8. POTENTIAL ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES TO PROTECT FISH HABITAT

8.1 Potential Effects on Fish and Fish Habitat

The following is a summary of the potential effects on fish and fish habitat:

- Temporary physical disturbance and alteration of upland, beach and foreshore areas within the work limits;
- Long term or permanent alteration of fish-bearing habitat within the work limits;
- Sediment release and associated sedimentation from the disruption of soils and/or substrate and upland erosion may adversely impact water quality and aquatic habitat;
- Spills or inadvertent release of harmful substances such as fuel oil, lubricating oil and hydraulic or coolant fluids from equipment during construction;
- The enhanced release of contaminants within impacted soils and containers in the form of particulate, dissolved and colloidally transported contaminants within surficial or free-phase and higher concentration fluids and products;
- Wind or wave generated loss of landfilled materials to the adjacent aquatic environment; and
- Overall net positive impact to soils, groundwater and the aquatic environments from the removal of contaminants and debris.

In light of the expected biophysical attributes of the aquatic environment in the vicinity of DYE-M, it is unlikely that any short-term physical disturbance of the intertidal or shallow subtidal zone (< 3 m depth) would directly impair fisheries habitat or otherwise significantly affect the ecological productivity of this zone. However, it is expected that the value of the aquatic habitat increases with an increase in water depth. As a result, this summary also considers those aspects of the proposed

activities that would alter, through indirect effects, the aquatic habitat beyond the immediate working areas.

A summary of the potential for significant impacts to fish and fish habitat is provided in the following table:

Impact	Potential for Impact*	Significance
Temporary physical disturbance and alteration of upland, beach and foreshore within the work limits	Negligible to low; highly localized	Significant negative effects not likely provided mitigation measures are implemented
Long term or permanent alteration of fish bearing (habitat) within the work limits	Negligible to low; highly localized	Significant negative effects not likely provided mitigation measures are implemented
Sediment release and associated sedimentation of ecologically productive aquatic habitat	Moderate to high, limited areal extent	Significant negative effects not likely provided mitigation measures are implemented
Spills or inadvertent releases of harmful substances such as fuels, lubricating oils impacting soils, groundwater and surface water	Low to moderate, dependant on size of release	Significant negative effects not likely provided mitigation measures are implemented
The enhanced release of contaminants within impacted soils of landfill or hydrocarbon plume and containers in the form of particulate, dissolved and colloidally transported contaminants within surficial or free-phase and higher concentration fluids and products	Moderate to high, dependant on size of release	Significant negative effects not likely provided mitigation measures are implemented
Wind or wave generated loss of landfilled materials to the adjacent aquatic environment	Low to moderate	Significant negative effects not likely provided mitigation measures are implemented
Removal of hydrocarbon and landfill contaminants and debris	High	Significant overall positive effect

* Prior to implementation of mitigation measures.

8.2 Mitigation Measures to Protect Fish Habitat

The potential adverse effects to fish habitat associated with the project activities are mitigable. The following mitigation measures will decrease the potential for significant impacts to fish and fish habitat associated with the project.

8.2.1 Sensitive Periods and Habitat Areas

An evaluation of the biophysical attributes of the aquatic environment in the vicinity of DYE-M indicates the proposed project and scheduling will not have a potential adverse impact on fisheries sensitive habitat areas or periods.

8.2.2 Physical Impacts on Fish Habitat

The following is a summary of mitigation measures incorporated into the project to avoid physical impacts on fish habitat:

- Minimization of the area of physical disturbance resulting from detailed site investigations, delineation and remediation design of impacted areas prior to commencement of project;
- Construction scheduling for generally favourable weather conditions (July to August);
- Construction timing of sensitive activities in areas adjacent to the aquatic environment (beach and foreshore areas) to coincide with periods of low tide and calm sea conditions;
- The areas of physical disturbance will be minimized by clearly defining work areas and areas of non-disturbance in the field prior to the commencement of activity;
- Access to work sites adjacent to fisheries sensitive areas will be limited to essential equipment and personnel only;
- Deployment of silt curtains and booms as necessary, downgradient of the work areas will prevent sedimentation and the release of contaminants to the marine environment;

- Design mitigation measures for erosion control such as slope gradients, specification of fill materials and surface drainage are incorporated in the closure and restoration design of disturbed areas;
- Temporary erosion control measures such as silt fencing and drainage controls will be employed during construction as required;
- Visual monitoring and water turbidity measurements of surface water will be regularly conducted during fisheries sensitive construction activity. Construction will be suspended if monitoring indicates an unacceptable impact to water quality and will only resume when effective mitigation measures are implemented;
- Separated petroleum products, if encountered will be properly contained, collected and disposed of;
- The collection, treatment and proper disposal or discharge of water from excavations will be implemented as necessary;
- Contract specifications require the contractor's use of proper equipment with adequate capacities and in good mechanical condition to avoid unnecessary delays and mechanical failures during construction;
- Contract specifications require Contractor submittal of site specific Work Methodology Plan for approval by the proponent prior to initiating the work. The methodology plan includes details regarding construction staging and sequencing to minimize the significance and duration of potential impacts;
- Contractor submittal of Sedimentation and Erosion Control Plans for approval by the proponent prior to initiating the work;
- Contract specifications require Contractor submittal of site specific contingency plans for the containment, collection and disposal of phase separated petroleum products and potentially impacted water from excavations;
- Heavy equipment will be cleaned and/or decontaminated prior to work within environmentally sensitive areas;

- The fuelling and servicing of equipment will be permitted only in designated, properly contained areas removed from environmentally sensitive areas; and
- Soils and materials removed during remedial excavations will be replaced with suitable coarse-grained erosion resistant material and graded to a stable condition that restores the natural drainage and prevents erosion.
- Project submission to the Nunavut Impact Review Board for review and approval (UMA 2003). The submission includes Environmental Protection and Spill Contingency Plans that are also incorporated into the project contract documents.

8.2.3 Fish Passage

It is not anticipated that the proposed project activities will impact fish passage or migration. The areas where temporary containment structures, such as the floating silt curtains, are installed will be inspected prior to installation to prevent the inadvertent entrapment of fish or marine mammals. During construction, contained areas will be regularly inspected and rescue/release measures will be initiated, if required. All containment structures will be removed upon completion of each season of the work.

8.2.4 Sedimentation

The following is a summary of mitigation measures to avoid sedimentation:

- Project design of cut/fill slopes, excavation areas, and restoration of disturbed areas to reduce the potential for erosion;
- Granular fill material is specified for restoration of the work sites;
- A site-specific Sedimentation and Erosion Control Plan will be submitted by the contractor for approval prior to construction;

- A site specific Work Methodology Plan will be submitted by the contractor for approval prior to construction. The methodology plan will include details regarding construction staging and sequencing to minimize the significance and duration of potential negative impacts from sedimentation;
- Construction timing of activities in fisheries sensitive areas (beach and foreshore areas) to coincide with periods of favourable weather, low tide and calm sea conditions to limit sediment mobilization;
- Temporary sediment and erosion control structures including floating silt curtains and silt fencing will be utilised. The contractor will be required to have suitable materials in sufficient quantities readily available on site to construct or replace the temporary control structures as necessary;
- Surface water will be directed away from or contained within disturbed upland areas when feasible and work areas will be isolated utilising interceptor ditches, swales or constructed berms. Collected surface water will be diverted to settling ponds or other structures as necessary;
- Erodible materials will not be stockpiled within fisheries sensitive areas;
- Visual and instrument monitoring of surface water turbidity levels and total suspended solids will be conducted during activity when the potential to impact water exists; and
- Disturbed areas will be promptly restored to a stable condition consistent with the existing landscape whenever feasible.

8.2.5 Spills and Spill Contingency Plan

The following mitigation measures will reduce the potential for significant impacts as a result of spills or inadvertent releases of hazardous materials:

- Project documents include a detailed Environmental Protection Plan and Spill Contingency Plan (UMA 2003, NIRB submission) which prescribes courses of action to be taken in the case of spills and handling and disposal methods for landfilled barrels and their contents.
- The contractor is required to submit site specific Spill and Emergency Response Plans prior to commencing work;
- All personnel on site will receive instruction regarding proper fuelling procedures for equipment, spill reporting, emergency spill response procedures and the use of spill response materials;
- Sufficient quantities of spill response materials will be kept on site and readily available for a timely response in the event of a spill; all minor spills will be promptly cleaned up and further remediation measures initiated as required;
- Equipment on site will be maintained in good working condition, regularly inspected for potential leaks and if a leak is detected immediately removed from service until repaired;
- All cleaning, servicing and fuelling of equipment will be restricted to designated areas with proper containment and emergency response (spill kits) supplies readily available;
- Phase separated petroleum products, if encountered will be properly contained, collected and disposed of;
- The collection, treatment and proper disposal or discharge of water from excavations will be implemented as necessary;
- Fuel and hazardous materials will be temporarily stored on site in accordance with all applicable regulations in designated areas outside environmentally sensitive areas; and
- When not working, inactive equipment will be temporarily stored or parked in designated areas outside environmentally sensitive areas.

9. SITE RESTORATION

The proposed restoration plan for areas impacted due to remediation activities includes the following:

- Upon completion of each work season, all equipment, temporary structures, and construction materials will be removed from the sites;
- Impacted soils, landfill materials, and collected debris will also be removed for proper treatment or disposal;
- Disturbed areas will be contoured to a stable, positive drainage condition. Disturbed areas will be graded and shaped to match the existing terrain and facilitate recovery of ecosystem components;
- Larger diameter stones within the impacted intertidal areas will be salvaged prior to excavation;
- The excavation areas will be backfilled and compacted with suitably sized, clean granular material obtained from local borrow sources; and
- Salvaged stones, supplemented by additional borrowed material as necessary will be replaced to stabilize and restore the impacted areas similar to the pre-disturbance condition.

The site clean up activities associated with the remedial work at the Beach Landfill – North, Construction Camp Debris Area – South, and Lower Camp Landfill - West will remove structures, debris, and impacted soils from the intertidal areas. The removal and containment of potential contaminants will result in an increase of the productive capacity of fish habitat in the adjacent areas. Therefore, the overall result of the project will be a positive permanent impact to the aquatic environment and result in 'net gain' to the productive capacity of fish habitat in the area.

10. ENVIRONMENTAL MONITORING

10.1 Construction Monitoring

During the construction activities, environmental personnel are responsible for providing quality assurance information to the project and to verify that activities are accomplished in accordance with all applicable environmental protection plans and permits. The on-site environmental personnel are members of the Environmental Sciences Group of the Royal Military College in Kingston.

The existing site conditions of the areas potentially impacted by the physical activities will be inspected and photo-documented by on-site environmental personnel prior to and during the construction activities.

In order to verify the efficiency of the mitigation measures, monitoring of the levels of sediment in the water in the intertidal area is proposed to be conducted before, during and after the construction activities. A combination of sampling and analysis for total suspended solids (TSS) and turbidity, as well as visual monitoring, of areas adjacent to the work areas will be conducted immediately outside the silt curtain.

The CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life will be used to help establish acceptable increases in the levels of total particulate matter in the water as a result of construction activities.

Defence Construction Canada will be represented on site by the Site Engineer and the environmental personnel that report to the Site Engineer. The Contractor maintains regular contact with the environmental personnel and Site Engineer. The Site Engineer is responsible for Contractor implementation and compliance with environmental protection plans, work

methodology plans and applicable regulations and guidelines. In association with the environmental personnel, the Site Engineer monitors the effectiveness of protection plans and mitigative measures and will initiate remedial or corrective measures, as necessary.

10.2 Post-Construction Monitoring

As part of the overall DEW Line Clean Up program, the Department of National Defence will undertake an extensive multiple year post-clean up monitoring program of the landfills on the site to identify actual or potential failure. Detailed information regarding the landfill monitoring program is included in the NIRB submission (UMA 2003) documents. This information is also updated upon construction completion.

In addition to the post-clean up monitoring program of the landfills on site, post-construction monitoring of potentially impacted fisheries sensitive areas will be completed.

Upon the completion of construction and site restoration activities, the on-site field personnel of the environmental team will visually inspect and photo-document post-construction site conditions of the aquatic areas at Beach Landfill – North, Construction Camp Debris Area – South, and Lower Camp Landfill - West areas.

Post-construction monitoring will also include TSS sampling and analysis. The samples will be obtained immediately following reclamation of the near shore/beach areas, and 30 days later, if environmental personnel are still operating on site.

A follow-up visual site inspection, including photo-documentation, will be completed one year following construction to confirm the habitat areas are stable and the restoration efforts are successful. Remedial work, if required, will be completed at this time to mitigate any concerns identified by the follow up inspection.

11. INFORMATION SOURCES

Aitken, A. E.; Fournier, J, 1993. Macrobenthos communities of Cambridge, McBeth and Itirbilung Fiords, Baffin Island, Northwest Territories, Canada. Arctic, 46, 60-71.

Bright, D., S. Harbicht, L. Johnston, S. Parker, K. Reimer and S. Solomon, 1995. Baffin Region Ocean Disposal Investigation: Seabed Debris and Contaminant Inputs Near Iqaluit, Resolution Island, Cape Dyer and Kivitoo. Report prepared by Environment Canada and the Department of National Defence.

Bright, D., P. Fortin, S. Harbicht, L. Johnston, S. Parker and K. Reimer, 1994. Historical Ocean Disposal in the Canadian Arctic: Survey of Materials Disposed in Cambridge Bay and State of the Marine Environment. Report prepared by Environment Canada and the Department of National Defence. 77 pp.

Carey, A. G., 1991. Ecology of North American Arctic Continental Shelf Benthos: A Review. Continental Shelf Research 11, 865-883.

Carey, A. G. Jr.; Scott, P. H.; Walter, K. R., 1984. Distributional ecology of shallow southwestern Beaufort Sea (Arctic Ocean) bivalve Mollusca. Marine Ecology Progress Series 17, 125-134.

Conlan, K. E.; Lenihan, H. S.; Kvitek, R. G.; Oliver, J. S., 1998. Ice scour disturbance to benthic communities in the Canadian High Arctic. Marine Ecology Progress Series 166, 1-16.

Curtis, M. A., 1972. Depth distribution of benthic polychaetes in two fjords on Ellesmere Island, NWT. J. Fish. Res. Bd. Can. 29, 1319-1327.

Denisenko, S., Sandler, H., Denisenko, N., and Rachor, E. 1999. Current state of zoobenthos in two estuarine bays of the Barents and Kara Seas. ICES Journal of Marine Research, 56 Supplement: 187-193.

Dunton, K. H.; Saupe, S. M.; Golikov, A. N.; Schell, D. M.; Schonberg, S. V., 1989. Trophic relationships and isotopic gradients among arctic and subarctic marine fauna. Marine Ecology Progress Series 56, 89-97.

Feder, H. M.; Naidu, A. S.; Jewett, S. C.; Hameedi, J. M.; Johnson, W. R.; Whitledge, TE, 1994. The northeastern Chukchi Sea: Benthos-environmental interactions. Marine Ecology Progress Series 111, 171-190.

Gutt J., Starmans A., Dieckmann G. 1996. Impact of iceberg scouring on polar benthic habitats. Marine Ecology Progress Series 137, 311-316.

Jùrgensen, L. L., T. H. Pearson, N. A. Anisimova, B. Gulliksen, S. Dahle, S. G. Denisenko · G. G. Matishov, 1999. Environmental influences on benthic fauna associations of the Kara Sea (Arctic Russia). Polar Biology, 22: 395-416

Kvitek, R. G., K. E. Conlan, P. J. Iampietro, 1998. Black pools of death: hypoxic, brine-filled ice gouge depressions become lethal traps for benthic organisms in a shallow Arctic embayment. Marine Ecology Progress Series 162:1-10.

Mikhail, M. Y., Welch, H. E., 1989. Biology of Greenland cod, *Gadus ogac*, at Saqvaqjuac, northwest coast of Hudson Bay. Environmental Biology of Fishes. The Hague 26,. 49-62.

Montgomery, D.R. and J.M. Buffington, 1993. Channel classification, prediction of channel response, and assessment of channel conditions. Washington State Dept. of Natural Resources, Timber/Fish/Wildlife Agreement, Rpt. TFW-SH10-93-002, 84 p.

Percy, J. A. 1983. Distribution of Arctic marine isopods of the *Mesidotea* (= *Saduria*) complex in relation to depth, temperature, and salinity in the southern Beaufort Sea. Arctic 36, 341-349.

Schewe, I., 2001. Small-Sized Benthic Organisms of the Alpha Ridge, Central Arctic Ocean. International Review of Hydrobiology [Int. Rev. Hydrobiol.]. 86, 317-335.

Syvitski, J.P.M. Farrow, G.E. Atkinson, R.J.A. Moore, P.G. Andrews, J.T. , 1989. Arctic 42, 232-247.

Reimer, K. J., 2002. The Environmental Consequences of Historic Ocean Disposal in The Canadian Arctic – Summary Document. December 2002.

Starmans, A., Gutt, J., Arntz, W. E., 1999. Mega-epibenthic communities in Arctic and Antarctic shelf areas. Marine Biology, 2, 269-280.

UMA 1991. Environmental Clean Up Study of 21 DEW Line Sites in Canada. Volume 23. Prepared by UMA Engineering Ltd, in association with Hardy BBT Limited and Jacques Whitford Group. June 1991.

UMA 2003. DYE-M, Cape Dyer Tender Drawings – Draft. Prepared by UMA Engineering Ltd., in association with SGE-Acres Ltd. July 2003

UMA 2003. Project Description for the Clean Up of DYE-M, Cape Dyer DEW Line Site - draft. Prepared by UMA Engineering Ltd. on behalf of Defence Construction Canada. July 2003.

Weslawski, J. M., Szymelfenig, M., Zajaczkowski, M., and Keck, A. 1999. Influence of salinity and suspended matter on benthos of an Arctic tidal flat. – ICES Journal of Marine Science, 56 Supplement: 194–202.

APPENDIX I

Project Drawings

Appendix II

Environmental Consequences of Historic Ocean Disposal in the Canadian Arctic

THE ENVIRONMENTAL CONSEQUENCES

of

HISTORIC OCEAN DISPOSAL

in

THE CANADIAN ARCTIC

SUMMARY DOCUMENT

Dr. K. J. Reimer
Professor, Chemistry & Chemical Engineering Department
Director, Environmental Sciences Group
The Royal Military College of Canada
Kingston, Ontario K7K 7B4

Tel: 613-541-6000 x6161
Reimer-k@rmc.ca

December 2002

Background

Many coastal communities in the Canadian Arctic have a recent history that involves the construction and operation of military sites. In particular the Distant Early Warning (DEW) Line and Pole Vault (or Pinegap) Line of radar sites built in the late 1950s, had many ramifications for the Arctic environment (ESG 1991, 1993a, 1993b, 1993c, 1995a, Fletcher, 1990, Grant, 1988).

There are few available records of the activities that took place at the Arctic radar sites prior to 1989. In order to assess possible environmental impact, and to determine appropriate cleanup strategies, it has been necessary to reconstruct a picture of past practices. The Department of National Defence, Indian and Northern Affairs Canada, and Environment Canada sponsored a series of environmental studies of the radar sites and several other military facilities in the Canadian Arctic. These investigations focused on terrestrial contaminant sources and redistribution and the ongoing environmental remediation of the sites (ESG, 1991, 1993a,b,c, 1994a, 1995a).

Among the initial environmental investigations of the radar sites were two studies examining the environmental impact of seabed debris and contaminant input into the marine environment (Bright *et al.*, 1994, ESG 1995b). Government agencies received anecdotal accounts suggesting that debris both from radar sites and northern communities had been directly disposed of into the ocean, either by transport of materials onto the ice or by dumping from ships or barges. The material suspected to have been disposed of in the ocean included large vehicles, and other iron-containing debris. However, ferrous metal debris is considered to be environmentally benign when placed in seawater.

There did not appear to be any motivation for the disposal of smaller hazardous materials (i.e. batteries and PCB-containing equipment) at sea, since in most cases this would require greater effort than the routine disposal of such materials in landfill sites. However, there is extensive evidence for the migration of PCBs or other contaminants from landfills and other contaminated terrestrial areas into marine environments adjacent to many of the radar installations and communities (ESG 1993c, 1995a). PCBs and a small suite of other contaminants tend to biomagnify in marine food webs. Since Arctic marine mammals comprise a substantial proportion of the diets of many Arctic residents, concern was expressed that ocean-dumped debris may impose a negative effect on these important Aboriginal food sources. This concern led to the following two investigations:

Study Sites

1. Cambridge Bay

In 1993, Environment Canada led an investigation into the effects of historical ocean disposal in the marine waters of Cambridge Bay (Bright *et al.*, 1994). Cambridge Bay was believed to be a possible worst-case example for the past disposal of debris in the ocean, given its size and location, and anecdotal accounts of extensive dumping from both the adjacent DEW Line site

and the community. In addition, the results of an underwater survey conducted during the spring of 1993 had suggested that electrical components might be present on the seabed.

2. Baffin Region

In 1994, a second investigation of the extent and environmental effects of past ocean disposal took place in the eastern Arctic, in the waters near Iqaluit, Resolution Island, Cape Dyer, and Kivitoo, Nunavut (ESG 1995b, Bright *et al.*, 1995). Disposal practices at east coast sites were thought to have differed from Cambridge Bay (central Arctic) due to the difference in terrain. Baffin Island and the Labrador are situated on very rugged terrain with limited access to overburden for the construction of landfills. Reimer *et al.* (1991, 1993) describe several sites where debris and chemical contaminants have been allowed to slide over a cliff and into the ocean (e.g. Cape Hooper, FOX-4). There are also anecdotal suggestions that debris may have been hauled onto the ice (e.g. Cape Dyer, DYE-M).

Objectives

The specific objectives of the ocean disposal studies were to:

- delineate the extent of debris in the sea near the study sites (both communities and military radar stations);
- determine the extent to which contaminants have been released from the debris; and,
- investigate the relative effects on Arctic marine animals of ocean disposal versus shore-based contaminant inputs.

Methods

A combination of methods was used during the two studies. Side-scan sonar was used to detect objects on the seabed. Objects on the seabed were identified on the basis of size, shape, and acoustic reflective characteristics. Once the side-scan sonar had established the position of the objects, temporary buoys were placed at the sites. The objects were subsequently examined in greater detail by SCUBA divers and/or Remote Operated Vehicles (ROVs) equipped with cameras and sector-scan sonar.

Samples of marine sediment, and of bottom-dwelling invertebrates and fish were collected from each of the sites and from background locations for comparison. Sediment and biota samples were analyzed for a large range of possible contaminants. Sediment samples were screened for inorganic elements, PCBs, PAHs. The tissues of a subset of biota were analyzed for inorganic elements, PAHs, PCBs, chlorinated pesticides, and toxaphene (or polychlorinated boranes). Detailed descriptions of collection and analytical methods are provided in by Bright *et al.*, 1995.

Results

1. Cambridge Bay

Exhaustive sonar and remotely operated vehicle (video-equipped unmanned submersibles) and diver surveys of the bay revealed the presence of 54 objects or groups of objects, including

natural rock outcroppings. A total of 44 of the objects were confirmed to be from dumped material: vehicles, two aircraft, and hundreds of empty barrels dominated the targets at the end of the bay near the DEW Line site; domestic garbage such as a kitchen sink, bedsprings and batteries were found nearer the community. Electronic components were found in only one area, adjacent to the airstrip.

Many of the submerged objects provided a solid substrate for marine life. Chemical analysis for a wide variety of contaminants indicated that the underwater debris did not significantly contribute to contamination in the bay. Shoreline sources of PCBs, both from the DEW Line site and especially the hamlet dump, were much more important. Sculpins (*Myoxocephalus quadricomis*) in the discharge of the community dumps had accumulated significant concentrations of PCBs, but other fish (Greenland Cod and Arctic Char) had much lower accumulations, with levels meeting consumption guidelines. It was concluded that Cambridge Bay was representative of sites in the central and western Arctic and that:

- debris from historical ocean disposal in the central and western Arctic was potentially quite extensive, but chemical contamination from such inputs was insignificant when compared to shoreline runoff;
- cleanup actions should be restricted to land and foreshore areas and not deep waters unless there is persuasive evidence to the contrary.

2. Baffin Region

Detailed searched of the waters adjacent to the Baffin region study sites revealed little debris. No objects were found in Sunneshine Fjord near Cape Dyer, nor near Kivitoo. Two barges and a third structure (either a barge or the remnants of an old causeway) were found in Koojesse Inlet (part of Frobisher Bay). Some isolated metal hull plates were all that remained of a ship that ran aground near Cape Warwick on Resolution Island in 1974. The sonar and photographic records confirmed that all of the areas are subject to extensive ice scouring of the sea floor, which had carried away any debris to deeper water. The absence of underwater debris in most areas investigated in the Baffin Region strongly suggests that past ocean disposal practices are not contributing to the present contamination of the marine environment.

A total of 76 sediment and 44 biological samples were collected during the study. Elevated levels of lead and arsenic were found within one metre of one of the objects found in Koojesse Inlet, near Innuit Head, however, the concentrations dropped to normal five metres away. The analysis of organic contaminants in the surface marine sediment and marine animals (isopods, soft-shelled clams and short-horn sculpins) showed that there is local contamination by polychlorinated biphenyls (PCBs), near Iqaluit, Resolution Island and Cape Dyer. The inputs were clearly attributable to shoreline, rather than seabed, sources.

Conclusions

Overall, there was no evidence that historical ocean disposal activities at either Cambridge Bay or four sites on eastern Baffin Island have resulted in contaminant inputs to the surrounding marine environment, except within a few metres of an individual metal-containing objects. In

contrast, there is substantial evidence that shoreline contaminant sources, including contaminated areas around radar sites and community dumps, are redistributed into the coastal marine environment. This information was communicated to government regulators, to the Hamlet Councils in Cambridge Bay and Iqaluit, the press, and to the Legislative Assembly of the Government of the Northwest Territories. Copies of the study reports (Bright *et al.*, 1994 and 1995) were distributed to numerous libraries throughout Canada.

References

Bright, D.A., P. Fortin, S. Harbicht, L. Johnson, S. Parker, and K Reimer, 1994. *Historical Ocean Disposal in the Canadian Arctic: Survey of Materials Disposed in Cambridge Bay and the State of the Marine Environment.* Report prepared for Environment Canada and National Defence.

Bright, D.A., S. Harbricht, L. Johnston, S. Parker, K. Reimer, and S. Solomon. 1995. *Baffin region ocean disposal investigation: seabed debris and contaminant inputs near Iqualuit, Resolution Island, Cape Dyer and Kivitoo.* Royal Military College*, Kingston, Ontario.

Environmental Sciences Group (ESG). 1991. *North warning system environmental study.* Three Volumes. Royal Military College*, Kingston, Ontario, Canada.

Environmental Sciences Group (ESG). 1993a. *Environmental study of abandoned DEW line sites: I. five intermediate sites from the Western and Central Arctic.* Two Volumes. Royal Military College*, Kingston, Ontario, Canada.

Environmental Sciences Group (ESG). 1993b. *Environmental study of eleven DEW line sites.* Three volumes. Royal Military College*, Kingston, Ontario, Canada.

Environmental Sciences Group (ESG). 1993c. *The environmental impact of the DEW line on the Canadian Arctic.* Two Volumes. Royal Military College*, Kingston, Ontario, Canada.

Environmental Sciences Group (ESG) and UMA Engineering LTD. 1995a. *DEW line cleanup: scientific and engineering summary report.* Prepared by ESG and UMA at Royal Military College*, Victoria, B.C. for the Department of National Defence.

Environmental Sciences Group (ESG), 1995b. *Baffin Region Ocean Disposal Investigation: Seabed Debris and Contaminant Inputs near Iqaluit, Resolution Island, Cape Dyer and Kivitoo.* Royal Military College*, Kingston, Ontario, Canada, K7K 7B4.

Fletcher R.J. (1990) *Military radar defense lines of North America: an historical geography.* Polar Record 26(159), 265-276.

Grant, S.D., (1988) *Sovereignty or Security? Government Policy in the Canadian North*, 1936-1950. University of B.C. Press, 385 pp.

*Note: The Environmental Sciences Group (ESG) was located at Royal Roads Military College, Victoria, British Columbia from 1989 to 1995, and now works out of the Royal Military College, Kingston, Ontario.

Appendix III

Site Photographs

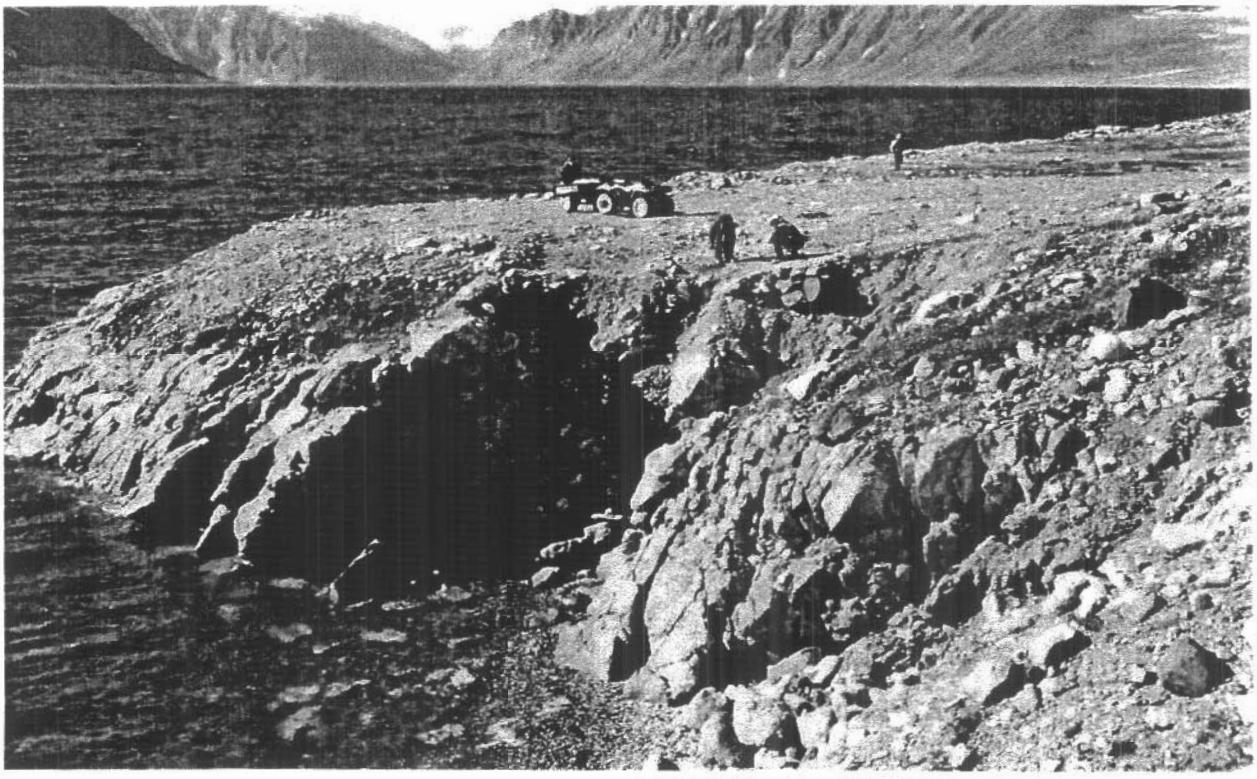
SITE PHOTOGRAPHS

Beach Landfill – North

Lower Camp Landfill – West and Debris Area #31.

SITE PHOTOGRAPHS

Lower Camp Landfill – West and Debris Area #31.



Construction Camp Debris Area – South

APPENDIX IV

HTA Correspondence

September 5, 2003 File: DYE-M 1.4.11

VIA FACSIMILE (867) 473-8741 and CANADA POST

Pangnirtung Hunters and Trappers Association
P.O. Box 02
Pangnirtung NU X0A 0R0

Dear Pangnirtung Hunters and Trappers Association:

RE: CLEAN UP OF DYE-M, CAPE DYER DEW LINE SITE

The DYE-M Cape Dyer Distant Early Warning (DEW) Line Site is located on the easternmost point of Baffin Island of the Nunavut Territory.

UMA Engineering Ltd., on behalf of Defence Construction Canada, has submitted project information regarding the proposed site clean up activities to the Department of Fisheries and Oceans (DFO) in Iqaluit for their review. DFO has requested that we contact your organization for information regarding your local knowledge and use of fisheries in and near the Cape Dyer DEW Line site. Any information that you can provide regarding the occurrence of fish of all species, marine mammals, clams etc. and angling, netting or hunting activity in the area of the site would be of interest and greatly appreciated.

If you have any questions or require more information please do not hesitate to contact the undersigned at phone (780) 486-7069 or fax. (780) 486-7070.

Sincerely,

UMA ENGINEERING LTD.

Laura Edwards, B.Sc.
Environmental Scientist
ledwards@umagroup.com

cc: Stephanie Critch, Department of Fisheries and Oceans, Iqaluit – Fax (867) 979-8039

September 5, 2003 File: DYE-M 1.4.11

VIA FACSIMILE (867) 473-8741 and CANADA POST

Nativak Hunters and Trappers Association
P.O. Box 10
Qikiqtarjuaq NU X0A 0B0

Dear Nativak Hunters and Trappers Association:

RE: CLEAN UP OF DYE-M, CAPE DYER DEW LINE SITE

The DYE-M Cape Dyer Distant Early Warning (DEW) Line Site is located on the easternmost point of Baffin Island of the Nunavut Territory.

UMA Engineering Ltd., on behalf of Defence Construction Canada has submitted project information regarding the proposed site clean up activities to the Department of Fisheries and Oceans (DFO) in Iqaluit for their review. DFO has requested that we contact your organization for information regarding your local knowledge and use of fisheries in and near the Cape Dyer DEW Line site. Any information that you can provide regarding the occurrence of fish of all species, marine mammals, clams etc. and angling, netting or hunting activity in the area of the site would be of interest and greatly appreciated.

If you have any questions or require more information please do not hesitate to contact the undersigned at phone (780) 486-7069 or fax. (780) 486-7070.

Sincerely,

UMA ENGINEERING LTD.

Laura Edwards, B.Sc.
Environmental Scientist
ledwards@umagroup.com

cc: Stephanie Critch, Department of Fisheries and Oceans, Iqaluit – Fax (867) 979-8039

September 5, 2003 File: DYE-M 1.4.11

VIA FACSIMILE (867) 924-6197 and CANADA POST

Namautaq Hunters and Trappers Association
P.O. Box 149
Clyde River NU X0A 0E0

Dear Namautaq Hunters and Trappers Association:

RE: CLEAN UP OF DYE-M, CAPE DYER DEW LINE SITE

The DYE-M Cape Dyer Distant Early Warning (DEW) Line Site is located on the easternmost point of Baffin Island of the Nunavut Territory.

UMA Engineering Ltd., on behalf of Defence Construction Canada, has submitted project information regarding the proposed site clean up activities to the Department of Fisheries and Oceans (DFO) in Iqaluit for their review. DFO has requested that we contact your organization for information regarding your local knowledge and use of fisheries in and near the Cape Dyer DEW Line site. Any information that you can provide regarding the occurrence of fish of all species, marine mammals, clams etc. and angling, netting or hunting activity in the area of the site would be of interest and greatly appreciated.

If you have any questions or require more information please do not hesitate to contact the undersigned at phone (780) 486-7069 or fax. (780) 486-7070.

Sincerely,

UMA ENGINEERING LTD.

Laura Edwards, B.Sc.
Environmental Scientist
ledwards@umagroup.com

cc: Stephanie Critch, Department of Fisheries and Oceans, Iqaluit – Fax (867) 979-8039