Status Report for the Historic Northern Transportation Route

submitted to:

Low-Level Radioactive Waste Management Office
Atomic Energy of Canada
Port Hope, Ontario

AECL

submitted by:

AMEC Earth & Environmental
Calgary, Alberta

December 2005
CE03176

22 December 2005
CE03176

Mr. Glenn Case
Manager, Projects and Facilities Development
Low-Level Radioactive Waste Management Office
Atomic Energy of Canada Limited
5 Mill Street South
Port Hope, Ontario L1A 2S6

Dear Mr. Case:

Re: Status Report for the Historic Northern Transportation Route (NTR)

AMEC Earth & Environmental is pleased to submit our draft report describing the current status of efforts to identify and manage contamination by uranium ores on NTR sites and/or communities. For each of the subject locations, the report describes the site and its operational history, summarizes radiological investigations and/or remedial efforts undertaken to date, and categorizes the significance of any remaining ore contamination.

We look forward to reviewing the contents of this draft with you. If you have any questions or comments in this regard, please feel free to contact the undersigned at 403-235-8136.

Yours truly,

AMEC Earth & Environmental

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TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

µR/h	micro-Roentgens per hour (exposure rate)
µSv/h	micro-Sieverts per hour (effective dose rate)
AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
AMEC	AMEC Earth & Environmental (a division of AMEC Americas Limited)
CCME	Canadian Council of Ministers of the Environment
CNSC	Canadian Nuclear Safety Commission
GNWT	Government of the Northwest Territories
H&S	Health & Safety
HBC	Hudson's Bay Company
INAC	Indian and Northern Affairs Canada
LAGS	Large Area Gamma Survey
LLRWMO	Low-Level Radioactive Waste Management Office
LTMF	Long-Term Management Facility
NSCA	*Nuclear Safety and Control Act*
NTCL	Northern Transportation Company Limited
NTR	Northern Transportation Route
NWT	Northwest Territories
PWGSC	Public Works and Government Services Canada
RMWB	Regional Municipality of Wood Buffalo
SLFN	Smith Landing First Nation
SRFN	Salt River First Nation

1.0 INTRODUCTION

1.1 Background

From the 1930s to the 1960s, a 2,200 km water transportation network, shown on Figure 1, was used by the Northern Transportation Company Limited (NTCL) to carry uranium ore and ore concentrates from Port Radium, Northwest Territories on Great Bear Lake to the barge-to-rail transfer point in Fort McMurray, Alberta. From Fort McMurray, the ore was transported by rail car to its final destination in Port Hope, Ontario for refining.

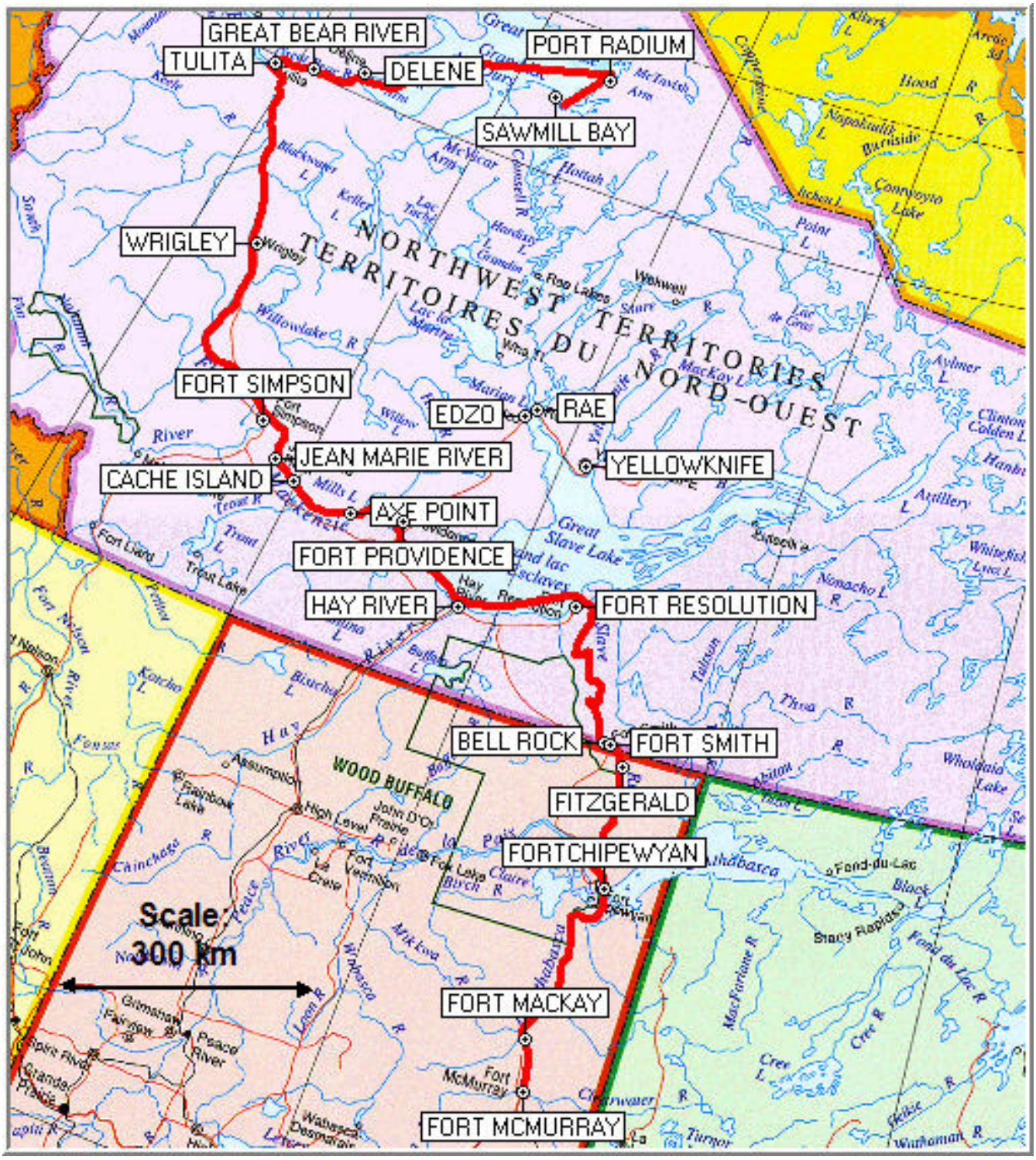
In the summer of 1992, transfer points along the water route were investigated and elevated levels of radioactivity discovered at various sites (SENES, 1994). It was assumed that incidental spillage and tracking during unloading of barges and loading of trucks and railcars were the causes of the contamination. The uranium contamination is considered a historic waste and falls under the mandate of the Low-Level Radioactive Waste Management Office (LLRWMO).

1.2 Objectives

The objective of the work was to summarize the current status of efforts to identify and manage contamination by uranium ores on these Northern Transportation Route (NTR) sites and/or communities. The status review was to be based on currently available information.

1.3 Scope

The report describes the current status of all those NTR sites and/or communities initially characterized in SENES (1994), excluding the Port Radium and Rayrock mine sites. The subject sites are listed on Table 1.



amec		Status Report for the Historic NTR **Uranium Ore Historic Northern Transportation Network**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 1**

Table 1: List of Sites/Communities to be Addressed in the Proposed Summary Report

Sawmill Bay ◆ Dock & Wharf Area ◆ Central Lodge Area ◆ Eldorado Airstrip ◆ Lodge Airstrip
Deline
Franklin Landing
Great Bear River Sites ◆ Lower Shipyard ◆ Bennett Alternate Landing ◆ Road from Bennett Original to Bennett Alternate Landing ◆ Bennett Original Landing ◆ Bennett Camp ◆ Road from Bennett Airstrip to Bennett Camp ◆ Cleared Area Between Bennett Camp and Airstrip ◆ Bennett Airstrip ◆ Road from Upper Portage Wharf ◆ Upper Portage Wharf ◆ Upper Shipyard
Tulita ◆ Bear River Landing ◆ NTCL Camp ◆ Overwinter Storage Site ◆ Mackenzie River Bluff ◆ Contaminated Soil Storage Mound
Middle Mackenzie Sites ◆ Wrigley ◆ Fort Simpson ◆ Jean Marie River ◆ Axe Point and Cache Island ◆ Fort Providence
Hay River, NWT ◆ Old Fishing Village ◆ NTCL Dock Area ◆ Old Indian Village: – Area by Cemetery – River Bank, Beach Area
Rae-Edzo ◆ Island Area of Community ◆ Mainland Area ◆ Rayrock Barge Loadout Area ◆ Marian Lake Indian Village
Yellowknife
Fort Resolution, NWT ◆ Quarry by Airport ◆ Power Plant, Beach Area

Table 1: *continued*

Bell Rock ◆ Wharf and Warehouse Area ◆ Slipway and Maintenance Camp Area ◆ Haul Road to Fort Smith
Fort Smith ◆ NTCL Warehouse ◆ Peregrine St. Ditch and Road ◆ Portage Avenue ◆ In-town Haul Roads ◆ Local Barge Debris ◆ Nuisance Grounds
Fort Smith to Fort Fitzgerald ◆ NTCL Portage ◆ HBC Portage ◆ Halfway House
Fort Fitzgerald ◆ NTCL Marine Terminal ◆ Town Roads ◆ Town Lands
Fort Chipewyan, Alberta ◆ Government Dock and Beach Area ◆ Little Island, Fraser Point ◆ Uranium City Homes
Fort MacKay, Alberta
Fort McMurray, Alberta ◆ NTCL Lands on Manning Avenue ◆ PWGSC Lands ◆ City of Fort McMurray Lands ◆ Transport Canada (Coast Guard) Lands ◆ Former Gunnar Mines Property ◆ NTCL Property at Waterways ◆ Long-Term Management Facility (LTMF)

2.0 METHODS

2.1 Site Categories

The current status of each site was characterized by describing how much is known about radiological conditions on the property, its regulatory status and, for those sites that have been surveyed, the nature and distribution of uranium ores. Site status was characterized by applying one of the following descriptive categories to each property:

- *Category 1* – The site has been adequately assessed and the need for any future site management (by way of remediation or regulatory oversight by the CNSC) has been discounted;
- *Category 2* – Soil contamination and/or waste stockpiles have been removed from the property and additional site management is not required;
- *Category 3* – Soil contamination and/or waste stockpiles will be maintained on the site under an existing regulatory instrument;
- *Category 4* – Soil contamination and/or waste stockpiles are present on-site and available site assessment data is sufficient to define future site management requirements. Decisions regarding future site management are pending;
- *Category 5* – Soil contamination and/or waste stockpiles are present on-site and additional site assessments are required to define future site management requirements; and
- *Category 6* – The site has not been surveyed.

2.2 Material Categories

The significance of ore contamination, and its implications on current and future use of the lands in question, depends largely on the density of ore accumulations in a particular area and the physical attributes of the area (i.e., existing and potential usage). For the purposes of this report, any radiological survey data available for the subject properties were categorized as follows:

- *Category L* – areas which contain ores of a type and/or density that would require a license under the Nuclear Substances and Radiation Devices Regulations (including proposed amendments) of the Nuclear Safety and Control Act (CNSC, 2005) (i.e., areas containing licensable materials);
- *Category 1* – areas which do not contain licensable materials, but in which the density of uranium ore accumulations is very likely incompatible with unrestricted use of the lands;
- *Category 2* – areas which do not contain licensable materials, but in which the density of uranium ore accumulations is potentially incompatible with unrestricted use of the lands; and
- *Category 3* – areas which show no evidence of ore contamination, or in which the density of uranium ore accumulations is unlikely to create any restrictions on use of the lands.

Scientifically robust and quantitative boundaries for each of the above categories would require a site-specific examination of contaminant transport and receptor exposures that was beyond the scope of this review. However, for the purposes of this assessment, the criteria listed in Table 2 were applied. These preliminary criteria were taken from similar programs undertaken elsewhere by the LLRWMO, or developed on the basis of AMEC's experience and judgment.

Table 2: Contaminated Soil Categories

Category	Description	Representative Gamma Radiation Range (@ 1 m abgl)	Typical Analytical Criteria
L	Areas containing licensable materials	—	>1.0 Bq/g Ra226
1	Likely incompatible with unrestricted future land use	>2 x Upper Range of Background (URB)	>0.3 Bq/g Ra226 >12 µg/g As >12 µg/g U
2	Potentially incompatible with unrestricted future land use	Between URB and 2 x URB	>0.3 Bq/g Ra226 >12 µg/g As >12 µg/g U
3	Likely compatible with unrestricted future land use	Upper Range of Background (URB)	<0.3 Bq/g Ra226 <12 µg/g As <12 µg/g U

Note that this categorization scheme is generally consistent with that applied to recent surveys conducted on some of the subject properties (AMEC, 2005).

2.3 Data Sources

This NTR status report is based solely on existing data. Information was compiled by:

- assembling and reviewing documents prepared previously by AMEC and/or other consultants on behalf of the LLRWMO;
- reviewing the LLRWMO's project files on-site in Port Hope, Ontario; and
- discussing survey activities with knowledgeable LLRWMO staff.

3.0 SITE INFORMATION

3.1 Sawmill Bay

3.1.1 Location

Sawmill Bay is located on the east side of Great Bear Lake at 65º, 43'N; 118º, 55'W, some 60 km southwest of Port Radium (see Figures 1 and 2).

3.1.2 Operational History and Site Description

Sawmill Bay was used as a land to air transfer point for Port Radium ores moving out of the NWT. Starting in 1946, uranium ore and concentrates were barged or trucked across the ice from Port Radium to a local landing, hauled 2 km through a serviced camp to an airstrip, and then shipped by air (DC-3) to Edmonton. From Edmonton, the uranium was shipped to Port Hope by rail. From 1954 to 1957, the site was also used for DEW Line operations. From 1961 until 1987, a lodge and a cookhouse were operated as Great Bear Lake Lodge. In more recent years, some of the facilities were destroyed by fire.

The Sawmill Bay area includes four distinct sites (see Figure 3):

- the dock and wharf area;
- the central lodge area;
- the Eldorado airstrip; and
- the lodge airstrip.

3.1.3 Radiological Investigations/Remediation

The following radiological surveys and/or remedial efforts have been completed on the Sawmill Bay sites:

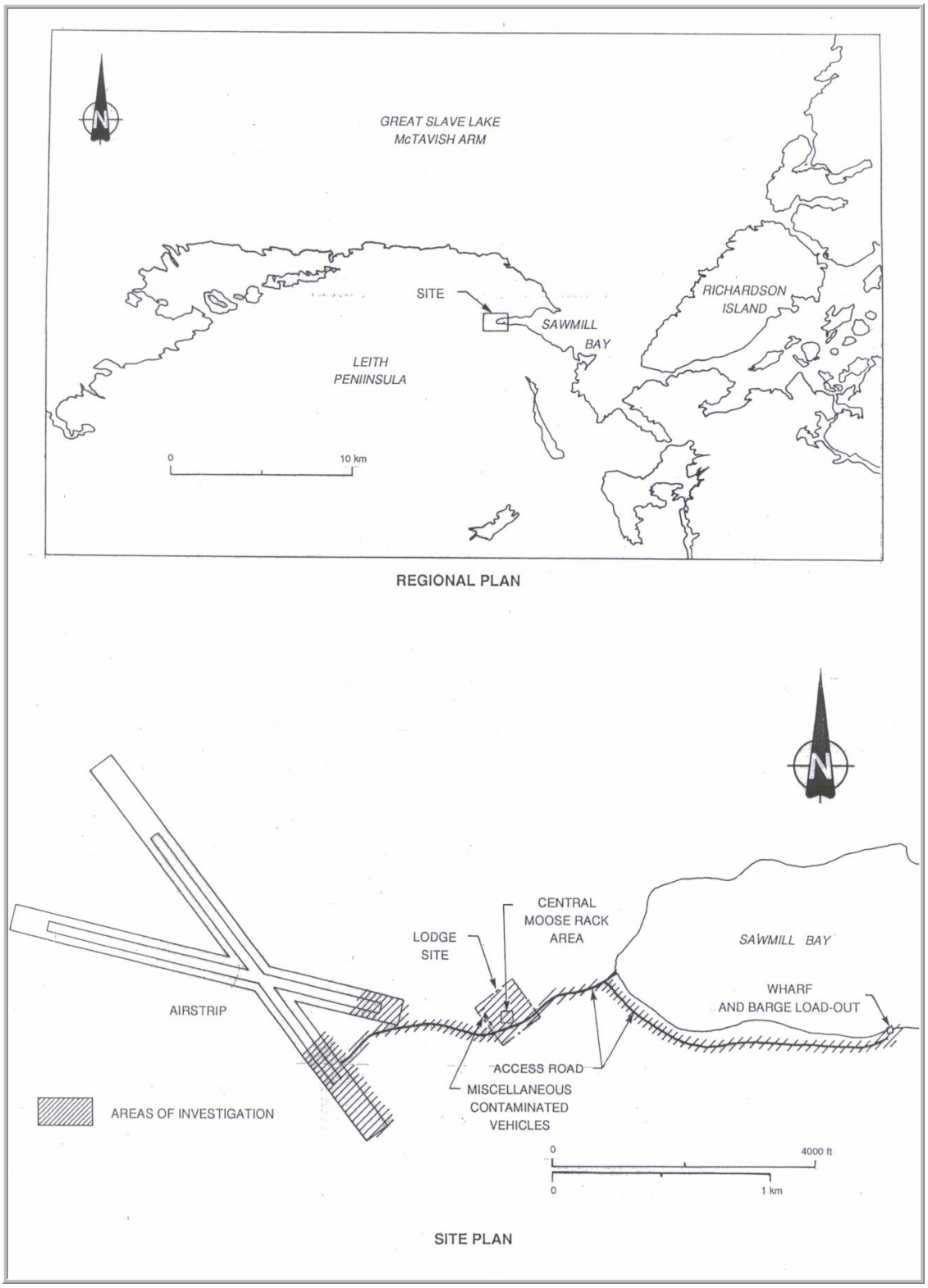
- reconnaissance level survey (SENES, 1994);
- uranium delineation program (RMC, 1997); and
- licensable material removal and packaging program (LLRWMO, 1998).

Executive summaries of these documents are provided in Appendix A.

SENES (1994) identified the uranium contamination at each of the four Sawmill Bay area sites. The LLRWMO participated in a subsequent Environmental Assessment (RMC, 1997) designed to delineate the extent of uranium contamination. In 1998 the LLRWMO carried out a radiation reduction program to remove concentrations of uranium that were licensable as defined by the AECB at that time. The purpose of the project was to hand-excavate licensable concentrations of uranium ores and concentrates, package the material into drums and ship them to the LLRWMO storage facility in Chalk River, Ontario for storage.

Map Reference: 86E Leith Peninsula

amec		Status Report for the Historic NTR **Sawmill Bay - Site Location**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 2**



amec		Status Report for the Historic NTR **Sawmill Bay Regional and Site Plans** (Note: from SENES (1994))		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 3**

A ten-man labour force with support staff was flown in from Deline. Radiation support staff from the LLRWMO directed and assisted in the work. Eighty-eight (88) drums of hand-excavated wastes of licensable concentrations were excavated, packaged, stored and then successfully flown out to Yellowknife where they were trans-shipped by truck to Chalk River. Post-operational measurements showed that no licensable concentrations remained at any of the excavation sites. Lower levels of residual radioactivity remained at each site and arsenic concentrations remained widespread at the Eldorado airstrip.

The site and material categories for the four Sawmill Bay areas are summarized on Table 3.

Table 3: Sawmill Bay – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[2]		
		L	1	2
Dock and Wharf Area[1]	4	Removed	60	300
Central Lodge Area[1]	4	Removed	80	100
Eldorado Airstrip[1]	4	Removed	300	1,000
Lodge Airstrip[1]	1	0	0	0

[1] RMC (1997)
[2] See Sections 2.1 and 2.2 for category definitions

3.1.3.1 Dock and Wharf Area

Surveys found the landing area had been covered with granular fill from nearby borrow sources. Three small remaining areas exhibited elevated surface gamma radiation levels. Due to the remote nature of the site, little equipment was available and test pits could not be excavated to depths representative of historic ground elevations. One cubic metre of the most contaminated soil was removed.

3.1.3.2 Central Lodge Area

Surveys found many wastes unrelated to uranium ore such as asbestos and hydrocarbon contamination. A small area in the center of a large compound surrounded by a stacked wall of thousands of empty drums was assumed to be a transfer point, or an area where uranium had been stored for a period of time. Elevated surface gamma radiation levels identified the presence of a shallow layer of licensable radionuclides in this area that were subsequently removed during the 1998 program.

3.1.3.3 Eldorado Airstrip

Surveys of the Eldorado airstrip identified a small area exhibiting elevated gamma radiation levels near the remains of a building on the edge of the runway. Much of the south end of the runway showed elevated surface gamma radiation levels, accompanied by elevated arsenic levels in soil samples.

3.1.3.4 Lodge Airstrip

The lodge airstrip (also still serviceable) intersects the Eldorado airstrip and exhibited no evidence of uranium contamination.

3.2 Deline

3.2.1 Location

Deline is located on the west side of Great Bear Lake at 65º,10'N; 123º,25'W, near the upper reaches of the Great Bear River (see Figures 1 and 4).

3.2.2 Operational History and Site Description

Deline was a meeting place for the Sahtu people and was originally settled by the Dene. Today it is a community of a little more than 650 Dene of Slavey heritage, and about 30 non-Aboriginals. During the period that the northern transportation route was active, Deline was known as Fort Franklin. Ore transfer operations in the Deline area took place at Franklin Landing on the south shore of the lake near the mouth of the Great Bear River (i.e., not in the community of Deline itself.

The Deline area includes the following radiological source areas:

- the Radium Gilbert; and
- Great Bear River Landing (Franklin Landing).

3.2.3 Radiological Investigations/Remediation

The following radiological surveys and/or assessments have been completed on the Deline area source sites/issues:

- reconnaissance level surveys (SENES, 1994 and LLRWMO, 2000); and
- general environmental assessment (Earth Tech, 2002).

Executive summaries of these documents are provided in Appendix A. In addition to these surveys, informal scans of the water landings and streets within the community of Deline itself found no evidence of uranium contamination.

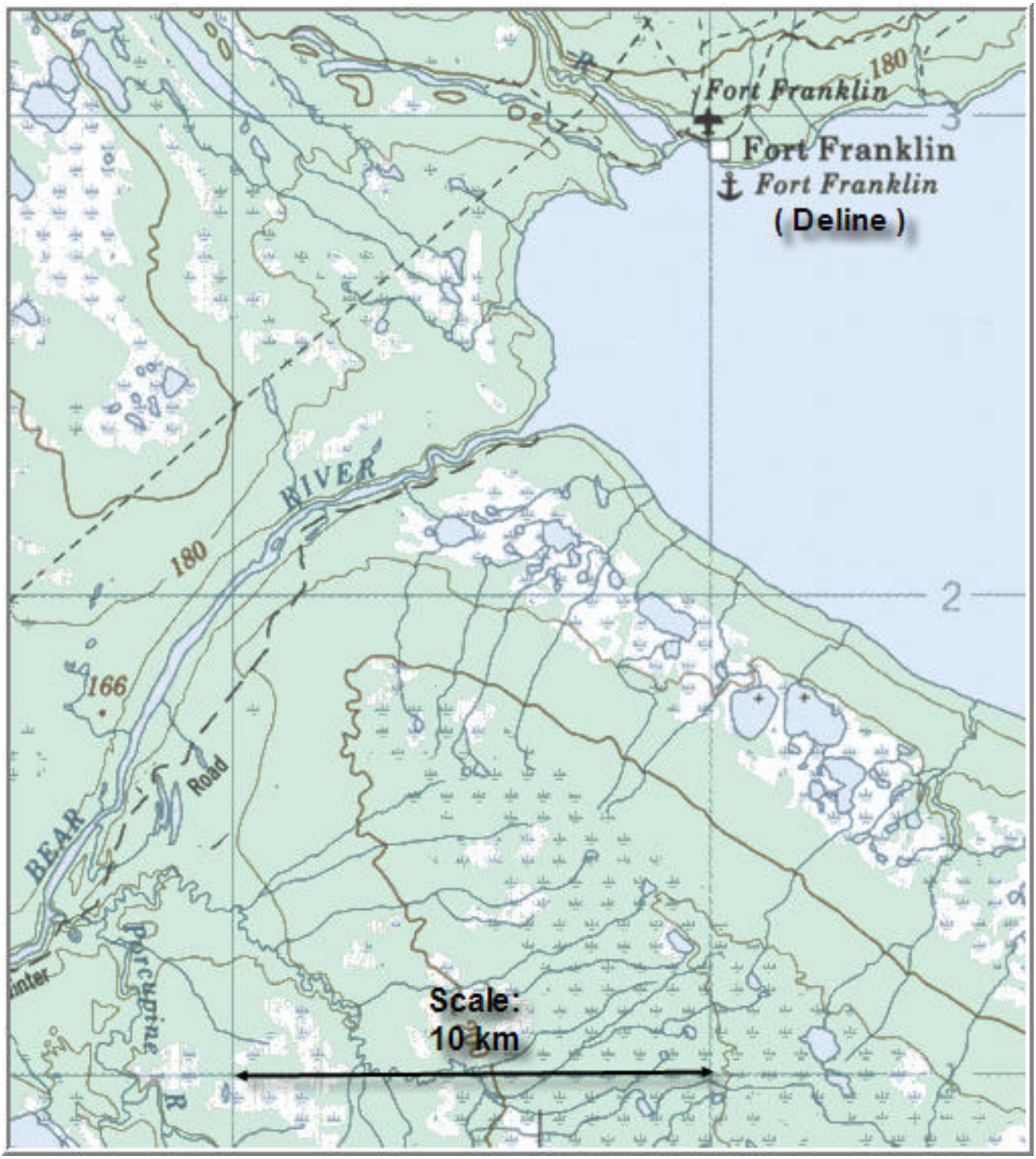
The site and material categories for the Deline area sources are summarized in Table 4.

Table 4: Deline Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[4]		
		L	1	2
Deline[1]	1	0	0	0
MV Radium Gilbert[2]	1	0	0	0
Great Bear River Landing[1,2,3]	4	0	5	0

1 SENES (1994)
2 LLRWMO (2000)
3 Earth Tech (2002)
4 See Sections 2.1 and 2.2 for category definitions

Map Reference: 96G Fort Franklin



amec		Status Report for the Historic NTR **Deline - Site Location**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 4**

3.2.3.1 The Radium Gilbert

The Radium Gilbert was used by NTCL to ship cargo and to move barges across Great Bear Lake. It was built in 1946 and was in use until the early 1980s when its engines and generators were removed by NTCL. The Deline Dene Band later purchased the vessel from NTCL. For many years, the Radium Gilbert sat aground in a small shallow bay approximately 2 km from Deline.

A 1991 survey of the vessel is described in SENES (1994). Gamma radiation readings throughout most of the vessel were 1 to 2 µR/h. Elevated gamma radiation readings were found in the concrete floors of the two heads and shower. Contact readings up to 120 µR/h were measured on the concrete floors, with readings of 20 to 25 µR/h at a height of one meter. These levels were confirmed during several later visits.

In 2003, under contract to PWGSC, the Radium Gilbert was dismantled and the sections removed to storage at a gravel pit near the local landfill in Deline. In 2005, PWGSC contracted the packing and overland transport of the scrapped vessel to disposition locations in southern Canada.

3.2.3.2 Great Bear River Landing (Franklin Landing)

A long wooden timber wharf, located a short distance downriver of Deline, was used as a tie-up for the transfer of ore from the lake barges to the smaller Bear River barges. The barges were typically “rafted” (tied together) to make the transfer. There was rarely any need for the ore to come ashore. A campfire area near the wharf exhibited up to 200 µR/h on contact over a small area (less than 0.5 m^2). Scrap wood from an older landing was reportedly burned here. Other small pieces of ore were found among the rock fill of the broken portions of the wharf during the 1994 survey (SENES, 1994).

A site visit in 2000 by representatives of the CNSC, the LLRWMO and INAC found radiological conditions similar to those described above (LLRWMO, 2000).

An environmental assessment conducted by Earth Tech Inc. confirmed the radiological conditions and identified other some other contaminants (e.g., hydrocarbons) (Earth Tech, 2002).

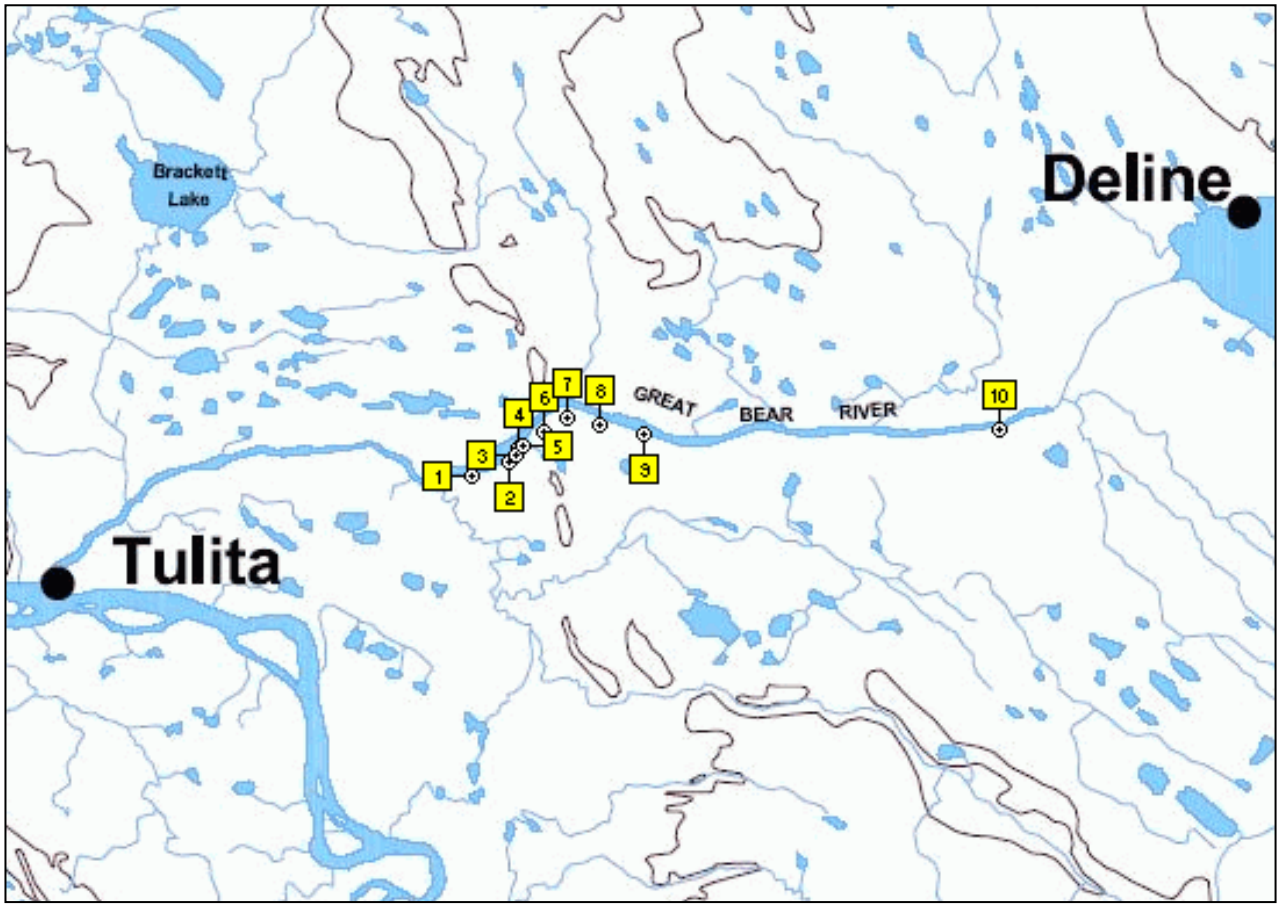
3.3 Great Bear River Sites

3.3.1 Location

The Great Bear River sites were associated with the portage around the St. Charles Rapids on the Great Bear River. The rapids are about half-way between Great Bear Lake (Deline) and the Mackenzie River (Tulita). Ores would be barged to the upstream end of the rapids, trucked over the portage and then transferred back to barge downstream of the rapids. The locations of the Great Bear River sites are shown on Figure 5.

3.3.2 Operational History and Site Descriptions

Brief descriptions of the operational history of the Great Bear River sites and their current condition are provided in Table 5.



Map Source: http://www.sahtugisproject.org/

Lower Shipyard **(1)**	Bennett Alternate Landing **(2)**	Road from Bennett Original Landing to Bennett Alternate Landing **(3)**	Bennett Original Landing **(4)**	Bennett Camp **(5)**	Road from Bennett Airstrip to Bennett Camp **(6)**	Bennett Airstrip **(7)**	Road from Bennett Airstrip to Upper Portage Wharf **(8)**	Upper Portage Wharf **(9)**	Upper Shipyard **(10)**

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Status Report for the Historic NTR

Great Bear River Site Locations

(Note: from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 5**

Table 5: Great Bear River Site Histories and Descriptions

Site	Site History/Description
Lower Shipyard	• Used primarily to over-winter barges. • Contains the burned remains of two wooden barges that hauled goods between Tulita and the Bennett Camp. • Remains of maintenance buildings are located in dense bush inland and east of the original shipways. • Former road from the shipyard to Bennett Camp is now overgrown and impassible.
Bennett Alternate Landing	• Used in the later years of operation as a landing for barges. • Has been almost obliterated by spring flooding. • Few wooden remains of the wharf structure are visible. • Built up truck turning area is well defined by sloughs.
Road Between Bennett Alternate and Original Landings	• This 1.4 km road was used during the later years of operation. • Built due to the necessity of annual rebuilding of the original landing wharf. • Remains are strewn with boulders left by regular flooding of the area.
Bennett Original Landing	• Provided river access/landing area for Bennett Camp. • Spring ice damage often made reconstruction necessary. • Large boulders and a depression along the bank mark the location from the river. • Submerged timbers are all that remain of the wharf.
Bennett Camp	• Collection of buildings including a post office, cookhouse, camp store, administrative and other buildings and sheds. Maintenance yard contains the remains of the service garage, several warehouse buildings, an off-loading truck ramp and the base for the generator building. • Camp is frequently visited by travelers to the area and has been used at least once for a major gathering of aboriginal people. • Local resident has moved a building from another location on the site to the former location of the post office building. This dwelling is used frequently throughout the year.
Road Between Bennett Camp and Bennett Airstrip	• Road shares the path of an ancient portage route. • Southern branch passes into the main Bennett camp while the northern “by-pass” truck route follows the river directly to the lower portage landings passing the maintenance area. • Clearing contains some modern road construction supplies, but mostly residential waste (food tins, etc) and industrial wastes (tires, engine blocks, drums, etc.).
Bennett Airstrip	• The airstrip was routinely used to supply Bennett Camp. • Constructed of sand obtained from many borrow pits along its route. • Airstrip maintenance buildings were located adjacent to a cleared area opposite the access road.
Road Between Bennett Airstrip and Upper Portage Wharf	• This 9 km long road was used to haul uranium (as well as other goods) by truck around the St. Charles Rapids. • Gravel pits are located along the route and this aggregate was used to build up the roadway. • In some locations, fill has been placed to several meters above the original portage road grade.
Upper Portage Wharf	• Eastern terminus of the St. Charles Rapids portage. • Partial remains of the concrete buttressed wooden wharf are in fair condition. • Haulage truck traffic was “one way” entering the landing from the east side down a steep road cut and exiting on the gentler grade to the west.
Upper Shipyard	• Contains the burned remains of the “Great Bear” a wooden vessel that hauled goods on Great Bear Lake from Port Radium to the head of the Great Bear River. • Several maintenance buildings were once located on the height of land east of the site.

3.3.3 Radiological Investigations

The following radiological surveys have been completed on the Great Bear River sites:

- reconnaissance level surveys (SENES, 1994 and LLRWMO, 2000); and
- detailed dose level surveys (AMEC, 2004).

Executive summaries of these documents are provided in Appendix A.

The site and material categories for the Great Bear River sites are summarized in Table 6.

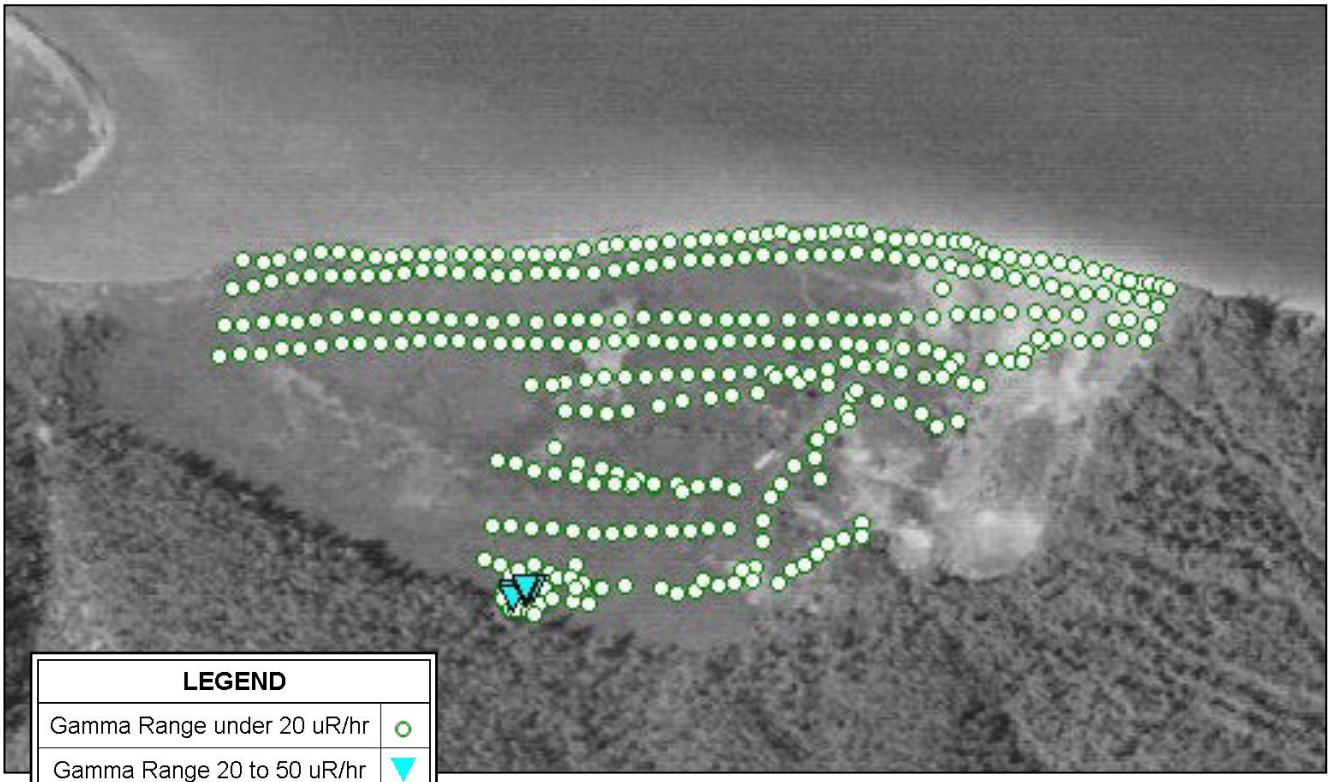
Table 6: Great Bear River Site – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[4]		
		L	1	2
Lower Shipyard[2]	1	0	25	0
Bennett Alternate Landing[2]	1	0	1	0
Road Between Landings[2]	1	0	0	0
Bennett Original Landing[2]	4	2	1,250	100
Bennett Camp				
◆ "Teepee" Area[2]	1	0	10	0
◆ "Reefer" Area[2]	1	0	10	0
◆ "Pink Powder"[2]	1	0	20	0
◆ Roads[2]	1	0	0	200
Road Between Bennett Camp & Airstrip[2]	4	0	100	0
◆ Dump/Storage Compound[2]	5	200	3,000	0
Bennett Airstrip[2]	1	0	1	0
Road Between Airstrip and Upper Wharf[2]	1	1	3	0
Upper Portage Wharf[2]	1	0	3	1
Upper Shipyard[1]	1	0	200	0

1 SENES (1994)
2 AMEC (2004)
3 LLRWMO (2000)
4 See Sections 2.1 and 2.2 for category definitions

3.3.3.1 Lower Shipyard

The general arrangement of the Lower Shipyard site is shown on Figure 6. Anomalous gamma radiation levels were found inside and in the immediate vicinity of the burnt remains of vessel wreckage in an area of 5 m x 10 m. The depth of contamination is unknown, but is likely shallow. Remains of another wooden vessel, reported by SENES (1994) some 75 m from this location, were not found in 2003. Small increases in background radiation were noted at ground contact in the haul-out area by the shore. Only a small amount of metal debris (e.g., cables, scrap steel) normally associated with shipyard activities was found in the haul-out area. It is possible that some materials have been buried onsite.



LEGEND	
Gamma Range under 20 uR/hr	
Gamma Range 20 to 50 uR/hr	
Gamma Range 50 to 100 uR/hr	
Gamma Range 100 to 250 uR/hr	

Air Photo Reference: A26354-81, July 1983

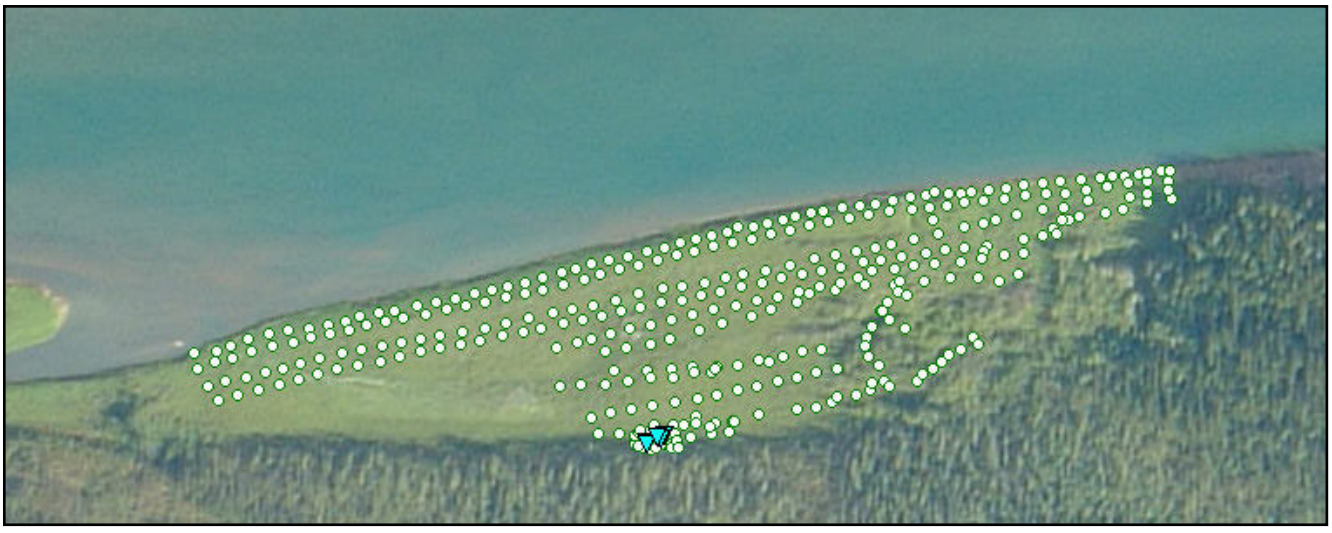


Photo Reference: Aerial oblique, July 2003

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Status Report for the Historic NTR

Lower Shipyard – General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 6**

3.3.3.2 Bennett Alternate Landing

The general arrangement of the Bennett Alternate Landing is shown on Figure 7. One localized area of anomalous gamma radiation was found along the north side of the truck turning area and 20 m west of the remains of a culvert that drains a pond south of the landing. Elevated radioactivity was found in an area of less than 1 m^2. This may be a single small spill area with shallow depth or may be a surface manifestation of a larger pocket of contamination at depth. The balance of the landing area has been completely scoured by spring ice and flooding. Very little of the debris (e.g., cables, scrap steel) normally associated with landings was evident. It is possible that some materials have been buried by grading operations in the landing area.

3.3.3.3 Road Between Bennett Alternate and Original Landings

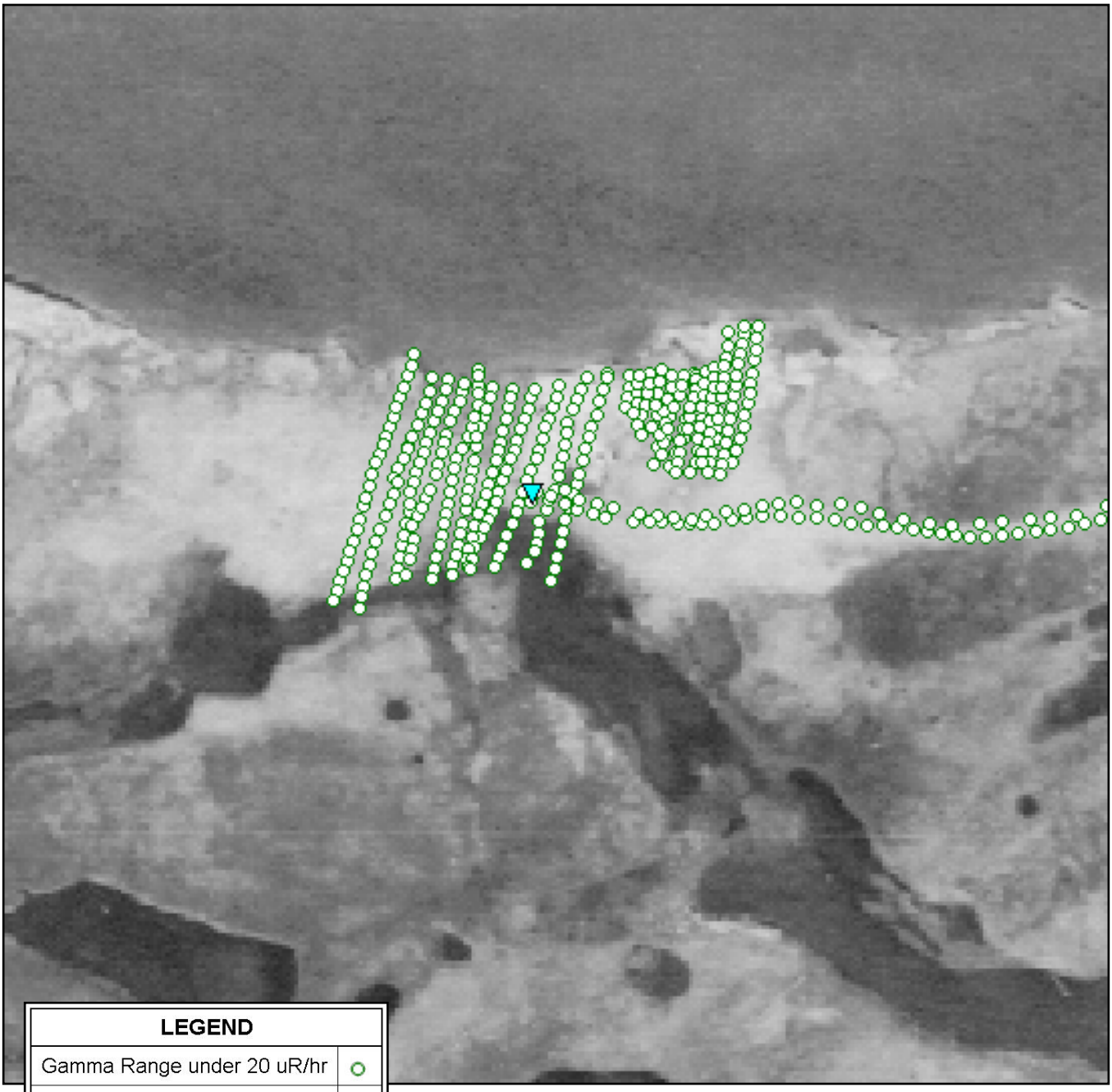
The remains of the narrow haul road between the Bennett landings stretch for about 1.4 km along gravel deposits (see Figure 8). The road is littered with boulders left by spring ice and flooding. Many of these granite boulders exhibit natural gamma radiation levels on contact slightly in excess of background. At 1 m, these are sometimes difficult to differentiate from background. Slightly elevated levels of gamma radiation occur at the northern edge of the road along the side of the original Lower Landing. The frequent annual flooding would have necessitated routine grading operations of the road, potentially burying or removing minor spills or tracking.

3.3.3.4 Bennett Original Landing

The present access road to the Bennett Camp runs across the northeast corner of the Bennett Original Landing (see Figure 9). The wharf structures that existed have been completely eradicated. From the top of the small bluff near the river's edge, an area approximately 60 m wide x 70 m long was the original materials handling area. Holes in the ground, and protruding steel and wood debris suggest that the area has been graded and waste materials may have been buried. Numerous small gamma-emitting anomalies are found scattered throughout, as well as larger uranium spill areas. Vehicular traffic likely tracked uranium from this area along the haul route to the camp truck maintenance area.

3.3.3.5 Bennett Camp

Two areas south of the main haul route had been cleared and graded (filled) to form a level maintenance support facility, some limited warehousing, and administration and personnel support areas (see Figure 10). Remaining buildings are in disrepair, with some collapsed, as is the small bridge crossing the creek that bisects the camp. Some re-growth of trees has started, but the edges of the clearing and filled areas are still easily identified.



LEGEND	
Gamma Range under 20 uR/hr	
Gamma Range 20 to 50 uR/hr	
Gamma Range 50 to 100 uR/hr	
Gamma Range 100 to 250 uR/hr	

Air Photo Reference: A26354-83, July 1983

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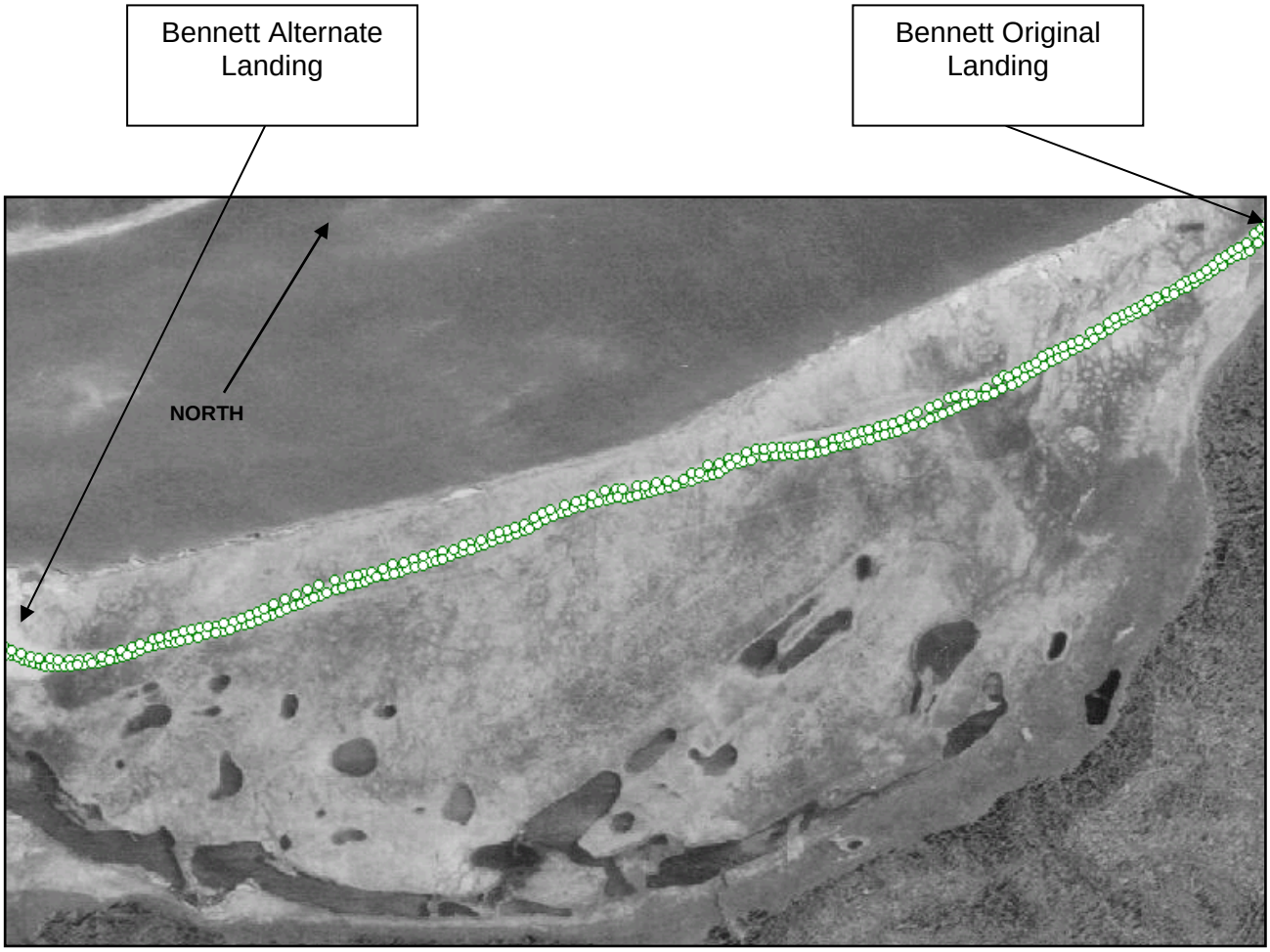
Atomic Energy of Canada Limited

Status Report for the Historic NTR

Bennett Alternate Landing – General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 7**



LEGEND	
Gamma Range under 20 uR/hr	○
Gamma Range 20 to 50 uR/hr	▽
Gamma Range 50 to 100 uR/hr	▽
Gamma Range 100 to 250 uR/hr	■

Air Photo Reference: A26354-81, July 1983

amec

Atomic Energy of Canada Limited

Status Report for the Historic NTR

Road between Bennett Alternate and Original Landings – General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 8**

Air Photo Reference: A26354-81, July 1983

amec

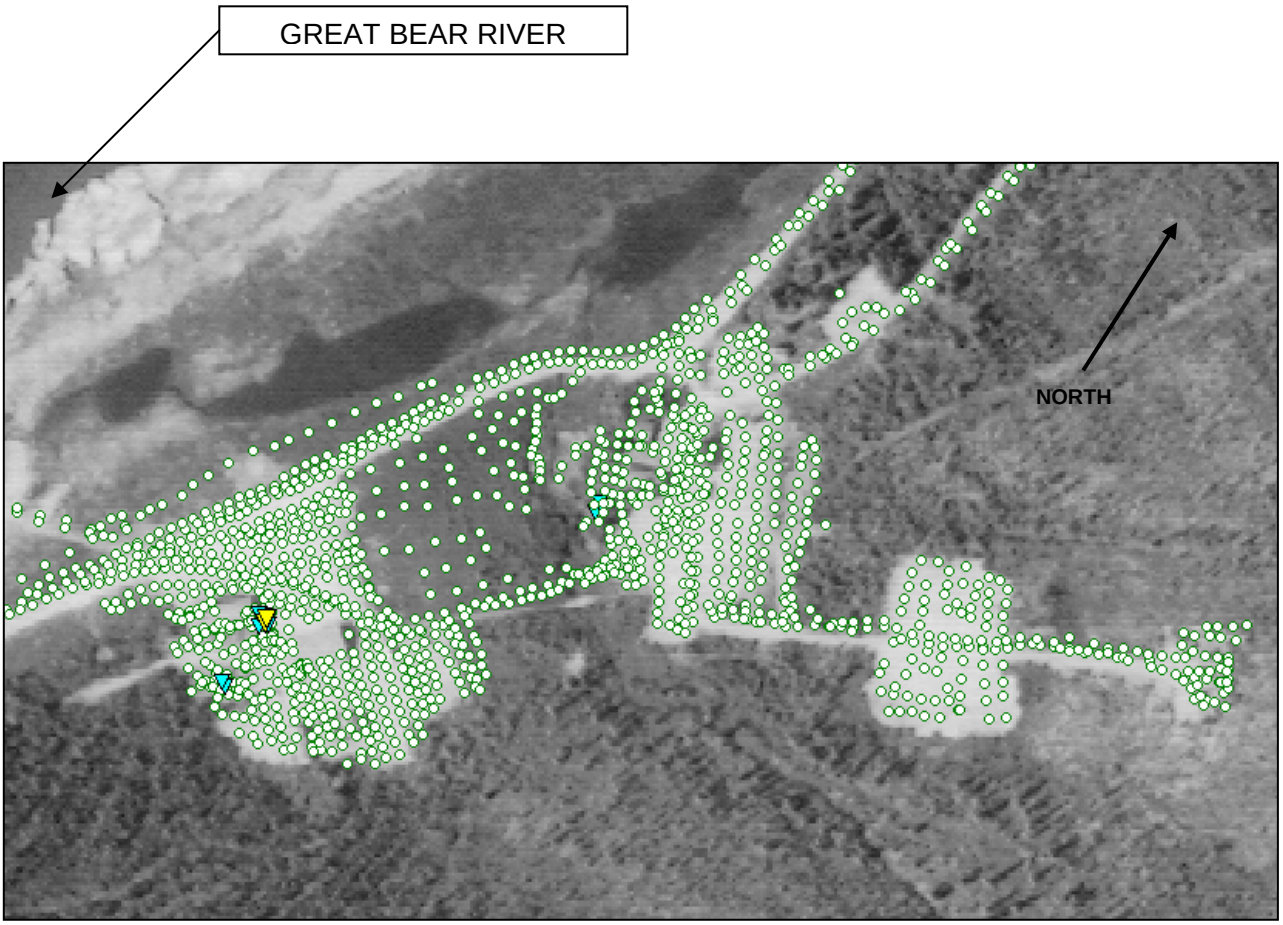
Atomic Energy of Canada Limited

Status Report for the Historic NTR

Bennett Original Landing – General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 9**



LEGEND	
Gamma Range under 20 uR/hr	○
Gamma Range 20 to 50 uR/hr	▽
Gamma Range 50 to 100 uR/hr	▽
Gamma Range 100 to 250 uR/hr	■

Air Photo Reference: A26354-83, July 1983

amec

Atomic Energy of Canada Limited

Status Report for the Historic NTR

Bennett Camp – General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 10**

Tiny isolated gamma-emitting anomalies (bits of ore) from tracking were found just below the surface of the camp roads. As point sources they had little effect on the 1 m gamma radiation levels and were difficult to differentiate from background. Bits of ore were found in the roadbeds near the landing during this survey (AMEC, 2004). SENES (1994) found similar tracking spills in roadbeds in the maintenance area. Small elevations above the natural background levels are evident in an overgrown parking area south and west of the maintenance area near the warehouse buildings. Identification of isolated particles requires slow, near-contact scans of the ground surface to note a slight change in background. In each case, soil had to be removed from the surface to find the anomaly.

SENES (1994) reported finding a "pink, powdery material" with levels of 300 µR/h at 1 m next to a small storage shed. Subsequently, some of this material was removed by the LLRWMO. Residual gamma radiation levels are now less than 80 µR/h (0.5 µSv/h) (AMEC, 2004). The area of residual contamination is approximately 5 m x 10 m. The depth is unknown, but likely shallow from descriptions of the past work.

3.3.3.6 Road Between Bennett Camp and Bennett Airstrip

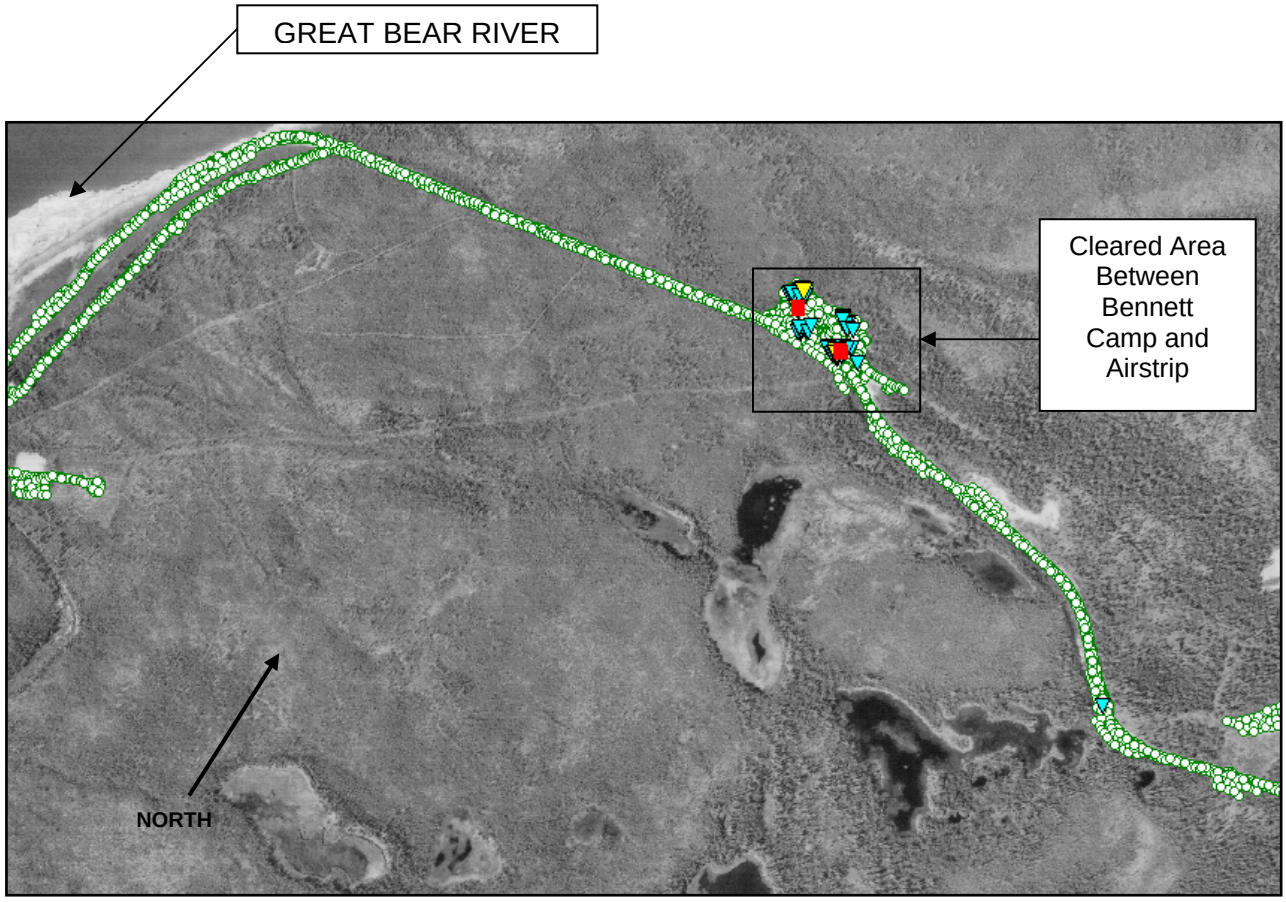
The general arrangement of the road connecting the Bennett Camp and Airstrip is shown on Figure 11. The truck bypass route, north of the Bennett Camp and along the top of the river bank, is strewn with washouts and spring flood-deposited boulders. Evidence of a small, localized spill was found on the edge of the road. A 1 m x 1 m area exhibited levels inconsistent with background values.

In a cleared and graded area (70 m x 150 m) along the side of the haul road, a relatively large deposit of contaminated soil was found. At the east end, the remains of buildings exhibited isolated, low levels of contamination. Portions of the cleared area had been graded to bedrock and exhibited background radiation levels. Five main pockets of contamination were distributed across the site. In two of these areas, 1 m gamma radiation levels exceeded 0.6 µSv/h (100 µR/h). Areas in-between the main pockets of contamination exhibited radiation levels in excess of background. Approximately 30% (3,300 m^2)of the clearing area exhibits gamma radiation levels in excess of background. The thickness of the filled portions ranges from 0.5-2 m. Contamination extends into the margin of the road. No contamination was found south of the road or in the bush beyond the fill line. Some of the contamination was tracked to the area of the former buildings. The two minor spill areas found appear to be localized. In each case, it is not known whether contamination extends below the road.

Further east, along the side of the road in an area about 10 m x 20 m, evidence was found of a uranium spill.

3.3.3.7 Bennett Airstrip

The Bennett Airstrip is located immediately north of the haul road, close to the point where the winter road joins the portage route (see Figure 12). It was constructed of local sand and gravel from the borrow pits along its route.



LEGEND	
Gamma Range under 20 uR/hr	○
Gamma Range 20 to 50 uR/hr	▽
Gamma Range 50 to 100 uR/hr	▽
Gamma Range 100 to 250 uR/hr	■

Air Photo Reference: A26354-83, July 1983

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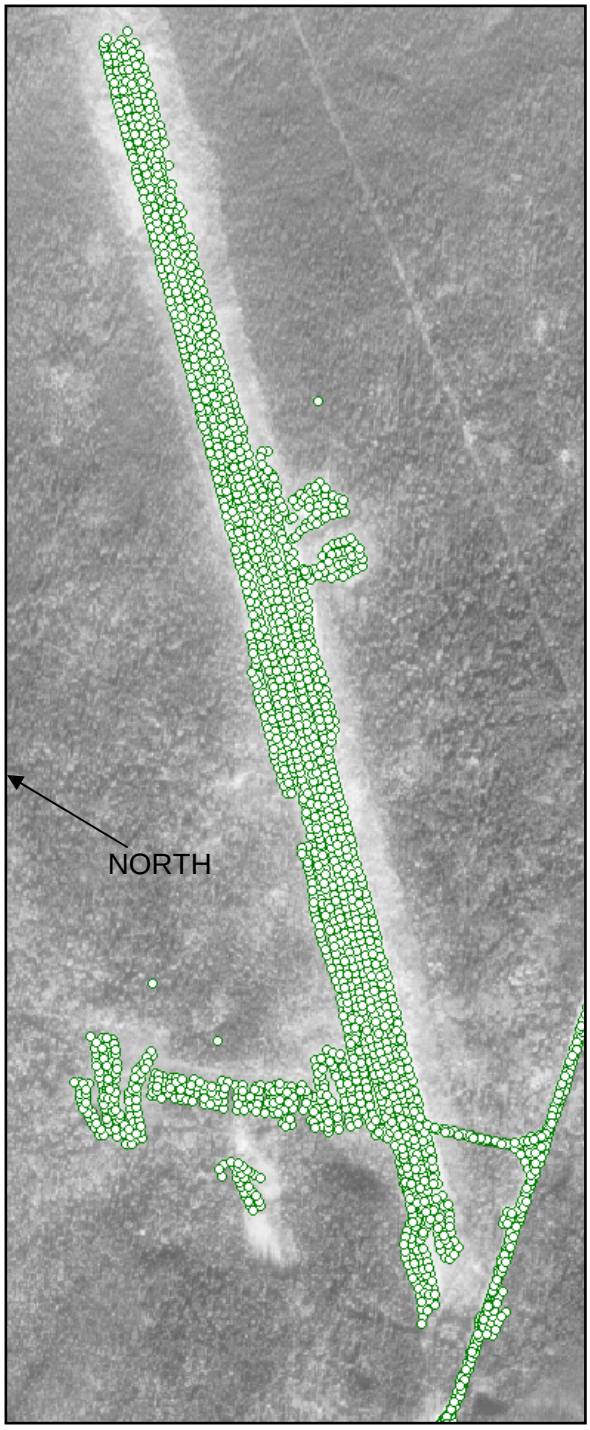
Atomic Energy of Canada Limited

Status Report for the Historic NTR

Road Between Bennett Camp and Bennett Airstrip– General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 11**



Air Photo Reference: A28130-99, September 1994

LEGEND	
Gamma Range under 20 uR/hr	
Gamma Range 20 to 50 uR/hr	
Gamma Range 50 to 100 uR/hr	
Gamma Range 100 to 250 uR/hr	

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Atomic Energy of Canada Limited

Status Report for the Historic NTR

Bennett Airstrip– General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 12**

Off the runway, close to the remaining building and opposite the point where the road meets the airstrip, a small area of anomalous gamma radiation was observed. Remains of a recent campsite were found over this spot. Levels were low (<20 µR/h at 1 m) and localized. This minor anomaly appeared to be spread over an area of about 2 m x 2 m and centered at a depth of about 15 cm. No other anomaly was found on the airstrip, on the approach road or in the borrow pits.

3.3.3.8 Road Between Bennett Airstrip and Upper Portage Wharf

The portage haul road between the lower and upper landings is partly shared with the well-used winter road between Tulita and Deline (see Figures 13 and 14).

A uranium spill was found on the south side of the road. The material was off the traveled portion of the road but in the top surface layer. It is not known if the spill continues under the road. The gamma radiation dose rates in this small localized area are greater than 0.6 µSv/h (100 µR/h). The anomalous area identified is approximately 1 m x 10 m.

3.3.3.9 Upper Portage Wharf

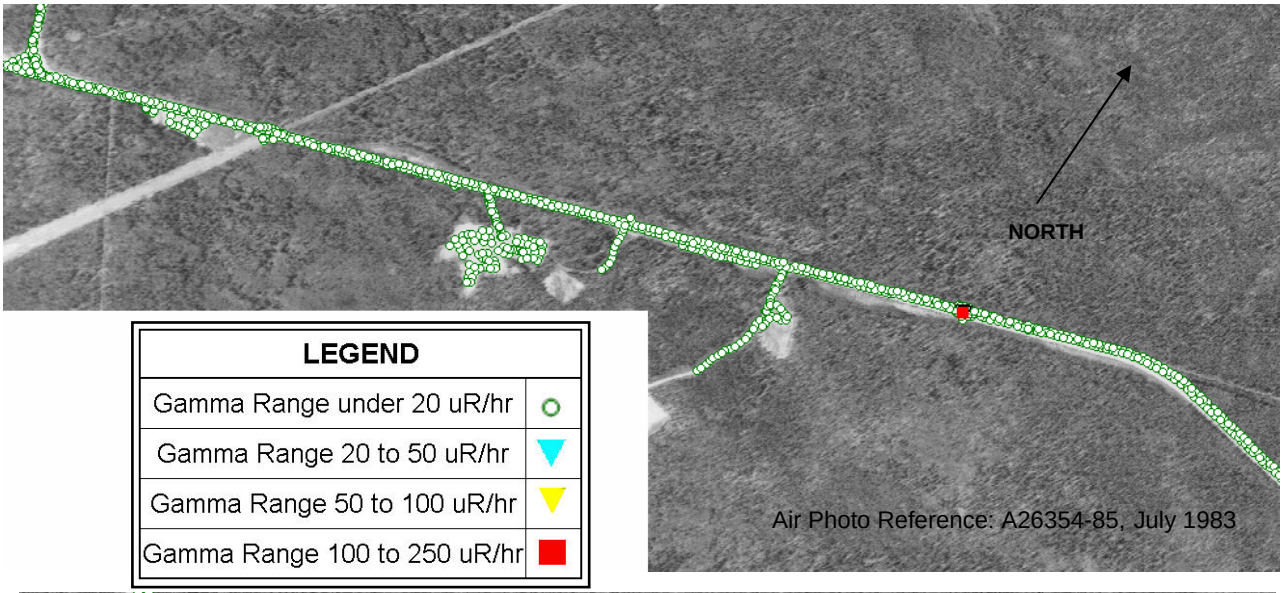
The general arrangement of the Upper Portage Wharf is shown on Figure 15. Three small uranium spills were identified during the 2003 survey, only one of which exhibited gamma radiation levels above 20 µR/h. One, on the side of the “out” ramp, was identified at 1 m and the others were found by near-surface gamma scans. Several small pieces of ore were identified inside the wharf cribbing through holes in the deck. The other spill was located just off the concrete abutment on the upstream end of the wharf (AMEC, 2004).

The spill on the side of the “out” ramp (the one anomaly with gamma radiation levels above 20 µR/h) is found off the road next to dumped trash and covers an area of about 2 m x 3 m. The bits of ore in the wharf cribbing could not be quantified. The spill at the end of the wharf covers an area of about 2 m^2 (depth unknown).

3.3.3.10 Upper Shipyard

Located some 30 km upstream from the upper portage landing and about the same distance to Deline, the upper shipyard has been extensively reshaped (see Figure 16). The southern portion of the site has been graded from the winter road toward the river, covering at least parts of the original cleared area. Towards the northwest portion of the shipyard, the remains of a wooden vessel protrude from the fill. Long square spikes, 15 cm in length and identical to those found in the contaminated hull in the Lower Shipyard, are part of these remains. Radiation levels are at background.

The two areas of surface contamination are likely contiguous below ground and cover an area roughly 10 m x 20 m. At the edge of the shipyard nearby is a drop-off into undisturbed ground of approximately 1m. This implies the depth of the contamination.



LEGEND	
Gamma Range under 20 uR/hr	○
Gamma Range 20 to 50 uR/hr	▽
Gamma Range 50 to 100 uR/hr	▽
Gamma Range 100 to 250 uR/hr	■

amec

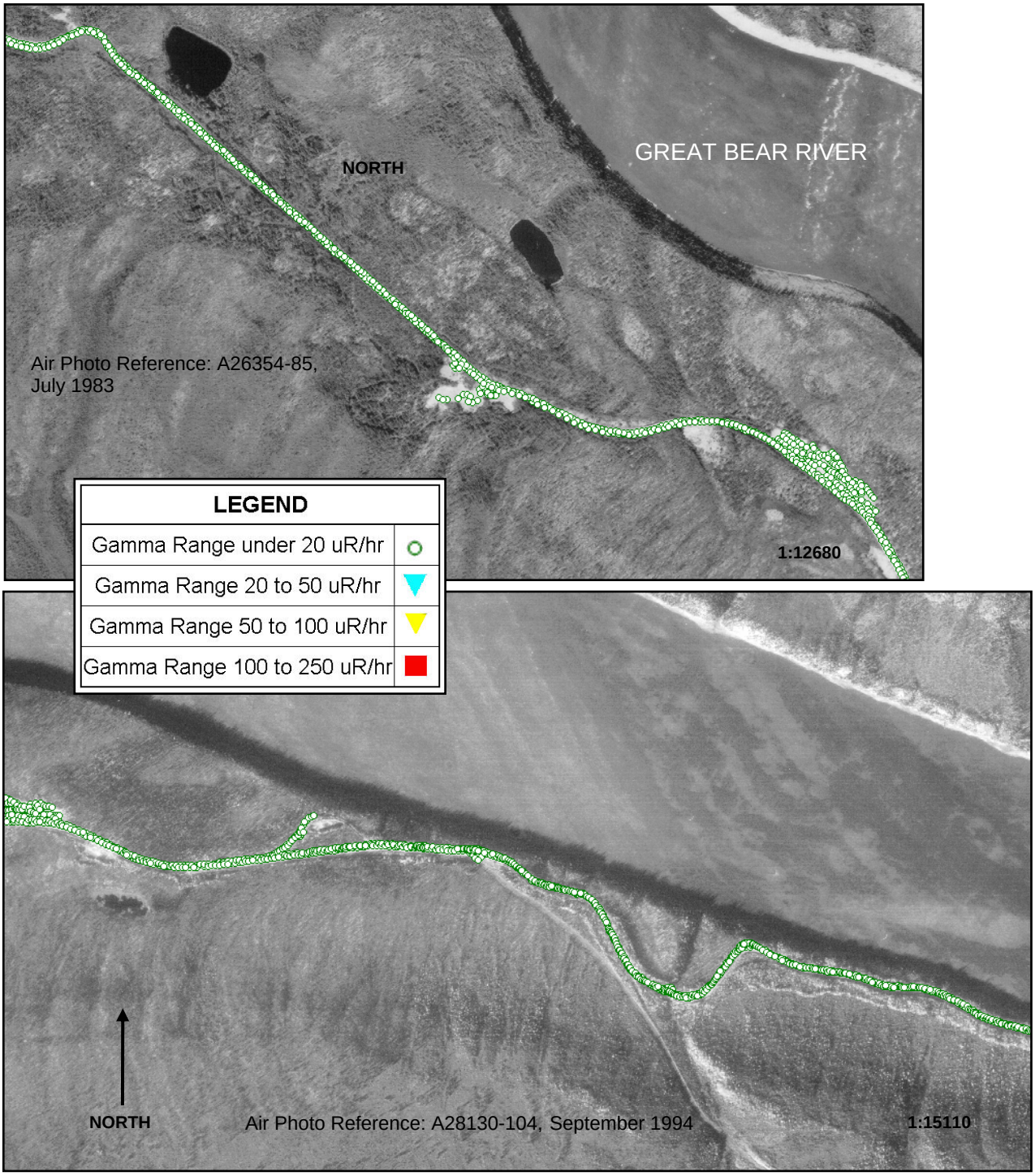
Atomic Energy of Canada Limited

Status Report for the Historic NTR

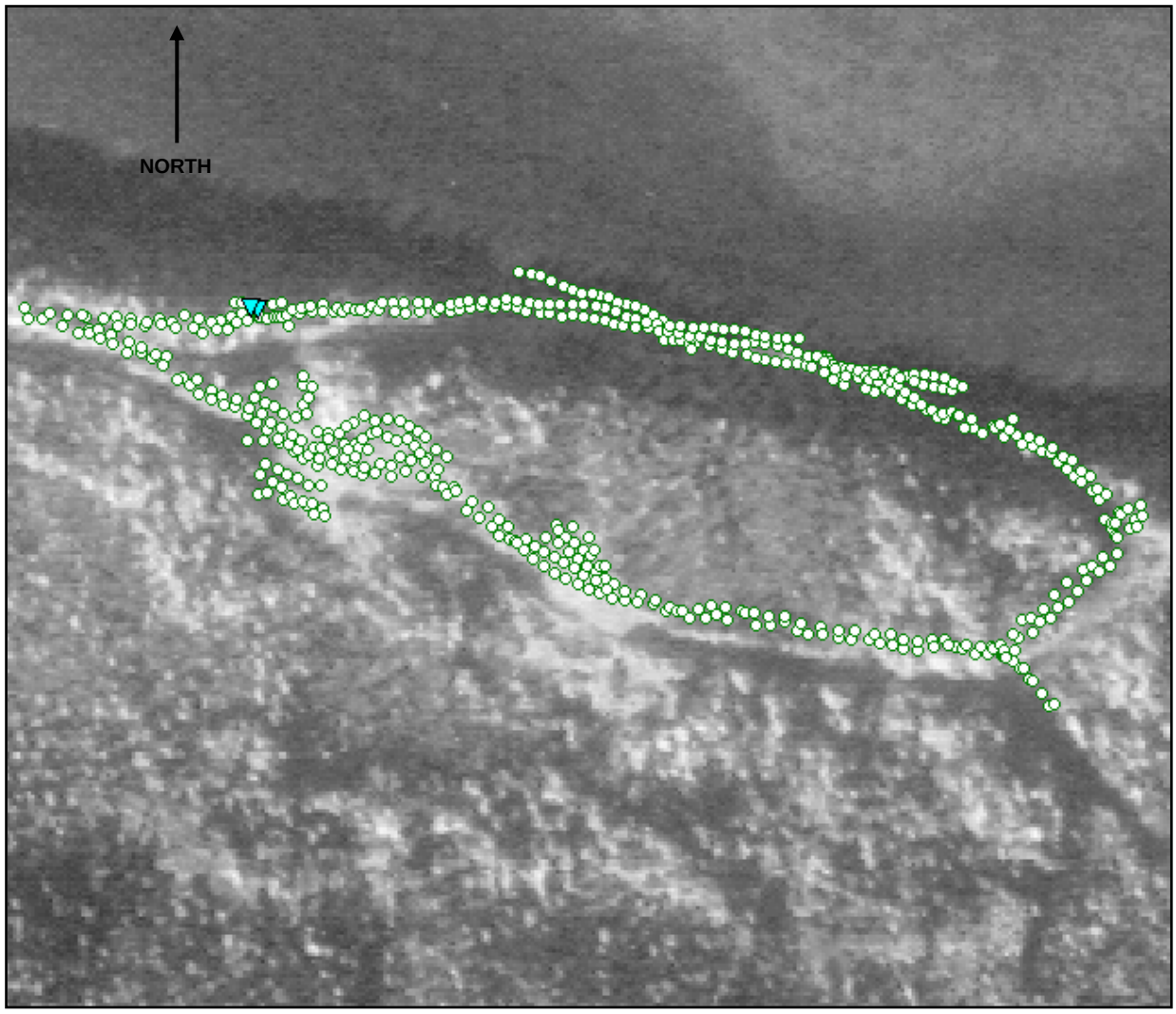
Road From Bennett Airstrip to Upper Portage Wharf (West) – General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 13**



amec		Status Report for the Historic NTR **Road From Bennett Airstrip to Upper Portage Wharf (East) – General Arrangement** (Note: gamma radiation data from AMEC (2004))		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 14**



LEGEND	
Gamma Range under 20 uR/hr	○
Gamma Range 20 to 50 uR/hr	▽
Gamma Range 50 to 100 uR/hr	▽
Gamma Range 100 to 250 uR/hr	■

Air Photo Reference: A28130-104, September 1994

amec

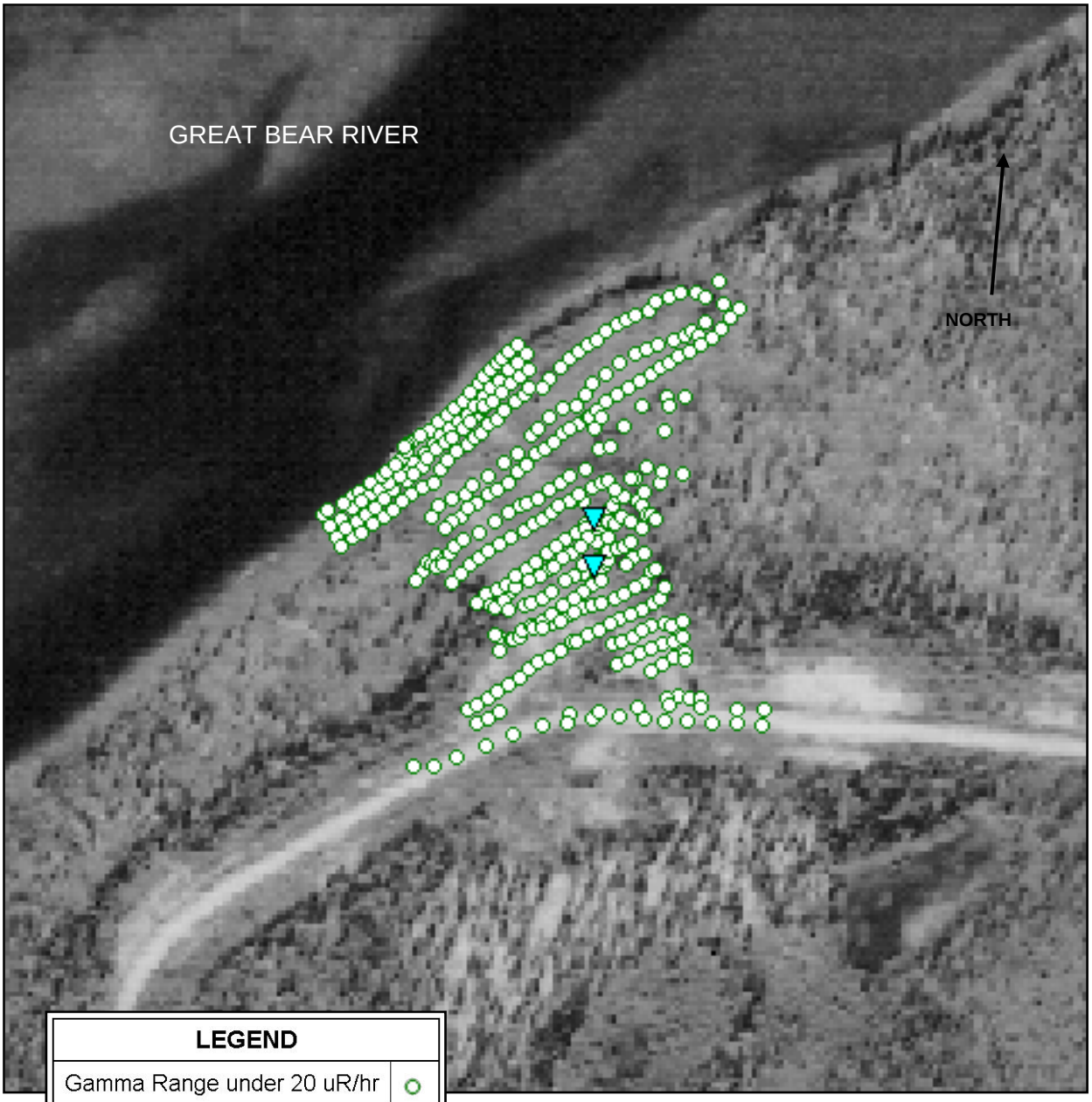
Atomic Energy of Canada Limited

Status Report for the Historic NTR

Upper Wharf – General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 15**



Air Photo Reference: A28282-203, July 1996

Atomic Energy of Canada Limited

Status Report for the Historic NTR

Upper Shipyard – General Arrangement

(Note: gamma radiation data from AMEC (2004))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 16**

3.3.3.11 Upper Winter Road

Conversations with a Deline resident (Joe Blondin Jr.) (Stenson, 2000) indicated that ore sacks were sometimes offloaded at the Great Bear River Landing and trucked to Bennett Landing. He confirmed that the route used was the same as the current-day winter road. This road has not been surveyed, although portions were traversed on all terrain vehicles by AMEC staff and a local guide from Bennett Field to access the upper shipyard and return (AMEC, 2004).

3.3.3.12 Upper River Tie-Ups

Former NTCL workers from Deline identified various locations along the Great Bear River between Deline and the Charles Rapids as former barge tie-up locations. Each of these sites were visited in 2000 by the LLRWMO, the CNSC and INAC. Surface gamma radiation scans were conducted with no uranium contamination identified at any of these sites.

The following are NAD-27 UTM coordinates measured at each of the sites using a hand-held GPS, and are accurate to approximately 3 m (LLRWMO, 2000):

- *Tie-Up #1*: E 385,291 N 7,207,136 Zone 10; and
- *Tie-Up #2*: E 391,933 N 7,209,780 Zone 10.

3.3.3.13 Lower River Tie-Ups

Four locations along the Great Bear River between Tulita and the Charles Rapids were identified as former barge tie-up locations by local community representatives (who were also former NTCL workers). Each of these sites were visited in 2000 by the LLRWMO, the CNSC, INAC, the GNWT and four community representatives [redacted]. Surface gamma radiation scans identified no evidence of uranium contamination at any of these sites.

The following are NAD-27 UTM coordinates measured at each of the sites using a hand-held GPS, and are accurate to approximately 3 m:

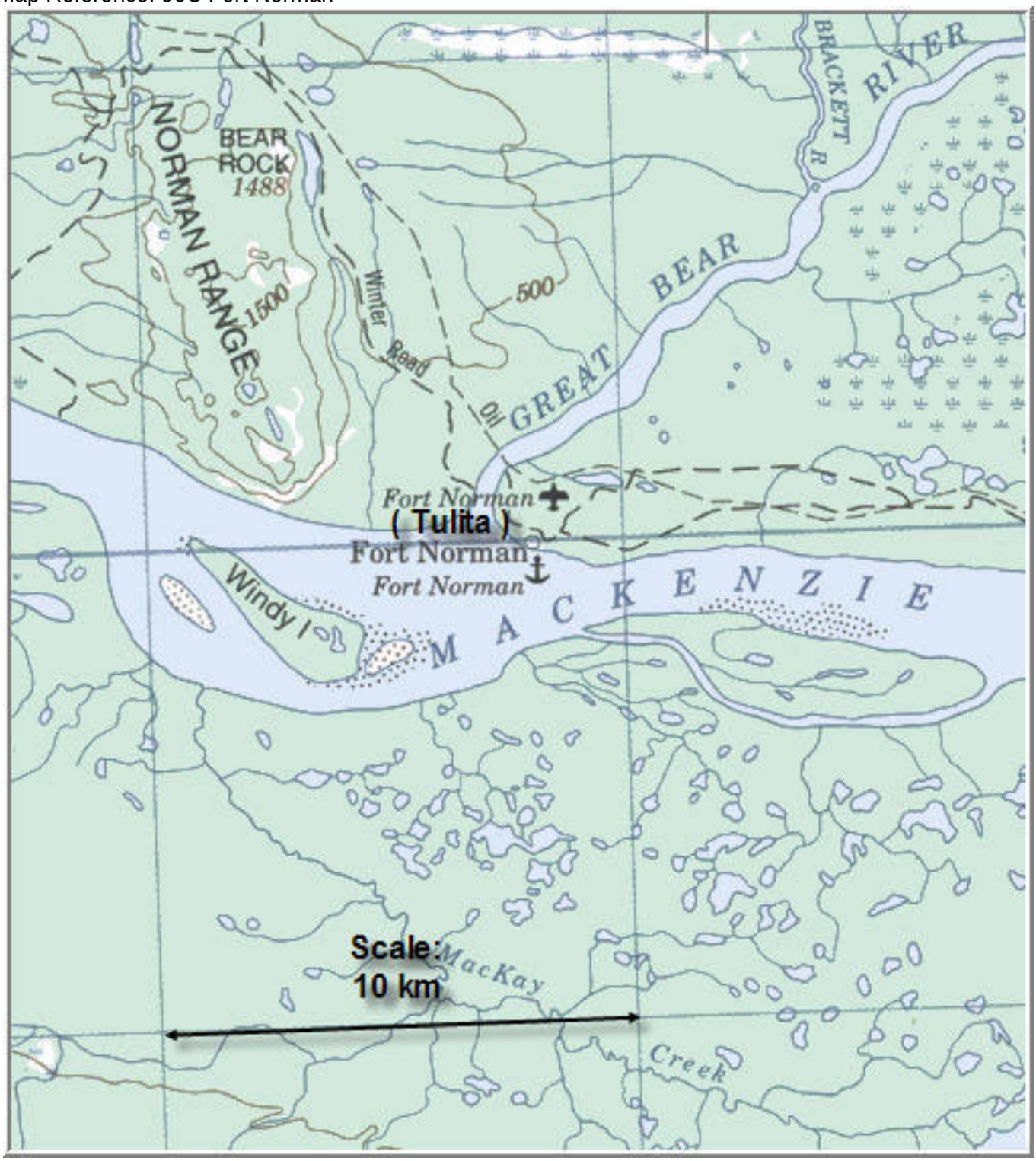
- *Tie-Up #3:* E 401,334 N 7,210,901 Zone 10;
- *Tie-Up #4:* E 411,961 N 7,207,836 Zone 10;
- *Tie-Up #5:* E 470,888 N 7,220,635 Zone 10; and
- *Tie-Up #6:* E 474,218 N 7,222,577 Zone 10.

3.4 Tulita

3.4.1 Location

Tulita is located at 64º,54'N; 125',34'W, where the Great Bear River enters the Mackenzie River (see Figures 1 and 17).

Map Reference: 96C Fort Norman



amec		Status Report for the Historic NTR **Tulita - Site Location**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 17**

3.4.2 Operational History and Site Description

Historically, Tulita (formerly know as Fort Norman) was the location at which ores were transferred from shallow-draught barges to the larger Mackenzie River versions. At present, Tulita is a hamlet of about 400 Slavey Dene and Metis people.

The Tulita area includes five distinct sites (see Figure 18):

- the Bear River Landing;
- the NTCL Camp;
- the over-winter storage site;
- the Mackenzie River bluff; and
- the contaminated soil storage mound.

3.4.3 Radiological Investigations/Remediation

The following radiological surveys and/or remedial efforts have been completed on the Tulita sites:

- reconnaissance level surveys (SENES, 1994; LLRWMO, 2000); and
- uranium ore contaminated soil remediation programs ([redacted] LLRWMO, 1999 and 2001b).

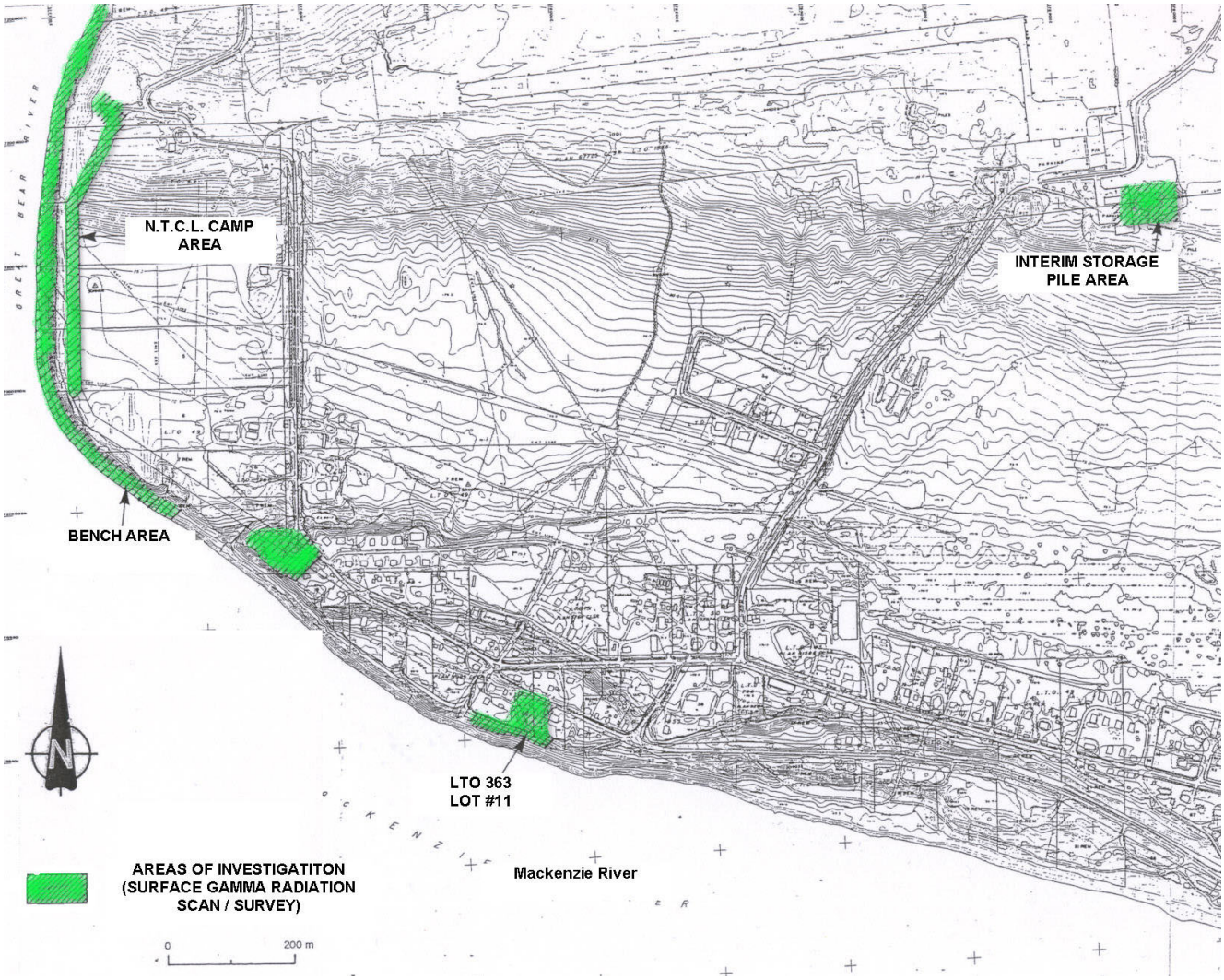
Executive summaries of these documents are provided in Appendix A.

The site and material categories for the Tulita area sites are summarized in Table 7.

Table 7: Tulita Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[5]		
		L	1	2
Bear River Landing[1]	1	0	0	0
NTCL Camp[2]	2	0	0	0
Over-winter Storage Site (Yakeleya Property)[3]	2	0	0	0
Mackenzie River Bank[3]	4	0	100	0
Tulita Storage Mound[4]	3	0	380	0

1 SENES (1994)
2 SENES (1994) and LLRWMO (2000)
3 DeJong (2000e)
4 LLRWMO (1999 and 2001b)
5 See Sections 2.1 and 2.2 for category definitions



amec		Status Report for the Historic NTR **Tulita – General Site Plan** **(Note: from SENES (2004))**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 18**

3.4.3.1 Bear River Landing at Tulita

A small wharf area on the south shore and near the mouth of the Great Bear River was used as a tie-up point for the transfer of ore from shallow-draught barges to the Mackenzie River barges. The river bank is steep at this point and spring flooding has removed much evidence of the landing. Radiological surveys (SENES, 1994) found no evidence of ore. In 2000, the site was visited by the LLRWMO, the CNSC, INAC, the GNWT, and four community representatives [redacted] Surface gamma radiation scans were conducted, and no evidence of uranium contamination was found (LLRWMO, 2000).

3.4.3.2 NTCL Camp

The remains of the NTCL camp are located at the top of a steep scarp above the Bear River Landing. The road leading to the camp was surveyed and several isolated pieces of ore were found (SENES, 1994). These were recovered and placed in the storage mound described in Section 3.4.3.5. Scans of the roadway and camp area were repeated in 1999 [redacted], and no further contamination was found. In 2000, the site was visited by the LLRWMO, the CNSC, INAC, the GNWT, and four community representatives [redacted]. Surface gamma radiation scans were conducted, and no evidence of uranium contamination was found (LLRWMO, 2000).

3.4.3.3 Over-Winter Storage Site

A community elder recalled one fall when the Mackenzie River barges failed to meet a shipment of ore from the Great Bear River. The ore was barged to the shore below the town site and hauled by horse cart to the top of the bank (SENES, 1994). Residual contamination was found in the yard of a newly constructed home and beside an older house. An immediate cleanup was undertaken by the LLRWMO (SENES, 1994). Twenty truckloads of contaminated soil (about 180 m^3) were excavated and hauled to an unused area near the airport (see Section 3.4.3.5 below). Some residual contamination remained around the edges of the excavation and in the crawl space of the new house.

In August 2001, uranium-contaminated soils were removed from the properties described above and an adjacent property identified by local residents. Staff from the LLRWMO, assisted by a local contractor, identified, segregated and moved some 200 m^3 from these properties to the storage pile near the airport. Very small amounts of residual contamination are known to remain at depth below the surface in previously cleaned areas (LLRWMO, 2001b).

3.4.3.4 Mackenzie River Bluff

The bluff along the Mackenzie River contained hundreds of pieces of uranium ore that had fallen from the eroding contaminated lot above and lodged among the vegetation on the face of the bluff. The area is approximately 40 m long and the bluff is 10 m high. Slightly elevated gamma radiation levels can be measured originating from the bluff while walking along the beach. Any excavation of the bank would likely result in erosion, and initial attempts at manual recovery did not materially reduce radiation levels.

3.4.3.5 Contaminated Soil Storage Mound

An area south of the Renewable Resources heliport has been used as the storage site for uranium contaminated soils removed from various sites in Tulita. The site is on top of a closed landfill owned by the town. In 1993, soils from the Yakeleya property were placed here and covered with a fabrene tarpaulin. Uncontaminated soils from the area were borrowed and placed along the sides of the pile to secure the tarpaulin (SENES, 1994).

In 1999, approximately 180 m^3 of the stored soil was sorted and characterized. About 5 kg of material with concentrations greater than 500 ppm of uranium were separated and stored. One drum of aliquot samples of each bucket of soil investigated was packaged as a bulk sample for further testing at the LLRWMO's Port Hope Field Services Office in Ontario. The drum, containing the smaller licensable package, was shipped to Chalk River, Ontario for long-term storage. The reconfigured pile was lined with tarpaulins, covered with a new tarpaulin, and secured with 30 cm of clean soil. The site was fenced with plastic snow fencing on "t" rails [redacted]

In 2001, the additional soils from the over-winter storage site (Section 3.4.3.3) were placed against the side of the existing pile and covered in the same manner as before. A new more robust snow fence was placed around the perimeter and appropriate signs posted. The facility is now monitored routinely by the LLRWMO and the CNSC (LLRWMO, 2001b).

3.5 Middle Mackenzie River Sites

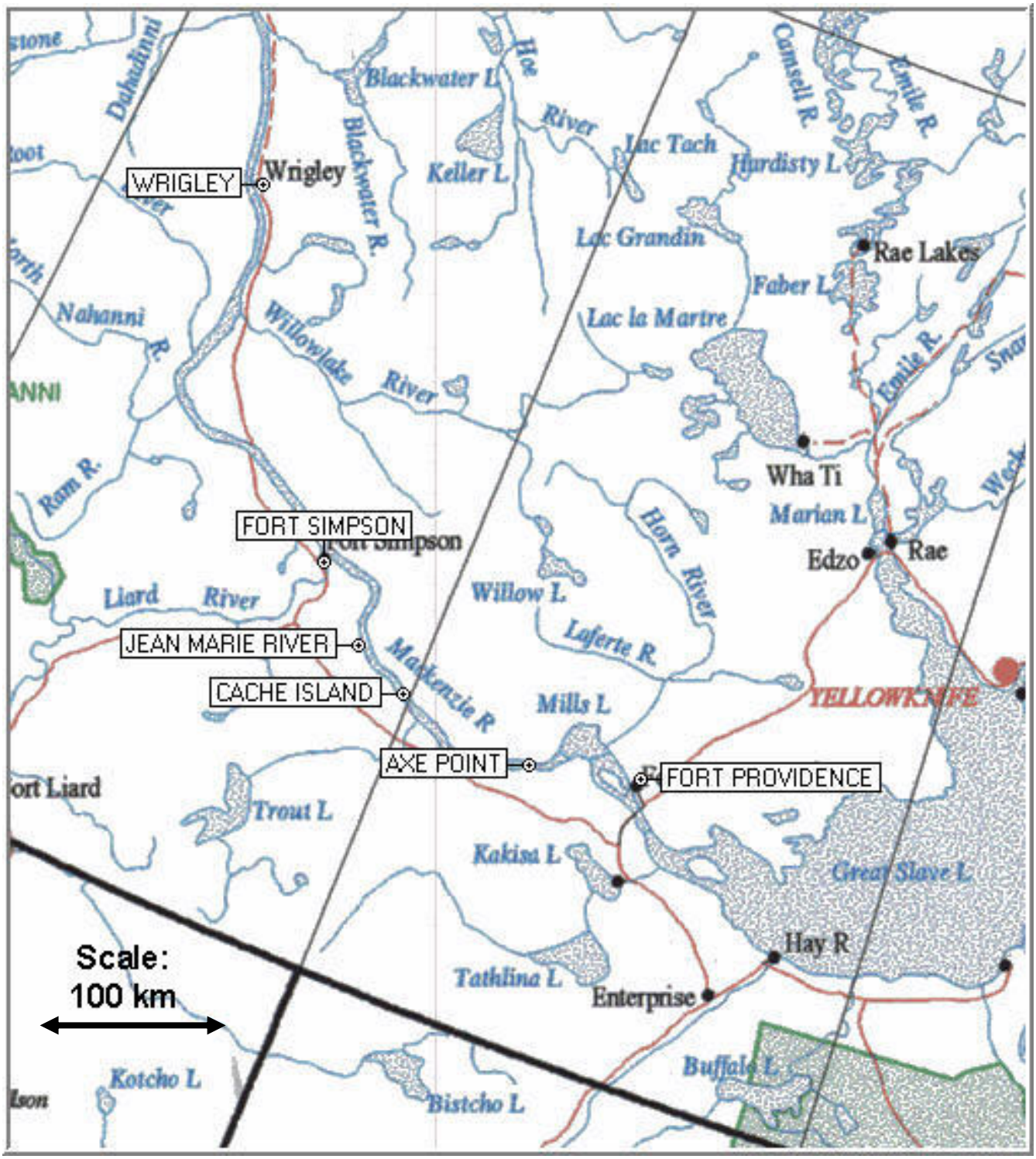
3.5.1 Location

The middle Mackenzie sites are located at various points along the Mackenzie River between Tulita and Hay River (see Figures 1 and 19). The specific locations in question are:

- Wrigley (63º,13'N; 123º,28'W);
- Fort Simpson (61º,52'N; 121º21'W);
- Jean Marie River (61º,31'N; 120º,38'W);
- Cache Island (61º,23'N; 120º,06'W);
- Axe Point (61º,18'N; 118º,41'W); and
- Fort Providence (61º,21'N; 117º,39'W).

3.5.2 Operational History and Description

The sites listed above were locations along the middle Mackenzie portion of the NTR route where it was possible that barges could have landed, at least temporarily. It was therefore considered plausible that uranium contamination associated with the movement of ores on and off the barges was possible.



amec		Status Report for the Historic NTR **Middle Mackenzie Sites**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 19**

3.5.3 Radiological Investigations/Remediation

The middle Mackenzie sites were all investigated by SENES (1994) (see Appendix A for executive summary). In each case, no evidence of uranium ore contamination was found. The site and material categories for these sites are summarized in Table 8.

Table 8: Middle Mackenzie – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[2]		
		L	1	2
Wrigley[1]	1	0	0	0
Fort Simpson[1]	1	0	0	0
Jean Marie River[1]	1	0	0	0
Cache Island[1]	1	0	0	0
Axe Point[1]	1	0	0	0
Fort Providence[1]	1	0	0	0

[1] SENES (1994)
[2] See Sections 2.1 and 2.2 for category definitions

3.5.3.1 Wrigley

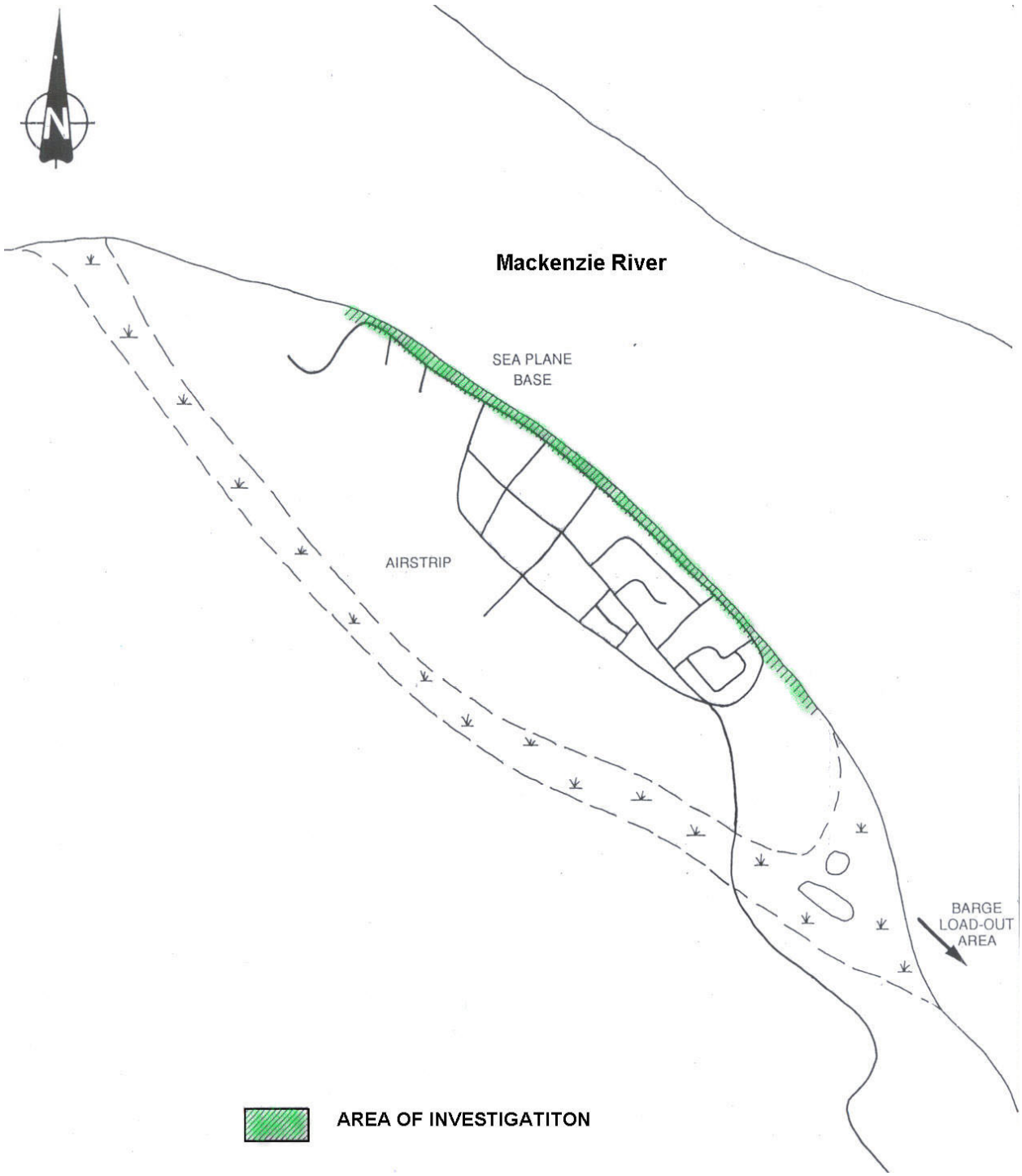
The local Chief indicated that the community of Wrigley had moved three times since the 1930s due to flooding. Based on his knowledge and discussions with elders, there was no indication that barges had unloaded any uranium cargo at the former community sites. The many years of flooding action have likely disturbed any potential areas of uranium spillage. No radiological surveys were considered necessary at this site (SENES, 1994).

3.5.3.2 Fort Simpson

Interviews with the environmental coordinator for the Fort Simpson Band Office and with two individuals familiar with the transportation network provided no evidence that barges unloaded uranium cargo at Fort Simpson. Gamma radiation scans were conducted along the top shoreline embankment of the Mackenzie River between the float plan base area, in the northern end of the community, and the “flats area” at the southern end of the community where barges were historically loaded and unloaded (see Figure 20). No indication of above background gamma radiation levels or uranium contamination were found during these scans (SENES, 1994).

3.5.3.3 Jean Marie River

A telephone interview with the Band Manager for the Jean Marie River Band was conducted in September 1993. Based on his discussions about the project with elders in the community of Jean Marie River, he indicated that barges carrying uranium ore did not unload their cargo in the community (SENES, 1994).



amec		Status Report for the Historic NTR **Fort Simpson – Site Plan** **(Note: from SENES (1994))**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 20**

3.5.3.4 Axe Point and Cache Island

In September 1993, the former U.S. military base at Axe Point was investigated for potential contamination associated with the handling of uranium ores from the Port Radium Mine (SENES, 1994). No evidence of any uranium contamination was found at the site. It had been reported that this site was used as a staging area during the second world war to support the CANOL project at Norman Wells. The discovery of old quonset buildings and a U.S. military (CANOL) truck confirmed this former site usage.

Some 80 km further downstream is a small island in the Mackenzie River called Cache Island. It was reported by several sources that during the 1940s a wooden barge carrying a load of uranium ore ran aground very close to this island. The uranium ore cargo was removed form the partially sunken barge and stored on the island over the winter, until the following summer when it was reloaded onto another southbound barge. Gamma radiation scans conducted in September 1993 found no evidence of uranium contamination on the western side of the island on which the ore was reportedly stockpiled.

3.5.3.5 Fort Providence

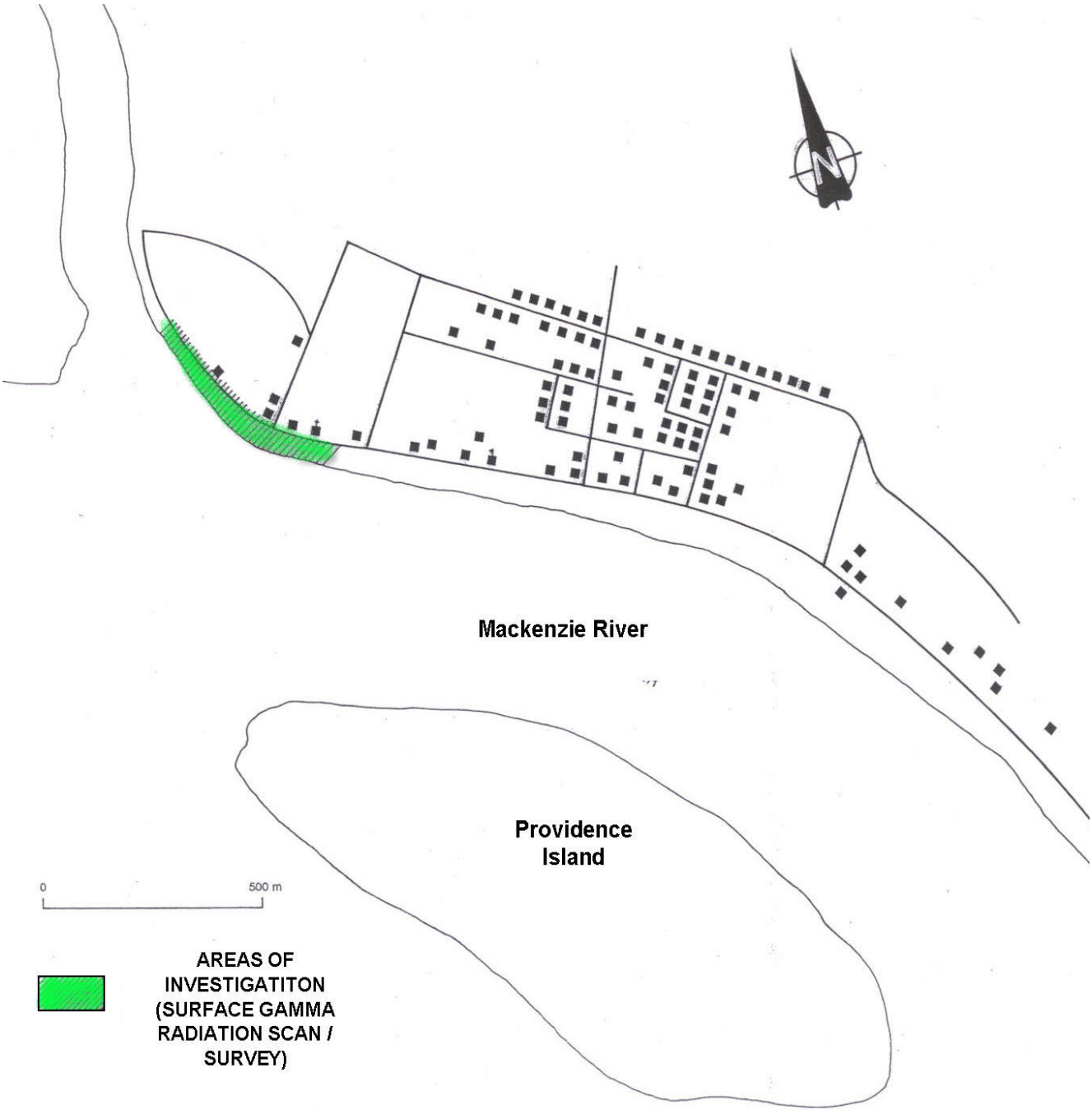
In September 1993, a meeting was held in the community of Fort Providence with the Chief of the local Dene Band (SENES, 1994). She identified several individuals living in the community who might have knowledge of the historic uranium transportation system and interviews were subsequently conducted with three residents. During these interviews no incidents of any uranium ore being unloaded in the community were recalled; however, details of a barge carrying bags of uranium ore running aground at Cache Island downstream from Fort Providence in the 1940s were substantiated. In addition, the site of a former U.S. military base at Axe Point, also downstream from Fort Providence, was identified as a potential cargo transfer point.

Although there was no indication that uranium ore had ever been unloaded in Fort Providence, gamma radiation scans were conducted in an area approximately 500 m long x 75 m wide along the banks and surrounding the docks (see Figure 21). These scans did not provide any evidence of uranium spillage within this area of the community.

3.6 Hay River

3.6.1 Location

The community of Hay River, NWT is located near 60º,51'N; 115º,44'W on the southern shore of Great Slave Lake (see Figures 1 and 22).



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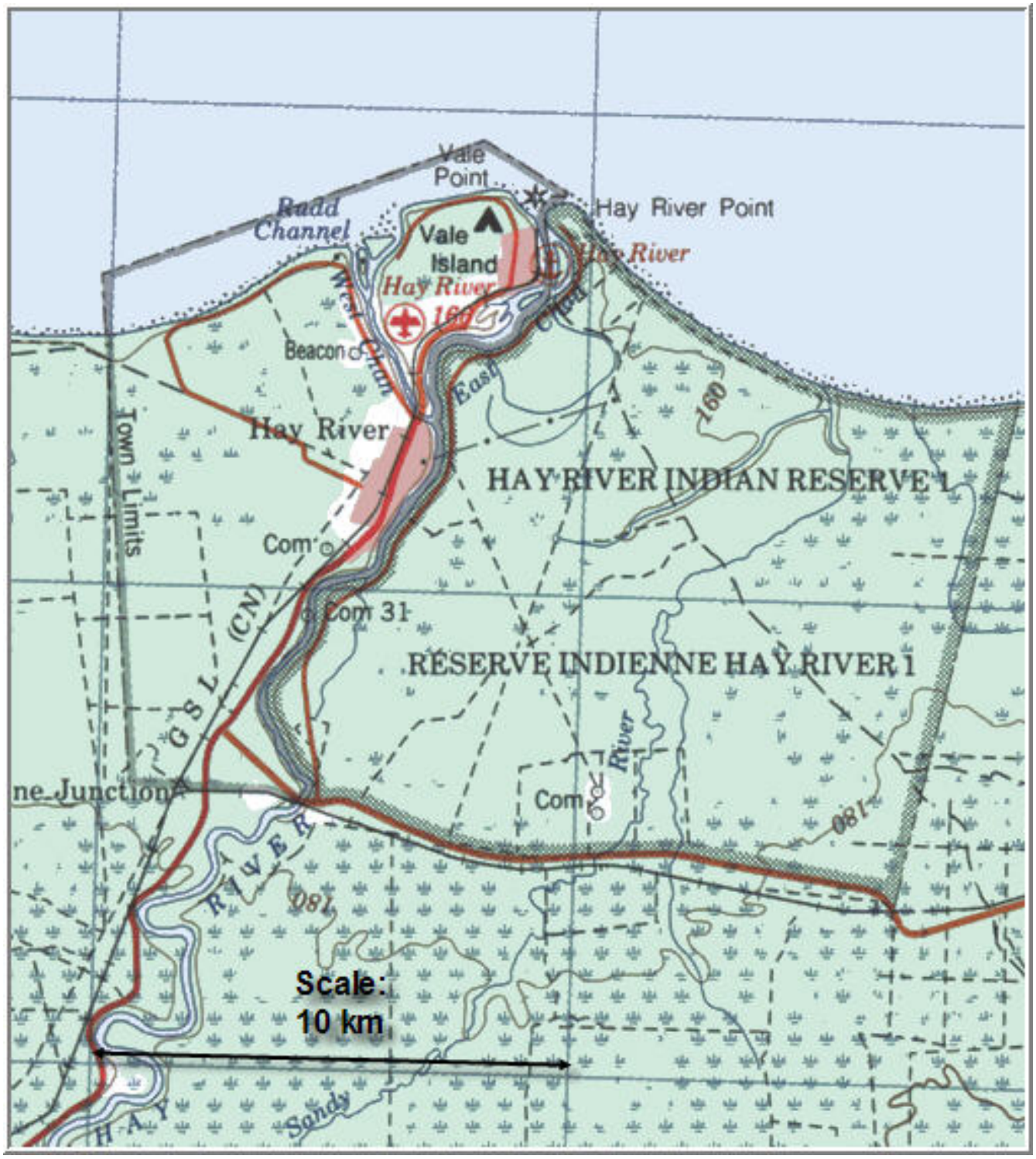
Status Report for the Historic NTR

Fort Providence – Site Plan

(Note: from SENES (1994))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 21**

Map Reference: 85B Buffalo Lake



amec		Status Report for the Historic NTR **Hay River - Site Location**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 22**

3.6.2 Operational History and Site Description

In the early 1960s, the railhead for the NTCL transportation route was moved from Fort McMurray to Hay River, and the Slave River portions of the water route were gradually phased out. Today, all materials that come to the NWT by railway pass through Hay River, a community of about 3,600 people. The "old town" and present NTCL operations are located on Vale Island, created by the delta of the river. An old fishing village was located on the west channel of Vale Island. A First Nations Reserve is located on the east bank of the east channel.

The Hay River area includes the following three sites that are potential sources of ore contamination (see Figure 23):

- the old fishing village;
- the NTCL dock area; and
- the old indian village.

3.6.3 Radiological Investigations/Remediation

The radiological investigations conducted on the Hay River sites are described in SENES (1994). Remedial works completed at the NTCL dock area and the old indian village are described in DeJong (1999) and LLRWMO (2003). Executive summaries of these references are provided in Appendix A.

The site and material categories for the Hay River area sites are summarized in Table 9.

Table 9: Hay River Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[4]		
		L	1	2
Old Fishing Village[1]	1	0	0	0
NTCL Dock Area[2]	2	0	0	0
Old Indian Village[3]	4	Removed	550	0

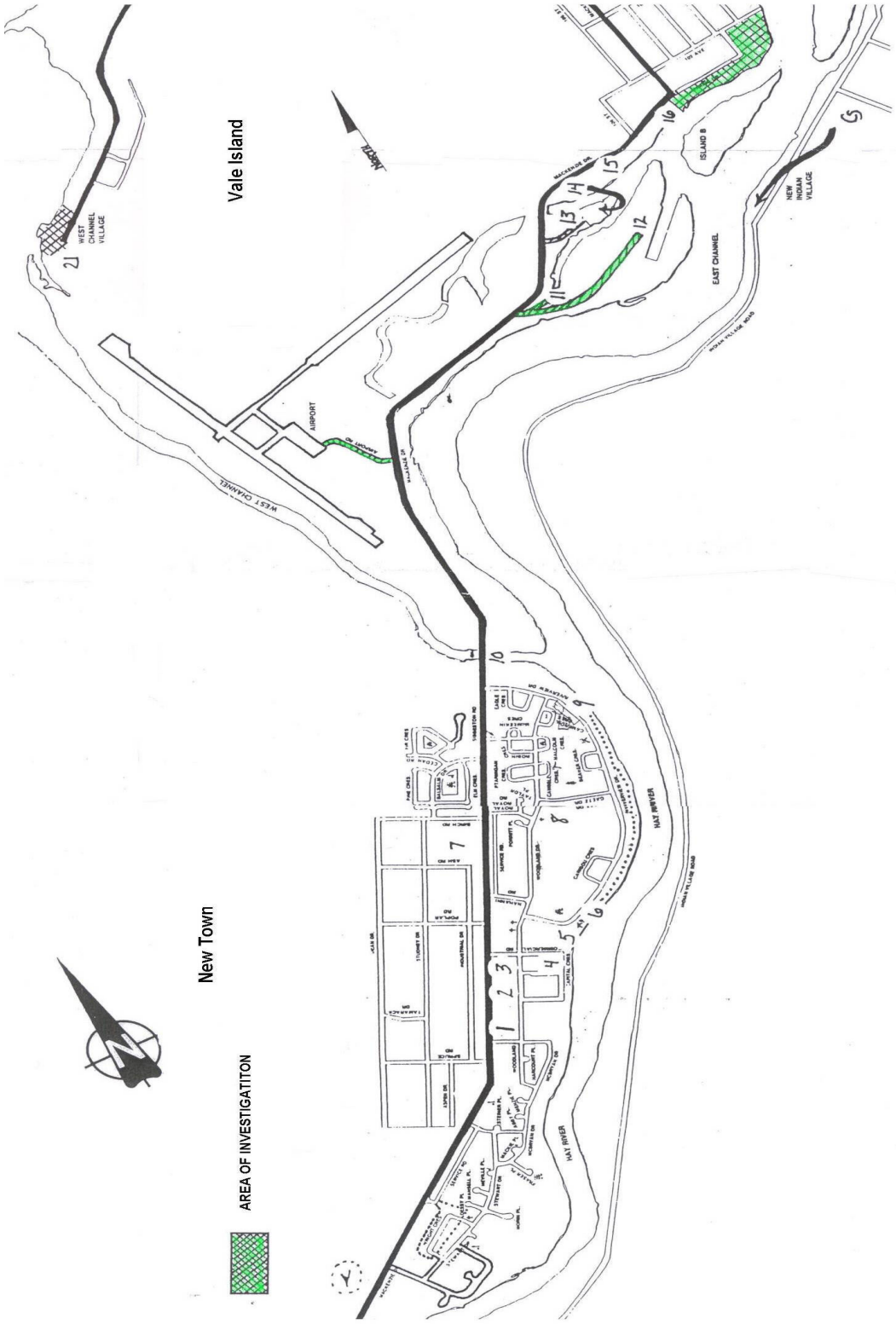
1 SENES (1994)
2 SENES (1994) and LLRWMO (2003)
3 DeJong (1999)
4 See Sections 2.1 and 2.2 for category definitions

3.6.3.1 Old Fishing Village

The old fishing village on the west Hay River delta channel was surveyed in 1993 and exhibited no evidence of contamination by uranium ores (SENES, 1994).

3.6.3.2 NTCL Dock Area

Investigations of the buried remains of an old warehouse and a number of NTCL vessels identified no evidence of ore contamination (SENES, 1994). A subsequent visit to the docks area in 2000 by the LLRWMO and the CNSC found evidence of uranium contamination on two barges. NTCL (LLRWMO, 2003), through its consultant FSC Architects and Engineers, completed a cleanup of these two barges in 2003. The cleanup was verified by the LLRWMO.



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Status Report for the Historic NTR

Hay River – Site Plan

(Note: from SENES (1994))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 23**

3.6.3.3 Old Indian Village – Cemetery and River Bank

The oldest portion of the Dene settlement on the east side of the west channel of the Hay River was scanned along the river (SENES, 1994). A former chief described how a load of ore had been over-wintered here when the Slave River had frozen over early one year. Three small areas of contamination were identified near a burial ground. Test pits and samples were collected confirming the presence of uranium.

In 1997, the LLRWMO conducted a detailed gamma radiation survey of the area and found an additional zone of contamination containing materials that were defined as licensable at the time. In 1998, the LLRWMO excavated and removed 27 drums of the most contaminated materials to Chalk River, Ontario. The wastes had been located directly on the riverbank and it was estimated that at least 200 m^3 to 550 m^3 of less contaminated soil remained at the site (DeJong, 1999).

3.7 Rae-Edzo

3.7.1 Location

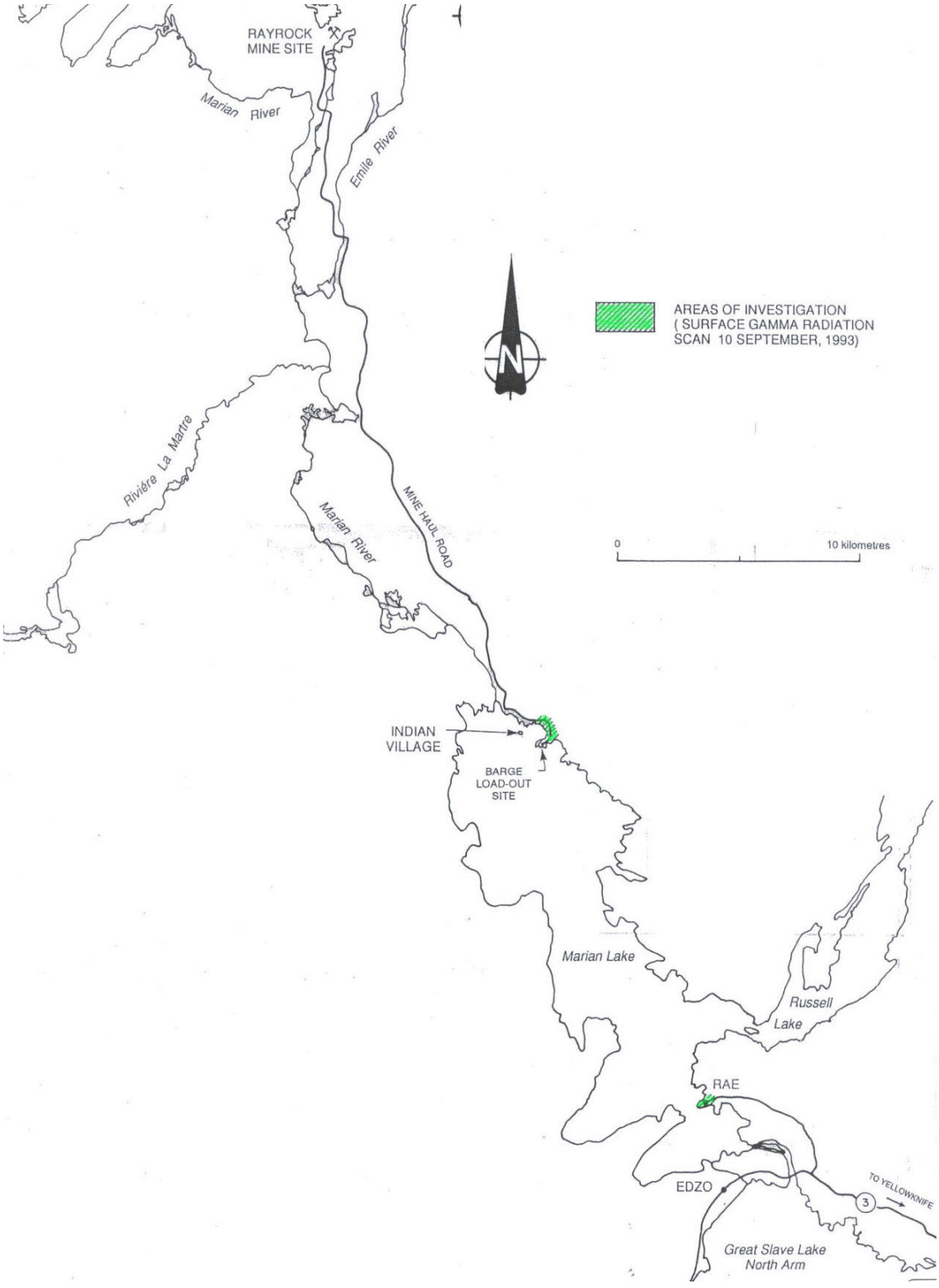
Rae is located at 62’50’N and 116’4’W on a rocky peninsula on the southeast shore of Marian Lake on the North Arm of Great Slave Lake (see Figure 1). Spread over two islands and part of the mainland, the community is 24 km from its sister community of Edzo. Located at 62º,40’N; 116º,4’W, Edzo is bound on the east side by the west channel flowing between Marian and Great Slave Lake. Rae is located 115 km northwest of Yellowknife and Edzo is 106 km northwest of the capital city via the Mackenzie Highway. The two centres are 6 km apart by boat.

3.7.2 Operational History and Site Description

Rae-Edzo was not part of the historic uranium northern transportation route from the Eldorado Mine at Port Radium. However, the community of Rae was involved in the transportation of uranium concentrates from the former Rayrock Mine to the north, which operated between 1957 and 1959. The combined communities of Rae and Edzo are now the largest Dene community in the NWT (total population of about 1,900) (GNWT, 2005).

The Rae-Edzo area includes the following four sites that are potential sources of ore contamination (Figure 24):

- the island area;
- the mainland area;
- the Rayrock barge loadout area; and
- the Marian Lake indian village.



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Atomic Energy of Canada Limited

Status Report for the Historic NTR

Rae - Edzo – Regional Location and Site Plan

(Note: from SENES (1994))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 24**

3.7.3 Radiological Investigations/Remediation

The Rae-Edzo area sites were all investigated by SENES (1994) (see Appendix A for Executive Summary). In each case, no evidence of uranium ore contamination was found. the site and material categories for these sites are summarized on Table 10.

Table 10: Rae-Edzo Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[2]		
		L	1	2
Island Area of Community[1]	1	0	0	0
Mainland Area[1]	1	0	0	0
Bayrock Barge Loadout Area[1]	1	0	0	0
Marian Lake Indian Village[1]	1	0	0	0

[1] SENES (1994)
[2] See Sections 2.1 and 2.2 for category definitions

3.7.3.1 Island and Mainland Areas

Two buildings in the community constructed with material salvaged from the Rayrock mining operation were inspected for contamination and no evidence of uranium contamination was found. Background gamma radiation levels in the community range from 15 to 50 µR/hr depending on location. Background gamma radiation levels in the range of 20 to 50 µR/hr were typical for the island portion of the community where homes had been constructed on the granite outcrops. Gamma radiation levels in the mainland part of the community were generally in the range of 15 to 20 µR/hr (SENES, 1994).

3.7.3.2 Rayrock Barge Loadout Area

As part of the investigations in Rae, the barge loadout area at the end of the haulage road from the Rayrock mine site was surveyed. Wooden timbers and pieces of equipment scattered across the site suggested that it had once been used as a load-out area. Gamma radiation scans conducted at this site did not indicate the presence of any uranium contamination. Naturally elevated gamma radiation levels ranging from 15 to 60 µR/hr were recorded on several granite outcrops on the site. The timber dock area was also checked for contamination using a pancake geiger instrument and none was found (SENES, 1994).

3.7.3.3 Marian Lake Indian Village

A sampling of three or four buildings at the Marian Lake Indian Village, located across the bay from the barge loadout site, was conducted. Gamma radiation readings in the community were generally 15 µR/hr and no evidence of contamination was found in any of the buildings investigated (SENES 1994).

3.8 Yellowknife

3.8.1 Location

Yellowknife, the capital city of the NWT, is located at 62º,276'N; 114º,226'W. The city sits on the west shore of Yellowknife Bay on the North Arm of Great Slave Lake (see Figure 1 and 25).

3.8.2 Operational History and Site Description

Yellowknife was never a component of the northern transportation route for uranium ores. However, many of the interviews conducted during the early phases of historical investigations were completed in Yellowknife. During these discussions, concerns were expressed about the potential contamination of steel barges formerly used on the NTR that were then used as floating docks in Yellowknife (i.e., NTCL barges Radium 260 and 261).

3.8.3 Radiological Investigations

SENES (1994) concluded that any uranium ore spillage that may have occurred during the transportation of uranium ore would have been removed during routine wash down operations for the NTCL barges Radium 260 and 261. In addition, it was considered very unlikely that any spilled uranium ore could be present on any steel decked barge considering the many years of exposure to rain and snow since the closure of the Port Radium Mine in 1960.

The site and material categories for the Yellowknife barges are summarized on Table 11.

Table 11: Yellowknife Barges – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[2]		
		L	1	2
Yellowknife[1]	1	0	0	0

1 SENES (1994)
2 See Sections 2.1 and 2.2 for category definitions

3.9 Fort Resolution

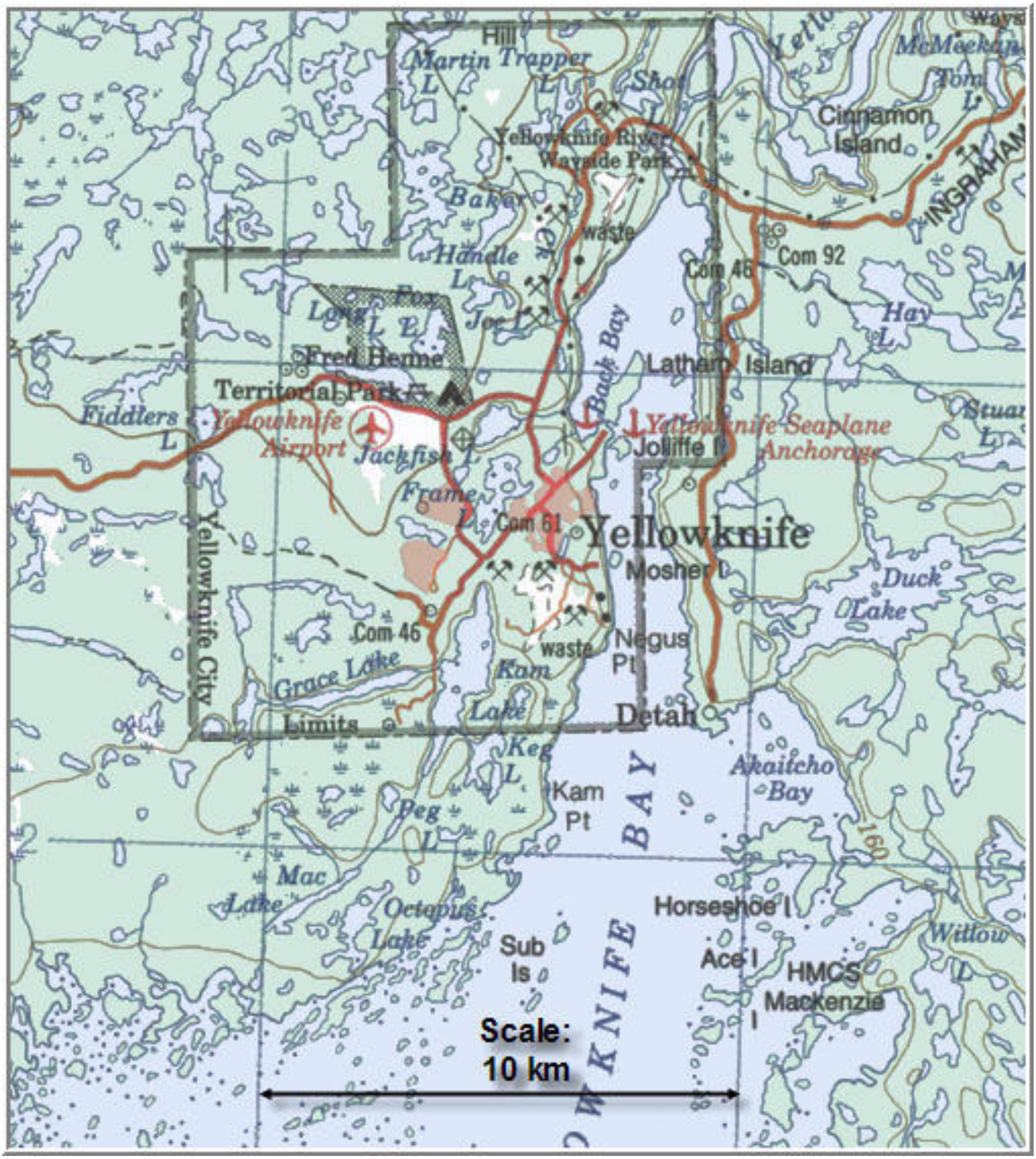
3.9.1 Location

Fort Resolution is built on a peninsula (ranging from 158 m to 163 m above sea level) southwest of the Slave River Delta on the south shore of Great Slave Lake. The community is located at 61º,11'N; 113º,41'W and is 153 km by air from Yellowknife (see Figures 1 and 26).

3.9.2 Operational History and Site Description

Fort Resolution is a small Chipewyan community of about 600 people. Although it was not a regular stopping point on the ore NTR, its proximity to suspect sites suggested that it should be included in radiological survey efforts.

Map Reference: 85J Yellowknife



amec		Status Report for the Historic NTR **Yellowknife - Site Location**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 25**

Map Reference: 85H Fort Resolution

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Status Report for the Historic NTR

Fort Resolution - Site Location

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 26**

Discussions with community members led to the identification of the following potential areas of impact in and around Fort Resolution (see Figure 27):

- the quarry by the airport; and
- the landings and beach area.

3.9.3 Radiological Investigations

The Fort Resolution area sites were investigated by SENES (1994) (see Appendix A for Executive Summary). The site and material categories for these sites are summarized in Table 12.

Table 12: Fort Resolution Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[3]		
		L	1	2
Quarry by Airport[1]	1	0	0	0
Landings and Beach Areas[1,2]	2	0	0	0

[1] SENES (1994)
[2] [redacted]
[3] See Sections 2.1 and 2.2 for category definitions

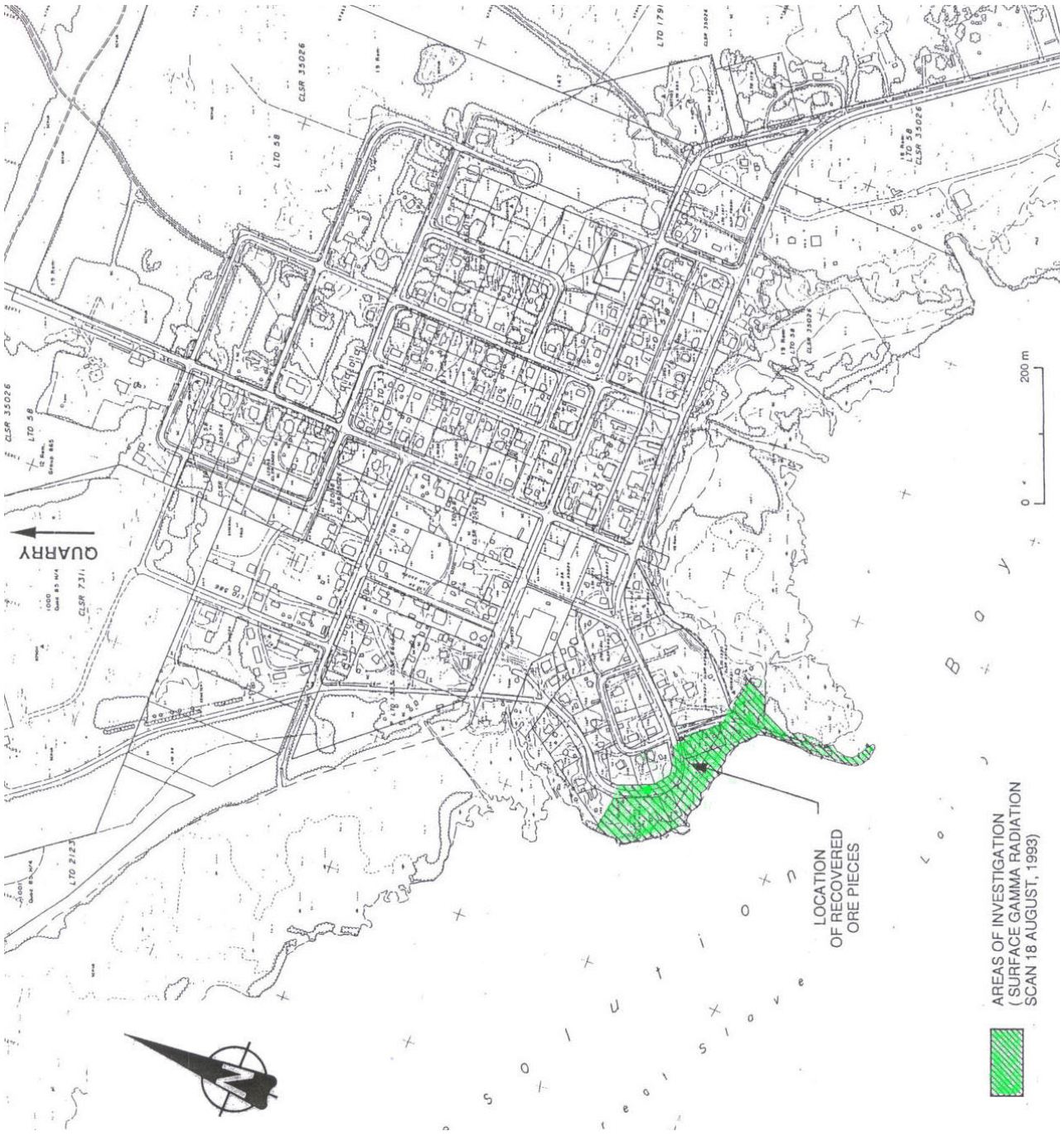
3.9.3.1 Quarry by Airport

Screening level surveys found no evidence of uranium contamination in the quarry area (SENES, 1994).

3.9.3.2 Landings and Beach Area

Gamma radiation scans were conducted in the wharf and beach area of Fort Resolution. Gamma radiation levels were typically in the range of 4 to 6 µR/hr with some granite boulders up to 11 µR/hr on contact. During the course of these gamma radiation scans, three localized spots of above background gamma radiation were detected. The maximum gamma radiation reading measured was 60 µR/hr on contact with the ground at one of the spots. Investigation of these locations led to the recovery of three pieces of uranium ore buried approximately 0.5 m below the surface, in an open grassy area between a power plant and a water intake pipe.

The planned construction of a new water treatment plant in 1995 prompted additional radiation surveys in the area. During the course of these surveys two additional pieces of ore were recovered. The base of the new water treatment plant excavation was also surveyed and no additional uranium contamination was found. The bits recovered were considered “samples” and were eventually transported to Chalk River [redacted]



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Status Report for the Historic NTR

Fort Resolution – Site Plan

(Note: from SENES (1994))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 27**

3.10 Bell Rock NTCL Marine Terminal

3.10.1 Location

The former Bell Rock Marine Terminal is located on the Slave River at 60º,01'N; 112º,06'W, about 10 km west-northwest of the town of Fort Smith, near the NWT-Alberta border (see Figures 1 and 28).

3.10.2 Operational History and Site Description

NTCL transferred its cargo handling operation from Fort Smith to Bell Rock in the late 1940s to eliminate problems at the Fort Smith docking area created by swift currents, eddies and ground instability. The Bell Rock marine terminal facility remained in operation until the early 1960s when NTCL moved the operation to Hay River. The railway had been extended to Hay River and there was no need for the NTCL Bell Rock site (SENES, 1994).

The Bell Rock area can be partitioned into the following three sites that are potential sources of ore contamination (see Figure 29):

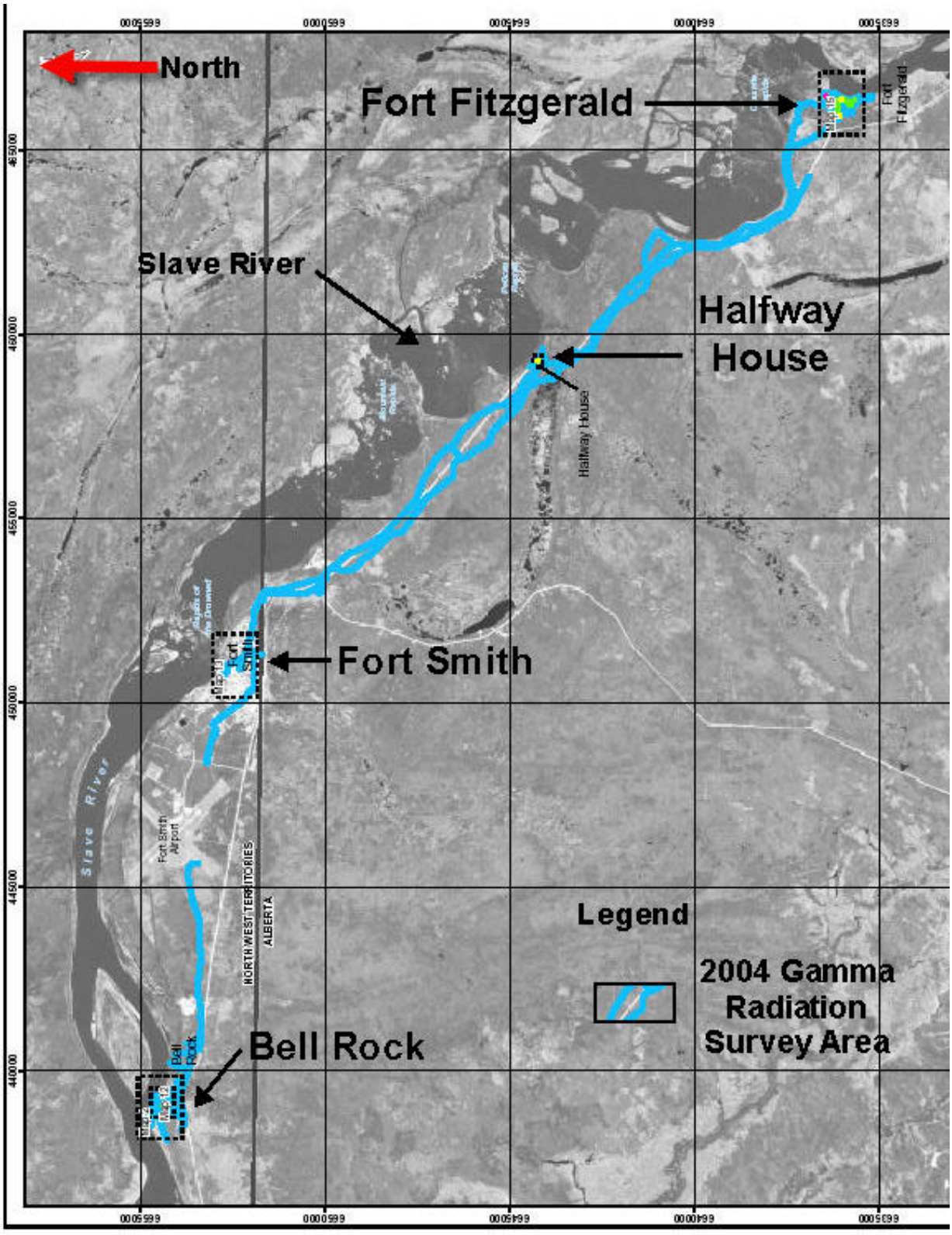
- the wharf and warehouse areas;
- the slipway and maintenance camp areas; and
- the haul road to Fort Smith.

3.10.2.1 Wharf and Warehouse Areas

The northwest portion of the site included a wharf with adjustable ramps, an adjacent wooden materials handling area and the main materials warehouse. Two earthen and timber truck off-loading ramps were used for large portaged items (e.g., new barges). A large steel fuel tank was located next to the public launch area. At present, very little of the wharf and warehouse are visible due to major ice damage and sediment deposits from flooding. With the exception of steel timber connectors around the perimeter of the warehouse and the wrecked wharf face, vegetation obscures much of the materials handling area. A fenced area west of the fuel tank contains a newly constructed house with outbuildings.

3.10.2.2 Slipways and Camp Areas

The terminal's maintenance and winter storage facility was located southeast of the materials handling area surrounding Bell Rock. Two slipways, nearly 300 m long, led from the beach next to the wharf up the slope past three large warehouses. Many buildings were built here over the years by NTCL, including bunkhouses, residences, a mess hall, truck garages, a smithy, diesel electric generation buildings and offices. Today, only one of these buildings remains habitable. The surface of the site has been graded at least once after the departure of NTCL.



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Atomic Energy of Canada Limited

Status Report for the Historic NTR

Bell Rock to Fort Fitzgerald – General Arrangement

(Note: from AMEC (2005))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 28**

Legend

Lot Boundary

1 Lot Number

Notes:
1. Lot boundaries from 962129 Ontario Ltd. (2000)

REFERENCE: Air Photo A15874-221 (1957)

50 0 50 100 150
Metres
1:8,000

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Status Report for the Historic NTR

Bell Rock – General Arrangement

(Note: from AMEC (2005))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 29**

3.10.2.3 Haul Road

The former NTCL haul road (or portage route) runs roughly parallel with, and north of, the present paved Highway 5. Before the highway was built as a connector to Hay River, an older trail ran west toward Salt River. The haul road presently leads to a former NTCL dump access road and terminates on the Transport Canada Fort Smith Airport lands. Local residents presently use the haul road for recreational purposes, although the municipality has constructed large earthen berms to prevent vehicle access. Other old trails pass through the area and portions have been used for dumping of automobile wrecks and other debris.

3.10.3 Radiological Investigations/Remediation

The following radiological surveys and/or remedial efforts have been completed on the Bell Rock site:

- reconnaissance level surveys (SENES, 1994);
- detailed surveys and test pitting programs ([redacted] and
- detailed dose level surveys (AMEC, 2005).

Executive Summaries of these documents are provided in Appendix A. Note that AMEC (2005) also includes a summary of all previous investigative work completed on the Bell Rock site.

The site and material categories for the Bell Rock area sites are summarized on Table 13.

Table 13: Bell Rock Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[3]		
		L	1	2
Wharf and Warehouse Area				
◆ Warehouse Floor and Soil[1]	5	0	390	0
◆ Wood Dump[1]	4	0	10	0
Slipways and Maintenance Camp Area				
◆ "A" at Bush[2]	4	0	180	0
◆ "B Handling[2]	5	0	540	0
◆ "C" Handling[2]	5	0	1,140	0
◆ "D" Handling[2]	5	0	120	0
◆ Garage Floor[2]	4	0	100	0
Haul Road to Fort Smith[1]	1	0	0	0

1 AMEC (2005)
2 AMEC (2005) and [redacted]
3 See Sections 2.1 and 2.2 for category definitions

3.10.3.1 Wharf and Warehouse Area

The wharf/docking area has been broken up by river ice and exhibits no evidence of ore. The warehouse superstructure has been torn down. The floor remains are contaminated and a pile of contaminated timbers was dumped in the bush several hundred metres away. The warehouse floor is now covered with 10 cm or more of sediment. Boreholes show a layer of

gravel-like material below the present ground surface to a depth of about 0.5 m. A shallow pocket of more contaminated material is located in the southeast corner of the warehouse. The area around the warehouse and below the sediment has not been characterized in detail.

Loading ramps, approach roads and an adjacent private dwelling lot were surveyed. Only one anomaly, not associated with the warehouse, was found near the ramps in 1994, but could not be relocated in subsequent surveys (AMEC 2005).

3.10.3.2 Slipway and Maintenance Camp Area

The slipway/camp area has been graded flat to accommodate other uses. As a result, bits of ore, powdered ore, and contaminated and burned building materials have been distributed over a large area. The materials are evident in the disturbed 15 to 25 cm layer of topsoil cover. At one metre above the ground, gamma radiation levels are difficult to differentiate from background levels.

Contaminated floor boards identified in the maintenance garage in 1994 have been burned with the building since 2000. Residual contamination remains at this location. In the southwest corner of the greater open area, a larger area of uranium contamination remains. Historic aerial photos show a building with a loading ramp at this location. There is no evidence of the building today (AMEC, 2005).

3.10.3.3 Haul Road to Fort Smith

Each of the historic haul roads at the Bell Rock facility and the road to the Fort Smith airport have been surveyed. A side road to and from the former NTCL dump were also surveyed. No evidence of ore has been found on these roads or at the dump (AMEC, 2005).

3.11 Fort Smith

3.11.1 Location

Fort Smith is located at 60º,00'N; 111º,53'W and is the southernmost community in the NWT. The town is situated on the shore of the Slave River, immediately north of the NWT/Alberta border. Fort Smith is about 320 km southwest of Yellowknife (Figures 1 and 28).

3.11.2 Operational History and Site Description

Fort Smith is a community of about 2,600 people situated downstream of a series of four rapids (e.g., Rapids of the Drowned, Mountain Rapids, Pelican Rapids and Cassette Rapids). The major economic drivers in Fort Smith are government, trapping and tourism.

At one time, Fort Smith was the northern end of the portage around the four sets of rapids on the Slave River. A 23 km road linked Fort Smith to Fort Fitzgerald, the southern end of the portage. Fort Smith was an active barge/cargo transfer point until the 1940s when the northern transportation marine terminal operation was moved to Bell Rock.

The following areas of potential concern exist in the Fort Smith area:

- the former NTCL warehouse;
- the Peregrine Street ditch and road;
- Portage Avenue;
- in-town haul roads;
- local barge debris; and
- the nuisance grounds.

3.11.3 Radiological Investigations/Remediation

The following radiological surveys and/or remedial efforts have been completed in the Fort Smith area:

- surveys related to satellite fallout (Gummer *et al.*, 1980 as cited in SENES (1994));
- reconnaissance level surveys (SENES, 1994);
- detailed source specific surveys [redacted]
- contaminated soil removal and building demolition programs (LLRWMO, 2000a, 2001c and 2001d); and
- detailed dose level surveys (AMEC, 2005).

Executive summaries of these documents are provided in Appendix A. Note that AMEC (2005) also includes a summary of all previous investigative work completed in the Fort Smith area.

Many of the original concerns associated with uranium ores in Fort Smith were identified as a consequence of the COSMOS 954 Satellite recovery operation conducted during 1978/79. COSMOS 954 was a Soviet nuclear-powered surveillance satellite that crashed in the NWT on 24 January 1978. The crash scattered a large amount of radioactivity over a 124,000 km^2 area in Canada's north, stretching southward from Great Slave Lake into northern Alberta and Saskatchewan. During the COSMOS investigations, intensive gamma radiation surveys, based on 2 m line spacings, were conducted in all inhabited areas of Fort Smith. Investigations resulted in the recovery of 1,100 radioactive particles associated with fallout from the satellite (Gummer *et al.*, 1980 as cited in SENES (1994)). The COSMOS surveys also identified above background radiation levels, believed to be associated with historic uranium transportation operations, in a ditch on Peregrine St. and in the yards of homes located on Portage Avenue and Primrose Lane.

The site and material categories for the Fort Smith area sites are summarized on Table 14:

Table 14: Fort Smith Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[4]		
		L	1	2
Former NTCL Warehouse[1]	1	0	0	0
Peregrine St. Road Bed[2]	4	0	100	0
Portage Ave. Property[2]	1	0	0	0
In-Town Haul Roads[3]	1	0	0	0
Barge Debris	6	–	–	–
Nuisance Grounds (Fort Smith Storage Facility)[2]	3	0	225	0

1 LLRWMO (2000a)
2 LLRWMO (2001d)
3 AMEC (2005)
4 See Sections 2.1 and 2.2 for category definitions

3.11.3.1 Former NTCL Warehouse

An abandoned warehouse located on the escarpment next to the historic haul road was demolished because it had become a safety hazard. The floorboards, support timbers and soil beneath the building were contaminated with uranium. The exterior of the building was clad with asbestos contaminated tarpaper. The Town of Fort Smith demolished the building, with radiation protection provided by the LLRWMO [redacted]. The asbestos wastes and superstructure were moved to a designated area in the Nuisance Grounds and the uranium contaminated materials were placed in a temporary storage facility at the same site (see Section 3.11.3.6 below).

3.11.3.2 Peregrine St. Ditch and Road

The COSMOS survey crew identified uranium waste in a ditch area on Peregrine Street across the road from an old garage. Bits of the ore had been spread to adjacent properties. In 1994 and 1995, intensive near-surface surveys recovered most of the ore on the adjacent lawn. In 2000, the Town removed the derelict garage to the nuisance grounds. In 2001, the LLRWMO excavated the remaining contaminated soils from both sides of the street and hauled them to the temporary storage facility, described in Section 3.11.3.6 below. A shallow layer of contamination remains below the roadbed at a depth of approximately 75 cm (LLRWMO, 2001d).

3.11.3.3 Portage Avenue

The COSMOS survey team also identified uranium at the corner of a house on Portage Avenue. This historically was the location of the inside curve of the portage road. Bits of the ore had been spread to an adjacent lawn. In 1994 and 1995 intensive near-surface surveys recovered the ore on the adjacent lawn. In 2001, the LLRWMO excavated the remaining contaminated soils and hauled them to the temporary storage facility, described in Section 3.11.3.6 below (LLRWMO, 2001d).

3.11.3.4 Fort Smith and In-Town Haul Roads

Although many of the former portage roads and the earlier "by-pass" in Town had been informally scanned during previous investigations, a more comprehensive survey was completed by AMEC (2005). All observed readings were at background values (i.e., consistent with granite aggregate typically used in the production of local asphalt).

3.11.3.5 Barge Debris

A chance encounter with a local businessman identified a former barge superstructure that was being used as a lumber storage building. Loose uranium contamination was found on the horizontal portion of the sill plates. The owner suggested that there were many other such salvaged NTCL buildings in the area. By 2004 the building was gone. Community residents advised that the building had been demolished with the better lumber salvaged and the remainder burned and buried.

One of the Radium series vessels is on display at the local museum. It exhibited no evidence of uranium contamination during the radiological surveys.

3.11.3.6 Nuisance Grounds (Fort Smith Storage Facility)

The remains of the former NTCL warehouse building (100 m^3) and the contaminated soils from Peregrine Street and Portage Avenue (125 m^3) are stored in a designated area at the local Nuisance Grounds. The material is held under CNSC license by the LLRWMO in a shallow depression lined, top and bottom, with tarpaulin. A 30 cm cover of sand protects the tarp. The site is fenced and signs posted to identify the materials. Routine inspections are conducted by the LLRWMO and the CNSC.

3.12 Fort Smith – Fort Fitzgerald

3.12.1 Location

The former portage routes between Fort Smith and Fort Fitzgerald were situated adjacent, or in generally close proximity, to the Slave River (see Figures 1 and 28).

3.12.2 Operational History and Site Description

The original portage from Fort Smith to Fort Fitzgerald was developed by the Hudson Bay Company (HBC) and followed the top of the escarpment along the west side of the Slave River. Competition between rival shipping companies (i.e., HBC, NTCL and [redacted]) resulted in the construction of an alternate and physically separate haul road (i.e., the NTCL portage route). The newer trail, used exclusively by NTCL for the transport of uranium ore around the Slave River rapids, is situated further away from the river and is connected to the other every mile by a crossover. Because large items such as new barges were hauled on both routes, vehicles traveling in the other direction were sometimes forced to cross over, or wait at a crossover. It is not known if the HBC haul road was used to haul uranium ore.

The road bases were regularly maintained by grading and filling with the sandy soils extracted from borrow pits along the way. The NTCL portage was rebuilt in 1942 by the U.S. army in support of the CANOL Project. At present, portions of the roads are maintained and other overgrown areas are still accessible by vehicles.

The Fort Smith to Fort Fitzgerald portage routes were partitioned into the following areas of interest:

- the NTCL portage;
- the HBC portage; and
- Halfway House.

3.12.3 Radiological Investigations

The portage routes between Fort Smith and Fort Fitzgerald were not surveyed in any detail until 2004 (AMEC, 2005). The executive summary of this investigative document is provided in Appendix A.

The site and material categories for the portage route sites are summarized in Table 15.

Table 15: Fort Smith to Fort Fitzgerald Portage Routes – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[2]		
		L	1	2
NTCL Portage[1]	1	0	0	0
HBC Portage[1]	1	0	0	0
Halfway House[1]	4	0	80	0

[1] AMEC (2005)
[2] See Sections 2.1 and 2.2 for category definitions

3.12.3.1 NTCL Portage

The more southerly and westerly of the two historic portage roads (often called the U.S. army road) was surveyed along its length in 2004. The survey crew was led to a 1949 spill location reported by a local resident, but could find no radiological evidence of it. Residual materials may have been covered by road maintenance operations (AMEC, 2005).

3.12.3.2 HBC Portage

The 2004 survey provided no evidence of uranium ore contamination along the former HBC portage route (AMEC, 2005).

3.12.3.3 Halfway House

The former Halfway House site is believed to be located in a clearing between the Slave River and the HBC road, at a point roughly equidistant between Fort Smith and Fort Fitzgerald. The clearing includes the remains of old buildings, a collapsed buried drum pit, many old surface

middens (cans, vehicle parts, etc.), fences and what appear to be old farm fields. There is evidence of more contemporary use of the site in the form of stockpiled buildings logs, a large cultivated garden, meat drying racks and a pit trap. An 8 m x 10 m area of uranium contamination was identified in a clump of tress, surrounded by signs of recent disturbance (AMEC, 2005).

3.13 Fort Fitzgerald

3.13.1 Location

Fort Fitzgerald (formerly known as Smith's Landing) is located at 59º,52'N; 111º,36'W, on a flood plain south of a granite headland where the Slave River turns northwest into a series of rapids (see Figures 1 and 28).

3.13.2 Operational History and Site Description

Fort Fitzgerald, Alberta, a hamlet of about 30 people, is the northernmost community within the Regional Municipality of Wood Buffalo (the regional municipality that includes the City of Fort McMurray). The residents of Fort Fitzgerald are typically employed in Fort Smith, or hunt and trap locally. At the height of river transportation operations, Fort Fitzgerald was home to nearly 800 residents. Hotels and commercial establishments supported residents and workers. None of these buildings remain, partially the result of Federal Government efforts to consolidate the population in Fort Smith. However, people have been returning, constructing new homes in the community, now the centre of the Smith's Landing First Nation (SLFN).

Both the NTCL and HBS portage roads entered and departed Fort Fitzgerald from the north and west. Old sketches of the community show development was centred on the more northern portion of the flood plain. The new highway, located west of the former NTCL haul road, now provides access to the community and newer roads and homes have been built to the east and west.

The HBC was long established and occupied the northern section of shoreline against the headland. NTCL holdings occupied much of the remaining lower shoreline areas that were subject to flooding. Existing sheet piling, concrete walls and an area with approximately one metre of regularly maintained fill, show the extent of the wharf and materials handling area. The areas immediately downstream of the NTCL shipping/handling area flood regularly and more than 60 cm of sediment can be observed around old haul-out ramp timbers.

The Fort Fitzgerald area can be partitioned into the following areas of potential interest (see Figure 30):

- the former NTCL Marine Terminal;
- the town roads; and
- various town lands.

Legend

Lot Boundary

1 Lot Number

Notes:
1. Lot boundaries from Department of the Interior (1913).

REFERENCE: Air Photo A15094-10 (1955)

50 0 50 100 150
Metres
1:6,000

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Status Report for the Historic NTR

Fort Fitzgerald – General Arrangement

(Note: from AMEC (2005))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 30**

3.13.3 Radiological Investigations/Remediation

The following radiological surveys and/or remedial efforts have been undertaken in the Fort Fitzgerald area:

- reconnaissance level surveys (SENES, 1994; [redacted];
- contaminated soil attenuation works (Owen, pers. comm., 2004);
- detailed dose level surveys (AMEC, 2005).

Executive summaries of these documents are provided in Appendix A.

The site and material categories for the Fort Fitzgerald area sites are summarized on Table 16.

Table 16: Fort Fitzgerald Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[2]		
		L	1	2
NTCL Marine Terminal[1]	5	200	4,100	0
Fort Fitzgerald Roads[1]	4	80	90	0
Fort Fitzgerald Lands[1]	5	10	1,960	0

[1] AMEC (2005)
[2] See Sections 2.1 and 2.2 for category definitions

3.13.3.1 NTCL Marine Terminal

Much of the marine terminal lands have been covered in river sediments or eroded away by spring flooding. The main wharf and materials handling area remain with new fill covering most of the contamination. Portions of the haul out ramps are still visible and a whole section of ramp has been bull-dozed into the river. Further north, flooding has washed out all but a few root-ball held pockets of contamination. In the low-lying areas surrounding the main built-up area, pockets of contamination remain in the scrub brush (AMEC, 2005).

3.13.3.2 Town Roads

The highway that currently bisects the town did not exist during NTCL's operations. The NTCL haul road enters the sloping floodplain north of and parallel to the present main road. Evidence of contamination associated with former buildings was found at this point. Numerous bits of ore, some quite large, are present along the roadway towards the river and main landing. A significant spill at the intersection of the haul road and the new highway was covered and attenuated by the LLRWMO in 2003 in response to a directive by the CNSC (Owen, pers. comm., 2004). A sand intrusion barrier was installed to reduce gamma radiation levels to near background.

A branch off the HBC road, towards the cemetery, at one time serviced a cookhouse used by NTCL workers. Spills were found on both sides of this road. No contamination was found on the new highway or on the newer residential roads to the south of the highway.

3.13.3.3 Town Lands

A large open area between the old NTCL road and the new highway includes a large communal building and one residential building, presently unoccupied. This was the former location of the town itself. The area has been extensively graded and smoothed out and, as a consequence, small bits of uranium ore have been widely spread and can be found near the surface. At the residence (not occupied at the time of the 2004 survey), a pocket of contaminated soil was found inside a fenced garden. Occasional bits of ore were found on lands formerly occupied by the HBC marine terminal. Open fields, slated for development by SLFN were also surveyed. No contamination was identified on these lands (AMEC, 2005).

3.14 Fort Chipewyan

3.14.1 Location

The community of Fort Chipewyan is located in Alberta, on the western end of Lake Athabasca near the head of the Slave River at 58º,43'N; 111º,09'W (see Figures 1 and 31).

3.14.2 Operational History and Site Description

Established in 1788, Fort Chipewyan is Alberta's oldest Euro-Canadian community. The town is now a community of about 1,400, mostly Mikisew Cree and Chipewyan Dene people. Until railways and roads replaced waterways as the main transportation corridors, Fort Chipewyan was the service centre for points north or west. For over 100 years, fort Chipewyan was the centre of the lucrative Athabasca fur trade region. Fort Chipewyan was a major stop along the transportation network used by NTCL to supply the communities along the historic uranium transportation network. Supplies going to, and any products from uranium mines in Northern Saskatchewan would also have passed by Fort Chipewyan (SENES, 1994; Appelbe, 2005; Gumm, 2005).

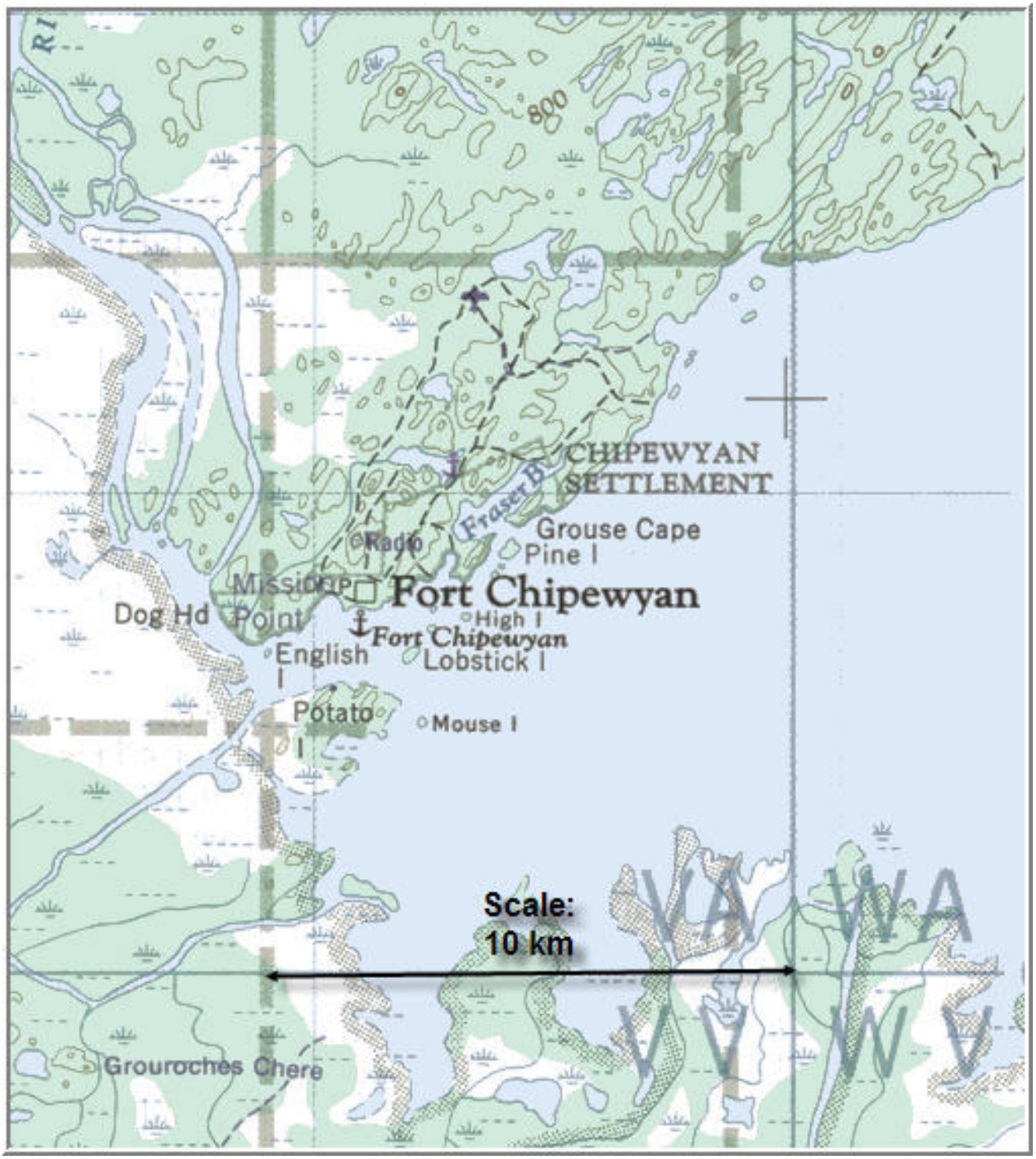
The Fort Chipewyan area can be partitioned into the following areas of potential interest (see Figure 32):

- the government dock and beach area;
- Little Island, Fraser Point; and
- the Uranium City houses.

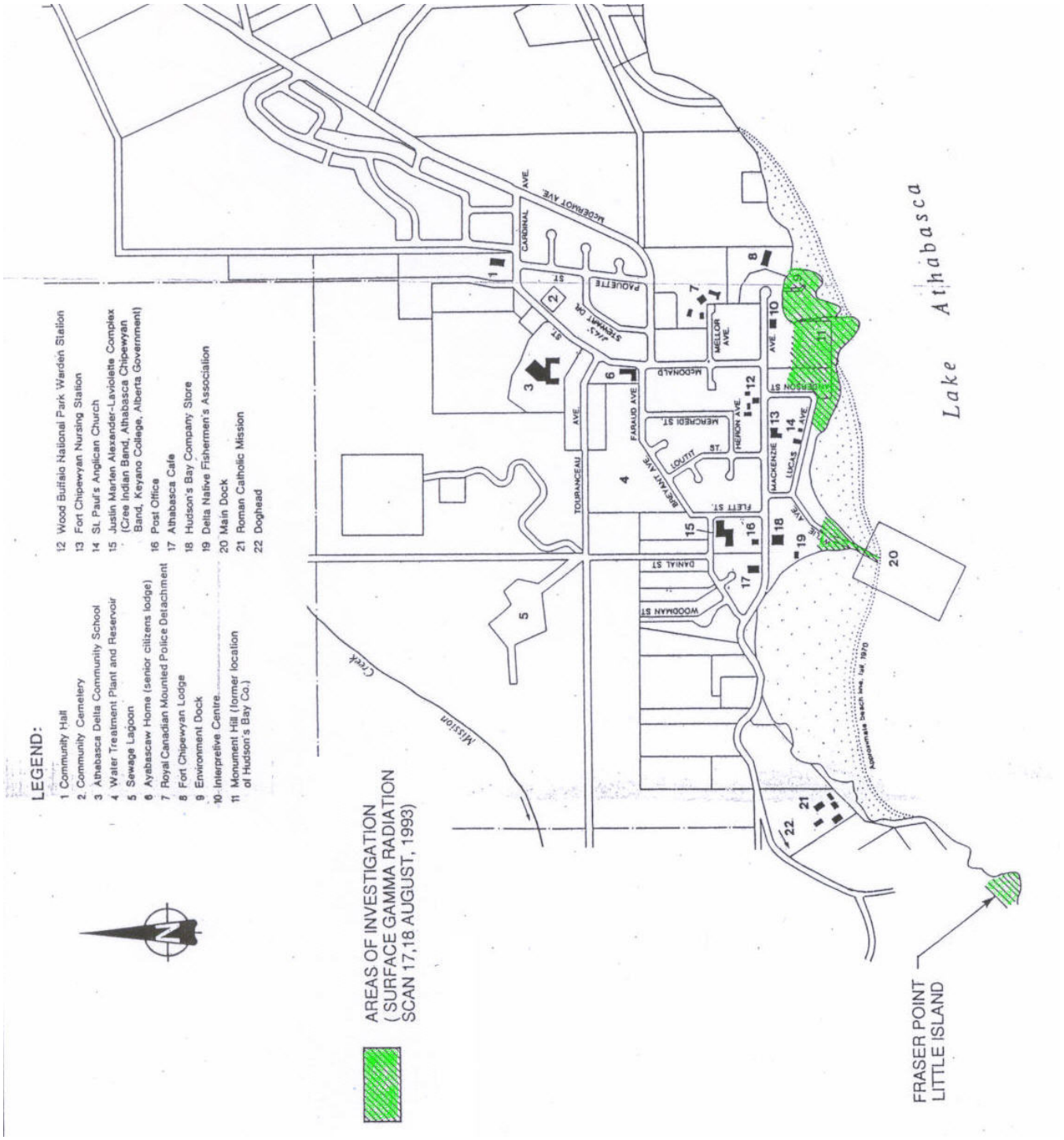
3.14.3 Radiological Investigations/Remediation

Reconnaissance level radiological surveys were conducted in the Fort Chipewyan area by SENES (1994) and [redacted] Executive summaries of these documents are provided in Appendix A.

Map Reference: 74D Fort Chipewyan



amec		Status Report for the Historic NTR **Fort Chipewyan - Site Location**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 31**



amec		Status Report for the Historic NTR **Fort Chipewyan – Site Plan** (Note: from SENES (1994))		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 32**

The site and material categories for the Fort Chipewyan area sites are summarized on Table 17.

Table 17: Fort Chipewyan Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[3]		
		L	1	2
Government Dock and Beach[1]	1	0	0	0
Little Island, Fraser Point[1]	1	0	0	0
Uranium City Houses[1, 2]	1	0	0	0

1 SENES (1994)
2 SENES (1994) and [redacted]
3 See Sections 2.1 and 2.2 for category definitions

3.14.3.1 Government Dock and Beach Area

The Town's lakefront and docks, and an area to the south known as Fraser's Point (or Little Island) were surveyed at the suggestion of local community members. Background radiation levels varied widely throughout the community with the lowest being near the beach and on the sloping plain below the Precambrian Shield rock outcroppings. Roads with granite aggregate showed slightly higher levels while natural radioactivity in the bedrock itself ranged to several times background. No evidence of uranium ore contamination was identified during these surveys (SENES, 1994).

3.14.3.2 Little Island, Fraser Point

The remains of a fuel pipeline and storage area that appeared to have been used for off-loading supplies were surveyed. Scans found no evidence of uranium ore contamination, although the natural radioactivity of the local bedrock exhibited levels several times that of background at the town site (SENES, 1994).

3.14.3.3 Uranium City Houses

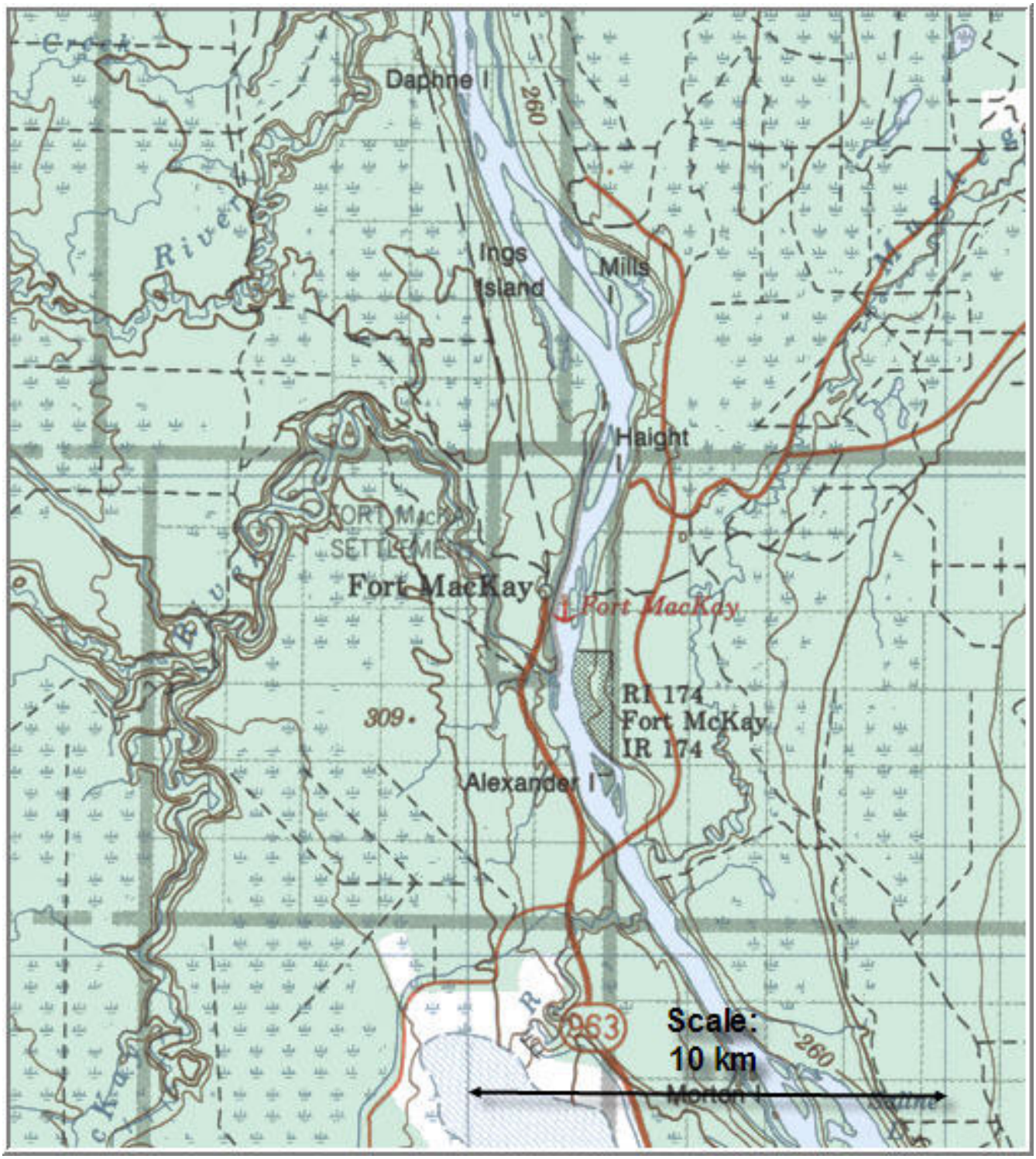
When the Uranium City mining operations on Lake Athabasca were shut down, many of the newer homes were loaded onto barges and hauled to Fort Chipewyan, Fort MacKay, Fort McMurray and Fort Smith. Four of these homes were surveyed in 1993 and nineteen additional homes were checked in 1994. Surveys consisted of a gamma radiation scan and surface contamination measurements on dust collecting surfaces (e.g., ventilation system components). No uranium contamination was found during these surveys (SENES, 1994; [redacted]

3.15 Fort MacKay

3.15.1 Location

Fort MacKay, Alberta is located at 57º,11'N; 111º,38'W, some 55 km north of Fort McMurray on the west bank of the Athabasca River (see Figures 1 and 33).

Map Reference: 74E Bitumount



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Status Report for the Historic NTR

Fort MacKay - Site Location

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 33**

3.15.2 Operational History and Site Description

Fort MacKay is a largely aboriginal community of about 300 people, located among various contemporary oilsands developments. The community has strong links to Fort McMurray which connects with Fort MacKay via an all-weather highway (RMWB, 2005). Fort MacKay was historically part of the Hudson Bay Transport network, not associated with the NTCL system.

3.15.3 Radiological Investigations

Fort MacKay was investigated by SENES (1994) (see executive summary in Appendix A). Gamma radiation scans were conducted in the area where cargo was unloaded from the barges and taken to the Hudson Bay building. No evidence of any uranium ore spillage was found at this location (see Figure 34).

SENES (1994) reported that the LLRWMO interviewed a long-time resident of the area who worked on the barges from 1949 to 1967. He did not recall any off-loading of uranium ore cargo at Fort MacKay, but did recall that barge loads of uranium concentrate were taken from the northern Saskatchewan mines (i.e., Larado, Goldfield, Gunnar) to the railhead at Fort McMurray.

The site and material categories for Fort MacKay are summarized on Table 18.

Table 18: Fort MacKay Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[2]		
		L	1	2
Fort MacKay[1]	1	0	0	0

[1] SENES (1994)
[2] See Sections 2.1 and 2.2 for category definitions

3.16 Fort McMurray

3.16.1 Location

Fort McMurray is in northeastern Alberta near 56º,65'N; 111º22'W, at the confluence of the Athabasca and Clearwater rivers (see Figures 1 and 35).

3.16.2 Operational History and Site Description

Fort McMurray has a population of about 60,000 and is the largest urban centre in the Regional Municipality of Wood Buffalo (RMWB). The RMWB is among the largest municipalities by area in North America, stretching from north central Alberta to the borders of Saskatchewan on the east, and the NWT in the north. Fort McMurray was established as a Hudson's Bay Company post in 1870.

Oil sands development spurred dramatic growth in the 1960s. The population doubled between 1964 and 1967 with the construction of Suncor's (GCOS or Great Canadian Oil Sands) plant. During the construction of Syncrude between 1975 and 1978, the population doubled again. Current forecasts predict that population could increase to over 70,000 as oilsands development continues (Alberta Human Resources and Employment, 2005).

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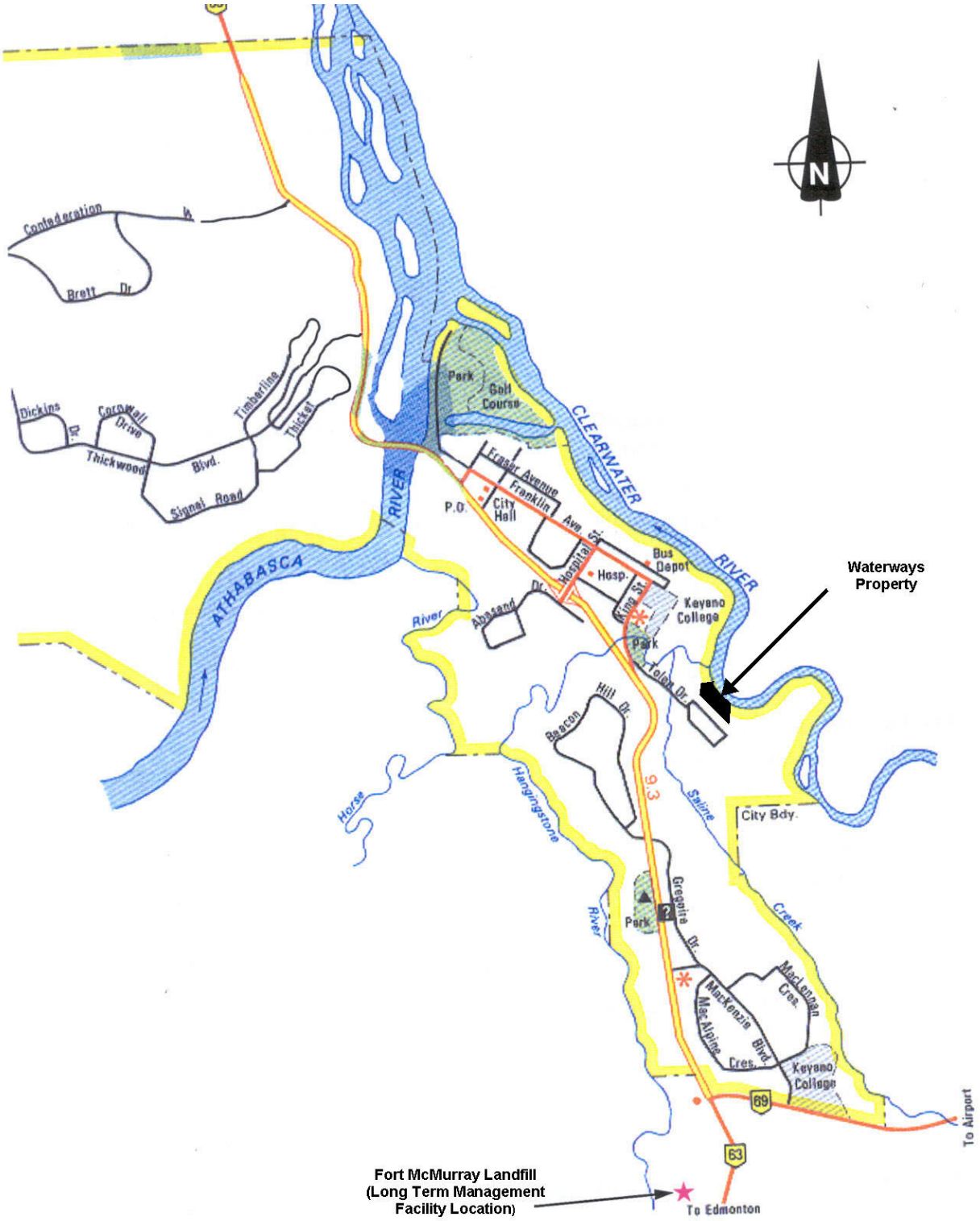
Status Report for the Historic NTR

Fort MacKay – Site Plan

(Note: from SENES (1994))

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 34**



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Status Report for the Historic NTR

Fort McMurray - Site Location

Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 35**

From the 1930s to the 1960s, the NTR was used by NTCL to carry uranium ore and ore concentrates from Port Radium to the barge-to-rail transfer point in Fort McMurray. From Fort McMurray, the ore was transported by rail car to its final destination in Port Hope, Ontario for refining. Until 1946, the NTCL warehouse in Fort McMurray was located at Waterways, a property presently owned by Canadian National (CN).

In the summer of 1992, during investigations of transfer points along the water route, elevated levels of radioactivity were discovered on riverside properties in the Lower Town site of Fort McMurray (SENES, 1994). It was assumed that incidental spillage and tracking during unloading of barges and loading of railcars were the causes of the contamination. Subsequent investigations found that properties adjacent to the Clearwater River in the Lower Town and Waterways areas of Fort McMurray exhibited uranium ore contamination. The sites in Fort McMurray that exhibited uranium ore contamination were as follows:

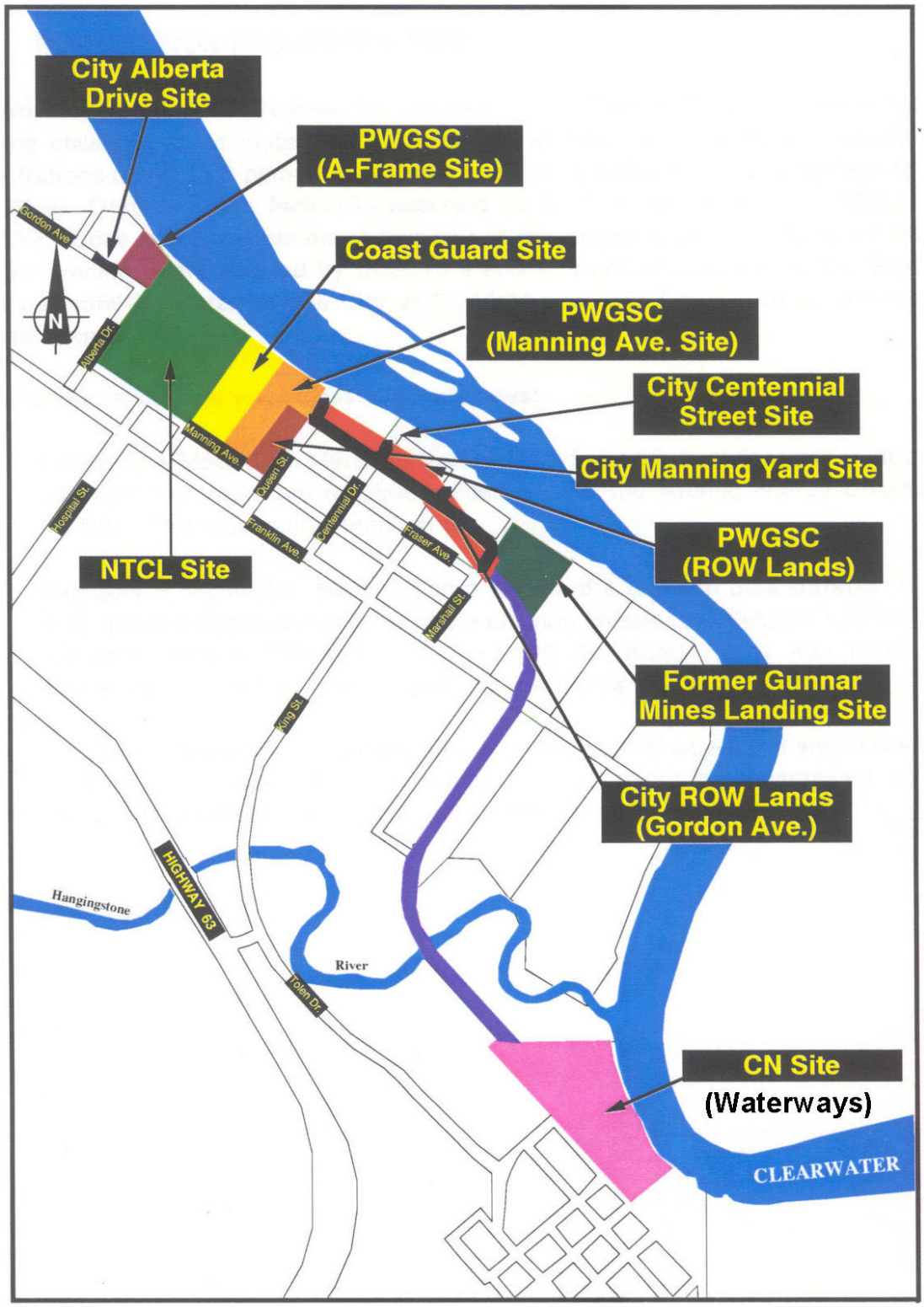
- the NTCL lands on Manning Avenue;
- Public Works and Government Services Canada (PWGSC) lands in Lower Town;
- City of Fort McMurray lands in Lower Town;
- the Transport Canada (Coast Guard) lands on Manning Avenue;
- the former Gunnar Mines landing site; and
- the former NTCL site in Waterways.

The locations of these sites are shown on Figure 36.

3.16.3 Radiological Investigations/Remediation

Following the initial radiological surveys on the above sites (SENES, 1994), a working group consisting of the LLRWMO, the Fort McMurray and district health unit, the City of Fort McMurray and Improvement District 18 was established to direct the cleanup project. A cleanup of contaminated soils from the NTCL Lower Town site began in the fall of 1992, using cleanup criteria and a waste management plan developed by the stakeholder working group. The mildly contaminated soil (described as Category B material) was placed in a secure, long-term management facility (LTMF) constructed at the Fort McMurray municipal landfill site. Materials considered low-level radioactive waste (described as Category A material) were shipped to the licensed LLRWMO storage facility at Chalk River Laboratories in Chalk River, Ontario. In 1994, cleanup work was completed at the seven neighbouring properties in Lower Town. The cleanup of an eighth property was completed in 1995. Remediation of the final site, the former NTCL site in Waterways, was completed between 2001 and 2003. Remedial activities at the Fort McMurray sites are described in the following documents:

- NTCL Manning Avenue lands – AGRA (1996a);
- PWGSC lands – AGRA (1995a, 1995b);
- City of Fort McMurray lands – AGRA (1995a);
- Transport Canada lands – AGRA (1996b);
- Gunner Mines landing – AGRA (1996); and
- NTCL Waterways site – AMEC (2004a).



Note: PWGSC is Public Works and Government Services Canada

amec		Status Report for the Historic NTR **Fort McMurray Historic Uranium Cleanup Project Study Areas**		
Atomic Energy of Canada Limited				
Drawn: ECW	**Scale:** As shown	**Date:** 12/21/2005	**Project No.:** CE03176	**FIGURE 36**

Executive summaries of these documents are provided in Appendix A.

The site and material categories for the Fort McMurray sites are summarized in Table 19.

Table 19: Fort McMurray Area – Site and Material Categories

Site	Site Category	Material Category Volumes (m^3)[7]		
		L	1	2
NTCL Property[1]	2	0	0	0
PWGSC Lands[3]	2	0	0	0
City of Fort McMurray Lands[4]	2	0	0	0
Transport Canada (Coast Guard Property)[2]	2	0	0	0
Gunnar Mines Landing[5]	2	0	0	0
Waterways Site[6]	2	0	0	0
LTMF[6]	3	0	42,000	0

1 AGRA (1996a)
2 AGRA (1996b)
3 AGRA (1995a, 1995b)
4 AGRA (1995a)
5 AGRA (1996)
6 AMEC (2004a)
7 See Sections 2.1 and 2.2 for category definitions

3.16.3.1 NTCL Lands on Manning Avenue

Cleanup of the NTCL site was initiated in the fall of 1992 when approximately 4,000 m^3 of contaminated soil was consolidated in a warehouse on the property. This work was undertaken to accommodate a scheduled redevelopment of the site. In addition, further radiological investigations were carried out, both on the NTCL site and various associated properties owned by the Canadian Coast Guard Division of Transport Canada (CCG), Public Works and Government Services Canada, the City of Fort McMurray and the Canadian National Railway.

Cleanup work in 1993 at NTCL included:

- excavation, transportation and disposal of Category B soils that had been excavated in 1992 and stored in the warehouse on-site;
- removal and drumming of Category A materials from contaminated areas north of the warehouse;
- decontamination and removal of the warehouse;
- excavation, transportation and disposal of in-situ Category B soils north of and below the warehouse;
- transportation and disposal of contaminated materials generated by the warehouse demolition operation; and
- backfilling of the test trenches excavated during the 1992 site characterization program that were outside of the proposed building footprint.

Initially, the work plan also called for the removal and on-site placement of Category C materials within the footprint of the building that had been planned for the site. However, the development was cancelled before the Category C material was removed. As a result, excavation of any Category C materials was deleted form the scope of work.

Work on the NTCL site in 1994 involved removing additional volumes of Category B material identified during verification program activities.

3.16.3.2 PWGSC Lands

Cleanup activities on PWGSC lands focused on three distinct areas, namely:

- those portions of the former railway right-of-way (ROW) lands between Queen Street and the eastern side of Marshall Street that were owned by PWGSC;
- the PWGSC property on Manning Avenue; and
- PWGSC land east of Alberta Drive and north of Gordon Avenue that was leased at the time to A-Frame Contracting.

Remedial activities were initiated on the former ROW lands in 1993 and completed on the Manning Avenue and A-Frame properties in 1994. In total, approximately 39 tonnes of Category A materials were removed form the PWGSC lands in 197 drums. Just over 7,300 m^3 of Category B materials were also removed and hauled to the LTMF.

3.16.3.3 City of Fort McMurray Lands

Cleanup activities on the City of Fort McMurray lands focused on the following areas, namely:

- Gordon Avenue ROW (between Queen Street and Centennial Street);
- Gordon Avenue ROW (between Alberta Drive and Reidel Street);
- Centennial Street ROW (at Clearwater Rive); and
- the former Canadian National railway ROW (at Marshall Street).

In addition, a fourth City of Fort McMurray property on Manning Avenue (Lot 3, Block 2, Plan 3359) was investigated between 1992 and 1994 and found not to require remediation.

Remedial activities were initiated on the former ROW lands in 1993 and completed on the remaining city properties in 1994. In total, approximately 5 tonnes of Category A materials were removed from the City of Fort McMurray lands in 23 drums. About 2,700 m^3 of Category B materials were also removed and hauled to the LTMF.

3.16.3.4 Transport Canada (Coast Guard) Lands

The bulk of cleanup activity on the Transport Canada (Coast Guard) property was undertaken during October 1994. In total, less than 1 kg of Category A material and about 390 m^3 of Category B material was removed from the CCG lands during the October 1994 cleanup and subsequent verification work completed in the spring of 1995.

3.16.3.5 Gunnar Mines Landing

The former Gunnar Mines Property is bounded by a road allowance/bicycle path along the Clearwater River to the northeast, a bicycle path to the southeast, the former CNR right-of-way to the southwest and Marshall Street to the northwest. The property covers an area of approximately 29,000 m^2.

The bulk of remedial activity on the former Gunnar Mines property was completed over a four-week period starting in late September 1995. A small volume of material was removed in July of 1996 as verification surveys were completed on the site.

In total, about 4,450 m^3 of Category B materials were removed and hauled to the LTMF. The cleanup itself did not generate any Category A materials. A small quantity of Category A material was generated by pre-remedial investigations and post-remedial verification work.

3.16.3.6 Waterways Site

The regulatory status of contaminated soils at the Waterways site changed in 2000 with the promulgation of the *Nuclear Safety and Control Act* (NSCA) and the creation of the Canadian Nuclear Safety Commission (CNSC). Specifically, there was no longer a distinction between the former Category A and B materials. At the same time, it was determined that the LLRWMO's storage facility at Chalk River could not accommodate the comparatively large quantity of material with uranium concentrations above 500 ppm that was expected to be generated at the Waterways site.

In the fall of 2000, discussions were initiated by the LLRWMO with the Regional Municipality of Wood Buffalo about the possibility of developing a local solution to the disposition of all contaminated materials generated by the Waterways site. There was general agreement that it would be appropriate to consider the existing cell at the Fort McMurray landfill as a possible site for the long-term management of these materials. The concept discussed involved placing materials that had previously been intended for Chalk River in a dedicated facility isolated from the environment and other waste materials. The remaining wastes from the Waterways site would, as previously proposed, be directed to the existing cell.

The purpose of the Waterways remediation was to provide for appropriate management of soils contaminated with uranium ores by removing the materials from the CN Waterways site and placing them into the LTMF. Between the fall of 2002 and the summer of 2003, about 11,000 m^3 of soil contaminated with uranium ores was excavated from the site and placed into the LTMF.

3.16.3.7 The Long-Term Management Facility

The contaminated materials excavated from the Lower Town and Waterways sites were transferred into long-term storage at a dedicated management facility constructed at the Fort McMurray landfill site. The Fort McMurray landfill has been in operation since 1975. The site is located approximately 1 km south of Fort McMurray between Highway 63 and the Hangingstone River. The landfill is an operating facility, managed by the Regional Municipality of Wood Buffalo and licensed by the Province of Alberta. The LTMF is located in the extreme northwestern corner of the landfill site. The area of the cell is separated from the remainder of the landfill site by a chain-link security fence. The LTMF is managed, maintained and monitored by the LLRWMO under an agreement made with the City of Fort McMurray (now part of the Regional Municipality of Wood Buffalo) in 1993 (LLRWMO, 1993).

The LTMF design combined waste disposal containment concepts with conventional embankment design approaches. The intent was to develop a stable, secure structure that could be readily monitored and maintained.

The uranium cleanup programs in Fort McMurray between 1992 and 1995 produced about 31,000 m^3 of soil that were directed to the LTMF for storage (AGRA, 1996). The Waterways cleanup program produced another 11,000 m^3 of material, meaning that a total of 42,000 m^3 of Below 500 soils are now stored at the LTMF (AMEC, 2004a).

3.17 Other Potential Sources

3.17.1 NTCL Ships

Ships were used along the NTR to move barges loaded with uranium ore and concentrates (among other materials and supplies). Some vessels also transported cargo on board. Fifteen Radium Series vessels used along the NTR were identified in SENES (1994). Three were determined to have been scrapped, and the disposition of one, the Radium Cruiser, was unknown. Radiological investigations were conducted on the other eleven vessels. Only one, the Radium Gilbert, showed any evidence of contamination.

During meetings in 2000, community representatives identified five additional vessels used on the Great Bear Lake/Great Bear River system. These vessels were the Radium Prince, George Askew, Watson Lake, Horn River and Sandy Jane. Of these, only the Radium Prince was identified in SENES (1994). The status of the other four ships is unknown.

Table 20 is a listing of all known and suspected ships used by the NTR. It has been acknowledged that other vessels may have been used to transport uranium ores along the NTR (LLRWMO, 2000).

Table 20: Disposition of Known Vessels Used Along the NTR

Name	Construction Date	Disposition
Radium King	1937	Museum in Fort Smith – no evidence of contamination
Radium Queen	1937	Scrapped
Radium Lad	1937	Scrapped
Radium Express	1939	Stored in Hay River – no evidence of contamination
Radium Cruiser	1939	Unknown
Radium Prince	1943	Scrapped
Radium Gilbert	1946	Aground near Deline – elevated gamma radiation levels (see Section 3.2)
Radium Charles	1946	Stored in Hay River – no evidence of contamination
Radium Scout	1946	Museum in Ft. McMurray – no evidence of contamination
Radium Yellowknife	1948	Stored in Hay River – no evidence of contamination
Radium Franklin	1951	Stored in Hay River – no evidence of contamination
Radium Dew	1955	Private owner, Hay River – no evidence of contamination
Radium Prospector	1956	Stored in Tuktoyaktuk – no evidence of contamination
Radium Trader	1956	Stored in Tuktoyaktuk – no evidence of contamination
Radium Miner	1956	Stored in Hay River – no evidence of contamination
George Askew	Unknown	Unknown
Watson Lake	Unknown	Hay River
Horn River	Unknown	Hay River
Sandy Jane	Unknown	Unknown
Great Bear	Unknown	Remains of burned hull at Upper Shipyard

3.17.2 NTCL Barges

NTCL used barges to move uranium ore and concentrates, as well as other supplies, to and from the Port Radium mine. Both wooden and steel hulled barges were reportedly used, although no written records on wooden hulled barges were found by SENES (1994).

In the mid 1940s, a series of steel hulled barges were introduced to replace the older wooden barges. The “radium line” steel hulled barges were identified by series number (10, 70, 80, 100, 200, 300, 400, 500, 600 or 700) based on size and load capacity. At least some of the steel hulled barges included wooden decks and superstructures built on top of the steel decks. Several of these wooden decks and superstructures were observed in various states of disrepair on the radium line of barges stored in Hay River. A sampling of 70, 100, 400 and 600 series steel hulled barges were checked for contamination by SENES (1994) and no evidence of contamination was found.

During inspections in July 2000 (LLRWMO, 2000), several radium series barges stored in Hay River were investigated. Some evidence of contamination was found on wooden decked barges, and on one barge with a steel deck. Contamination was found ground into or between wooden deck boards, and loose contamination was found in places where sandy soils had accumulated on hatch covers on one steel deck. Gamma radiation measurements up to 250 µR/h on contact and 20 µR/h at 1 m were found. Two such barges were decontaminated by NTCL. While it is known that some of the radium series barges are contaminated, the number and current disposition of these vessels is not known, although perhaps two dozen were seen in storage in Hay River, and others are known to be in storage in Tuktoyaktuk.

The CNSC sent a letter ([redacted]) to the Nunasi Corporation (one of the current owners of NTCL) indicating that the LLRWMO is responsible for the characterization and, where required, cleanup of the barges. The letter also indicated that Nunasi Corporation must contact the CNSC if they intend to remove any of the superstructures, or scrap or sell any of the barges.

3.17.3 Aircraft

Aircraft were used to fly some uranium ore and concentrates from the Port Radium site and from the airstrip at Sawmill Bay. One aircraft known to haul uranium ore and concentrates was a Bellanca 66-70 Aircruiser C-27 named the “Eldorado Radium Silver Express” registered as CF-AWR (Figure 37). This is the aircraft captured in the Robert W. Bradford painting “The Big Bellanca” as it is being loaded with uranium ore and concentrates in sacks on the ice at Cameron Bay (near Port Radium) during the winter of 1937-38. This aircraft flew from Great Bear Lake to Edmonton for Eldorado during 1936-1939. In 1947 she went down 200 miles northeast of Sioux Lookout, Ontario, and was recovered in 1973 by the Western Canada Aviation Museum in Winnipeg. The museum plans to restore the aircraft.

Figure 37: "The Big Bellanca" by Robert W. Bradford

The airframe stored at the museum was investigated by the LLRWMO in 1995 during Radium Roundup investigations. No surface contamination was found. It is not known if any other aircraft were used to haul ore and concentrates.

3.17.4 Edmonton Municipal Airport and Rail Switching

It is believed that the southern destination for aircraft carrying uranium ore and concentrates from Port Radium and Sawmill Bay was the Edmonton Municipal Airport. There is little documentary evidence of this, and it is not known where on the airport site the ore would have been offloaded. No radiological surveys of potentially impacted sites at the airport have ever been undertaken.

4.0 SUMMARY

From the 1930s to the 1960s, a 2,200 km water transportation network (see Figure 1) was used by the Northern Transportation Company Limited (NTCL) to carry uranium ore and ore concentrates from Port Radium, Northwest Territories on Great Bear Lake to the barge-to-rail transfer point in Fort McMurray, Alberta. From Fort McMurray, the ore was transported by rail car to its final destination in Port Hope, Ontario for refining.

In the summer of 1992, transfer points along the water route were investigated and elevated levels of radioactivity discovered at various sites (SENES, 1994). It was assumed that incidental spillage and tracking during unloading of barges and loading of trucks and railcars were the causes of the contamination.

The objective of this work was to summarize the current status of efforts to identify and manage contamination by uranium ores on these Northern Transportation Route (NTR) sites and/or communities. The status review was to be based on currently available information. This report describes the current status of all those NTR sites and/or communities initially characterized in SENES (1994), excluding the Port Radium and Rayrock mine sites. The current status of each site was characterized by describing how much is known about radiological conditions on the property, its regulatory status and, for those sites that have been surveyed, the nature and distribution of uranium ores.

The findings of the historic NTR status review are summarized on Table 21.

Table 21: Status of Historic NTR Sites at 2005

Site	Site Category	Material Category Volumes (m^3)			Reference(s)
		L	1	2	
Sawmill Bay					
Dock and Wharf Area	4	Removed	60	300	RMC (1997)
Central Lodge Area	4	Removed	80	100	RMC (1997)
Eldorado Airstrip	4	Removed	300	1,000	RMC (1997)
Lodge Airstrip	1	0	0	0	RMC (1997)
Deline					
Deline	1	0	0	0	SENES (1994)
MV Radium Gilbert	1	0	0	0	LLRWMO (2000)
Great Bear River Landing	4	0	5	0	SENES (1994); LLRWMO (2000); Earth Tech (2002)
Great Bear River Sites					
Lower Shipyard	1	0	25	0	AMEC (2004)
Bennett Alternate Landing	1	0	1	0	AMEC (2004)
Road Between Landings	1	0	0	0	AMEC (2004)
Bennett Original Landing	4	2	1,250	100	AMEC (2004)
Bennett Camp					
◆ "Teepee" Area	1	0	10	0	AMEC (2004)
◆ "Reefer" Area	1	0	10	0	AMEC (2004)
◆ "Pink Powder"[2]	1	0	20	0	AMEC (2004)
◆ Roads	1	0	0	200	AMEC (2004)
Road Between Bennett Camp & Airstrip	4	0	100	0	AMEC (2004)
◆ Dump/Storage Compound[2]	5	200	3,000	0	AMEC (2004)
Bennett Airstrip	1	0	1	0	AMEC (2004)
Road Between Airstrip and Upper Wharf	1	1	3	0	AMEC (2004)
Upper Portage Wharf	1	0	3	1	AMEC (2004)
Upper Shipyard	1	0	200	0	SENES (1994)
Tulita					
Bear River Landing	1	0	0	0	SENES (1994)
NTCL Camp	2	0	0	0	SENES (1994); LLRWMO (2000)
Over-winter Storage Site (Yakeleya Property)	2	0	0	0	DeJong (2000e)
Mackenzie River Bank	4	0	100	0	DeJong (2000e)
Tulita Storage Mound	3	0	380	0	LLRWMO (1999 and 2001b)
Middle Mackenzie					
Wrigley	1	0	0	0	SENES (1994)
Fort Simpson	1	0	0	0	SENES (1994)
Jean Marie River	1	0	0	0	SENES (1994)
Cache Island	1	0	0	0	SENES (1994)
Axe Point	1	0	0	0	SENES (1994)

Site	Site Category	Material Category Volumes (m^3)			Reference(s)
		L	1	2	
Fort Providence	1	0	0	0	SENES (1994)
Hay River Area					
Old Fishing Village	1	0	0	0	SENES (1994)
NTCL Dock Area	2	0	0	0	SENES (1994); LLRWMO (2003)
Old Indian Village	4	Removed	550	0	DeJong (1999)
Rae-Edzo Area					
Island Area of Community	1	0	0	0	SENES (1994)
Mainland Area	1	0	0	0	SENES (1994)
Bayrock Barge Loadout Area	1	0	0	0	SENES (1994)
Marian Lake Indian Village	1	0	0	0	SENES (1994)
Yellowknife	1	0	0	0	SENES (1994)
Fort Resolution Area					
Quarry by Airport	1	0	0	0	SENES (1994)
Landings and Beach Areas	2	0	0	0	SENES (1994); DeJong (1995)
Bell Rock Area					
Wharf and Warehouse Area					
◆ Warehouse Floor and Soil	5	0	390	0	AMEC (2005)
◆ Wood Dump	4	0	10	0	AMEC (2005)
Slipways and Maintenance Camp Area					
◆ "A" at Bush	4	0	180	0	AMEC (2005); DeJong (2000a)
◆ "B Handling	5	0	540	0	AMEC (2005); DeJong (2000a)
◆ "C" Handling	5	0	1,140	0	AMEC (2005); DeJong (2000a)
◆ "D" Handling	5	0	120	0	AMEC (2005); DeJong (2000a)
◆ Garage Floor	4	0	100	0	AMEC (2005); DeJong (2000a)
Haul Road to Fort Smith	1	0	0	0	AMEC (2005)
Fort Smith Area					
Former NTCL Warehouse	1	0	0	0	LLRWMO (2000a)
Peregrine St. Road Bed	4	0	100	0	LLRWMO (2001d)
Portage Ave. Property	1	0	0	0	LLRWMO (2001d)
In-Town Haul Roads	1	0	0	0	AMEC (2005)
Barge Debris	6	–	–	–	–
Nuisance Grounds (Fort Smith Storage Facility)	3	0	225	0	LLRWMO (2001d)
Fort Smith to Fort Fitzgerald Portage Routes					
NTCL Portage	1	0	0	0	AMEC (2005)
HBC Portage	1	0	0	0	AMEC (2005)
Halfway House	4	0	80	0	AMEC (2005)

Site	Site Category	Material Category Volumes (m^3)			Reference(s)
		L	1	2	
Fort Fitzgerald Area					
NTCL Marine Terminal	5	200	4,100	0	AMEC (2005)
Fort Fitzgerald Roads	4	80	90	0	AMEC (2005)
Fort Fitzgerald Lands	5	10	1,960	0	AMEC (2005)
Fort Chipewyan Area					
Government Dock and Beach	1	0	0	0	SENES (1994)
Little Island, Fraser Point	1	0	0	0	SENES (1994)
Uranium City Houses	1	0	0	0	SENES (1994); DeJong (2000d)
Fort MacKay	1	0	0	0	SENES (1994)
Fort McMurray Area					
NTCL Property	2	0	0	0	AGRA (1996a)
PWGSC Lands	2	0	0	0	AGRA (1995a, 1995b)
City of Fort McMurray Lands	2	0	0	0	AGRA (1995a)
Transport Canada (Coast Guard Property)	2	0	0	0	AGRA (1996b)
Gunnar Mines Landing	2	0	0	0	AGRA (1996)
Waterways Site	2	0	0	0	AGRA (1996)
LTMF	3	0	42,000	0	AMEC (2004a)
TOTALS		**493**	**57,133**	**1,701**	

Site Categories

- *Category 1* – The site has been adequately assessed and the need for any future site management (by way of remediation or regulatory oversight by the CNSC) has been discounted;
- *Category 2* – Soil contamination and/or waste stockpiles have been removed from the property and additional site management is not required;
- *Category 3* – Soil contamination and/or waste stockpiles will be maintained on the site under an existing regulatory instrument;
- *Category 4* – Soil contamination and/or waste stockpiles are present on-site and available site assessment data is sufficient to define future site management requirements. Decisions regarding future site management are pending;
- *Category 5* – Soil contamination and/or waste stockpiles are present on-site and additional site assessments are required to define future site management requirements; and
- *Category 6* – The site has not been surveyed.

Material Categories

- *Category L* – areas which contain ores of a type and/or density that would require a license under the Nuclear Substances and Radiation Devices Regulations (including proposed amendments) of the Nuclear Safety and Control Act (CNSC, 2005) (i.e., areas containing licensable materials);
- *Category 1* – areas which do not contain licensable materials, but in which the density of uranium ore accumulations is very likely incompatible with unrestricted use of the lands;
- *Category 2* – areas which do not contain licensable materials, but in which the density of uranium ore accumulations is potentially incompatible with unrestricted use of the lands; and
- *Category 3* – areas which show no evidence of ore contamination, or in which the density of uranium ore accumulations is unlikely to create any restrictions on use of the lands.

5.0 CLOSURE

The American Society for Testing and Materials Standard of Practice notes that no environmental site assessment can wholly eliminate uncertainty regarding the potential for recognized environmental conditions in connection with a property. Performance of a standardized environmental site assessment protocol is intended to reduce, but not eliminate, uncertainty regarding the potential for recognized environmental conditions in connection with the property, given reasonable limits of time and cost.

This report has been prepared for the exclusive use of Atomic Energy of Canada Limited (AECL) and authorized users for specific application to this project site. The environmental investigation was conducted in accordance with the proposed work scope prepared for this site, verbal and written requests from the AECL, and generally accepted assessment practices. No other warranty, expressed or implied, is made. The general limitations of this report are specified in Appendix B.

Respectfully submitted,

AMEC Earth & Environmental *Reviewed by:*

[redacted]

[redacted]

[redacted]

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Appendix A

Reference Document Executive Summaries

REMEDIATION OF URANIUM CONTAMINATED SOILS ON THE CITY OF FORT MCMURRAY LANDS DURING 1993 AND 1994

Submitted To:

The Low-Level Radioactive Waste Management Office,
Atomic Energy of Canada Limited

Submitted By:

AGRA Earth & Environmental Limited

Calgary, Alberta

November 1995

CC00431

EXECUTIVE SUMMARY

Background

Beginning in the 1930s, uranium ore and uranium concentrates were shipped by barge from the Port Radium mine on Great Bear Lake via a system of lakes and rivers to various points in Fort McMurray, Alberta. From there, the ore and concentrates were shipped by rail to the Eldorado Refinery in Port Hope, Ontario. During the summer of 1992, the Low Level Radioactive Waste Management Office (LLRWMO) of Atomic Energy of Canada Limited, started investigating transfer points along the water route from Port Radium to Fort McMurray. The LLRWMO was conducting this work as part of its mandate to address the Canadian government's responsibilities relating to the management and resolution of historic low level radioactive waste problems. During these surveys, elevated levels of radioactivity were found at various sites owned by the City of Fort McMurray. It was suspected that these levels were the result of spillage of uranium ores and concentrates that had occurred while handling materials destined for the Port Hope refinery.

In 1993, a working group comprised of various stakeholders was established to guide the development and implementation of remediation plans for the City of Fort McMurray sites and other properties in Fort McMurray. In addition, detailed work plans were developed, contaminated materials characterized and classified and cleanup criteria developed.

Remediation Program Scope

The remediation program provided for cleanup of City of Fort McMurray lands by removing soils and other materials contaminated with uranium. Soils and materials with concentrations above 500 ppm uranium were shipped in sealed drums to a storage facility operated by the LLRWMO at Chalk River, Ontario. Soils and materials exceeding any of the project cleanup criteria but less than 500 ppm uranium were shipped by truck to a specially constructed cell at the Beacon Hill Sanitary Landfill (operated by the City of Ft. McMurray).

The materials on the sites were classified as follows:

Category A Materials: Materials that exhibited a uranium concentration at or above 500 ppm and therefore required a licence from the Atomic Energy Control Board (AECB). This was mainly uranium ore.

Category B Materials: Materials that exhibited a uranium concentration less than 500 ppm but above one or more of the cleanup criteria for uranium (30 ppm), arsenic (30 ppm) or radium-226 (0.1 Bq/g). This was mainly mildly contaminated soil with an average uranium concentration that had been estimated at 50 ppm or less. It was defined and treated as industrial waste.

Category C Materials: Materials that, on average, did not exceed any of the cleanup criteria for uranium, arsenic or radium-226, but might have contained occasional rocks with elevated amounts of one or more of these elements.

Cleanup activities on the City of Fort McMurray lands focussed on the following areas, namely:

- Gordon Avenue Right-of-Way (between Queen St. and Centennial Street);

- Gordon Avenue Right-of-Way (between Alberta Drive and Reidel Street);
- Centennial Street Right-of-Way (at Clearwater Drive); and
- Former Canadian National Railway Right-of-Way (at Marshall St.).

In addition, a fourth City of Fort McMurray property on Manning Avenue (Lot 3, Block 2, Plan 3359) was investigated between 1992 and 1994 and found not to require remediation.

Remedial activities were initiated on the former ROW lands in 1993 and completed on the remaining City properties in 1994.

In total, approximately 5 tonnes of Category A materials were removed from the City of Fort McMurray lands in 23 drums. About 2,700 m^3 (5,500 tonnes) of Category B materials were also removed and hauled to the Beacon Hill Landfill disposal cell.

Regulatory Issues

Early in the project planning process, discussions with various stakeholders were initiated to clarify the regulatory status of the program (eg. Alberta Environmental Protection, Alberta Health, the Fort McMurray and District Health Unit, the City of Fort McMurray and the Atomic Energy Control Board). As a result of these discussions it was agreed that the local health unit, namely the Fort McMurray and District Health Unit, would assume the role as primary project regulator while the AECB would be the regulator for licensable (i.e. Category A) materials.

Contamination Control

A program of environmental monitoring and personnel training and control was implemented to ensure that the health and safety of workers and the public, and the condition of environmental media were protected during execution of the cleanup. Contamination control measures were based on the premise that exposures should not only be below regulatory limits but should adhere to the ALARA (as low as reasonably achievable) principle. Engineered measures were implemented to provide such control, including site access restrictions, personnel monitoring and equipment, and continuous monitoring of environmental impacts. Monitoring of ambient gamma radiation, ambient radon, long lived alpha in air and total airborne particulates indicated that the control measures were effective in satisfying the ALARA objective.

Verification Program

A comprehensive verification program approved by the Fort McMurray and district Health Unit was undertaken by the LLRWMO on all of the City of Fort McMurray lands. The program concluded that no exceedences of the cleanup criteria established for the Fort McMurray Historic Uranium Cleanup Project remained following verification activities.

Backfilling and Reclamation

Once the verification program had confirmed that properties satisfied the project cleanup criteria, completed excavations were cleared for backfilling and reclamation. This involved importing fine grained subsoils, compacting to a specified density and covering with a 100 mm layer of imported topsoil. Finished surfaces were then seeded.

REMEDIATION OF URANIUM CONTAMINATED SOILS ON PUBLIC WORKS AND GOVERNMENT SERVICES CANADA LANDS IN FORT MCMURRAY, ALBERTA DURING 1993 AND 1994

Submitted To:

The Low-Level Radioactive Waste Management Office,
Atomic Energy of Canada Limited

Submitted By:

AGRA Earth & Environmental Limited

Calgary, Alberta

March, 1995

CC00407

EXECUTIVE SUMMARY

Background

Beginning in the 1930s, uranium ore and uranium concentrates were shipped by barge from the Port Radium mine on Great Bear Lake via a system of lakes and rivers to various points in Fort McMurray, Alberta. From there, the ore and concentrates were shipped by rail to the Eldorado Refinery in Port Hope, Ontario. During the summer of 1992, the Low Level Radioactive Waste Management Office (LLRWMO) of Atomic Energy of Canada Limited, started investigating transfer points along the water route from Port Radium to Fort McMurray. The LLRWMO was conducting this work as part of its mandate to address the Canadian government's responsibilities relating to the management and resolution of historic low level radioactive waste problems. During these surveys, elevated levels of radioactivity were found at various sites in Fort McMurray owned by Public Works and Government Services Canada (PWGSC). It was suspected that these levels were the result of spillage of uranium ores and concentrates that had occurred while handling materials destined for the Port Hope refinery.

In 1993, a working group comprised of various stakeholders was established to guide the development and implementation of remediation plans for the PWGSC sites and other properties in Fort McMurray. In addition, detailed work plans were developed, contaminated materials characterized and classified and cleanup criteria developed.

Remediation Program Scope

The remediation program provided for cleanup of PWGSC lands by removing soils and other materials contaminated with uranium. Soils and materials with concentrations above 500 ppm uranium were shipped in sealed drums to a storage facility operated by the LLRWMO at Chalk River, Ontario. Soils and materials exceeding any of the project cleanup criteria but less than 500 ppm were shipped by truck to a specially constructed cell at the Beacon Hill Sanitary Landfill (operated by the City of Ft. McMurray).

The materials on the sites were classified as follows:

Category A Materials: Materials that exhibited a uranium concentration at or above 500 ppm and therefore required a licence from the Atomic Energy Control Board (AECB). This was mainly uranium ore.

Category B Materials: Materials that exhibited a uranium concentration less than 500 ppm but above one or more of the cleanup criteria for uranium (30 ppm), arsenic (30 ppm) or radium-226 (0.1 Bq/g). This was mainly mildly contaminated soil with an average uranium concentration that had been estimated at 50 ppm or less. It was defined and treated as industrial waste.

Category C Materials: Materials that, on average, did not exceed any of the cleanup criteria for uranium, arsenic or radium-226, but might have contained occasional rocks with elevated amounts of one or more of these elements.

Cleanup activities on PWGSC lands focussed on three distinct areas, namely:

- those portions of the former railway right-of-way (ROW) lands between Queen Street and the eastern side of Marshall street that are owned by PWGSC (primarily Lot 1, Block 1 of Plan 3359);

- the PWGSC property on Manning Avenue (Lot 1, Block 1 of Plan 7518 and Lot 7, Block 2 of Plan 8722837); and

- PWGSC land east of Alberta Drive and north of Gordon Avenue that is leased to A Frame Contracting (Lot 5, Block 2 of Plan 8722837).

Remedial activities were initiated on the former ROW lands in 1993 and completed on the Manning Avenue and A-Frame properties in 1994.

In total, approximately 39 tonnes of Category A materials were removed from the PWGSC lands in 197 drums. Just over 7,300 m^3 (15,000 tonnes) of Category B materials were also removed and hauled to the Beacon Hill Landfill disposal cell.

Regulatory Issues

Early in the project planning process, discussions with various stakeholders were initiated to clarify the regulatory status of the program (eg. Alberta Environmental Protection, Alberta Health, the Fort McMurray and District Health Unit, the City of Fort McMurray and the Atomic Energy Control Board). As a result of these discussions it was agreed that the local health unit, namely the Fort McMurray and District Health Unit, would assume the role as primary project regulator while the AECB would be the regulator for licensable (i.e. Category A) materials.

Contamination Control

A program of environmental monitoring and personnel training and control was implemented to ensure that the health and safety of workers and the public, and the condition of environmental media were protected during execution of the cleanup. Contamination control measures were based on the premise that exposures should not only be below regulatory limits but should adhere to the ALARA (as low as reasonably achievable) principle. Engineered measures were implemented to provide such control, including site access restrictions, personnel monitoring and equipment, and continuous monitoring of environmental impacts. Monitoring of ambient gamma radiation, ambient radon, long lived alpha in air and total airborne particulates indicated that the control measures were effective in satisfying the ALARA objective.

Verification Program

A comprehensive verification program approved by the Fort McMurray and district Health Unit 2was undertaken by the LLRWMO on all of the PWGSC lands. The program concluded that no exceedences of the cleanup criteria established for the Fort McMurray Historic Uranium Cleanup Project remained following verification activities.

Backfilling and Reclamation

Once the verification program had confirmed that properties satisfied the project cleanup criteria, completed excavations were cleared for backfilling and reclamation. For most of the PWGSC lands, this involved importing fine grained subsoils, compacting to a specified density and covering with a 100 mm layer of imported topsoil. Finished surfaces were then seeded.

REMEDIATION OF URANIUM CONTAMINATED SOILS ON THE FORMER GUNNAR MINES PROPERTY

Submitted To:

The Low-Level Radioactive Waste Management Office,
Atomic Energy of Canada Limited

Submitted By:

AGRA Earth & Environmental Limited

Calgary, Alberta

October 1996

CC00684

EXECUTIVE SUMMARY

Background

Beginning in the 1930s, uranium ore and uranium concentrates were shipped by barge from the Port Radium mine on Great Bear Lake via a system of lakes and rivers to various points in Fort McMurray, Alberta. From there, the ore and concentrates were shipped by rail to the Eldorado Refinery in Port Hope, Ontario. During the summer of 1992, the Low Level Radioactive Waste Management Office (LLRWMO) of Atomic Energy of Canada Limited, started investigating transfer points along the water route from Port Radium to Fort McMurray. The LLRWMO was conducting this work as part of its mandate to address the Canadian government's responsibilities relating to the management and resolution of historic low level radioactive waste problems. During these surveys, elevated levels of radioactivity were found at the former Gunnar Mines property in the City of Fort McMurray. It was suspected that these levels were the result of spillage of uranium ores and concentrates that had occurred while handling materials destined for the Port Hope refinery.

In 1993, a working group comprised of various stakeholders was established to guide the development and implementation of remediation plans for various sites in Fort McMurray, including the former Gunnar Mines property. In addition, detailed work plans were developed, contaminated materials characterized and classified and cleanup criteria developed.

Remediation Program Scope

The remediation program provided for cleanup of the former Gunnar Mines property by removing soils and other materials contaminated with uranium. Soils and materials with concentrations above 500 ppm uranium were shipped in sealed drums to a storage facility operated by the LLRWMO at Chalk River, Ontario. Soils and materials exceeding any of the project cleanup criteria but less than 500 ppm uranium were shipped by truck to a specially constructed cell at the Beacon Hill Sanitary Landfill (operated by the City of Ft. McMurray).

The materials on the site were classified as follows:

Category A Materials: Materials that exhibited a uranium concentration at or above 500 ppm and therefore required a licence from the Atomic Energy Control Board (AECB). This was mainly uranium ore.

Category B Materials: Materials that exhibited a uranium concentration less than 500 ppm but above one or more of the cleanup criteria for uranium (30 ppm), arsenic (30 ppm) or radium-226 (0.1 Bq/g). This was mainly mildly contaminated soil with an average uranium concentration that had been estimated at 50 ppm or less. It was defined and treated as industrial waste.

Category C Materials: Materials that, on average, did not exceed any of the cleanup criteria for uranium, arsenic or radium-226, but might have contained occasional rocks with elevated amounts of one or more of these elements.

The former Gunnar Mines Property is located in the Lower Town area of Fort McMurray. The site is bounded by a road allowance/bicycle path along the Clearwater River to the northeast, a bicycle

path to the southeast, the former CNR right-of-way to the southwest and Marshall Street to the northwest. The property covers an area of approximately 29,000 m^2.

The bulk of remedial activity on the former Gunnar Mines property was completed over a four week period starting in late September, 1995. A small volume of material was removed in July of 1996 as verification surveys were completed on the site.

In total, about 4,450 m^3 (9,300 tonnes) of Category B materials were removed and hauled to the Beacon Hill Landfill disposal cell. The cleanup itself did not generate any Category A materials. A small quantity of Category A material was generated by pre-remedial investigations and post-remedial verification work.

Regulatory Issues

Early in the project planning process, discussions with various stakeholders were initiated to clarify the regulatory status of the program (eg. Alberta Environmental Protection, Alberta Health, the Northern Lights Regional Health Authority, the City of Fort McMurray and the Atomic Energy Control Board). As a result of these discussions it was agreed that the local health unit, namely the Northern Lights Regional Health Authority, would assume the role as primary project regulator while the AECB would be the regulator for licensable (i.e. Category A) materials.

Contamination Control

A program of environmental monitoring and personnel training and control was implemented to ensure that the health and safety of workers and the public, and the condition of environmental media were protected during execution of the cleanup. Contamination control measures were based on the premise that exposures should not only be below regulatory limits but should adhere to the ALARA (as low as reasonably achievable) principle. Engineered measures were implemented to provide such control, including site access restrictions, personnel monitoring and equipment and continuous monitoring of environmental impacts. Monitoring of ambient gamma radiation, ambient radon, long lived alpha in air and total airborne particulates indicated that the control measures were effective in satisfying the ALARA objective.

Verification Program

A comprehensive verification program approved by the Northern Lights Regional Health Authority was undertaken by the LLRWMO on the former Gunnar Mines property. The program concluded that no exceedances of the cleanup criteria established for the Fort McMurray Historic Uranium Cleanup Project remained following verification activities.

Backfilling and Reclamation

The site was backfilled in areas after the completion of the verification survey to establish finished grades compatible with the current land use. Backfill material was either hauled from the Contractor's yard or from the Poplar Creek gravel pit. In areas by the property line, clay material which had been excavated from the disposal cell subgrade was used for backfilling.

REMEDIATION OF URANIUM CONTAMINATED SOILS ON NORTHERN TRANSPORTATION COMPANY LIMITED LANDS IN FORT MCMURRAY, ALBERTA

Submitted To:

The Low-Level Radioactive Waste Management Office,
Atomic Energy of Canada Limited

Submitted By:

AGRA Earth & Environmental Limited

Calgary, Alberta

May 1996

CC00234/4000

EXECUTIVE SUMMARY

Background

Beginning in the 1930s, uranium ore and uranium concentrates were shipped by barge from the Port Radium mine on Great Bear Lake via a system of lakes and rivers to various points in Fort McMurray, Alberta. From there, the ore and concentrates were shipped by rail to the Eldorado Refinery in Port Hope, Ontario. During the summer of 1992, the Low Level Radioactive Waste Management Office (LLRWMO) of Atomic Energy of Canada Limited, started investigating transfer points along the water route from Port Radium to Fort McMurray. The LLRWMO was conducting this work as part of its mandate to address the Canadian government's responsibilities relating to the management and resolution of historic low level radioactive waste problems. During these surveys, elevated levels of radioactivity were found at a site in Fort McMurray owned by the Northern Transportation Company Limited (NTCL). It was suspected that these levels resulted from the spillage of uranium ores and concentrates that had occurred at the NTCL site while handling materials destined for the Port Hope refinery.

In 1993, a working group comprised of various stakeholders was established to guide the development and implementation of remediation plans for the NTCL site and other properties in Fort McMurray. In addition, detailed work plans were developed, contaminated materials characterized and classified and cleanup criteria developed.

Remediation Program Scope

The remediation program provided for cleanup of NTCL lands by removing soils and other materials contaminated with uranium. Soils and materials with concentrations above 500 ppm uranium were shipped to a storage facility operated by the LLRWMO at Chalk River, Ontario. Soils and materials exceeding any of the project cleanup criteria but less than 500 ppm uranium were shipped by truck to a specially constructed cell at the Beacon Hill Sanitary Landfill (operated by the City of Ft. McMurray).

The materials on the site were classified as follows:

Category A Materials: Materials that exhibited a uranium concentration at or above 500 ppm and therefore required a licence from the Atomic Energy Control Board (AECB). This was mainly uranium ore.

Category B Materials: Materials that exhibited a uranium concentration less than 500 ppm but above one or more of the cleanup criteria for uranium (30 ppm), arsenic (30 ppm) or radium-226 (0.1 Bq/g). This was mainly mildly contaminated soil with an average uranium concentration that had been estimated at 50 ppm or less. It was defined and treated as industrial waste.

Category C Materials: Materials that, on average, did not exceed any of the cleanup criteria for uranium, arsenic or radium-226, but might have contained occasional rocks with elevated amounts of one or more of these elements.

The bulk of cleanup activity on the NTCL property was undertaken during the spring of 1993. A comparatively modest remedial program was completed in 1994 to address materials identified by verification activities. In total, approximately 17 tonnes of Category A material and about 16,000 m^3 (33,000 tonnes) of Category B materials were removed from the NTCL lands.

Regulatory Issues

Early in the project planning process, discussions with various stakeholders were initiated to clarify the regulatory status of the program (eg. Alberta Environmental Protection, Alberta Health, the Fort McMurray and District Health Unit, the City of Fort McMurray and the Atomic Energy Control Board). As a result of these discussions it was agreed that the local health unit, namely the Fort McMurray and District Health Unit, would assume the role as primary project regulator while the AECB would be the regulator for licensable (i.e. Category A) materials.

Contamination Control

A program of environmental monitoring and personnel training and control was implemented to ensure that the health and safety of workers and the public, and the condition of environmental media were protected during execution of the cleanup. Contamination control measures were based on the premise that exposures should not only be below regulatory limits but should adhere to the ALARA (as low as reasonably achievable) principle. Engineered measures were implemented to provide such control, including site access restrictions, personnel monitoring and equipment, and continuous monitoring of environmental impacts. Monitoring of ambient gamma radiation, ambient radon, long lived alpha in air and total airborne particulates indicated that the control measures were effective in satisfying the ALARA objective.

Verification Program

A comprehensive verification program approved by the Fort McMurray and District Health Unit was undertaken by the LLRWMO on the NTCL property. The program concluded that no exceedances of the cleanup criteria established for the Fort McMurray Historic Uranium Cleanup Project remained following verification activities.

REMEDIATION OF URANIUM CONTAMINATED SOILS ON TRANSPORT CANADA (CANADIAN COAST GUARD DIVISION) LANDS IN FORT MCMURRAY, ALBERTA

Submitted To:

The Low-Level Radioactive Waste Management Office,
Atomic Energy of Canada Limited

Submitted By:

AGRA Earth & Environmental Limited

Calgary, Alberta

April, 1996

CC00408

EXECUTIVE SUMMARY

Background

Beginning in the 1930s, uranium ore and uranium concentrates were shipped by barge from the Port Radium mine on Great Bear Lake via a system of lakes and rivers to various points in Fort McMurray, Alberta. From there, the ore and concentrates were shipped by rail to the Eldorado Refinery in Port Hope, Ontario. During the summer of 1992, the Low Level Radioactive Waste Management Office (LLRWMO) of Atomic Energy of Canada Limited, started investigating transfer points along the water route from Port Radium to Fort McMurray. The LLRWMO was conducting this work as part of its mandate to address the Canadian government's responsibilities relating to the management and resolution of historic low level radioactive waste problems. During these surveys, elevated levels of radioactivity were found at a site in Fort McMurray owned by Transport Canada (Canadian Coast Guard Division). The site was once part of a larger Northern Transportation Company Limited (NTCL) property in the area. It was suspected that these levels were the result of spillage of uranium ores and concentrates that had occurred at the NTCL site while handling materials destined for the Port Hope refinery.

In 1993, a working group comprised of various stakeholders was established to guide the development and implementation of remediation plans for the Canadian Coast Guard (CCG) site and other properties in Fort McMurray. In addition, detailed work plans were developed, contaminated materials characterized and classified and cleanup criteria developed.

Remediation Program Scope

The remediation program provided for cleanup of CCG lands by removing soils and other materials contaminated with uranium. Soils and materials with concentrations above 500 ppm uranium were shipped to a storage facility operated by the LLRWMO at Chalk River, Ontario. Soils and materials exceeding any of the project cleanup criteria but less than 500 ppm uranium were shipped by truck to a specially constructed cell at the Beacon Hill Sanitary Landfill (operated by the City of Ft. McMurray).

The materials on the sites were classified as follows:

Category A Materials: Materials that exhibited a uranium concentration at or above 500 ppm and therefore required a licence from the Atomic Energy Control Board (AECB). This was mainly uranium ore.

Category B Materials: Materials that exhibited a uranium concentration less than 500 ppm but above one or more of the cleanup criteria for uranium (30 ppm), arsenic (30 ppm) or radium-226 (0.1 Bq/g). This was mainly mildly contaminated soil with an average uranium concentration that had been estimated at 50 ppm or less. It was defined and treated as industrial waste.

Category C Materials: Materials that, on average, did not exceed any of the cleanup criteria for uranium, arsenic or radium-226, but might have contained occasional rocks with elevated amounts of one or more of these elements.

The bulk of cleanup activity on the CCG property was undertaken during October, 1994. In total, less than one kilogram of Category A material and about 391 m^3 (782 tonnes) of Category B materials were removed from the CCG lands during the October, 1994 cleanup and subsequent verification work completed in the spring of 1995.

Regulatory Issues

Early in the project planning process, discussions with various stakeholders were initiated to clarify the regulatory status of the program (eg. Alberta Environmental Protection, Alberta Health, the Fort McMurray and District Health Unit, the City of Fort McMurray and the Atomic Energy Control Board). As a result of these discussions it was agreed that the local health unit, namely the Fort McMurray and District Health Unit, would assume the role as primary project regulator while the AECB would be the regulator for licensable (i.e. Category A) materials.

Contamination Control

A program of environmental monitoring and personnel training and control was implemented to ensure that the health and safety of workers and the public, and the condition of environmental media were protected during execution of the cleanup. Contamination control measures were based on the premise that exposures should not only be below regulatory limits but should adhere to the ALARA (as low as reasonably achievable) principle. Engineered measures were implemented to provide such control, including site access restrictions, personnel monitoring and equipment, and continuous monitoring of environmental impacts. Monitoring of ambient gamma radiation, ambient radon, long lived alpha in air and total airborne particulates indicated that the control measures were effective in satisfying the ALARA objective.

Verification Program

A comprehensive verification program approved by the Fort McMurray and District Health Unit was undertaken by the LLRWMO on the CCG property. The program concluded that no exceedances of the cleanup criteria established for the Fort McMurray Historic Uranium Cleanup Project remained following verification activities.

Backfilling and Reclamation

Completed excavations were reclaimed by importing fine grained subsoils, compacting to a specified density and covering with a 100 mm layer of imported topsoil. Finished surfaces were then seeded.

CHARACTERIZATION OF NTR SITES UNDER INSTITUTIONAL CONTROLS

Submitted to:

Canadian Nuclear Safety Commission
Ottawa, Ontario

Submitted by:

AMEC Earth & Environmental
a division of AMEC Americas Limited
Calgary, Alberta

February 2004

CE02731/3000

EXECUTIVE SUMMARY

Since 1992, the Atomic Energy Control Board (AECB) (now the Canadian Nuclear Safety Commission [CNSC]) has been aware of the existence of approximately 30 sites that were potentially contaminated during the transportation of uranium ore from the mine at Port Radium, Northwest Territories (NWT) to the railhead at Fort McMurray, Alberta. The sites were located in populated areas and were, over the course of 10 years, remediated under license where required. With the coming into force of the *Nuclear Safety and Control Act* (*NSCA*), 12 sites required some form of regulatory control. All of these remaining sites were located along the Great Bear River, which drains Great Bear Lake to the Mackenzie River. The information available to Canadian Nuclear Safety Commission (CNSC) staff indicated that some elevated gamma radiation levels had been observed on site visits to these remote areas. Based on the potential for public health risks if the sites are developed, CNSC staff put in place institutional controls requiring the cooperation of other federal government agencies and the local First Nations bands. These were reported to the Commission in CMD 01-M78 and an exemption from licensing the possession, management and storage of nuclear substances at these sites was granted. One of the conditions of granting the exemption was that CNSC staff would report on the status of the sites every five years.

This document describes the program undertaken to assemble the characterization information necessary to satisfy this reporting obligation and to present that information to the public.

PROJECT OBJECTIVES

The objectives of the project were to obtain radiological characteristics of Northern Transportation Route (NTR) sites currently being regulated through institutional controls due to potential contamination, and to assist CNSC staff with communicating the draft results of the investigation to the local population.

FIELD PROGRAM

The field program required to assemble the radiological characteristics of the Great Bear River sites was conducted between July 20 and 28, 2003. The field program involved:

- establishing a base camp at the Bennett Airstrip to support a field crew comprised of AMEC Earth & Environmental (AMEC) staff (two) and guides/outfitters (three) from Deline and Tulita;
- recording gamma radiation levels 1 m above ground surface over a 10 m x 10 m grid (approximately) at all the subject sites;

- locating each of the gamma radiation readings using a Trimble Pathfinder Power Global Positioning System (GPS) that included a TSC1 data logger and Asset Surveyor software; and
- collecting 13 soil samples from representative site areas (some of which exhibited elevated gamma radiation levels) and four water samples from creeks or standing water traversing the subject sites.

DATA COMPILATION AND INTERPRETATION

The gamma radiation readings were plotted on aerial photographs of each site, then categorized and interpreted as follows (SENES, 2002).

Gamma Radiation	Interpretation
<20 µR/h	Typical upper range of exposure level from terrestrial sources
20-50 µR/h	Common levels in areas of natural mineralization
50-100 µR/h	Exposure levels that are relatively rare for natural conditions
100-250 µR/h	Values used in some instances to indicate that remediation actions could be considered, depending on the circumstances
>250 µR/h	Used in some instances as a trigger for remediation actions

Soil and water testing results were compared to guidelines published by the Canadian Council of Ministers of the Environment (CCME, 2002).

FINDINGS AND CONCLUSIONS

Summary of Findings

The findings of the Great Bear NTR sites characterization program are summarized in Table E1. The table also describes the significance of the results and the associated implications for the future management of the properties. The concluding comments in Table E1 are based on the application of the interpretive categories described above to the body of gamma radiation data available for each site.

Gamma Radiation Category Breakdowns and Survey Conclusions

The breakdown of gamma radiation levels by site and category is shown in Table E2. The table shows that gamma radiation levels are very low throughout eight of the ten sites. The CNSC uses a risk-based approach to regulating these sites. Under current and any likely future land uses, it would appear that no unreasonable radiological risk exists at these eight sites. This suggests that institutional controls are probably not needed for these eight properties. Gamma radiation levels at some locations on the Bennett Original Landing and the road between the Bennett Camp and Airstrip are elevated to levels that will likely require the maintenance of institutional controls.

PUBLIC INFORMATION SESSIONS

The public information sessions conducted as part of the project scope followed from the CNSC's commitment to provide local communities with additional information relating to the condition of the subject sites. Information sessions were held at the following times and locations:

- Tulita – November 18, 2003 from 11:00 am to 6:00 pm at the Band Hall; and
- Deline – November 19, 2003 from 11:00 am to 6:00 pm at the Deline Cultural Center.

At each session, the conduct and findings of the radiological survey were described on a series of fifteen 600 mm x 1,000 mm poster boards. Introductory boards describing the project scope and survey methods were followed by separate boards presenting results for each individual site. Two final boards described the water sampling data and summarized the survey findings.

Attendees arriving at the sessions were asked to sign a visitors register and given a brief introduction to the poster board layout and content. Staff from the CNSC (Ron Stenson and Jocelyne Martin) and AMEC (Brian Geddes and Jim Ross) then responded one-on-one to any inquiries from the attendees as they reviewed the boards. A total of 19 people attended the Tulita information session and 23 the Deline session. In addition, brief one-on-one meetings were held prior to the sessions, with Chief Frank Andrew in Tulita and Chief Raymond Tutcho in Deline.

In general terms, the public response to the information provided was similar in both communities. Many attendees were aware of the basic issues and had personal knowledge of, and experience with, at least some of the sites. A number of the attendee's questions related to the gamma radiation levels at specific locations that individuals were familiar with. During the one-on-one discussions, most attendees appeared to understand and acknowledge the study findings without offering strongly negative or positive comment. Those attendees expressing interest in the future management of the sites seemed to accept the rationale for considering the removal of institutional controls for most of the properties.

Table E1: Conclusions by Site

Site	Site History/Description	Survey Results	Significance of Results
Lower Shipyard	• Used primarily to over-winter barges. • Contains the burned remains of two wooden barges that hauled goods between Tulita and the Bennett Camp. • Remains of maintenance buildings are located in dense bush inland and east of the original shipways. • Former road from the shipyard to Bennett Camp is now overgrown and impassible.	• 363 gamma radiation readings taken over a 4.01 ha area. • Five of these readings (or 1.3%) were above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 32 µR/h. • The elevated readings were associated with the barge remains on the site.	• The vast majority of the site exhibits gamma radiation readings indistinguishable from background. • A small portion of the site near the wooden barge remains exhibits slightly elevated gamma radiation levels. • The gamma radiation levels observed do not require restrictions on the current use of the lands.
Bennett Alternate Landing	• Used in the later years of operation as a landing for barges. • Has been almost obliterated by spring flooding. • Few wooden remains of the wharf structure are visible. • Built up truck turning area is well defined by sloughs.	• 345 gamma radiation readings taken over a 1.32 ha area. • One of these readings was above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 22 µR/h. • The elevated reading was located near the access road entry.	• The vast majority of the site exhibits gamma radiation readings indistinguishable from background. • A small portion of the site near the access road entry exhibits a slightly elevated gamma radiation level. • The gamma radiation levels observed do not require restrictions on the current use of the lands.
Road Between Bennett Alternate and Original Landings	• This 1.4 km road was used during the later years of operation. • Built due to the necessity of annual rebuilding of the original landing wharf. • Remains are strewn with boulders left by regular flooding of the area.	• 214 gamma radiation readings taken over a 2.34 ha area. • None of these readings was above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 16 µR/h.	• The site exhibits gamma radiation readings that are largely indistinguishable from background. • The gamma radiation levels observed do not require restrictions on the current use of the lands.
Bennett Original Landing	• Provided river access/landing area for Bennett Camp. • Spring ice damage often made reconstruction necessary. • Large boulders and a depression along the bank mark the location from the river. • Submerged timbers are all that remain of the wharf.	• 810 gamma radiation readings taken over a 2.7 ha area. • 24 (3%) of these readings were above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 195 µR/h. • The elevated readings were clustered near the centre of the site.	• The vast majority of the site exhibits gamma radiation readings indistinguishable from background. • A small portion of the site west of the access road exhibits elevated gamma radiation levels. • An individual would have to stand continuously over the most contaminated portion of the site for about 34 days each year to receive the maximum allowable incremental dose (CNSC, 2000) for a member of the public. • The elevated gamma radiation levels require the maintenance of institutional controls, which may include land use restrictions or site remediation.

Site	Site History/Description	Survey Results	Significance of Results
Bennett Camp	• Collection of buildings including a post office, cookhouse, camp store, administrative and other buildings and sheds. Maintenance yard contains the remains of the service garage, several warehouse buildings, an off-loading truck ramp and the base for the generator building. • Camp is frequently visited by travelers to the area and has been used at least once for a major gathering of aboriginal people. • Local resident has moved a building from another location on the site to the former location of the post office building. This dwelling is used frequently throughout the year.	• 1085 gamma radiation readings taken over a 3.2 ha area. • 11 (1%) of these readings were above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 80 µR/h. • The elevated readings were clustered near buildings at the west side of the site and behind a wooden tepee near a cabin at the east end of the site.	• The vast majority of the site exhibits gamma radiation readings indistinguishable from background. • Small portions of the east and west end of the site exhibit slightly elevated gamma radiation levels. • The gamma radiation levels observed do not require restrictions on the current use of the lands.
Road Between Bennett Camp and Bennett Airstrip	• Road shares the path of an ancient portage route. • Southern branch passes into the main Bennett camp while the northern “by-pass” truck route follows the river directly to the lower portage landings passing the maintenance area. • Clearing contains some modern road construction supplies, but mostly residential waste (food tins, etc) and industrial wastes (tires, engine blocks, drums, etc.).	• 2410 gamma radiation readings taken over a 7 ha area. • 86 (3.6%) of these readings were above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 240 µR/h. • The majority of elevated readings were clustered in a clearing midway between the airstrip and Bennett Camp.	• The vast majority of the site exhibits gamma radiation readings indistinguishable from background. • An individual would have to stand continuously over the most contaminated portion of the site for about 27 days each year to receive the maximum allowable incremental dose for a member of the public (CNSC, 2000). • The elevated gamma radiation levels require the maintenance of institutional controls, which may include land use restrictions or site remediation.
Bennett Airstrip	• The airstrip was routinely used to supply Bennett Camp. • Constructed of sand obtained from many borrow pits along its route. • Airstrip maintenance buildings were located adjacent to a cleared area opposite the access road.	• 1914 gamma radiation readings taken over a 19.7 ha area. • None of these readings was above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 15 µR/h	• The vast majority of the site exhibits gamma radiation readings indistinguishable from background. • The gamma radiation levels observed do not require restrictions on the current use of the lands.

Site	Site History/Description	Survey Results	Significance of Results
Road Between Bennett Airstrip and Upper Portage Wharf	• This 9 km long road was used to haul uranium (as well as other goods) by truck around the St. Charles Rapids. • Gravel pits are located along the route and this aggregate was used to build up the roadway. • In some locations, fill has been placed to several meters above the original portage road grade.	• 2650 gamma radiation readings taken over a 24.4 ha area. • 3 of these readings were above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 101 µR/h.	• The vast majority of the site exhibits gamma radiation readings indistinguishable from background. • A small portion of the site exhibits a slightly elevated gamma radiation level. • The gamma radiation levels observed do not require restrictions on the current use of the lands.
Upper Portage Wharf	• Eastern terminus of the St. Charles Rapids portage. • Partial remains of the concrete buttressed wooden wharf are in fair condition. • Haulage truck traffic was “one way” entering the landing from the east side down a steep road cut and exiting on the gentler grade to the west.	• 549 gamma radiation readings taken over a 1.1 ha area. • 2 of these readings were above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 21 µR/h.	• The vast majority of the site exhibits gamma radiation readings indistinguishable from background. • The gamma radiation levels observed do not require restrictions on the current use of the lands.
Upper Shipyard	• Contains the burned remains of the “Great Bear” a wooden vessel that hauled goods on Great Bear Lake from Port Radium to the head of the Great Bear River. • Several maintenance buildings were once located on the height of land east of the site.	• 406 gamma radiation readings taken over a 1.6 ha area. • 2 of these readings were above the typical upper range of exposures from terrestrial sources. • The maximum gamma radiation reading was 24 µR/h.	• The vast majority of the site exhibits gamma radiation readings indistinguishable from background. • The gamma radiation levels observed do not require restrictions on the current use of the lands.

Table E2: Breakdown of Gamma Radiation Readings by Site

Site	Site Area (ha)	Total	Gamma Radiation Range <20 µR/h	Gamma Radiation Range 21-50 µR/h	Gamma Radiation Range 51-100 µR/h	Gamma Radiation Range 101-250 µR/h	% of Gamma Radiation Readings in 101-250 µR/h Range	Maximum Gamma Radiation (µR/h)
Lower Shipyard	4.0	363	358	5	0	0	0	32
Bennett Alternate Landing	1.3	345	344	1	0	0	0	22
Road from Bennett Original to Bennett Alternate Landing	2.3	214	214	0	0	0	0	16
Bennett Original Landing	2.7	810	786	20	3	1	0.12	195
Bennett Camp	3.2	1,085	1,074	9	2	0	0	80
Road from Bennett Airstrip to Bennett Camp	5.8	1,773	1,772	1	0	0	0	23
Cleared Area Between Bennett Camp and Airstrip	1.2	637	552	73	4	8	1.26	240
Bennett Airstrip	19.7	1,914	1,914	0	0	0	0	15
Road from Upper Portage Wharf	24.4	2,650	2,647	2	0	1	0.04	101
Upper Portage Wharf	1.1	549	547	2	0	0	0	21
Upper Shipyard	1.6	406	404	2	0	0	0	24
Totals	**67.3**	**10,746**	**10,612**	**115**	**9**	**10**		

Gamma Radiation	Interpretation (from SENES, 2002)
<20 µR/h	Typical upper range of exposure level from terrestrial sources
20–50 µR/h	Common levels in areas of natural mineralization
50–100 µR/h	Exposure levels that are relatively rare for natural conditions
100–250 µR/h	Values used in some instances to indicate that remediation actions could be considered, depending on the circumstances
>250 µR/h	Used in some instances as a trigger for remediation actions

REMEDIATION OF URANIUM-CONTAMINATED SOILS AT THE WATERWAYS SITE

PROJECT CLOSURE REPORT

Submitted to:

Low-Level Radioactive Waste Management Office
Atomic Energy of Canada Limited
Port Hope, Ontario

Submitted by:

AMEC Earth & Environmental Limited
Calgary, Alberta

January 2004

CE02710/2000

EXECUTIVE SUMMARY

E.1 BACKGROUND

From the 1930s to the 1960s, a 2,200 km water transportation network was used by the Northern Transportation Company Limited (NTCL) to carry uranium ore and ore concentrates from Port Radium, Northwest Territories on Great Bear Lake to the barge-to-rail transfer point in Fort McMurray, Alberta. From Fort McMurray, the ore was transported by rail car to its final destination in Port Hope, Ontario for refining. Until 1946, the NTCL warehouse in Fort McMurray was located at Waterways, a property presently owned by Canadian National (CN).

In summer 1992, during investigations of transfer points along the water route, elevated levels of radioactivity were discovered on riverside properties in the Lower Town site of Fort McMurray (LLRWMO, 1994). It was assumed that incidental spillage and tracking during unloading of barges and loading of railcars were the causes of the contamination. The uranium contamination was considered a historic waste and fell under the mandate of the Low-Level Radioactive Waste Management Office (LLRWMO). Subsequent investigations found that properties adjacent to the Clearwater River in the Lower Town and Waterways areas of Fort McMurray exhibited uranium ore contamination.

In 1992, a cleanup of contaminated soils from the NTCL Lower Town site began using cleanup criteria and a waste management plan developed by a Stakeholder Working Group. Mildly contaminated soil, described as Category B material, was placed into a Long-Term Management Facility (LTMF) constructed at the Fort McMurray municipal landfill site. Materials considered low-level radioactive waste, or Category A material, were shipped to the licensed LLRWMO storage warehouses at Chalk River Laboratories in Chalk River, Ontario. In 1994, cleanup work was completed at seven neighbouring properties in Lower Town. The cleanup of an eighth property was completed in 1995.

This document describes the remediation of the ninth and final site included in the Fort McMurray program, namely the CN property at Waterways.

E.2 PURPOSE OF THE PROJECT

The purpose of the project was to provide for appropriate long-term management of soils contaminated with uranium ores by removing the materials from the CN Waterways site and placing them into long-term storage in a dedicated cell at the Regional Municipality of Wood Buffalo landfill site.

E.3 WASTE CATEGORIES

The contaminated soils at the Waterways site were categorized as ‘Above 500 soils’ (materials with uranium concentrations above 500 ppm) or ‘Below 500 soils’ (materials with uranium concentrations below 500 ppm). With the enactment of the *Nuclear Safety and Control Act* in 2000, a distinction between soils with uranium levels above and below 500 ppm was no longer relevant in a licensing context. However, the above categories were adopted because they

aligned with those applied to previous uranium cleanups in Fort McMurray (Above 500 soils were the old Category A materials, while Below 500 soils were the Category B materials), and because they retained some relevance for planning and design of the LTMF.

E.4 ENVIRONMENTAL ASSESSMENT

The *Canadian Environmental Assessment Act* (Government of Canada, 1992; Canadian Environmental Assessment Agency, 1999) outlines a process for evaluating and addressing the environmental implications of projects that involve federal participation. The *Act* describes the various circumstances under which federal involvement would trigger the need for an assessment. For the Waterways project, discussions with likely Responsible Authorities (RAs under the *Act*) established that there were no applicable *CEAA* triggers and that an environmental assessment under the *CEAA* would therefore not be required. However, an environmental assessment report for the Waterways site remediation was prepared to meet Atomic Energy of Canada Limited's (AECL's) policy requirements and its commitment to environmental sustainability. The Waterways assessment report (AMEC, 2002a) concluded that the potential environmental effects resulting from the remediation project were either positive, not significant, or could be mitigated through known technology, environmental design and conformance with existing legislation and regulations.

E.5 CONTRACTING SCOPE AND EXECUTION

The work associated with the Waterways Remediation Project was contracted under the following two packages:

1. Remediation and Restoration of the Waterways Site; and
2. Expansion and Closure of the LTMF.

The execution of these scopes is summarized in Table E-1. The table describes the basic scope elements of each package, identifies the selected contractor and summarizes departures from the originally specified scopes and schedules.

E.6 ENVIRONMENTAL MONITORING AND CONTAMINATION CONTROL

A program of environmental monitoring, and personnel training and contamination control was implemented to ensure that the health and safety of workers and the public as well as the condition of environmental media were protected during execution of the cleanup. Contamination control measures were based on the premise that exposures should not only be below regulatory limits, but should adhere to the ALARA (as low as reasonably achievable, considering social and economic factors) principle. Engineered measures were implemented to provide such control, including site access restrictions, personnel and equipment monitoring , and continuous monitoring of environmental effects. Monitoring of ambient gamma radiation, ambient radon, long-lived alpha in air and total airborne particulates indicated that the control measures were effective in satisfying the ALARA objective (see Table E-1).

Table E-1: Execution Summary for the Waterways Remediation Project

Contract	Original Scope Elements	Contractor	Executed Scope	Schedule	Contamination Control	
					Scope	Results

1. Remediation and Restoration of the Waterways Site	• Excavate about 500 m^3 of Above 500 material and 3,300 m^3 of Below 500 material.
	• Transport excavated materials to the LTMF.
	• Restore the remediated Waterways property by:
	  • site grading;
	  • application of topsoil and seed.
		H. Wilson Industries	Per the specified scope, except the following.
			• Excavated and transported about 11,000 m^2 of Below 500 material.
			• Did not categorize any of the excavated materials as Above 500.
			• Extended excavations all the way down to the bank of the Clearwater River.
				• Original scheduled called for all work to be completed in fall 2002.
				• Higher-than-expected Below 500 volumes required that restoration activities (i.e., topsoiling and seeding) be deferred until spring 2003.
				• All work on Waterways site was completed by mid-June 2003.
					• Access control.	• No instances of unauthorized access.

					• Gamma radiation monitoring:
					  • fence line;
					  • workface;
					  • equipment cabs;
					  • approach roads; and
					  • site trailer.
						• No action or alarm levels exceeded.

					• Radon gas monitoring.	• No action level exceedances.
					• Long-lived alpha in air monitoring.	• No action level exceedances.
					• Total airborne particulate monitoring.	• No action level exceedances.
					• Offsite contaminant migration testing.	• No evidence of offsite contaminant movement.

2. Expansion and Closure of the LTMF	• Placement of Below 500 materials.
	• Placement of Above 500 materials in a dedicated area with upgraded containment features.
	• Construction of a cover comprised of:
	  • 60 cm of low-permeability fill;
	  • 15 cm drainage layer;
	  • 20 cm of subsoil;
	  • 15 cm of topsoil; and
	  • seeding.
	• Construction of a perimeter toe drain system.
	• Construction of a surface drainage system discharging to the Prairie Creek escarpment.
		H. Wilson Industries	Per the original scope except for the following.
			• There were no Above 500 materials placed at the LTMF.
			• As-built cover consisted of:
			  • 60 cm of low-permeability fill;
			  • 10 cm drainage layer;
			  • 30 cm of subsoil;
			  • 10 cm of topsoil; and
			  • seeding.
			• The perimeter toe drain and ditch discharged to an infiltration sump immediately northeast of the LTMF instead of a ditch draining to the Prairie Creek escarpment.
				• Original schedule called for waste placement to be completed in fall 2002 and LTMF closure by June 30, 2003.
				• In practice, waste placement was completed in fall 2002; however, the LTMF closure was not complete until early August 2003, largely because of delays generated by unusually wet weather.
					• Access control.	• No instances of unauthorized access.

					• Gamma radiation monitoring:
					  • fence line;
					  • workface;
					  • equipment cabs;
					  • approach roads; and
					  • site trailer.
						• No action or alarm levels exceeded.

					• Radon gas monitoring.	• No action level exceedances.
					• Long-lived alpha in air monitoring.	• No action level exceedances.
					• Total airborne particulate monitoring.	• No action level exceedances.
					• Offsite contaminant migration testing.	• No evidence of offsite contaminant movement.

E.7 APPROVALS OBTAINED

Various inputs were sought from Alberta Environment and the Department of Fisheries and Oceans (DFO) prior to, and during, execution of the remedial program. These regulatory inputs related principally to excavation activities immediately adjacent to the Clearwater River at the Waterways site. Alberta Environment provided approvals for works in and around the river and DFO reviewed the works and advised that formal authorization would not be required, subject to specified conditions.

At the conclusion of the project, the Canadian Nuclear Safety Commission (CNSC), the regulator for the program, inspected both the Waterways property and the LTMF site. The CNSC's inspection report (Appendix K) indicated that there were no longer any regulatory concerns associated with the Waterways property, and that conditions at the LTMF site were satisfactory.

E.8 PUBLIC INFORMATION AND CONSULTATION

An effective process of engaging and informing the local community was always an integral component of the historic uranium cleanup project in Fort McMurray. A public participation program was initiated in spring 2000 by re-establishing the Stakeholder Working Group that guided planning and implementation of the project. In addition to the Stakeholder Working Group, the program also included:

- local community stakeholder consultation through one-on-one interviews, and tracking of their concerns and issues;
- information events (e.g., open houses) conducted in the community at appropriate project junctures; and
- media notices to advise the public about the project and its progress, and to provide details regarding pending information events.

The public consultation program was effective in disseminating project information into the community and eliciting public input to the project.

2004 RADIOLOGICAL SURVEYS
BELL ROCK TO FORT FITZGERALD

Submitted to:

Low-Level Radioactive Waste Management Office
Atomic Energy of Canada Limited
Port Hope, Ontario

Submitted by:

AMEC Earth & Environmental
Calgary, Alberta

September 2005

CE03051/3000

EXECUTIVE SUMMARY

E.1 BACKGROUND

From the 1930s to the 1960s, a 2200 km water transportation network was used by the Northern Transportation Company Limited (NTCL) to carry uranium ore and ore concentrates from Port Radium, Northwest Territories (NWT) on Great Bear Lake to the barge-to-rail transfer point in Fort McMurray, Alberta. From Fort McMurray, the ore was transported by rail car to its final destination in Port Hope, Ontario for refining. At several locations along the water route, materials were transferred between barges and trucks to circumvent rapids located on the Great Bear and Slave Rivers. In the case of the Slave River rapids, NTCL initially used landings at the Town of Fort Smith, NWT and at Fort Fitzgerald, Alberta to transfer materials (barge to truck) around a series of four rapids. In the 1940s, NTCL moved the Fort Smith docking and transfer facilities further downstream to a location known as Bell Rock, about 10 km west of Fort Smith. Operations continued at Bell Rock until the 1960s when NTCL closed down all Slave River operations and moved to Hay River, NWT.

In the summer of 1992, during investigations of transfer points along the 2200 km water route, elevated levels of radioactivity were discovered on the former NTCL Bell Rock site, within the Town of Fort Smith, and at Fort Fitzgerald (SENES, 1994). Incidental spillage and tracking of uranium-bearing materials during transfers between barges and trucks is suspected to be the cause of the contamination at these sites. The uranium contamination was considered to be historic Low-Level Radioactive Waste (LLRW) and therefore fell under the mandate of the Low-Level Radioactive Waste Management Office (LLRWMO), an agency operated by Atomic Energy of Canada Limited (AECL) under the policy, direction and funding of Natural Resources Canada (NRCan).

E.2 PROJECT OBJECTIVE

The objective of the project was to assemble existing data and collect additional information as required to better define the nature and extent of soils contaminated with uranium ores and ore concentrates in the Fort Smith, Bell Rock and Fort Fitzgerald area. This information will be required to support regulatory decisions regarding the future status and management of the subject sites.

E.3 SCOPE OF WORK

The scope of work included the design, data collection and data interpretation for radiological surveys on the following sites and/or areas:

- Bell Rock;
- former haul roads (portage routes) between Bell Rock and Fort Smith;
- selected sites within Fort Smith;
- former haul roads (portage routes) between Fort Smith and Fort Fitzgerald; and

- Fort Fitzgerald (including the former NTCL Marine Terminal Lands).

E.4 FIELD PROGRAM

The radiological field surveys were completed between October 5 and 18, 2004 by a three-person AMEC field crew comprised of:

- a Team Leader/Data Management Specialist;
- a radiological surveyor; and
- a support technician.

Prior to, or concurrent with, the field survey, the understanding of potential contaminant source areas was expanded through reviews of local archives (e.g., at the Northern Life Museum in Fort Smith) and through interviews with long time, local residents. In addition, the survey team attended a meeting of the Smith Landing First Nation band council on October 8, 2004 to describe the survey program and to solicit relevant historical information.

The surveys were conducted with a combination of hardware and software that provided for the simultaneous logging of gamma radiation count rates and geographic data. The instrumentation was mounted on a four-wheeled all-terrain vehicle or truck in a manner that allowed for consistent scanning of the entire area of interest from a height of 1 m above ground level. To the extent possible, areas not accessible to either of the survey vehicles were investigated on foot using the same instrumentation mounted on a backpack.

The surveys were conducted on grid patterns of approximately 10 m modified as necessary in areas of high gamma radiation. The grid pattern was difficult to maintain in densely treed areas, yards, near wetlands and in the vicinity of chained dogs. The survey was not conducted in areas containing excessive debris such as car wrecks, garbage, piles of wood, barbed wire and residential demolition.

A cursory soil sample collection and analysis program was conducted to help characterize the area soils (including background) and to determine preliminary cut-off depths for contaminated soil volume calculations. In areas exhibiting elevated gamma radiation readings (or in selected background locations) shallow, 15 cm deep surface soil samples were collected, or deeper holes were completed with a hand-operated dutch auger. Samples were shipped to the LLRWMO Field Services Office in Port Hope, Ontario, where they were split into two subsamples. One was analyzed in Port Hope for radium and the other at SGS Lakefield Research Limited in Lakefield, Ontario for uranium and arsenic. In accordance with previous investigations uranium, radium and arsenic were designated as the contaminants of primary concern for this study.

E.5 SURVEY FINDINGS

The survey findings are presented in a series of maps depicting each of the study areas at various scales (see Site Maps section). These maps present:

- all of the gamma radiation data collected during the 2004 survey;
- gamma radiation data collected in 1995 for portions of the Bell Rock site by the LLRWMO using the Large Area Gamma Survey (LAGS) system;
- the locations of boreholes completed in 2004 and the gamma radiation and analytical data compiled for them; and
- the locations of selected photographs taken during the 2004 field survey (Appendix D).

E.6 DATA INTERPRETATION

The significance of ore contamination, and its implications on current and future use of the lands investigated, depends largely on the density of ore accumulations in a particular area and the physical attributes of the area (i.e., existing and potential usage). For the purpose of this study, the areas surveyed were categorized as follows:

- **Category 1** – areas in which the density of uranium ore accumulations is very likely incompatible with unrestricted use of the lands;
- **Category 2** – areas in which the density of uranium ore accumulations is potentially incompatible with unrestricted use of the lands; and
- **Category 3** – areas which show no evidence of ore contamination, or in which the density of uranium ore accumulations is unlikely to create any restrictions on use of the lands.

Scientifically robust and quantitative boundaries for each of these categories would require a site-specific examination of contaminant transport and receptor exposures that was beyond the scope of this survey. However, for the purposes of this assessment, the criteria listed in Table E-1 were applied. These preliminary criteria were taken from similar programs undertaken elsewhere by the LLRWMO, or developed on the basis of AMEC's experience and judgment.

Table E-1: Contaminated Soil Categories

Category	Description	Gamma Radiation Range (@ 1 m abgl)	Applicable Analytical Criteria
1	Likely incompatible with unrestricted future land use	>2 x Upper Range of Background (URB): ◆ 20 µR/h (Outside Fort Fitzgerald) ◆ 25 µR/h (Fort Fitzgerald Soils)	>0.3 Bq/g Ra266 >12 µg/g As >12 µg/g U
2	Potentially incompatible with unrestricted future land use	Between URB and 2 x URB	>0.3 Bq/g Ra266 >12 µg/g As >12 µg/g U
3	Likely compatible with unrestricted future land use	Upper Range of Background (URB): ◆ 10 µR/h (Outside Fort Fitzgerald) ◆ 12 µR/h (Fort Fitzgerald Soils)	<0.3 Bq/g Ra266 <12 µg/g As <12 µg/g U

E.7 CONCLUSIONS AND RECOMMENDATIONS

The volumes of Category 1 and 2 soils in the South Slave Area are estimated to be in the order of 7300 m^3 and 1800 m^3, respectively. The breakdown of these totals by specific study area is presented in Table E-2. These estimates are preliminary in nature and are based on gamma radiation and soil analytical data (both from the 2004 investigation and previous programs), supplemented by the judgment of the field survey team (as informed by previous experience with soil excavation operations on LLRWMO remediation programs).

Based upon the results of the 2004 surface and subsurface radiological survey program the following conclusions have been drawn:

- soils containing above background levels of uranium, radium and arsenic have been identified at sites along the South Slave portion of the Northern Transportation Route;
- the aerial extent of these above background areas has been determined and documented through the use of a GPS-based radiation detection system;
- preliminary estimates of depth of the above background areas have been estimated based upon a limited subsurface sampling program, but more detailed investigations will be required to provide more definitive depth profiles;
- there are a number of areas in Bell Rock, Fort Fitzgerald and the haul roads connecting them that contain concentrations of uranium ores that are very likely incompatible with the unrestricted future use of the lands in question;
- many of these ore accumulations appear restricted to small areas and do not involve substantial volumes of soil;
- eight of the ore accumulations involve relatively large, contiguous surface areas that could generate substantial volumes of soil if contamination extends to any significant depth; and
- the available information on the depth profiles for the historic contamination in these eight areas of impact is not sufficient to produce reliable estimates of the volume of contaminated soil in these areas.

It is recommended that additional subsurface (depth profiling) assessment work be undertaken on selected sites in the Bell Rock to Fort Fitzgerald area to better understand the volumes of soils that are contaminated with uranium ores at densities likely to create restrictions on the future use of the lands. More specifically, follow-up subsurface sampling and analysis should be undertaken at selected locations to better define the depth of contamination.

Table E-2: Contaminated Soil Volume Estimates

Study Area	Estimated Volume (m^3)	
	Category 1	**Category 2**
Bell Rock	2482	0
Haul Road, Bell Rock to Airport	0	0
Haul Road Through Fort Smith	100	0
Haul Roads from Fort Smith to Fort Fitzgerald	80	0
Fort Fitzgerald and Area	345	1793
Fort Fitzgerald, NTCL Marine Terminal Lands	4305	0
Total	**7312**	**1793**

HAY RIVER, NT, 1998 WASTE REMOVAL PROJECT REMEDIAL WORK REPORT

By
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For

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1595 Telesat Court, Suite 700
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Revision 0

1999 February

1.0 INTRODUCTION

One of the responsibilities of the Department of Indian and Northern Affairs is the management of contamination on native reserves in the Northwest Territories. On 1997 September 12, detailed radioactivity surveys were performed at the request of Indian and Northern Affairs Canada, by the Low-Level Radioactive Waste Management Office (LLRWMO) which resulted in the delineation of a number of small areas of uranium contaminated soil on the east bank of the Hay River, NT. This contamination resulted from spillage of uranium ore placed on a flat area across the road from the Hay River Dene Band burial grounds during a winter in the 1940s. Apparently the Slave River had frozen early and ore, which was in gunnysacks, was stored on shore and later shipped.

This report documents the work conducted to remove soils contaminated with uranium ore at concentrations greater than 500 ppm from the Dene First Nations' Band lands at Hay River, Northwest Territories, in September 1998. This material requires an Atomic Energy Control Board (AECB) licence for possession and is considered low-level radioactive waste (LLRW). The work was carried out in compliance with the AECB license PSL-202/99 "Possession of Prescribed Substances at Unspecified Locations".

The removal project, sponsored by Indian and Northern Affairs Canada was conducted under the direction of a Radiation Specialist under contract to the Low-Level Radioactive Waste Management Office in accordance with the project specific Work Plan [1].

1.1 Site Investigations

1.1.1 *1993 Site Investigation*

In 1993, a preliminary investigation was conducted at Hay River by staff from the Low-Level Radioactive Waste Management Office (LLRWMO) and SENES Consultants Limited [2]. Hay River was investigated as one of many locations that were part of the water transportation route used to transport uranium ores and concentrates from Port Radium. The 1993 investigations involved the identification and investigation of all sites of potential spillage of the uranium ore.

Gamma radiation scans conducted along the Hay River in 1993 indicated the presence of radioactive contamination between the Road and the Burial Grounds in the area where uranium ore had been stored temporarily.

1.1.2 *1997 Site Characterization and Waste Delineation*

The 1997 September 12 survey found that approximately 170 m^2 of the area contained soils with gamma radiation readings higher than local background. A few localized areas on site, totalling about 10%, contained materials which may be considered LLRW. Hand dug test pits showed that the LLRW is found just below the surface sod in a thin layer. Soils above and below the LLRW had become mildly contaminated. The depth of mildly contaminated soils was generally limited to the organic topsoil layer from 15 to 45 cm.

The estimated volume of LLRW was 6 m^3. Contaminated soils were estimated at 80 m^3. For the LLRW, the total uranium inventory was expected to be approximately 9 kg, assuming an average density of approximately 1.5 tonnes/m^3, and an average concentration of approximately 1,000 ppm.

A site assessment report [3] was provided to Indian and Northern Affairs Canada by the LLRWMO in 1997. One recommendation of this report was that soil exhibiting gamma radiation readings greater than 200 μR/h[1] (1.2 μSv/h) be excavated, containerized and transported to a facility that can accept low-level radioactive waste. It was also recommended that a cleanup should take place prior to development as a park, a change in land use, that could result in exposing people to the contaminants or in the uncontrolled spreading of the contaminants.

1.2 Description of Work Area

The contaminated areas are found on the east side of the Hay River in the flood plain. The area is flat and is bisected by the main road to Vale Point. East of the road is a flat, grassy, maintained area directly in front of the Burial Grounds.

2.0 PURPOSE, SCOPE AND CLEANUP CRITERIA

2.1 Purpose

The purpose of this project was the removal of contaminated soils that require an AECB license to possess (ie. which contain >500 ppm Uranium) to licenced storage facilities.

2.2 Scope of Work

The scope of this project was the removal of contaminated soils containing greater than 500 ppm uranium (referred to as LLRW) from the identified areas on the east side of the Hay River, across the road from the Hay River Dene Band burial grounds. Machine excavation of mildly contaminated top cover would expose the LLRW which would be hand-excavated, packaged into drums and shipped to the LLRWMO storage facility in Chalk River, Ontario for storage and future disposal. This facility is licenced by the AECB, and is operated by Atomic Energy of Canada Limited (AECL) for the LLRWMO. The mildly contaminated soils were to be returned to their former location and covered with new material.

2.3 Cleanup Criteria and Objectives

The maximum residual contaminant levels was to be 500 ppm natural uranium averaged over one cubic metre of soil.

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[1] Instruments used by the LLRWMO report values of gamma radiation exposure rates in units of micro roentgen per hour (μR/h), a non-SI unit. The conversion from the exposure rate unit of μR/h to dose rate unit of μSv/h is based on the application of three conversion factors: 0.87 Rad/R [4]; 0.7 Sv/Gy [5]; and 0.01 Gy/Rad, by definition.

reported in Appendix A. No residual contamination was found in the TSS Unit after removal of the drums.

6.0 VERIFICATION TESTING

6.1 Soil Sampling

Upon completion of the excavations at the work site, soil samples were collected from within the main excavation area and of the mildly contaminated stockpiled soils to be used for backfill. Sample locations are shown on Figures 6.1. Soil samples were analyzed by neutron activation at Becquerel Laboratories Inc., Mississauga, Ontario. Sample analysis results are shown in Table 6.1 Since the maximum uranium concentration measured was 89 ppm, no individual verification sample exceeds the project criterion of 500 ppm uranium.

Table 6.1: Verification Soil Sample Results for Uranium

Sample Number	Location	U ppm	Comments
1	Borrow Stockpile	60	These soils used to fill excavation.
2	Borrow Stockpile	23	These soils used to fill excavation.
3	Excavation, north, near bank	87	Bottom of excavation
4	Excavation, center, near bank	5	Bottom of excavation
5	Excavation, south, near bank	1	Bottom of excavation
6	Excavation, south-center	7	Bottom of excavation
7	Excavation, north-center	89	Bottom of excavation
8	Excavation, east end	18	Bottom of excavation
	Average	36	

6.2 Gamma Radiation Measurements

Upon completion of the waste removal, a series of gamma radiation readings was taken on a 2 m grid spacing over the primary work area before restoration. At each grid location, a measurement was taken on contact with the ground surface and at a height of 1 m from the excavated surface. The maximum gamma radiation reading measured at a height of 1 m was 50 μR/h (0.30 μSv/h). Additional measurements were made at contact with the ground over all four areas after the areas had been restored to final grade. Measurements recorded at one metre above the ground in the south test pit area ranged from 5 to 15 µR/h (0.03 to 0 09 µSv/h), in the middle test pit area from 5 to 7 µR/h (0.03 to 0.04 µSv/h) and in the north-east pit area from 5 to 19 µR/h (0 03 to

0.11 μSv/h). Bottom of excavation measurements (pre-restoration) and after backfilling (post-restorational) surveys of the primary cleanup area are found in Figures 6.1, 6.2 and 6.3 at the end of the report text.

7.0 SUMMARY AND CONCLUSIONS

Areas of bulk uranium contamination exceeding concentrations of 500 ppm uranium as evidenced by gamma radiation readings greater than 1.2 μSv/h (200 μR/h) were excavated from the site, containerized, temporarily stored on site under PSL 202/99, and shipped in twenty-seven steel drums in accordance with Transportation of Dangerous Goods regulations to the LLRWMO storage facility at Chalk River, Ontario.

The cleanup objectives for the 1998 Removal of Uranium Contaminated Soils from Hay River, Northwest Territories were met. This was demonstrated by having no verification samples with concentrations exceeding the project criterion of 500 ppm.

The cleanup activities at the site reduced the gamma radiation exposure rate, measured at 1 m from the ground surface to less than 0.60 μSv/h (100 μR/h).

The health and safety program was successful in preventing injury or incidence during the waste removal work at Hay River. The administrative control level for radon was exceeded when the contaminated soil was first disturbed and workers were asked to work upwind from the excavation. At no other time were administrative control levels exceeded.

Environmental monitoring at the work sites during waste removal did not indicate any effect discernable from background measurements. At no time were administrative control levels exceeded at the perimeter of the controlled areas.

The estimated volume of residual material with elevated gamma radiation readings is unchanged at approximately 80 m^3.

RADIOLOGICAL ASSESSMENT OF THE FORMER BELL ROCK MARINE TERMINAL IN THE MUNICIPALITY OF FORT SMITH, NT

By:

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For:

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Revision 0
2000 April

EXECUTIVE SUMMARY

Radiation surveys by the LLRWMO in 1993 identified the presence of uranium-contaminated lumber and soils on Lot 16, outside the municipal limits of Fort Smith. This area was part of the Bell Rock marine terminal operated by NTCL from the late 1940s until 1960. In response to an application for a change of land use in 1994, further intensive surveys were conducted over terminal lands that were within the municipal limits at Lots 1, 5 and an adjacent lot to the west.

During the 1980s, extensive leveling and regrading of the site, including the leveling of former warehouse buildings was undertaken to prepare a meeting site for First Nations peoples from all over the region and Canada. Consequently, uranium contamination was spread and significantly diluted over much of the area. Gamma radiation levels at one metre above the ground throughout the area are difficult to differentiate from natural background levels. Most of the bits of uranium ore are found below the surface of the ground, but within the top 30cm.

Low-levels of surface contamination were found on an abandoned warehouse floor on Lot 16, on debris found in the bush south of Lot 16 and on the floor of the maintenance garage on Lot 5. Disposition of many of the other former buildings shown on historic drawings has not been established. One is known to be in use for storage at a local lumberyard.

On the portions of the site within the limits of the municipality, soils that contain occasional bits of uranium ore and concentrates amount to approximately 8,000 m^3. The volume of relatively easily separable source concentrates and ores is estimated to be <5 m^3.

More surveys on adjacent Lot 16 and lands to the south are required.

RADIOLOGICAL ASSESSMENT OF PORTAGE AVENUE AND PEREGRINE STREET SITES IN THE MUNICIPALITY OF FORT SMITH, NT

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Revision 0
2000 April

EXECUTIVE SUMMARY

Uranium ore spills at several locations in Fort Smith were identified in the late 1970s (during the massive recovery of radioactive debris from a Russian satellite by Federal Government survey teams). Screening level radiation surveys by the LLRWMO in 1993 verified the presence of these materials in Fort Smith that appear to have been spilled from trucks making the portage around rapids to Fitzgerald. Detailed surveys to better characterize these materials were performed in 1994 and 1995.

A number a pieces of ore were found in the front yard of a private home on Portage Avenue. The largest pieces were recovered, but 1 to 2 m^3 of contaminated soils remain.

A spill centered in a small section of ditch, just off the haul route on Peregrine Street, has been spread along the road 50m in both directions and onto two adjacent properties. The elevated gamma radiation field from the ditch was attenuated by placing a sand cover over it. Most survey-identified individual bits of ore were recovered from the lawn area of one of the properties but the more numerous bits of ore and contaminated soils were left in the flower garden next to the ditch. Ore spread over the road bed and in a parking area of another property were left untouched. It is estimated that approximately 600 m^3 of contaminated soils remain at this location, with perhaps 1 m^3 of material having uranium concentrations >500 ppm.

Other sites investigated at the request of the owner and/or administrators, include the local elementary school, the museum and a local lumberyard building. In each case, some poured concrete exhibits the same naturally enhanced radioactivity of the granite-like aggregate used. Radon levels measured by very limited grab sampling found low levels in the school, while the sub-grade museum archives showed more elevated levels. Surface contamination was found on sill plates of one of the NTCL buildings salvaged for use as a lumber storage building.

PRELIMINARY RADIOLOGICAL ASSESSMENT OF SHORE AREAS AND HOUSES FROM URANIUM CITY IN FORT CHIPEWYAN, ALBERTA

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Investigations to 1994
This Report April 2000

EXECUTIVE SUMMARY

1.1 Background

From the 1930s to the 1960s, a 2,200 km water transportation network was used by the Northern Transportation Company Limited (NTCL) to carry uranium ore and ore concentrates from the Port Radium mine, Northwest Territories on Great Bear Lake to the barge-to-rail transfer point in Fort McMurray, Alberta. From Fort McMurray, the ore was transported by railcar to its final destination in Port Hope, Ontario for further refining. At several locations along the water route, materials were transferred from barge to truck to circumvent rapids. In 1960, NTCL closed down all Slave River operations and moved to Hay River, NT.

Loaded barges normally passed by Fort Chipewyan on their way to Waterways without stopping. Barge traffic from uranium mines on Lake Athabaska also passed by this community on the way to the railhead.

A long-time resident recalled that barges had stopped to unload and reload their contents at a rock outcrop known as Fraser's Point or Little Island. Community residents also expressed concern that uranium contamination might be present in houses recently acquired from Uranium City, a mining community on Lake Athabaska.

1.2 Purpose

Further preliminary radiological surveys were conducted by the LLRWMO in 1994 in Fort Chipewyan. The purpose of the surveys was:

1) to determine if any uranium-contaminated material was present at other potential locations along the shoreline.
2) to determine if any uranium contamination was present in other "Uranium City" houses within the community.

2.0 RESULTS

2.1 Waterfront Area Scans

No readings anomalous to natural background gamma radiation levels were encountered. All observed levels could be attributed to the soil type beneath or the natural radioactivity of some of the materials in rock outcroppings.

2.2 "Uranium City" Houses.

Table 1 provides a summary of observed measurements in each of the houses visited. The names of the occupants identify the structure measured.

All observed levels were consistent with natural background radioactivity in Fort Chipewyan. Radon gas levels were not measured. Since no indication of man-introduced uranium contamination was found, radon concentrations would be due entirely to that produced naturally in the area.

Table 1:
Houses from Uranium City Checked for Uranium Contamination in 1993 and 1994

Name	PO Box (if known)	Interior Gamma Radiation (µR/h)	Exterior Gamma Radiation (µR/h)	Total α, β, γ at Cold Air Return (cpm)	Total α, β, γ on Vacuum Bag (cpm)
[redacted]		5 to 7	5 to 7	Not Measured	Not Measured
		5 to 7	5 to 7	Not Measured	Not Measured
		5 to 7	5 to 7	Not Measured	Not Measured
		5 to 7	5 to 7	Not Measured	Not Measured
		5 to 6	6 to 7	< 50	Not Measured
		4 to 5	5 to 8	< 50	< 50
		4 to 6	7 to 9	<50	< 50
		5 to 7	5 to 7	Not Measured	< 50
		4 to 6	5 to 8	< 50	< 50
		4 to 5	5 to 6	Not Measured	< 50
		5 to 7	5 to 8	Not Measured	< 50
		5 to 6	5 to 8	Not Measured	< 50
	e or available				
		4 to 9	4 to 8	Not Measured	60
		4 to 6	5 to 8	Not Measured	< 50
		4 to 6	6 to 8	Not Measured	60
		4 to 5	5 to 7	< 50	< 50
		4 to 6	4 to 7	Not Measured	60
	e or available				
		4 to 5	4 to 8	< 50	< 50
		5 to 7	4 to 8	Not Measured	< 50
[redacted]	No one home or available				

Notes: 1. Normal background gamma radiation levels in residential areas ranged up to 10 µR/h. Occasional natural levels in contact with rock outcroppings were up to 5 times that.
2. Normal background count-rate values for total alpha, beta, gamma measured with this geiger counter range from 40 to 70 counts per minute (cpm).

3.0 SUMMARY

Additional areas of shoreline were scanned for the presence of uranium ore and concentrates. No man-introduced uranium contamination was found in 1993 or 1994. Nineteen houses that had originated in Uranium city were checked for contamination. None was found.

TULITA, NT
1999 SOIL CHARACTERIZATION AND WASTE REMOVAL PROJECT, REMEDIAL WORK REPORT

By
J. DeJong
for

The Low-Level Radioactive Waste Management Office
1595 Telesat Court, Suite 700
Gloucester, Ontario K1B 5R3
Rev. 0
2000 February

Executive Summary

In 1992 September, approximately 200 m^3 of soil with elevated concentrations of uranium were removed from a residential property in Tulita, Northwest Territories. These soils were placed in a temporary stockpile on land owned by the Hamlet of Tulita near the airport.

In 1999 September, approximately 5 kg of material containing concentrations of uranium in excess of 500 ppm (the concentration limit for an Atomic Energy Control Board possession licence) was removed from this stockpile. This material was shipped to the Low-Level Radioactive Waste Management Office storage facility at Chalk River, Ontario for long-term storage and future disposal.

The uranium concentration of the remaining stockpile is estimated to be in the range of 23 to 54 ppm. Determination of the final disposition of this material awaits consultation with the community.

LLRWMO-xx-xx-98-xxx

DRAFT Not released.

SAWMILL BAY 1997 WASTE REMOVAL PROJECT

Low-Level Radioactive Waste Management Office
1595 Telesat Court, Suite 700
Gloucester, Ontario K1B 5R3
Revision 0
1998 May

EXECUTIVE SUMMARY

In 1997 September a waste removal project was conducted at Sawmill Bay, NT Over the course of 5 days, between 1997 September 6 and 1997 September 10, a total of 17.4 m^3 of soil contaminated with uranium ore and ore concentrates was excavated, packaged into 208 L steel drums, and transported to Yellowknife by aircraft. The drummed soil was subsequently transported from Yellowknife to the Low-Level Radioactive Waste Management Office (LLRWMO) storage facility operated by AECL at Chalk River Laboratories, in Chalk River, Ontario The project was conducted at a cost of $199,000.

The history of the project began in 1946 when a 1500 metre long airstrip was constructed near the western point of Sawmill Bay on Great Bear Lake to transport uranium ore from the Port Radium mine From 1946 to 1960, uranium ore and ore concentrates were barged 65 km across Great Bear Lake and loaded onto DC-3 aircraft at Sawmill Bay for transport to Edmonton, Alberta. Over the course of the years of use, areas of the site became contaminated with ore and ore concentrates due to incidental spillage and weathering of materials stored on site.

As part of a 3 year comprehensive investigation of cargo vessels and handling and transfer points along the 2,100 km northern transport route from Port Radium, Northwest Territories to Fort McMurray, Alberta, gamma radiation surveys were conducted by the LLRWMO and SENES Consultants Ltd. at Sawmill Bay in 1993. The surveys indicated the presence of radioactive contamination at the beach landing area, in front of the Great Bear Lodge complex, and at one of the two airstrips. The investigation concluded no immediate need for action exists, however, when any changes in land use are planned, consideration should be given to the contaminated material Remedial work may be required The findings of this investigation were presented to the community of Déline in January 1995

In August 1996, an environmental assessment was conducted at Sawmill Bay jointly by the Environmental Sciences Group (ESG) of the Royal Military College and the LLRWMO. The ESG was contracted by the Contaminated Sites Office (CSO) of Indian and Northern Affairs Canada (INAC). This followed a 1995 resolution made at the Sahtu Annual General Meeting for the government to cleanup uranium contaminated sites in the Sahtu. The field work for the environmental assessment was visited by a delegation of about 20 representatives from Déline. A second resolution supporting cleanup work in the Sahtu area was passed at the 1996 Sahtu Annual General meeting

The 1996 environmental assessment better delineated the uranium ore in soil contamination and other contaminants, such as drums, hydrocarbons, asbestos and derelict vehicles were identified. The assessment concluded that, unless the land use changes and occupancy on site increases, no immediate action is required It was, however, recommended that the estimated 22 m^3 of soil that exceed 500 ppm uranium should be excavated, containerized and removed to a facility licensed to accept such material This concentration of uranium normally requires disposal as radioactive waste A dose assessment concluded that for no credible scenario would the recommended

AECB dose limit for members of the general public of 1 mSv/year be exceeded at the Sawmill Bay site, even if no materials were to be removed

In 1997, the CSO of INAC initiated the waste removal project at the site The decision to proceed with the project was made after a presentation of the findings of the 1996 environmental assessment to members of the Déline Band Council, in Déline, in 1997 July, and approval from the band council was given

The goals of the waste removal project conducted in 1997 were to:

- remove soils with uranium concentrations exhibiting gamma radiation readings greater than 200 μR/h (1 2 μSv/h) from the three areas identified in the 1996 waste delineation survey;

- transport the material to the storage facility operated by Atomic Energy of Canada Limited (AECL) for the LLRWMO and licensed by the Atomic Energy Control Board (AECB) to contain these materials; and

- reduce exposure rates measured at a height of 1 metre from the ground surface to less than 0 60 μSv/h (100 μR/h).

The project was funded by the CSO under a contribution agreement with Déline Management Limited. The labour force of ten persons came from the community of Déline, as did the camp support staff of three persons. The LLRWMO prepared the Work Plan, provided Radiation Specialists to direct the work and ensure worker safety, and accepted the resulting waste for storage. Excavation work was conducted by hand-shoveling the contaminated soils into 208 L steel drums. The drums were then sealed and transported to a temporary storage site at the airstrip, operated under AECB Prescribed Substance License PSL 202/97 Most drums were transported using all-terrain vehicles with trailers. Three drums from the beach landing area were transported the 2 3 km distance to the temporary storage site by helicopter because parts of the roadway were passable only with difficulty. From the airstrip, drums were loaded, by hand, into aircraft for transport to Yellowknife A total of 87 drums was filled by the crew of 10 over a 5 day period.

Prior to selection, by draw, of the labour force from the interested group of workers, a presentation of the project specific health and safety program was made in Déline. Following the presentation, workers were provided copies of the work plan which included the details of the health and safety program. A second worker briefing was held on arrival at Sawmill Bay and safety equipment distributed Work was conducted in a controlled work area. For work in the controlled area safety equipment consisted of cloth coveralls, steel-toed boots, gloves, and safety glasses. Workers were checked for the presence of contaminated material by a Radiation Specialist before leaving a controlled area. No contamination was measured on any worker or equipment.

The Work Plan contained an assessment of potential doses to workers which predicted that no worker would receive a dose greater than the AECB *de minimis* dose of 0 05 mSv/year (5% of the recommended AECB permissible dose to members of the general public) Workers wore personal dosimeters during all work activities. The maximum dose recorded was 0 009 mSv, 18% of *de minimis* No injuries or incidents occurred as a result of the waste removal work at Sawmill Bay. However, complaints about living conditions at the camp were made by the labour force Environmental monitoring at the work sites during the waste removal indicated no impact discernable from background measurements.

The cleanup objectives for the 1997 removal of uranium contaminated soils from Sawmill Bay, Northwest Territories were met Areas of bulk contamination exceeding concentrations of 500 ppm uranium were excavated from the three targeted areas at Sawmill Bay, containerized, and shipped in accordance with Transportation of Dangerous Goods regulations to the LLRWMO storage facility at Chalk River Laboratories The estimated uranium concentrations in the 87 drums shipped ranged from 37 to 2423 ppm and averaged 484 ppm. The cleanup activities at the site reduced the gamma radiation exposure rate, measured at 1 m from the ground surface to less than 0.60 μSv/h (100 μR/h), ranging from 0 06 μSv/h to 0 54 μSv/h, with average values at each of the sites no greater than 0 20 μSv/h.

Following the removal of the pockets of contaminated material with a uranium content greater than 500 ppm, approximately 1 2 hectares with elevated gamma radiation readings from residual pieces of uranium ore remain at Sawmill Bay. Gamma radiation readings range up to 0.54 μSv/h with an average of 0 17 μSv/h. This average is approximately three times the local background for the Sawmill Bay site, and within the range found on pre-Cambrian rock in the Northwest Territories. Elevated concentrations of arsenic, associated with uranium ore, also remain. Sampling at the site estimated that the volume of residual contaminated soil at the site that exceeds the CCME Remediation Guideline of 30 ppm for arsenic is approximately 150 m^3 The total volume of soil with gamma radiation readings distinguishable from the local background at Sawmill Bay is estimated to be 1,425 m^3. The remaining residual uranium ore, and the other contaminants identified in the 1996 environmental assessment (hydrocarbons, asbestos, derelict vehicles, drums, etc) should be considered when the site is decommissioned or the site use changes

WORK PLAN

1999 SOIL CHARACTERIZATION AND REMOVAL

TULITA, NORTHWEST TERRITORIES

Low-Level Radioactive Waste Management Office
1595 Telesat Court, Suite 700
Gloucester, Ontario K1B 5R3
Revision 0
1999 September

1.0 INTRODUCTION

In 1992 September, radioactivity surveys performed in Fort Norman (now Tulita) by SENES Consultants Limited on behalf of the Low-Level Radioactive Waste Management Office (LLRWMO) resulted in the delineation of uranium contaminated soil on the east bank of the MacKenzie River at a residential property on which two homes were located. This contamination was the result of spillage while uranium ore in gunny-sacks was stockpiled here in the 1940s.

Surface gamma radiation levels prompted interim remedial action at this location. In 1992 September, approximately 200 m^3 of soil was excavated and moved to a temporary storage location on land owned by the Hamlet of Fort Norman (now Tulita), close to the south end of the Renewable Resources Office complex near the airport. From past radiation surveys, it is estimated that less than 6 m^3 of this soil contains concentrations of uranium greater than 500 parts per million (ppm) which is the present licensing threshold under Atomic Energy Control Regulations. Plastic sheeting underlies and surrounds the stored materials. Local fill soils were placed along the sides of the storage pile to protect it from the weather. A description of the 1992 activities is provided in "Phase I, II, and III Investigations of the Historic Northern Uranium Transportation Network in the Northwest Territories and Northern Alberta" (NUTN Report), September 1994, by SENES Consultants Limited for the Low-Level Radioactive Waste Management Office.

This Work Plan addresses the separation and removal from the temporary storage site of soils containing greater than 500 ppm uranium. Soils with less than 500 ppm uranium will remain at the present location while a permanent solution for the material is sought.

1.1 Present Radiological Conditions

A gamma radiation survey of the temporary storage pile conducted in 1993 (NUTN Report) is shown in Figure 1. Gamma radiation levels, around the shielded sides of the pile, range from 8 to 14 μR/h, consistent with the background in the area. At the unshielded top of the pile, levels range from 9 to 130 μR/h on contact with the soil and average 29 μR/h at 1 m above the soil. This 1 m exposure rate may be considered representative of the dose rate to a worker standing on this soil and has been used for this purpose in Section 4.3, Assessment of Potential Dose.

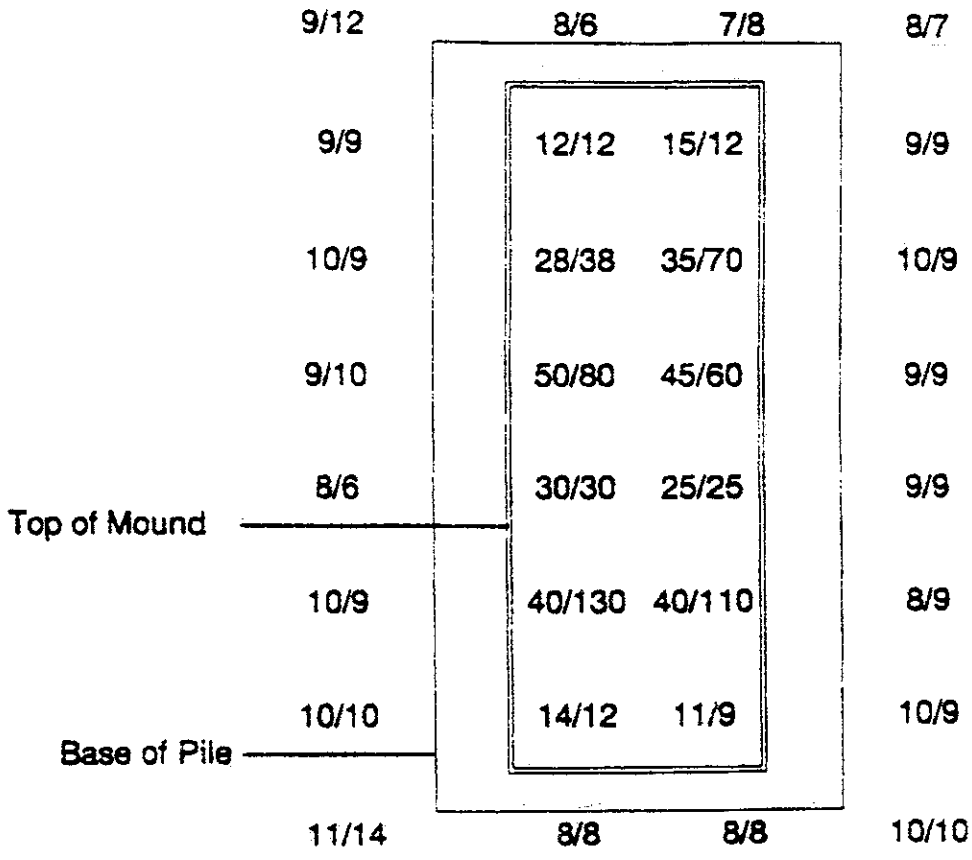
From surveys of the original source location of these stored soils in the NUTN Report, it is estimated that licensable concentrations could range from one to thirty drums of material.

1.2 Description of Work Area

The temporary storage pile is located on land owned by the Hamlet of Tulita, close to the south end of the Renewable Resources Office complex near the airport. The area is flat and contains grading fill of crushed shale. The temporary storage pile is about 9 m x 20 m x 1.5 m high, is wrapped in fabrene and the sides are protected with about 0.5 m of cover soils.

FIGURE 1

RESULTS OF GAMMA RADIATION SURVEY
FORT NORMAN INTERIM STORAGE PILE



(Grid approximately 3m x 3m)

Date: 20 September 1993

Instrument: Eberline PRM-7 #480

Readings: uR/hr

Surveyors: G. Case, B. McCallum

1.3 Scope of Work

The purpose of this project is to:

- characterize and sort the wastes held at the temporary storage pile in Tulita,
- package soils that contain greater than 500 ppm uranium (averaged over no more than 1 cubic metre) and ship to the LLRWMO storage facility in Chalk River, Ontario,
- place the remaining soils back into temporary storage adjacent to the present location, and
- ensure that the stored soils have a minimal effect on the local environment.

1.4 Regulatory Control

Primary regulatory control under Atomic Energy Control Act is through the Atomic Energy Control Board (AECB). Their direct regulatory involvement is through Prescribed Substances Licence (PSL) - 202 which allows the temporary possession of licensable concentrations of radioactive materials at unspecified locations across Canada by the LLRWMO.

2.0 RESPONSIBILITIES

Department of Indian and Northern Affairs Canada Representative (Carol Mills)

The Indian and Northern Affairs Canada representative will be responsible for:

- sponsorship of the work on behalf of Indian and Northern Affairs Canada;
- providing funds for the execution of the Work Plan; and
- external communications.

LLRWMO Project Manager (Barry McCallum)

The LLRWMO project Manager will be responsible for providing the full scope of the project. He will be responsible for the budget, schedule, obtaining required regulatory and AECL approvals, ensuring regulatory requirements are carried out, and administration of contracts and purchase orders required to conduct the work. The Project Manager will be responsible for the approval of the Work Plan.

LLRWMO Radiation Protection Program Manager ([redacted]

This position advises the LLRWMO Project Manager.

The Radiation Protection Program Manager will ensure that this document meets AECL's Radiation Protection Program requirements, and will provide approval to proceed with work, possibly with modified procedures, if limits specified in Section ~~7.5~~ 4.5 are exceeded.

4.8 Emergency Contact Listings

AGENCY	CONTACT/ADDRESS	TELEPHONE
Hospital	Health Centre	867-588-4251
Ambulance	Air Ambulance arranged by Health Centre	
Fire Department	Emergency Firehall	867-588-4222 867-588-3611
Police	RCMP	867-588-4211
Tulita Municipal Contact	Hamlet Office	876-588-4471
Renewable Resources	[redacted]	
INAC/DIAND Representative	Carol Mills	867-669-2665
LLRWMO Project Manager, Ottawa	Barry McCallum	613-293-3738
Contractor	[redacted]	
Radiation Protection Specialist/ Site Safety Officer		

5.0 SUMMARY

At the completion of the work radiation levels in the general area will be consistent with background gamma radiation levels. Drums containing soil with concentrations greater than 500 ppm of uranium will have been shipped to the LLRWMO storage facility at Chalk River Laboratories (Atomic Energy of Canada Limited), Chalk River, Ontario for storage.

Historic Uranium Northern Transportation Route

Current Status of Sites

INTERNAL DRAFT FOR DISCUSSION ONLY

2000 October 31

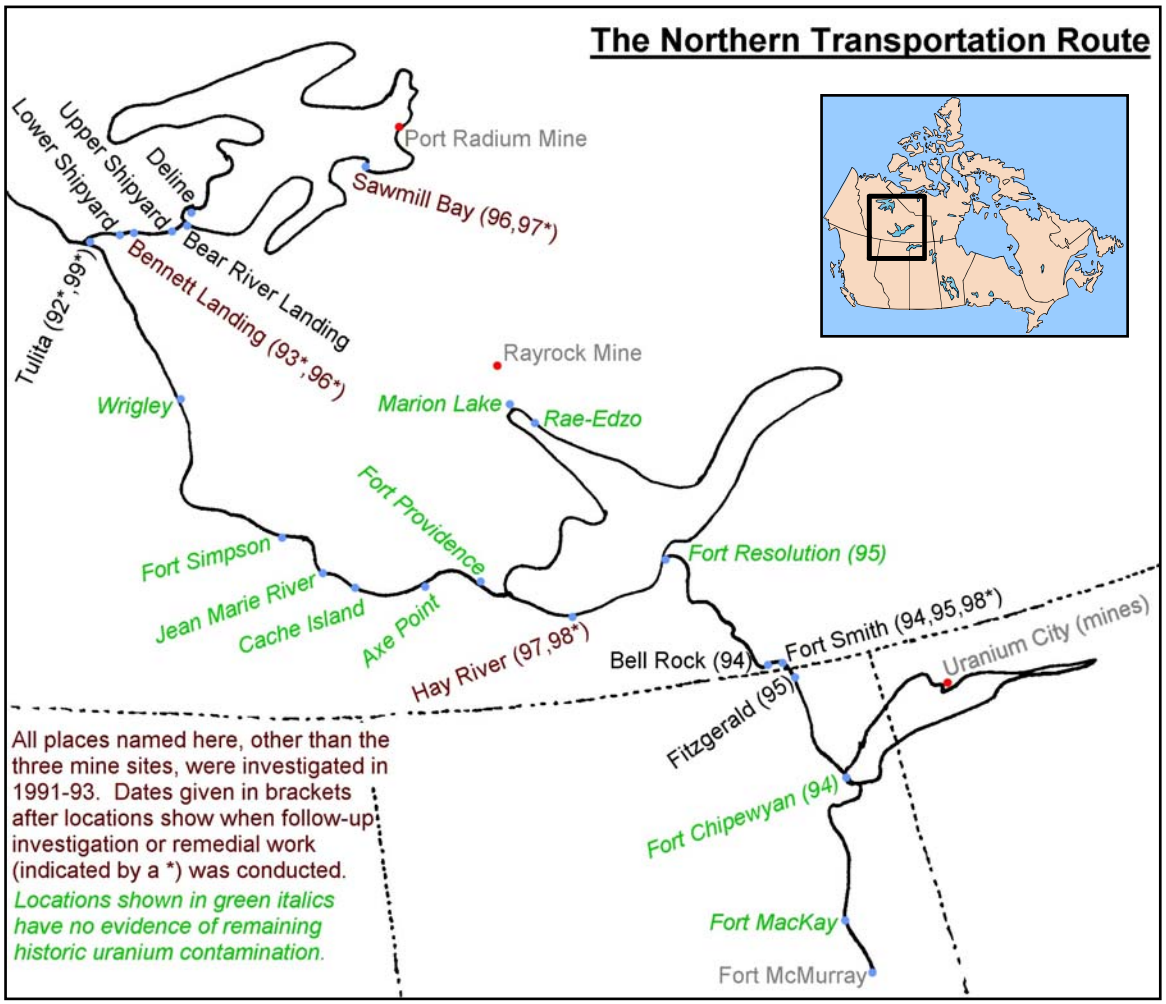
C.H. Clement
Low-Level Radioactive Waste Management Office

Table of Contents

1 BACKGROUND

2 OVERVIEW OF NTR SITES

Figure X: Current Status of Northern Transportation Route Sites



RADIATION PROTECTION SUPPORT, FORT SMITH, NT. RADIATION MONITORING RESULTS

In Support of the Demolition of a Uranium-Contaminated Building by the Town of Fort Smith, NT

Low-Level Radioactive Waste Management Office
1595 Telesat Court, Suite 700
Gloucester, Ontario K1B 5R3
Revision 0
2000 April

EXECUTIVE SUMMARY

In October and November 1998, the Town of Fort Smith demolished a structurally unsafe derelict building on their property as required by the Fire Marshall's Office. The building, moved from Fitzgerald in the 1960s, had been identified in 1993 as associated with historic NTCL uranium transportation operations. Flooring materials and soils beneath the floor were contaminated with uranium dust. The walls and roof were not contaminated with uranium but the exterior was clad with asbestos containing materials. The LLRWMO provided radiation protection support in the form of a work plan and a contracted radiation specialist to conduct worker training, worker and environmental monitoring, and to provide direction during demolition.

The work was carried out in accordance with the plan by local contractors using conventional construction equipment. Monitoring results showed the work had little radiological impact on workers or the environment. Following the work, radiation levels at both the demolition site and the temporary holding area were difficult to differentiate from natural background levels.

The contaminated floor structure and a small amount of contaminated soil was transported to the local landfill site where it was buried in previously undisturbed soils near the operational fill area. The materials are demarked with tarpaulins above and below the wastes. Soils were mounded over the materials and a temporary "construction" fence erected to delineate the area limits. Signs instruct persons not to dig, with a phone number for information. The volume is estimated to be in the order of 100 m^3 with large voids. This storage location was designed for a short life span. Eventually, the cover will fill the voids, the fence will deteriorate and collapse, and the location may conflict with future operational uses.

WORK PLAN

URANIUM-CONTAMINATED SOIL REMOVAL AT THREE SITES IN FORT SMITH, NORTHWEST TERRITORIES

Low-Level Radioactive Waste Management Office
1595 Telesat Court, Suite 700
Gloucester, Ontario K1B 5R3

2001 August 24

1.0 INTRODUCTION AND BACKGROUND

In the late 1970s, the Russian satellite Cosmos-954 fell to earth, spreading radioactive debris across a portion of Canada's north. During the door-to-door search for this material in Fort Smith, historic spills of uranium ore were found at several locations in the town. In 1992 and 1993, radioactivity surveys performed in Fort Smith by SENES Consultants Limited on behalf of the Low-Level Radioactive Waste Management Office (LLRWMO) verified that the materials were still present. Subsequent detailed surveys by LLRWMO and contracted staff are reported in "Radiological Assessment of Portage Avenue and Peregrine Street Sites in Fort Smith, NT" 2000 April. During these surveys, a small piece of uranium ore was recovered from a property previously identified on Primrose Lane. No further contamination was found at that site. Remaining locations known to contain uranium contamination are located at:

1) 53 Portage Avenue (at former bend in haul road)
2) 226 Primrose Lane (Peregrine Street West Ditch)
3) 224 Primrose Land (Peregrine Street East Side, Parking Area and Former Garage)

Surface gamma radiation levels prompted interim remedial action at location 3) in 1995, consisting of the placement of cover soils to attenuate radioactivity levels in the ditch.

At the request of the involved homeowners and the Canadian Nuclear Safety Commission (CNSC), the LLRWMO has undertaken this cleanup work and placement of the excavated soil into the existing temporary storage pile at the nuisance grounds site which will be licensed by the CNSC.

1.1 Present Radiological Conditions

Each of the identified locations contain small amounts of buried pieces of uranium ore which exhibit gamma radiation levels at one metre generally at background (7 to 9 μR/h). A maximum one metre reading of 50 μR/h can be found at one spot above the Peregrine Street ditch, the source of contamination at sites 2 and 3. The average one metre exposure rate in the occupied areas is 8 μR/h or 0.05 μSv/h (indistinguishable from background).

1.2 Description of Work Areas

Each location is found on level ground and is easily accessible with standard excavating equipment.

The existing temporary storage pile, which contains the remains of a former NTCL structure demolished in 1999, is located on land owned by the municipality, close to the south side of the active landfill area within the nuisance grounds. The area is flat and is located on native sand material. The present temporary storage area is about 10 m x 10 m x 0.5 m high. The buried lumber is wrapped in fabrene tarps and covered with 0.5 m of clean soil.

1.3 Scope of Work

The purpose of this project is to:

- mark out the previously delineated extent of the contamination,
- construct an expanded temporary storage pile for contaminated soils,
- excavate all soils that exhibit radiation levels above that of the local background,
- transport the contaminated soils to the temporary storage pile,
- ensure that the stored soils have a minimal effect on the local environment, and
- restore excavated areas to conditions equivalent to pre-remedial conditions.

1.4 Regulatory Control

Primary regulatory control under Canadian Nuclear Safety Regulations is through the CNSC. Their direct regulatory involvement is through Prescribed Substances Licence (PSL) - 202 which allows the temporary possession of licensable concentrations of radioactive materials at unspecified locations across Canada by the LLRWMO.

2.0 RESPONSIBILITIES

LLRWMO Project Manager (Glenn Case)

The LLRWMO project Manager will be responsible for providing the full scope of the project. He will be responsible for the budget, schedule, obtaining required regulatory and AECL approvals, ensuring regulatory requirements are carried out, and administration of contracts and purchase orders required to conduct the work. The Project Manager will be responsible for the approval of the Work Plan

LLRWMO Radiation Protection Program Manager (Glenn Case)

The Radiation Protection Program Manager will ensure that this document meets AECL's Radiation Protection Program requirements, and will provide approval to proceed with work, possibly with modified procedures, if limits specified in Section 4 5 are exceeded.

Radiation Specialist/Site Safety Officer (Mike Owen assisted by John DeJong)

This position reports to the LLRWMO Project Manager. The Radiation Specialist/Site Safety Officer will be responsible for conducting the on-site work including:

- implementing health and safety programs;
- worker and environmental monitoring;
- project materials acquisition and scheduling;
- directing and carrying out the work in the field;
- conducting a radiation protection briefing to workers (briefing handout is attached here as Appendix A);
- providing 100% direct supervision of all work carried out in controlled areas; including the work of the Contractor;
- conducting measurements to ensure worker and environmental protection;
- ensuring the conditions of the Prescribed Substance Licence PSL 202/99 are met;

REPORT ON
URANIUM-CONTAMINATED SOIL REMOVAL
AT SITES IN
TULITA (FORMERLY FORT NORMAN),
NORTHWEST TERRITORIES

EXECUTIVE SUMMARY

During the period of 2001 August 27 to September 8, uranium-contaminated soils were removed from two private properties in Tulita (formerly Fort Norman), NWT. Radiation Specialists from the LLRWMO, assisted by a local contractor, identified, segregated and moved some 300 m^3 from these properties to an expanded Temporary Storage Pile (TSP) for uranium-contaminated materials at a former landfill site near the airport. Restoration was completed at one site and was left at the other for the local contractor to complete. The lack of resources in the community (gravel and topsoil) will require the importation of these materials over the winter in order to complete restoration next summer. Small amounts of residual contamination are known to remain at depth below the surface in previously cleaned areas and on the exposed bank of the MacKenzie River at the edge of that property.

The community provided assistance by identifying an adjacent property location to survey. Small amounts of uranium contamination were found and removed from this property. When the cleanup team was about to leave, additional suspected areas were suggested, but could not be surveyed due to time and equipment constraints.

Materials were handled in accordance with a site-specific work and safety plan. Environmental and worker protection monitoring were carried out during the work. All observed levels were low and well within Administrative Control Levels for this work.

This report describes the work carried out, results for worker protection and environmental monitoring, and radiation verification surveys.

REPORT ON
URANIUM-CONTAMINATED SOIL REMOVAL
AT SITES IN
FORT SMITH, NORTHWEST TERRITORIES

EXECUTIVE SUMMARY

From 2001 September 9 to 15, previously identified areas of uranium-contaminated soils were removed from three private properties in Fort Smith, NWT. Radiation levels at each location were above that of the local background but were much lower than that which would result in an incremental dose of 1 mSv/a, the regulatory limit for the general public under CNSC regulations. Technical staff, representing the LLRWMO, assisted by a local contractor, identified, segregated and moved some 125 m^3 of these soils from these properties to an expanded Temporary Storage Site (TSS) for uranium-contaminated materials at the local landfill site. Restoration was completed at one site and was left at two others for the local contractor to complete.

Although Peregrine Street ditches were decontaminated during this work, uranium-contaminated soils remain in-situ under portions of the road bed. Residual volumes here are estimated to be in the order of 100 to 150 m^3.

Materials were handled in accordance with a site-specific work and safety plan. Environmental and worker protection monitoring were carried out during the work. All observed levels were low and well within Administrative Control Levels for this work.

This report describes the work carried out, results for worker protection and environmental monitoring, and radiation verification surveys.

RMC

EXECUTIVE SUMMARY

Sawmill Bay is situated on the southern edge of Great Bear Lake, Northwest Territories. The site has had a varied history as an airfield for the trans-shipment of uranium ore, a staging area for the construction of the DEW Line and a fishing lodge; originally it was the site of two timber sawmills, the remains of which are present to the south of the lodge. Its varied history has left three areas contaminated with uranium ore, large numbers of empty barrels and a variety of buildings in various states of repair.

Three areas which contain residual uranium ore were discovered in 1993 by personnel from the Low Level Radioactive Waste Management Office (LLRWMO). However, the extent of this uranium ore was not known. In addition, it was known that there were a large number of abandoned buildings at the site, and although the aesthetic impact of the physical contamination was obvious, the extent or impact of any chemical contamination in the soil was not known. Without this information, it was not possible to develop a cleanup plan for the site. The Environmental Sciences Group (ESG) at the Royal Military College has recently completed assessments of all the former DEW Line sites in the Arctic. The ESG were therefore asked by Indian and Northern Affairs Canada to conduct a preliminary environmental assessment of the site in conjunction with the LLRWMO. The purpose of the assessment was threefold: to determine the extent of the uranium ore contamination; to determine whether there was any other chemical contamination at the site and if so whether it was having a negative impact on the environment; and to identify cleanup requirements for the site.

The Sawmill Bay site has essentially three areas each of which contains a zone of uranium contamination. The beach landing has a loading area near which is a sunken barge and the area is contaminated with uranium ore. Further to the west is a small leased beaching area containing two huts and to the east a very large cache of approximately 8500 empty drums. The second area is the Great Bear Lake Lodge camp which comprises eight buildings. Two of these, the lodge and kitchen/dining room are relatively new; the remainder date from the 1940s and 1950s. Uranium ore contamination is present in a clear area in the centre of the camp. There are a series of dumps to the south of the camp. The third area is the airstrip which comprises two runways. One end of the older runway is contaminated with uranium ore. Several old barrel caches are present near the runways and small piles of barrels are found elsewhere around the site.

A total of 134 soil, 12 plant and three water samples were collected from various locations at the site; 63 of the soil samples were from pits which were dug in the uranium ore contaminated areas. These samples were analyzed for inorganic elements and their radioactivity measured. Most of the remaining 68 samples were also analyzed for inorganic elements though this was a slightly different suite of elements. Some soil samples were also analyzed for PCBs, total petroleum hydrocarbon content, PAHs and pesticides. Samples of paint, wood, insulation materials, and liquids from transformers and barrels were also collected and analyzed. In addition, the areal extent of elevated radioactivity in the three uranium ore contaminated areas was determined with a portable detector system.

The main environmental contamination of the site is as a result of the uranium ore contamination. Three maps showing the extent and level of radioactivity were prepared, one for each of the affected areas. Only very small areas gave gamma radiation readings indicating greater than 500 ppm uranium, the concentration that is classified as licensable by the Atomic Energy Control Board (AECB). Arsenic, barium, cobalt and antimony were found to be associated with the uranium ore contamination. The limiting contaminant is arsenic. Results obtained indicate that the arsenic has separated from the ore to a large degree and is now associated with the sandy soil at the site. The CCME remediation guideline of 30 ppm arsenic for residential/parkland is exceeded in large areas at the three ore contaminated zones. The size of these zones can be roughly determined by using the zone that exceeds the upper end of background gamma radiation. While size fractionation of substrate from two of the three zones would be useful in reducing the volume of sandy soil exceeding radioactivity levels, it did not fractionate the arsenic contamination.

There was very little other chemical contamination at the site. Hydrocarbon contaminated soil was found in several locations but PAHs in these were found at very low levels. PCBs were barely detectable in soil samples; PCBs at low concentrations were detected in one of the four transformers that were sampled. DDT was detectable in the soil samples from the site but overall pesticide loadings were below remediation guidelines. Physical debris at the site consisted mostly of barrels, nearly all of which were empty. Debris was also present at the dumpsites and the demolition of buildings at the central camp and near to the lake would produce non-hazardous waste. Asbestos containing insulation was present on pipes in the old accommodation building and around the two old wood burning boilers in the boiler house. PCBs were not detected in the paint used on the buildings though lead levels were high. Various petroleum products were

identified in barrels at the site but generally these contained materials suitable for disposal by on-site incineration.

The DEW Line Cleanup (DLCU) Protocol (the general approach to cleaning up a northern contaminated site) has been used to develop cleanup recommendations together with experiences in Canada in dealing with low level radioactive contamination. The arsenic in the uranium contaminated soil is not leachable as shown by laboratory tests and plant life is generally absent from the contaminated areas. Calculation of a dose assessment shows that a radiation dose of 1 mSv/a would not be received by occupants at the site for the present land use. Unless the land use changes, no immediate action is required.

The cleanup of the site would require the following actions to be taken. Soils containing greater than 500 ppm uranium (22 m^3) should be removed from the site and taken to a facility that can accept this material as low-level radioactive waste. For soils containing arsenic above the 30 ppm level but uranium below 500 ppm (655 m^3) two criteria are proposed. Soils where little or no vegetation is present, the arsenic is not leachable, there are no nearby water bodies or drainage pathways and there is only casual land use, should be cleaned up to a level of 50 ppm arsenic. Soils where vegetation is present, the arsenic is leachable, there are nearby water bodies or drainage pathways or the area is frequently used, should cleanup to a level of 30 ppm arsenic. These soils should be placed in a facility that can accept such non-hazardous industrial waste. Examination of the data obtained in this work show that the 50 ppm and 30 ppm arsenic levels correspond to gamma readings of about 15 uR/h and 10 uR/h respectively and cleanup to these criteria rather than arsenic levels could be used if further studies show these relationships to be reliable; this would greatly facilitate cleanup work..

Consideration should be given to constructing such a facility in the form of a properly designed landfill at the Sawmill Bay site. If this were done cleanup of the uranium ore contaminated areas to 10 uR/h is proposed as the incremental costs for additional soils would be low. Non-hazardous debris including all demolition materials should be placed in a properly designed landfill on site. Asbestos containing materials should be removed by trained personnel prior to building demolition and doubly wrapped and placed in the on-site landfill. Barrels should be crushed or shredded and landfilled or shipped south if this is economical; barrel contents should be incinerated or shipped south as described in the DLCU Protocol. Petroleum contaminated soil should be bioremediated.

Report
On

PHASE I, II and III INVESTIGATIONS OF THE HISTORIC NORTHERN URANIUM TRANSPORTATION NETWORK IN THE NORTHWEST TERRITORIES AND NORTHERN ALBERTA

For The

Low-Level Radioactive Waste Management Office
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By

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September 1994

1.0 INTRODUCTION

1.1 BACKGROUND TO THE PROJECT

In September 1991, SENES Consultants Limited was retained by the federal Low-Level Radioactive Waste Management Office (LLRWMO) to conduct a radiological assessment of suspected radioactive contamination at specific sites in Fort Franklin and Yellowknife, Northwest Territories. The sites were suspected to have been contaminated by uranium ore being transported from Eldorado's Port Radium mine on the east shore of Great Bear Lake. The two areas of concern at Fort Franklin were the **Merchant Vessel Radium Gilbert**, used to pull barges loaded with uranium ore across Great Bear Lake, and the former Northern Transportation Company Limited (NTCL) **Bear River Landing dock** at the head of the Great Bear River, where the Radium Gilbert's cargo was unloaded and transferred to smaller barges for the trip down the Great Bear River. The one area of concern in Yellowknife was a dock made of barges that reportedly were used to carry uranium ore.

The LLRWMO had been contacted, in the spring of 1991, by the Inuvik Regional Health Board (IRHB) to provide technical assistance in determining the possible presence of radioactive contamination at i) the former NTCL Bear River Landing dock, and whether the dock could be used by the local community as a source of firewood, and ii) the Radium Gilbert vessel aground in a small bay some 1 to 2 km from Fort Franklin. A preliminary radiological survey of the Radium Gilbert by IRHB staff in 1989 had found above background gamma radiation levels in certain areas of the vessel. The LLRWMO was asked by the IRHB to conduct a comprehensive radiation survey of the vessel and determine the nature of the contamination (if any) and what steps were needed to resolve the problem. In addition to these two issues at Fort Franklin, discussions with a former crew member from the Radium Gilbert had identified the potential for contamination on a dock in Yellowknife, that was constructed with barges that reportedly once hauled uranium ore. Technical assistance to resolve this potential problem was also requested.

SENES personnel conducted radiological investigations at the Fort Franklin sites and inspected the dock at Yellowknife during September 1991. Rock with elevated levels of radioactivity, used as aggregate in the concrete floors of the toilet areas and shower stall, was found to be the source of the above background gamma radiation levels on the Radium Gilbert. A surface gamma survey of the Bear River Landing dock and surrounding area identified isolated point sources of

elevated gamma radiation, due to spillage of uranium ore; however, no contamination was found on the timbers of the dock. In Yellowknife, two NTCL "200" series steel barges were found in use as floating docks by a local yacht club. An inspection of the barges indicated that it was highly unlikely that radioactively contaminated material was present on the barges.

The discoveries of elevated radioactivity levels on the Radium Gilbert vessel and at the Bear River Landing prompted a review of the historic uranium ore transportation network in the Northwest Territories. Through discussions with NTCL in Edmonton and museum staff at Norman Wells and Fort Smith, the details of the historic uranium transportation system from Eldorado's Port Radium Mine on the east shore of Great Bear Lake to the rail head at Waterways (now Fort McMurray) Alberta were established. The system involved a network of vessels, barges, docks, portages, trucks, and storage warehouses that were needed to transport the uranium ore, the approximately 2100 km (1300 miles) from the Port Radium mine to Waterways.

In August and September 1992, SENES personnel under contract to the LLRWMO conducted radiological investigations of 10 vessels, three former warehouse sites, two portages, seven dock/transfer sites, one outdoor ore storage area, and a number of steel barges used by Northern Transportation Company Limited for the transportation of uranium ore. Although no low-level radioactive contamination was found on any of the vessels or steel barges, radioactively contaminated building materials and/or soil were found at most of the dock/transfer, warehouse, and storage sites that were investigated. At many of the sites, discrete pieces of uranium ore were also found. Most of the contaminated sites identified during the 1992 investigations were located in non-residential areas; however, at Fort Norman a clean-up of contaminated soil was conducted on two adjoining residential properties.

The investigations conducted in 1991 and 1992 had identified low-level radioactive contamination at several sites along the transportation route. Several of the sites were located at points consistent with ore handling/transfer operations; however, additional sites of ore spillage were found beyond the limits of the areas where ore handling/transfer operations are reported to have taken place (i.e. at a private residence within the community of Fort Norman).

The discovery of uranium ore spillage at a site within the community of Fort Norman prompted the LLRWMO to schedule, for 1993, a comprehensive radiological investigation program that would involve all potential cargo handling/transfer points along the entire 2100 km route from

Port Radium (in the Northwest Territories) to Waterways (in Alberta). The 1993 phase called for the identification and investigation of all sites or portages along the route where barges may have stopped to load or unload any cargo, not just uranium ore.

A poster that provided additional details about the 1993 investigations was prepared and sent to all communities along the route. Long-time residents of the communities with any information on the historic uranium transportation operations were encouraged to contact the LLRWMO in Ottawa. During August and September 1993 representatives from the LLRWMO and SENES Consultants visited the communities, interviewed local residents and conducted radiological investigations.

This report summarizes the results of the investigations, conducted during 1991 (Phase I), 1992 (Phase II) and 1993 (Phase III), into the historic uranium ore transportation network in the Northwest Territories and Northern Alberta.

1.2 REPORT OUTLINE

Chapter 2 provides a historical overview of uranium mining and transportation in the Northwest Territories and Northern Alberta. The routes followed, the various modes of transport used, and the overall time frame for the various operations are also presented.

Chapter 3 provides a brief chronology of the 1991, 1992 and 1993 investigations, the various sites that were visited during the three field programs and an overview of the people and their affiliations who were contacted at each location.

Chapter 4 reviews the results of the radiological investigations conducted during the three phases. Included in this chapter are the results of the "Radium" series vessel investigations. The design, size, port of construction, area of operation and disposition at the time of the survey are presented, along with the results of the radiation surveys. With respect to the barge investigations, information on the design, size and areas of operation for the various type of barges is presented, along with the results of the radiation surveys. The results for the investigations conducted at the various loading docks, transfer points, and portages used in the historic transportation network are also presented in this chapter along with the results of the

investigations conducted at other communities along the transportation route that were not directly involved in the handling of uranium ore cargo.

Chapter 5 describes the interim remedial actions conducted at Fort Norman and Bennett Landing sites during the Phase II and III investigations. Considerations for remedial actions at other sites along the historical transportation route are also discussed in this chapter.

Chapter 6 presents an overview of the potential radiation exposures for each of the sites where uranium ore spillage was found. Maximum and average exposure scenarios are presented.

Chapter 7 presents the conclusions and recommendations resulting from the Phase I, II and Phase III investigations.

1.3 THE LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT OFFICE

The Phase I , II and III investigations were conducted under the direction of the Low-Level Radioactive Waste Management Office. The LLRWMO was established in 1982 to carry out the responsibilities of the federal government for low-level radioactive waste management in Canada. The mandate of the LLRWMO is to:

- resolve historic waste problems that are a federal responsibility,
- establish, as required, a user-pay service for the disposal of LLRW produced on an on-going basis, and
- address general public information needs about low-level radioactive wastes.

(Historic wastes are defined as low-level radioactive wastes for which the original owner can no longer be held responsible and which are managed in a manner no longer considered acceptable.)

The LLRWMO is operated by Atomic Energy of Canada Limited (AECL) Research through a cost recovery agreement with Natural Resources Canada (formerly the Department of Energy, Mines and Resources), the federal department which provides the funding and establishes national policy for LLRW management. The main office for the LLRWMO is located in Ottawa, while its field operations centre and laboratory are located in Port Hope, Ontario. The LLRWMO

operates as a small project management organization, and contracts projects to private sector consultants, contractors, and to other divisions of AECL.

1.4 SENES CONSULTANTS LIMITED

The Phase I, II and III investigations were conducted by SENES Consultants Limited. SENES has extensive experience in the measurement and assessment of environmental radioactivity and in low-level radioactive waste management. SENES provides consulting services to regulatory agencies from all levels of government, private sector companies, industrial associations, and public organizations. SENES also provides specialty services on many aspects of the environment, including air quality, occupational health, hazardous and solid waste management, risk assessment and mining.

The Phase I, II and III field work was conducted by Mr. Glenn Case, P.Eng., Manager of the SENES Port Hope, Ontario office. Port Hope, Ontario, is the town to which the Port Radium ores were sent, during the period of 1932 to 1960, for uranium and radium refining. During the Phase III field investigations Mr. Case was accompanied by Mr. Barry McCallum, project manager with the Low-Level Radioactive Waste Management Office.

4.5 SUMMARY OF INVESTIGATIONS

4.5.1 Radium Vessel Contamination

Radium Gilbert -Fort Franklin, NWT

A small quantity (0.5 m^3) of aggregate material with elevated levels of radioactivity has been used in the construction of concrete floors in the shower and toilet areas of the Radium Gilbert vessel. Gamma radiation readings in the vicinity (1 to 2 metres) of these areas within the vessel are above background. The estimated volume of contaminated material is less than 0.5 m^3 (i.e. approximately 2 barrels).

The vessel is currently aground in a small bay some 2 to 3 kilometres from Fort Franklin (Deline) and the contaminated areas of the vessel are not very accessible to members of the general public. Based on the limited area of above background radiation levels within the vessel and the type of contamination (i.e. concrete with elevated levels of radioactivity covered with rubberized paint) the potential exposure for a visitor to the vessel and the potential impact on the surrounding environment are both considered to be negligible. It would not be difficult, however, to remove the small amount of contaminated material present on the vessel and reduce the potential impact to people and the environment to zero.

Radium King -Fort Smith, NWT

Evidence of uranium ore spillage was found beneath a portion of flooring in the front cabin of Radium King. The vessel is being restored by the Northern Life Museum and National Exhibition Centre in Fort Smith. The source of the spillage (i.e. small amount of dust and dirt beneath a crack in the flooring) was removed and no additional corrective action is required on the vessel.

NTCL Marine Terminal -Hay River, NWT

No evidence of uranium ore spillage was found on any of the Radium Series vessels in storage at either of the NTCL Terminal Facilities at Hay River or Tuktoyaktuk; however, three radium dialled compasses were found during surveys of Radium Series vessels in storage at the NTCL

Hay River Terminal Facility. Radiation surveys and inspections of the compasses indicate that no mitigative action is required for these compasses; however, should the protective glass become damaged or broken corrective action should be taken to remove the compasses from general service.

4.5.2 NTCL Barge Contamination

With respect to potential contamination of steel barges (i.e. in particular Radium 260 and 261 in use as floating docks in Yellowknife), the conclusion has been reached that any uranium ore spillage that may have occurred during the transportation of uranium ore would have been removed during routine wash down operations. In addition, it is very unlikely that any spilled uranium ore could still be present on any of steel decked barges considering the 30 years or more of rain and snow that the barges have been exposed to since the closure of the Port Radium Mine in 1960.

With respect to wooden barges, investigations of the two charred barge hulks on the Great Bear River indicate that uranium ore was spilled during transportation, and the spilled material can still be found in the cracks and crevices between the wooden planks of the wooden barges.

In their present locations the burned remnants of wooden barges present minimal risk to the general public and the environment. They are located in very remote locations and considerable effort is required not only to get to the two shipyards, but to find the exact locations of the contamination. At the Upper Shipyard site an estimated 60 m^3 of material is contaminated. At the Lower Shipyard the remains of the 7 m x 14 m wooden barge are also contaminated. Because of the bulkiness of the wooden barge material and the potential for the underlying soils to be contaminated, the estimated volume of affected material could be in the order of 50 to 100 m^3. However,a more extensive surface gamma radiation survey of both sites would be required to determine the full extent of contamination at these sites.

Two additional issues to be addressed are whether any other of the original wooden barges used to transport are still in existence, and if so, what are their current dispositions, especially with respect to potential exposures to members of the public (e.g. floating dock, museum piece, permanent breakwater, etc.). The second issue relates to the potential use of the steel hulled wooden decked barges, observed in Hay River, for the transportation of uranium ore.

4.5.3 Sites Along the NTCL Transportation Route

Table 4.9 presents a summary of the radiological investigations conducted at the various docks, transfer points, portages and other communities along the uranium transportation route. The table presents the range in background gamma radiation levels measured at each site, as well as maximum gamma radiation levels measured on natural occurrences at the site (e.g. boulders, rocks, crushed rock, outcrops, etc.). Also noted in the table is whether or not any evidence of uranium ore spillage was found during the investigations, and for the sites where material was found the average and maximum gamma radiation levels measured in areas of contamination are summarized in the table. For the sites where uranium ore spillage was found a general description as to the nature of the contamination is also provided (i.e. pieces of uranium ore found, contaminated soil found). Included in the table is a first-order estimate of the volume of contaminated material that may be present at the sites. These estimates are only preliminary and could increase by 50% or more based on more extensive investigations.

In Table 4.9 the sites are divided into five geographical regions, Sahtu, Deh Cho, North Slave, South Slave and Athabasca. Approximately 12,000 m^3 of contaminated material was found in the Sahtu region at six locations along the transportation route from Sawmill Bay to Fort Norman. In the Deh Cho region no contamination was found at the three communities or two sites investigated along the Mackenzie River. No contamination was found at the North Slave community of Rae or at the Rayrock loadout site; however, within the South Slave Region approximately 1400 m^3 of contaminated material was found at 5 sites. In the Athabasca region (Fort Chipewyan to Fort McMurray) only sites in Fort McMurray were found to be contaminated with approximately 40,000 m^3 of material.

Table 4.9: Summary of Radiological Investigations

Region	Site	Gamma Radiation		Evidence of Uranium Ore Spillage					
		Background Range (uR/hr)	Max. Natural Occurrence (uR/hr)	Yes/No	Gamma Radiation Maximum (uR/hr)	Gamma Radiation Average (uR/hr)	Description Discrete Pieces of Ore	Description Contaminated Soil/Other	Estimated Volume Of Material (m^3)
Sahtu	SAWMILL BAY, NWT								
	Dock & Wharf Area	8-10	--	YES	100	20	X	X	100
	Central Lodge Area	8-10	--	YES	200	35	X	X	600
	Msc. Vehicles	8-10	--	YES	200	8		X	5
	Eldorado Airstrip	10-12	--	YES	300	30	X	X	9000
	Lodge Airstrip	8-10	--	NO					
	FORT FRANKLIN, NWT								
	Radium Gilbert	1-2	--	YES	25	2		X	0.5
	GREAT BEAR RIVER LANDING, NWT								
	Dock Area	7-10	20	YES	38	11	X		5
	GREAT BEAR RIVER SITES, NWT								
	Upper Shipyard	8-11	--	YES	20	12		X	60
	Lower Shipyard	8-11	--	YES	180	35		X	100
	BENNETT LANDING, NWT								
	Upper Public Dock	8-11		NO					
	Lower Public Dock	8-11	25	YES	60	15	X	X	1000
	NTCL Compound Area	8-11	--	YES	300	11		X	5
	FORT NORMAN, NWT								
	Interim Storage Pile	8-10	15	--			X	X	200
	LTO #363 Lot #11	8-10	--	YES	30	10	X	X	500 *
	Transfer Dock/Beach Area	6-8	35	NO					
	Old NTCL Camp Area	6-8	--	YES	100	8	X	X	200 *
								Total	11,775 m^3
Deh Cho	WRIGLEY, NWT	--	--	NO					
	FORT SIMPSON, NWT								
	River Bank Area	7-10	11	NO					
	CACHE ISLAND, NWT	7-10	35	NO					
	AXE POINT, NWT	5-9	--	NO					
	FORT PROVIDENCE, NWT								
	Dock and Wharf Area	5-8	10	NO					
								Total	0 m^3
Dogrib	RAE, NWT								
	Island Area of Community	15-35	50	NO					
	Mainland Area	10-15	30	NO					
	Rayrock Barge Loadout Area	10-15	60	NO					
	Marian Lake Indian Village	10-15	15	NO					
								Total	0 m^3

Table 4.9 (Continued): Summary of Radiological Investigations

Region	Site	Gamma Radiation		Evidence of Uranium Ore Spilage					
		Background Range (uR/hr)	Max. Natural Occurrence (uR/hr)	Yes/No	Gamma Radiation		Description		Estimated Volume Of Material (m^3)
					Maximum (uR/hr)	Average (uR/hr)	Discrete Pieces of Ore	Contaminated Soil/Other	
South Slave	HAY RIVER, NWT								
	Old Fishing Village	4-6	–	NO					
	NTCL Dock Area	4-6	–	NO					
	Old Indian Village:								
	Area by Cemetary	5-7	–	YES	30	6		X	550
	River Bank, Beach Area	5-7	–	NO					
	FORT RESOLUTION, NWT								
	Power Plant, Beach Area	3-6	11	YES	20	6	X		200 *
	Quarry by Airport	4-5	15	NO					
	BELL ROCK, NWT								
	Warehouse Floor	–	–	YES	40	10		X	150
	Main Camp, Shipyard Area	6-8	20	NO					
	Access Road	8-10	15	NO					
	FORT SMITH, NWT								
	NTCL Warehouse	–	–	YES	50	15		X	25
	Peregrine St. Ditch	–	–	YES	90	25		X	5
	Other Small Sites	–	–	YES	10	8		X	5
	FORT FITZGERALD, ALBERTA								
	Dock Area	–	–	YES	50	15	X	X	250
	Old Portage to Fort Smith	5-10	–	YES	20	10	X		200 *
	Road at Hay Camp Exit	10-15	–	NO					
								Total	1385 m^3
Athabasca	FORT CHIPEWYAN, ALBERTA								
	Gov't Dock and Beach Area	5-10	20	NO					
	Little Island, Fraser Point	10-15	1000	NO					
	Uranium City Homes	3-5	–	NO					
	FORT MacKAY, ALBERTA								
	Dock Area	4-6	–	NO					
	FORT McMURRAY, ALBERTA								
	NTCL Warehouse	–	–	YES	100	25		X	1000
	NTCL Compound	–	–	YES	300	20	X	X	17,000 **

NOTES: * -only aware of small volume of material (<5m^3); however, more extensive surveys may discover additional material, so nominal volume of 200 m^3 assumed.

** -other sites found within Fort McMurray, total volume currently estimated at 40,000 m^3.

Appendix B

Limitations

Limitations

1. The work performed in this report was carried out in accordance with the Standard Terms of Conditions made part of our contract. The conclusions presented herein are based solely upon the scope of services and time and budgetary limitations described in our contract.

2. The report has been prepared in accordance with generally accepted environmental study and/or engineering practices. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of our contract and included in this report.

3. The services performed and outlined in this report were based, in part, upon visual observations of the site and attendant structures. Our opinion cannot be extended to portions of the site that were unavailable for direct observation, reasonably beyond the control of AMEC Earth & Environmental, a division of AMEC Americas Limited.

4. The objective of this report was to assess environmental conditions at the site, within the context of our contract and existing environmental regulations within the applicable jurisdiction. Evaluating compliance of past or future owners with applicable local, provincial and federal government laws and regulations was not included in our contract for services.

5. Our observations relating to the condition of environmental media at the site are described in this report. It should be noted that compounds or materials other than those described could be present in the site environment.

6. The conclusions of this report are based in part, on the information provided by others. The possibility remains that unexpected environmental conditions may be encountered at the site in locations not specifically investigated. Should such an event occur, AMEC Earth & Environmental, a division of AMEC Americas Limited, must be notified in order that we may determine if modifications to our conclusions are necessary.