occurrence of and response to leaks or spills.

Snow and water should be regularly removed from secondary containment areas and drip trays to ensure that capacity is maintained. Accumulated snow or water should first be checked for fuel contamination and contaminated material should be appropriately disposed of.

4.1.3 Storage of Empty Drums

All unused fuel and empty fuel and hazardous material containers must be removed from the campsite and properly disposed of when the operation is complete. Empty fuel drums can be collected on-site until there are enough to back-haul. Caps should be replaced on the empty drums in case there is remnant fuel within them. Costs for container removal can be reduced by progressively back-hauling drums on return trips of supply trucks or aircraft.

FIGURE 19. This fuel storage area is well marked with pylons, and drums are stored on their side and well spaced to allow for leak inspection, but snow should be cleared to facilitate leak inspection.

4.2 Waste Management

Appropriate waste storage and disposal can lower environmental risk, minimize wildlife attractants and reduce reclamation costs through progressive removal of wastes from the site. Failure to properly dispose of waste is a common reason why land use permits remain open after site demobilization, requiring a subsequent trip by the operator to clean up the site.

Waste management practices vary depending upon waste characteristics and available facilities. Proponents should develop a waste management plan based on the following hierarchy of preferred waste management methods:

1. Source reduction
2. Reuse or recycle
3. Disposal

Source reduction involves eliminating or reducing the volume of waste generated by a camp through the use of alternative products, methods or processes. Proponents should always consider source reduction first, when planning camp operations, to reduce the amount of waste generated at the site. The following sections outline waste disposal options.

4.2.1 Solid Waste

Solid waste disposal will be specified in the land use permit. Solid waste management options include:

- incineration;
- temporary storage and removal to an appropriate facility; and
- burial on-site (only if approved by the land use regulator, in an area that is not underlain by permafrost).

Solid waste management streams for combustible and non-combustible wastes are shown in Table 4. Combustible wastes primarily include kitchen wastes and packaging that are suitable for disposal by burning. To prevent wildlife attractants and health hazards, food wastes should be stored in odour-proof containers and incinerated on a daily basis. Non-combustible wastes include materials that can negatively affect air quality if burned, such as plastics, and materials that cannot be disposed of by burning, such as metals. These wastes should be separated, organized and stored on-site for eventual removal and disposal off-site.

Table 4. Solid waste management streams.

SOLID WASTE MANAGEMENT STREAMS

1. **Separate combustible and non-combustible solid wastes**
   Note that plastics, styrofoam, and rubber should not be burned to protect air quality

COMBUSTIBLE WASTES

2. **Store combustible solid wastes in odour proof secure containers**
   Wastes should be stored to avoid attracting wildlife
3. **Incinerate combustible wastes daily**
   Incinerator residue should be removed from site or disposed of at an approved area on-site

NON COMBUSTIBLE WASTES

2. **Separate non-combustible solid wastes and store on-site**
   Wastes should be organized in containers with secure lids
3. **Progressively remove non-combustible solid wastes from site throughout operations**
   Make use of empty trucks or aircraft to back-haul wastes

4. **All wastes should be removed from the site at closure**
   Collect and remove wastes from the entire camp area

FIGURE 20. A fuel-fired incinerator with a bin nearby to store non-combustible wastes.

FIGURE 21. Temporarily stored wastes sorted into secure, labelled containers.

Incineration

To promote complete combustion of wastes, a proper incinerator should be used following Environment Canada's Technical Document for Batch Waste Incineration *(www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=F53EDE13-1)*. This document guides owners and operators of batch waste incinerators regarding proper system selection, operation, maintenance and record keeping to assist them in meeting Canada-wide standards for dioxins, furans and mercury, and reducing releases of other toxic substances.

Incinerator residue, such as ash, remaining after burning is complete should be regularly removed and properly disposed of off-site.

Open-pit burning is prohibited, except in the Northwest Territories where it may be used to dispose of inert cardboard and wood waste.

Temporary Storage and Removal

All wastes that are not incinerated must be removed from the campsite. Wastes that are temporarily stored on-site should be kept in secure containers at least 31 m away from a water body. Some non-combustible materials can be crushed to reduce their volume.

Stored wastes should be back-hauled on the return leg of supply trips for reuse, recycling or disposal at an approved facility.

Burial

In special cases on-site burial of non-combustible material, such as scrap metal, may be approved by the land use regulator. Burial is not an option in permafrost terrain due to the difficulty of excavation, likelihood of subsidence if ground ice is present and probability of frost-jacking heaving wastes back to the surface. Expert advice should be obtained if an on-site waste disposal facility is planned.

4.2.2 Sewage and Greywater

Sewage refers to toilet wastes, and greywater refers to water from washing and kitchen facilities. Sewage is more likely to contain pathogens, but all waste water should be stored and treated well away from the water supply.

Small Mobile Camps

In the Northwest Territories, small mobile camps that remain at a site for no more than a few days may be permitted to disperse sewage and greywater over land. Overland dispersal is permitted in permafrost terrain because there is a greater environmental risk from excavating sumps than from spreading small volumes of waste water over land.

Small Stationary Camps

Camps that stay in the same place for more than a few days require waste-water treatment or storage. Sewage may be treated and disposed of on-site, placed in a pit privy or stored in a holding tank for future removal from the site by pump truck. Greywater can be stored and treated in a sump, or stored in a tank for future removal from the site by truck.

In small camps, chemical, incinerating or composting toilets can be used for sewage treatment as they can render the sewage pathogen-free, and reduce the volume of waste. However, once treated, the remaining waste, such as ash, must be removed from camp.

Pit privies can be used to dispose of sewage and provide slow treatment. In permafrost terrain, excavation of pit privies may cause the surrounding ground to thaw and subside. To prevent health problems, privies should be located downslope and downwind from the camp in deep, stable, fine-grained soil. They should also be downstream of the water intake, and at least 31 m away from a water body. Privies should be large enough to hold all of the sewage from the camp and should be covered for health reasons. The shape of the privy depends on the camp layout. For example, in a trailer camp the pit could be long and narrow to service several trailers. To control sewage pathogens, pits can be periodically treated with lime. When full, pits should be covered with at least 30 cm of compacted soil.

Greywater should not be discharged directly next to or into a water body. Instead, greywater can be stored in an excavated sump that will allow for slow infiltration into the soil. The sump should be located at least 31 m away from a water body. Coarse gravel can be placed in the bottom of the sump to provide filtration, and supports can be built on the sides to prevent slumping. The sump should have adequate capacity to store expected greywater volumes, and should be located in mineral soil. Operators should inspect the greywater sump regularly and remove food particles that may attract wildlife. When full, greywater sumps should be covered with enough material to allow for future ground settlement.

Large Stationary Camps

In larger camps with greater volumes of waste water, a portable sewage treatment system or an engineered sewage lagoon can be used to treat sewage and greywater. Proponents should seek expert engineering advice before siting or installing these systems, as an approval by the appropriate licensing board.

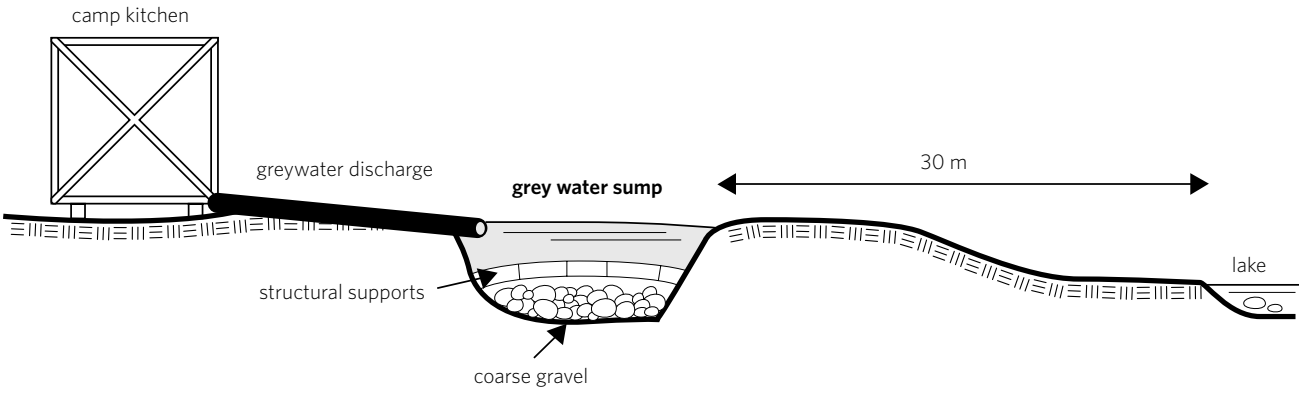


FIGURE 22. A properly excavated greywater sump.

4.3 Water Supply

Camps require a freshwater intake for domestic water use. The amount of water drawn should not be harmful to fish or fish habitat. Water intakes should be screened to prevent fish from being drawn in. For further information, consult the Department of Fisheries and Oceans' Freshwater Intake End-of-Pipe Fish Screen Guideline *(www.dfo-mpo.gc.ca/library/223669.pdf)*. To avoid excessive drawdown during the winter, consult the Department of Fisheries and Oceans Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut.

A water pump is often located next to the water source. Fuel should not be stored near water pumps to reduce the risk of a fuel spill into the water. Drip trays should be used underneath the pump to catch fuel drips.

4.4 Temporary Closure

Some camps are seasonal in nature. Equipment may be left on-site for the next season if properly stored and approved in the land use permit. Equipment should be protected from weather damage, vandalism and wildlife by storing it in a secure, inaccessible location. An on-site, weather-tight building, such as a grain bin, is recommended for storage at seasonal camps.

All wastes should be removed when the camp is temporarily closed. Tents and other structures should be taken down and stored, but tent frames can remain standing. Perishable food should be removed from the site and non-perishable items can be stored in a weather-tight, wildlife-proof building. Fuel drums should be resealed and stored in the fuel storage area. Fittings on heating fuel drums should be removed, the bungs resealed and drums angled so that water does not collect against the bungs.

4.5 Storage Authorization

In some cases, storage authorization may be obtained from the appropriate land use regulator to retain materials such as buildings, equipment and fuel drums at the campsite after the operating land use permit has expired. Such authorization is typically issued if the operator requires the equipment for a future land use operation in the area.

FIGURE 23. A large stationary camp with a sewage lagoon for waste-water treatment.

FIGURE 24. At this seasonal camp, tents will be removed and stored in the weather-tight grain bin.

CHAPTER 05

Spills

Spills can involve fuel or other hazardous materials. Spills of reportable quantities must be reported immediately to the 24-hour spill line (867-920-8130). A list of immediately reportable spill quantities is available in INAC's *Guidelines for Spill Contingency Planning* (www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/SCP-eng.asp).

5.1 Spill Contingency Plan

A spill contingency plan should be in place during all phases of camp construction and operation, and must be submitted with the land use permit application. Unexpected spill events do occur and a plan will help camp employees respond to them quickly and effectively. The spill contingency plan should be implemented immediately after a spill event. The plan outlines a logical order of how personnel should respond to a spill, resources available on-site for spill response, and agencies and individuals that must be notified. All personnel working on the site should be aware of and understand the plan so that they can respond effectively to a spill. A spill contingency plan template is provided in INAC's *Guidelines for Spill Contingency Planning.*

5.2 Spill Prevention

Hydrocarbon spills from equipment are a major source of environmental damage and are often preventable. Equipment should be properly maintained and in good working condition to minimize potential leaks from hydraulic hoses and other working components. Drip trays can be placed under equipment when it is not in use to contain hydrocarbon leaks.

5.3 Spill Response

Spill response includes stopping, containing and reporting a spill event. A spill-response kit should be available on-site and be well stocked with materials that can be used to contain a spill. Once a spill has been contained and reported, photographs should be taken of the spill area, the extent of the spill should be delineated and a cleanup strategy should be developed. Ensure that there is never an ignition source in the vicinity of spilled flammable products.

FIGURE 25. A spill-response kit should include absorbent booms to contain spills on water.

CHAPTER 06

Closure and Reclamation

When a camp is no longer required, it must be closed and reclaimed according to the closure and reclamation plan approved by the land use regulator or as directed in the land use permit. Operators should allocate sufficient time and resources to reclamation activities while equipment and personnel are still on-site during regular operations. Returning to the site to address problems after demobilization is complete can be costly and time consuming. Progressive cleanup during camp operation is the most efficient approach to reclamation.

Land use permits require a final land use plan within 60 days after completion of the land use operation or expiration of the land use permit. The final land use plan should describe the land used, any deviations from conditions specified in the initial land use permit application, details of any fuel or chemical spills and a description of the spill cleanup measures employed.

A closure and reclamation plan is also a common land use permit requirement and at a minimum should include:

- site conditions prior to development;
- environmentally sensitive areas;
- reclamation goal(s);
- equipment and methods to be used;
- reclamation waste management practices;
- monitoring activities to assess the success of reclamation measures; and
- contingencies if reclamation measures are unsuccessful.

6.1 Reclamation Goals

Reclamation goals provide direction for the closure and reclamation plan, and help in determining the methods and equipment needed to achieve final closure. Specific reclamation requirements may be outlined in the land use permit. Common reclamation goals include:

- Returning the site to a condition comparable to that which existed before camp development. Baseline information collected during the planning phase can be used to determine pre-development conditions.
- Reclaiming the site to a state suitable for some other land use (e.g., wildlife habitat, airstrip or equipment storage area).

Reclamation goals are a key component of the closure and reclamation plan and will require approval of the appropriate regulators. They should be discussed with all stakeholders, including community members and Aboriginal groups.

6.2 Reclamation Activities

6.2.1 Complete Removal

Camp closure requires removal of all material that was brought on-site, including structures and equipment. In addition, all garbage must be removed. Final cleanup should be conducted during the summer when surface debris is visible.

Areas contaminated by fuel or chemical spills must be completely cleaned up and contaminated soils properly disposed of.

6.2.2 Landscape Reconstruction

At sites where the topography has been changed to develop the camp area, it may be necessary to re-establish the original contours, especially if slopes have been excavated and drainage control structures have been used to control surface runoff. The goal of landscape reconstruction is to create a stable, maintenance-free site. This can be accomplished by recontouring the site to restore natural drainage patterns. If recontouring is not feasible, a stable drainage control system can be constructed to prevent surface water from eroding the site. Water collection and diversion structures, such as ditches, water bars and check dams, can be used.

Natural revegetation of the site should be encouraged to control soil erosion. This can be accomplished by spreading organic topsoil, stored during site construction, over the surface. The topsoil will provide a natural seed bank and a growth medium. A rough surface is preferable to a smooth surface to catch seeds and provide sites for growth. In non-permafrost areas, a simple way to create a rough surface is to run over the site with a tracked vehicle such as a dozer.

To assist erosion control as vegetation naturally re-establishes, mulched vegetation can be spread over the site, or a soil binder can be sprayed on the surface. Windrowed brush from the initial site clearing can also be spread over the site and compacted with a dozer to control erosion.

FIGURE 26. (top) A properly reclaimed campsite with all materials removed. Core sample boxes may remain in place.

FIGURE 27. (middle) Reclaimed sites should be stable and maintenance free. This site will require better drainage control structures to avoid further erosion.

FIGURE 28. (bottom) Water diversion ditches can be used to control surface runoff across a site.

FIGURE 29. Spreading and compacting brush over the site can control erosion and catch seeds.

FIGURE 30. Willow plugs can be planted to control erosion in sensitive areas such as riparian zones.

6.2.3 Revegetation

Assisted revegetation may be required in erosion-prone areas, such as steep slopes, where recontouring and natural revegetation cannot control erosion in the short term. Revegetation can include seeding of grass or legume species, planting trees or shrubs, and using fertilizer.

Where seeding is required, native seed mixes are preferred to reduce the risk of introducing invasive species. Prior to using any seed mixes or fertilizers, or for more information on appropriate seed mixes and fertilizers, contact the local INAC resource management officer and obtain advice from revegetation specialists.

If seeding is carried out during the winter and the site is located on level terrain, seeds and fertilizer can be distributed directly onto the snow cover and in most cases will successfully germinate. In other cases, it may be necessary to return to the area during the spring for seeding.

High Arctic and high altitude sites are very difficult to revegetate. Minimizing the extent of disturbance is the best mitigation approach.

6.2.4 Access

Airstrips should be reclaimed unless otherwise directed in the land use permit. All materials, including portable beacons and fuel barrels, must be removed.

Requirements for reclamation of roads are outlined in the land use permit. Primary reclamation activities include removing all materials, establishing erosion control and restricting access. See the Access: Roads and Trails volume of this series for more information.

Docks should be removed from the site at closure. Ease of removal should be considered when a dock is constructed as docks that are well anchored may be difficult to remove.

6.3 Reclamation Monitoring

Monitoring may be required for several years after reclamation activities have been completed to assess whether reclamation objectives have been met. Reclamation monitoring should answer the following questions:

- Have erosion-control measures been successful?
- Is water being successfully controlled on the site?
- Has vegetation been re-established to predicted levels?

If monitoring demonstrates that some reclamation techniques have been unsuccessful, additional reclamation work may be required. When the INAC resource management officer is satisfied that the site is stable and reclamation objectives have been met, the land use permit will be recommended to the local land use regulator for closure.

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Glossary

Berm

Low earth mound constructed in the path of flowing water to divert its direction.

Binder

Substance that encourages the adherence of soil particles, such as a chemical mat.

Cut and fill

Construction practice in which earth materials are excavated from part of an area and used as fill in adjacent areas.

Drip tray

A containment structure designed to catch fuel drips beneath fittings, valves or fuel transfer nozzles.

Evapotranspiration

Water lost from the soil by direct evaporation and transpiration from the surfaces of plants.

Greywater

Waste water originating from kitchen or washing facilities.

Ground ice

Ice present in ground materials. It dominates the geotechnical properties of the material and can cause terrain instability if it melts.

High-water mark

A mark or line indicating the highest level reached by a body of water.

Peatland

Poorly drained organic terrain characterized by a high water table and the presence of permafrost.

Permafrost

Ground frozen for at least two consecutive years. Continuous permafrost is defined as an area where at least 90 percent of the land area is underlain by permafrost. Discontinuous permafrost is defined as an area where 10 to 90 percent of the land area is underlain by permafrost.

Pit privy

An excavated pit designed for storage and slow release of sewage.

Riparian

Area of land adjacent to a stream, river, lake or wetland containing vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas.

Secondary containment

A structure designed to contain hazardous materials if the primary containment, such as a fuel tank, fails.

Sewage

Toilet wastes.

Sewage lagoon

A body of water designed to contain and treat sewage.

Source reduction

Reduction or elimination of the volume of waste generated by using alternative methods or processes.

Subsidence

Ground surface settlement.

Sump

An excavated pit designed to contain waste.

Treeline

The zone above which trees do not grow. Occurs at high latitudes and high altitudes.

Appendix A: INAC Local Resource Manager Contact Information

NORTHWEST TERRITORIES

Land Administration
Indian and Northern Affairs Canada
P.O. Box 1500
Yellowknife NT X1A 2R3
TEL.: 867-669-2671 FAX: 867-669-2713
EMAIL: NWTLands@ainc-inac.gc.ca

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District Manager, South Mackenzie District
Indian and Northern Affairs Canada
16 Yellowknife Airport
Yellowknife NT X1A 3T2
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North Mackenzie District
Inuvik, Norman Wells
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Indian and Northern Affairs Canada
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Inuvik NT X0E 0T0
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NUNAVUT

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APPENDIX K

DFO Operational Statement for Culvert Maintenance

CULVERT MAINTENANCE

Fisheries and Oceans Canada
Northwest Territories Operational Statement

Version 3.0

Culvert maintenance is undertaken to extend the life of the structure and to ensure that it functions as designed, thus ensuring public safety and safe fish passage. Culvert maintenance includes the removal of accumulated debris (e.g., logs, boulders, garbage, ice build-up) that prevents the efficient passage of water and fish through the structure. Culvert maintenance may also include the reinforcement of eroding inlets and outlets, but does not include the replacement of damaged or destroyed bevel ends. Culverts requiring regular maintenance should be considered for future remediation via redesign or reinstallation.

Culvert maintenance activities can affect fish and fish habitat by the removal of woody debris that is important for cover and food production, by causing flooding and excessive stream scouring if blockages are removed too quickly, excessive erosion and sedimentation from the use of equipment along the stream bank, and disruption of critical fish life stages. Replacement of eroded rock armouring can alter flows and fish movement patterns if done excessively.

Fisheries and Oceans Canada (DFO) is responsible for protecting fish and fish habitat across Canada. Under the *Fisheries Act* no one may carry out a work or undertaking that will cause the harmful alteration, disruption or destruction (HADD) of fish habitat unless it has been authorized by DFO. By following the conditions and measures set out below you will be in compliance with subsection 35(1) of the *Fisheries Act*.

The purpose of this Operational Statement is to describe the conditions under which it is applicable to your project and the measures to incorporate into your project in order to avoid negative impacts to fish habitat. You may proceed with your culvert maintenance project without a DFO review when you meet the following conditions:

- your planned work is not located in a critical area, as identified in a NWT Community Conservation Plan or other applicable land use plan,
- the work does not include realigning the watercourse, installing a culvert liner or support struts, replacing damaged or destroyed bevels ends, or extending/replacing the existing culvert,
- explosives are not used to remove debris,
- the work does not include any dredging, infilling (e.g., filling scour pools) or excavation of the channel upstream or downstream of the culvert,
- this Operational Statement is posted at the work site and is readily available for reference by workers, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when Maintaining Culverts* listed below in this Operational Statement.

If you cannot meet all of the conditions listed above and cannot incorporate all of the measures listed below then your project may result in a violation of subsection 35(1) of the *Fisheries Act* and you could be subject to enforcement action. In this case, you should contact the DFO office in your area if you wish to obtain DFO's opinion on the possible options you should consider to avoid contravention of the *Fisheries Act*.

You are required to respect all local, municipal, territorial or federal legislation that applies to the work being carried out in relation to this Operational Statement. The activities undertaken in the Operational Statement must also comply with the *Species at Risk Act* (**www.sararegistry.gc.ca**). If you have questions regarding this Operational Statement, please contact the DFO office in your area (see Northwest Territories DFO office list).

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Northwest Territories Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the DFO office in your area. This information is requested in order to evaluate the effectiveness of the work carried out in relation to this Operational Statement.

Measures to Protect Fish and Fish Habitat when Maintaining Culverts

1. Use existing trails, roads, or cut lines wherever possible to avoid disturbance to the riparian vegetation.

2. While this Operational Statement does not cover the clearing of riparian vegetation, the removal of select plants may be required. This removal should be kept to a minimum.

3. Unless accumulated material (i.e., branches, stumps, other woody materials, garbage, ice build-up, etc) is preventing the passage of water and/or fish through the structure, time material and debris removal to prevent disruption to sensitive fish life stages by adhering to appropriate fisheries timing windows (see the Northwest Territories In-Water Construction Timing Windows). Any proposal to conduct such work under ice-covered conditions, with the exception of ice build-up removal, requires prior review by DFO.

4. Emergency debris removal using hand tools or machinery (e.g., backhoe) can be carried out at any time of year. Emergencies include situations where carrying out the project immediately is in the interest of preventing damage to property or the environment, or is in the interest of public health or safety. DFO is to be notified immediately. You should follow all other measures to the greatest extent possible.

5. Install effective sediment and erosion control measures before starting work to prevent sediment from entering the watercourse. Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs.

6. Limit the removal of accumulated material (i.e., branches, stumps, other woody materials, garbage, etc) to the area within the culvert, immediately upstream of the culvert and to that which is necessary to maintain culvert function and fish passage.

7. Remove accumulated material and debris slowly to allow clean water to pass, to prevent downstream flooding and reduce the amount of sediment-laden water going downstream. Gradual dewatering will also reduce the potential for stranding fish in upstream areas.

8. Operate machinery on land (from outside of the water) and in a manner that minimizes disturbance to the banks of the watercourse.

    8.1. Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks.
    8.2. Wash, refuel and service machinery and store fuel and other materials for the machinery away from the water to prevent any deleterious substance from entering the water.
    8.3. Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.
    8.4. Restore banks to original condition if any disturbance occurs.

9. If replacement rock reinforcement/armouring is required to stabilize eroding inlets and outlets, the following measures should be incorporated:
    9.1. Place appropriately-sized, clean rocks into the eroding area.
    9.2. Do not obtain rocks from below the ordinary high water mark (see definition below) of any water body.
    9.3. Avoid the use of rock that is acid-generating. Also avoid the use of rock that fractures and breaks down quickly when exposed to the elements.
    9.4. Install rock at a similar slope to maintain a uniform stream bank and natural stream alignment.
    9.5. Ensure rock does not interfere with fish passage or constrict the channel width.
    9.6. If any in-water work is involved, adhere to fisheries timing windows, as outlined in Measure 3 above.

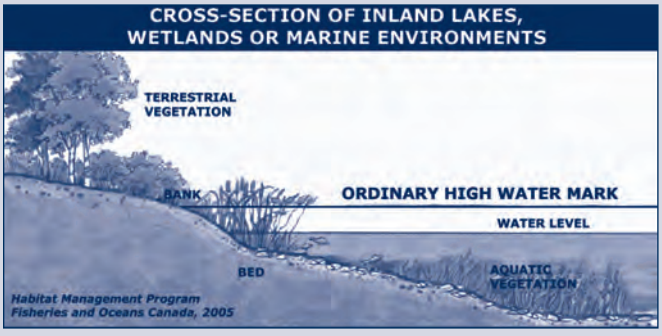
10. Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps or planting them with grass or shrubs.

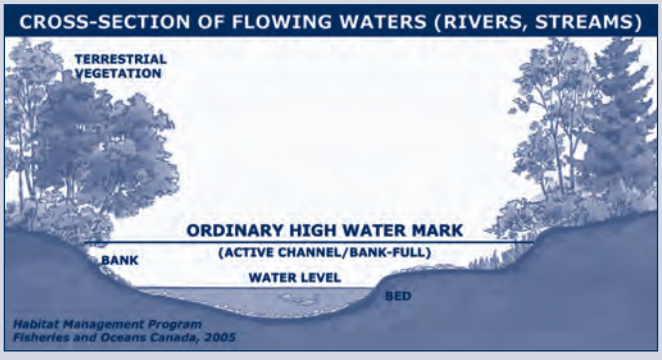
11. Vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site should be stabilized using effective sediment and erosion control measures. In areas with permafrost, care should be exercised to ensure these measures do not cause thawing or frost heave.

    11.1. Maintain effective sediment and erosion control measures until re-vegetation of the disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

Definition:

Ordinary high water mark – The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. In flowing waters (rivers, streams) this refers to the "active channel/bank-full level" which is often the 1:2 year flood flow return level. In inland lakes, wetlands or marine environments it refers to those parts of the water body bed and banks that are frequently flooded by water so as to leave a mark on the land and where the natural vegetation changes from predominately aquatic vegetation to terrestrial vegetation (excepting water tolerant species). For reservoirs this refers to normal high operating levels (Full Supply Level).





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DFO/2007-1329

APPENDIX L

DFO Operational Statement for Bridge Maintenance

BRIDGE MAINTENANCE

Fisheries and Oceans Canada
Northwest Territories Operational Statement

Version 3.0

Bridge maintenance is undertaken to extend the life of the structure and to ensure that it functions as designed, thus ensuring public safety. This Operational Statement applies only to: deck sweeping and washing to remove traction material (e.g., sand and salt residue), cleaning of all bridge components (substructure, superstructure and deck), the removal and application of protective coatings, deck wearing surface replacement, the removal of debris to protect piers and abutments, and structural repairs.

Bridge maintenance activities have the potential to negatively impact fish and fish habitat by introducing sand, sediments, deck surface materials such as concrete and asphalt, and other deleterious substances (e.g., salt, paint, solvents, oil and grease) into watercourses. Removal of woody debris and riparian vegetation may alter natural habitat features and flows that exist in the watercourse. Operation of machinery may impact habitat on the banks and bed, and result in erosion and sedimentation. Placement of rock to stabilize structures may alter natural habitat and flows, and block fish passage.

Fisheries and Oceans Canada (DFO) is responsible for protecting fish and fish habitat across Canada. Under the *Fisheries Act* no one may carry out a work or undertaking that will cause the harmful alteration, disruption or destruction (HADD) of fish habitat unless it has been authorized by DFO. By following the conditions and measures set out below you will be in compliance with subsection 35(1) of the *Fisheries Act.*

The purpose of this Operational Statement is to describe the conditions under which it is applicable to your project and the measures to incorporate into your project in order to avoid negative impacts to fish habitat. You may proceed with your bridge maintenance project without a DFO review when you meet the following conditions:

- your planned work is not located in a critical area, as identified in a NWT Community Conservation Plan or other applicable land use plan,
- the work does not include realigning the watercourse or replacing the existing bridge,
- the work does not involve new dredging, placing fill (e.g., filling scour pools) or excavating the bed or bank of the watercourse below the ordinary high water mark (HWM) (see definition below),
- explosives are not used to remove debris, including ice build-up,
- the withdrawal of any water will not result in reduction in the wetted width of a stream, and will not exceed 10% of the instantaneous flow, in order to maintain existing fish habitat,
- this Operational Statement is posted at the work site and is readily available for reference by workers, and
- you incorporate the *Measures to Protect Fish and Fish Habitat when Maintaining a Bridge* listed below in this Operational Statement.

If you cannot meet all of the conditions listed above and cannot incorporate all of the measures listed below then your project may result in a violation of subsection 35(1) of the *Fisheries Act* and you could be subject to enforcement action. In this case, you should contact the DFO office in your area if you wish to obtain DFO's opinion on the possible options you should consider to avoid contravention of the *Fisheries Act*.

You are required to respect all local, municipal, territorial or federal legislation that applies to the work being carried out in relation to this Operational Statement. The activities undertaken in this Operational Statement must also comply with the *Species at Risk Act* (**www.sararegistry.gc.ca**). If you have questions regarding this Operational Statement, please contact the DFO office in your area (see Northwest Territories DFO office list).

We ask that you notify DFO, preferably 10 working days before starting your work by filling out and sending the Northwest Territories Operational Statement notification form (**www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/prov-terr/index_e.htm**) to the DFO office in your area. This information is requested in order to evaluate the effectiveness of the work carried out in relation to this Operational Statement.

Measures to Protect Fish and Fish Habitat when Maintaining a Bridge

1. Deck Sweeping

1.1. Adequately seal drains and open joints before sweeping to prevent material from falling into the watercourse.

1.2. Clean and remove debris and sediment from drainage devices and dispose of the material in a way that will prevent it from entering the watercourse.

2. Deck Washing

2.1. Sweep decks, including curbs, sidewalks, medians and drainage devices to remove as much material as practical before washing.

2.2. Adequately seal drains and open joints before washing to prevent sediment-laden wash-water from entering the watercourse.

2.3. Direct wash-water past the ends of the bridge deck to a vegetated area to remove suspended solids, dissipate velocity and prevent sediment and other deleterious substances from entering the watercourse. If this cannot be achieved, use silt fences or other sediment and erosion control measures to prevent wash-water from entering the watercourse.

2.4. When extracting water from a watercourse, follow DFO's *NWT Winter Water Withdrawal Protocol* (available from the DFO offices listed below) and ensure the intakes of pumping hoses are equipped with an appropriate device to avoid entraining and impinging fish. Guidelines to determine the appropriate mesh size for intake screens may be obtained from DFO (*Freshwater Intake End-of-Pipe Fish Screen Guideline* (1995), available at **www.dfo-mpo.gc.ca/Library/223669.pdf**).

2.5. Where possible, avoid using small streams as a source for water.

3. Removal and Application of Protective Coatings

3.1. Remove paint or protective coatings in a manner that prevents any paints, paint flakes, primers, blasting abrasives, rust, solvents, degreasers or other waste material from entering the watercourse.

3.2. Use measures such as barges or shrouding to trap and prevent blasting abrasives, protective coatings, rust and grease from entering the watercourse.

3.3. Contain paint flakes, abrasives, and other waste materials for safe disposal.

3.4. Store, mix and transfer paints and solvents on land and not on the bridge to prevent these materials from entering the watercourse in the event of a spill.

3.5. Do not clean equipment in the watercourse or where the wash-water can enter the watercourse.

4. Removal of Debris (e.g., including woody debris, garbage and ice build-up)

4.1. Unless the debris accumulation is an immediate threat to the integrity of the piers and abutments, time debris removal to avoid disruption to sensitive fish life stages by adhering to appropriate fisheries timing windows (see the *Northwest Territories In-Water Construction Timing Windows*), with the exception of ice build-up removal, which can be done at any time of year.

4.2. Limit the removal of material to that which is necessary to protect piers and abutments.

4.3. Remove debris by hand or with machinery operating from shore or a floating barge.

4.4. Emergency debris removal using hand tools or machinery (e.g., backhoe) can be carried out at any time of year. Emergencies include situations where carrying out the project immediately is in the interest of preventing damage to property or the environment, or is in the interest of public health or safety. DFO is to be notified immediately. **You should follow all other measures to the greatest extent possible.**

5. Structural Repairs and Reinforcements

5.1. Use barges or shrouding to trap and prevent concrete and other bridge materials from entering the watercourse.

5.2. If replacement rock reinforcement/armouring is required to stabilize eroding areas around bridge structures (e.g., abutments and/or wing walls), the following measures should be incorporated:

5.2.1 Place appropriately-sized, clean rocks into the eroding area.

5.2.2 Do not obtain rocks from below the HWM of any water body.

5.2.3 Avoid the use of rock that is acid-generating. Also avoid the use of rock that fractures and breaks down quickly when exposed to the elements.

5.2.4 Install rock at a similar slope to maintain a uniform stream bank and natural stream alignment.

5.2.5 Ensure rock does not interfere with fish passage or constrict the channel width.

5.2.6 If any in-water work is involved, adhere to fisheries timing windows, as outlined in Measure 4.1 above.

6. If working from land, install effective sediment and erosion control measures before starting work to prevent the entry of sediment into the watercourse. Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs.

7. While this Operational Statement does not cover the clearing of riparian vegetation, the removal of select plants may be required. This removal should be kept to a minimum and limited to the right-of-way of the bridge.

8. Operate machinery on land (from outside of the water) or on the water (i.e., from a barge or vessel) in a manner that minimizes disturbance to the banks or bed of the watercourse.

8.1. Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks.

8.2. Wash, refuel and service machinery and store fuel and other materials for the machinery away from the water to prevent any deleterious substance from entering the water.

8.3. Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.

8.4. Restore banks to original condition if any disturbance occurs.

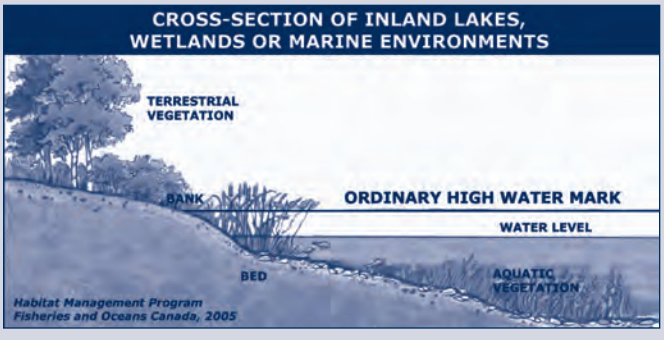
9. Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps or planting them with grass or shrubs.

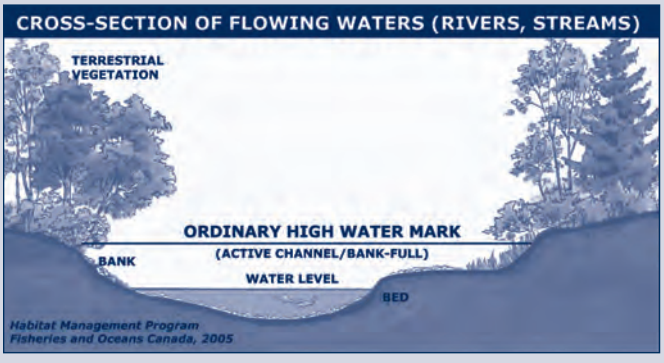
10. Vegetate any disturbed areas by planting and seeding preferably with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. If there is insufficient time remaining in the growing season, the site should be stabilized (e.g., cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring. If re-vegetation is not possible due to climatic extremes and/or lack of appropriate seed or stock, the site should be stabilized using effective sediment and erosion control measures. In areas with permafrost, care should be exercised to ensure these measures do not cause thawing or frost heave.

10.1. Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved or until such areas have been permanently stabilized by other effective sediment and erosion control measures, in the event that re-vegetation is not possible.

Definition:

Ordinary high water mark (HWM) – The usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. In flowing waters (rivers, streams) this refers to the "active channel/bank-full level" which is often the 1:2 year flood flow return level. In inland lakes, wetlands or marine environments it refers to those parts of the water body bed and banks that are frequently flooded by water so as to leave a mark on the land and where the natural vegetation changes from predominately aquatic vegetation to terrestrial vegetation (excepting water tolerant species). For reservoirs this refers to normal high operating levels (Full Supply Level).





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