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Canadian Forces Station Alert
Nunavut Water Board Water Licence Application – Supplementary Information

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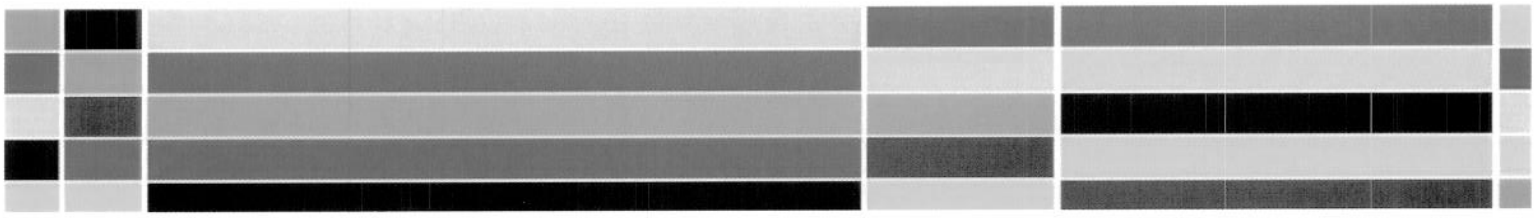

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1. Unusual Acronyms Used in This Report

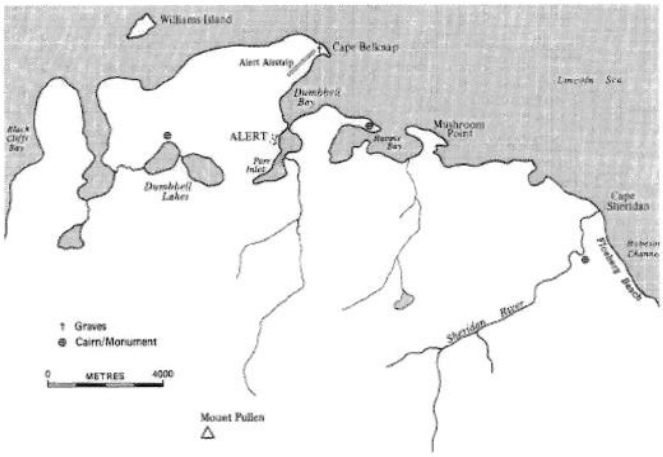
BOD	Biochemical oxygen demand – a measure of sewage strength
CAEAL	Canadian Association of Environmental Analytical Laboratories
CBO	Canadian Base Operations – civilian contract operational personnel
CFU/dL	Colony forming units per 100 millilitres
CWS	Canadian Wildlife Service
Igal	Imperial gallons
INAC	Indian and Northern Affairs Canada
GAW	Canadian Global Atmospheric Watch Observatory
HAPS	Headquarters, Administration Personnel Services Building
L/sec	Litres per second
lbs	pounds
log	Logarithm (suggesting orders of magnitude)
LWPH	Lower water pump house (the pumphouse at Upper Dumbell Lake)
mg/L	Milligrams per litre
NTU	Netholametric turbidity units – a measure of the cloudiness of water
NWB	Nunavut Water Board
O&M	Operation and maintenance
pH	Measurement of alkalinity or acidity
RMC	Royal Military College, Kingston, Ontario.
SOW	Statement of Work
SWTP	Station water treatment plant
T-P	Total phosphorus
TSS	Total suspended solids
USGPM	US gallons per minute
WEF	Water, Fuel, Environment Technician

2. Introduction

2.1 Location

CFS Alert is situated on the north-eastern tip of Ellesmere Island; approximately 817 kilometres from the geographic North Pole at coordinates 82°28' N, 62°30' W.

CFS Alert has been in continuous operations as part of the Canadian Military since September 1958.



2.2 General Environment

The rugged terrain of CFS Alert is surrounded by hills and valleys. The shore is composed primarily of slate and shale, and the sea is covered with pack ice year-round. The polar climate is semi-arid.

2.3 Shared Use

CFS Alert is more than a military installation. Environment Canada has a permanent station at CFS Alert for various high arctic weather, flora and fauna studies.

2.4 Climate

Table 2.1: Average Monthly Temperatures, Precipitation, Snowfall & Weather Extremes

Temperature:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Daily Average (°C)	-32.4	-33.4	-32.4	-24.4	-11.8	-0.8	3.3	0.8	-9.2	-19.4	-26.4	-30.1	-18	A
Standard Deviation	2.5	3.4	2.6	2.9	1.7	1.4	0.8	1.1	1.6	2.3	2.7	2.5	0.9	A
Daily Maximum (°C)	-28.8	-29.8	-28.7	-20.5	-8.7	1.6	5.9	3.3	-6	-15.8	-22.8	-26.4	-14.7	A
Daily Minimum (°C)	-35.9	-37	-36.1	-28.2	-14.9	-3.2	0.7	-1.8	-12.2	-22.8	-30	-33.7	-21.3	A
Extreme Maximum (°C)	0	1.1	-2.2	-0.2	7.8	18.2	**20**	19.5	11.2	4.4	0.6	3.2		
Date (yyyy/dd)	1958/23+	1965/26	1957/12	1978/23	1951/25	2000/30	**1956/08**	1990/01	1989/26	1968/08	1963/07	1978/22		
Extreme Minimum (°C)	-48.9	**-50**	-49.4	-45.6	-29	-13.9	-6.3	-15	-28.2	-39.4	-43.5	-46.1		
Date (yyyy/dd)	1966/07	**1979/09+**	1970/15	1954/02+	1989/02	1963/03+	1982/28	1952/30	1979/30	1962/31	1980/19+	1951/20+		
Precipitation:														
Rainfall (mm)	0	0	0	0	0	0.8	11.1	4	0.1	0	0	0	16.1	A
Snowfall (cm)	8.5	7.5	8.1	11.7	16.6	12.3	17.3	18	33.6	18	13.1	8.7	173.3	A
Precipitation (mm)	6.8	6.3	7	10.3	11	11.1	27.8	21.2	23.4	12.3	9.7	6.8	153.8	A
Average Snow Depth (cm)	28	30	32	36	37	22	1	1	11	20	23	26	22	A
Median Snow Depth (cm)	28	31	32	35	37	21	0	0	11	20	23	26	22	A
Snow Depth at Month-end (cm)	29	31	33	37	36	5	0	3	20	21	24	27	22	A
Extreme Daily Rainfall (mm)	0.3	0	0	0	0.2	18.5	**18.8**	17	1.5	0	0	0		
Date (yyyy/dd)	1958/23	1951/01+	1951/01+	1951/01+	1988/21	1956/18	**1968/26**	1954/09	1967/10	1950/01+	1950/01+	1950/01+		
Extreme Daily Snowfall (cm)	10.4	5.1	5.4	20.6	16	10.6	16.6	22.9	**25.2**	20.3	21.2	11.9		
Date (yyyy/dd)	1987/28	1953/23	1983/03	1976/15	1995/19	1991/24	1988/07	1967/24	**1980/13**	1953/14	1997/17	1969/10		
Extreme Daily Precipitation (mm)	10.2	19	5.3	19.3	11.4	18.5	18.8	23.4	**25.2**	20.3	11	11		
Date (yyyy/dd)	1965/26	2000/02	1957/13	1976/15	1952/29	1956/18	1968/26	1967/24	**1980/13**	1953/14	1997/17	2004/30		
Extreme Snow Depth (cm)	66	73	79	79	87	**89**	33	30	52	53	57	61		
Date (yyyy/dd)	1965/31	1989/14+	1989/19+	1957/21+	1956/25+	**1956/04+**	1961/01	1993/08	1978/25+	1969/24+	1955/26+	1969/11+		

3. The Water System

3.1 General

The water system is designed to provide water for all the uses at the Station and to as much as possible, prevent freeze ups, especially in the main service lines. As a result, there are water bleeders in most buildings, water tempering to higher temperatures, and additional heat taped water lines.

The water system employs older, yet serviceable equipment.

3.2 Raw Water Source

Upper Dumbell Lake has a surface area of 364 hectares, and an average depth of 7.6 metres. Winter ice depth is 1800mm to 2750mm. Breakup is mid-July and freezeup is early September. Runoff during open water was gauged at 13,600 cubic metres/day. The summer temperature reaches 4°C and the winter temperature ranges from 0°C to 2°C at the bottom[1].

Upper Dumbell Lake discharges to Lower Dumbell Lake, then through an unnamed stream to the ocean.

3.3 Raw Water Pumping

Raw water is pumped continuously from Upper Dumbell Lake, approximately 2.5 kilometres, to the water treatment plant (WTP). The intake extends 46 metres on a 14° angle and is 5 metres deep.

The intake and return lines are now about 30 years old and the insulation has deteriorated as it does when exposed. The intake lines are only 75mm diameter. The main concern is for freezing. Should the station lose circulation (ie continuous flow) in the winter, the lines will be frozen in less than 30 minutes.

3.4 Raw Water Quality

Data exists from 1992. Given the history of the water quality, Upper Dumbell Lake would likely qualify as a pristine source. Appendix B shows some typical water quality results.

3.5 Treatment

All the water is treated by two, 1 metre diameter sand/anthracite pressure filters each rated at 3.2 L/s, chlorinated, then pumped continuously to two storage reservoirs each with at capacity of 227,000 litres. Such a procedure is to ensure freshness and continuous chlorine residual in the water.

[1] Arctic Water Supply System, E.G. Taylor, quoted by CFS Alert Water Treatment Plant Operation and Maintenance Manual, 1 Construction Engineering Unit, CFS Winnipeg, January 1979.

3.6 Distribution

Water is pumped from storage to either a return line to Upper Dumbell Lake, or to distribution within the complex. Excess water overflows from the storage reservoirs to sewage. Wastewater also sent to sewage includes filter backwash water, raw water drain, and the raw water pressure relief valve (PRV) drain.

FSC Figure C1 in Appendix E shows a schematic drawing of the water and sewage piping system based on the observations during the site visit.

Water is distributed to the complex through a single pipe that first primarily feeds the power, maintenance and warehouse buildings (support buildings), then crosses the compound, entering Polaris Hall in the main complex building. The water pipe runs through a crawlspace in the linkway that serves as a service utilidor and connects the accommodations buildings, Ops and HAPS.

The water supply pipe terminates in Churchill Hall (HAPS) where it becomes the feed for the fire sprinkler system for the main complex. Ancillary buildings connected to the water supply include: the incinerator, the gymnasium and the curling rink.

3.7 Bleeders

In the current system, bleeders are critical to keep both water lines and sewage lines flowing. Table 3.1 shows the current buildings in the complex on water/sewer.

The station was built for some 220 people. With populations now at approximately half that, before bleeders were installed, freeze ups were common.

A freeze up is a very dangerous situation and, depending on where it happened, could compromise fire safety and sanitation at the entire station. For these reasons, bleeders must continue with the present building conditions. That said, there are several initiatives and building renovation/refurbishment projects planned for CFS Alert that, as spin-off, may allow water use to be reduced in the future. See 3.12 following.

Table 3.1 – Buildings in Compound on Water/Sewer				
Building	**Water**	**Bleeder**	**Sewer**	**Status**
Water Treatment Plant	Yes	No	Yes	Operational
Standby Power Plant	Yes	Yes - 1	Yes	Operational
Main Power Plant	Yes	No	Yes	Operational
Main Supply & Warehouse	Yes	Yes - 1	Yes	Operational
Main Workshop & Firehall	Yes	No	Yes	Operational
Maintenance Transport	Yes	No	Yes	Operational
Transport Storage	No	No	No	Operational
Main Ops	Yes	Yes - 1	Yes	Operational
Chimo Quarters	Yes	Yes – 2	Yes	Operational
Ladner Quarters	Yes	Yes – 2	Yes	Operational
Whitehorse Quarters	Yes	Yes – 1	Yes	Operational
Churchill Hall	Yes	No	Yes	Operational
Cold Storage	No	No	No	Operational
Incinerator	Yes	Yes – 1	Yes	Lavatory, toilet, sinks removed; bleeding to keep water/sewer operational
Gymnasium	Yes	Yes – 1	Yes	Operational
Curling Rink	Yes	No	No	Closed – now storage

3.8 Water Use Volumes

Table 3.2 – Average Daily Water Volumes						
Year	**Produced**		**Returned**		**Consumed**	
	USGPM	**Litres**	**USGPM**	**Litres**	**USGPM**	**Litres**
	Note 1				Note 2	
2003	52		20		32	174,000
2004	52		20		32	174,000
2005	52		18		34	185,000
2006	50.2		20		30.2	165,000
2007	52.4		20.2		32.2	176,000
2008	50.6		17.7		32.9	179,000

Notes to Table 3.2

1. *Beginning in 2003, measurements were all made in USGPM*
2. *All values shown in litres after 2003 have been calculated using this data and rounded to 3 significant figures.*

3.9 Drinking Water Quality

Appendix B shows drinking water quality data that is collected now, plus the most recent chemical analysis. In summary, the water is better than the Canadian Drinking Water Guidelines for the chemical, organic, and coliforms tested.

Water is routinely tested on site for pH, hardness, turbidity, and E.Coli. Water is tested every two to three years for a full chemical suite including organic, inorganic, and radioactive parameters.

Parameters are tested against drinking water standards and parameters such as organic (pesticides) and radioactive are less than detection limits.

Table 3.3 – Summary of Raw Drinking Water On-Site Testing

Year	Months Reporting	Turbidity Range (NTU)	Hardness Range (mg/L)	pH range (unitless)	Total Dissolved Solids Range (mg/L)
1992		Note 1	102 - 120	7.9 – 8.2	
1995	8		119 – 136	8.1 – 8.3	
1996	10		119 – 136	7.6 – 8.5	
1997	12		Note 1	6.6 – 8.2	
1998	7		95 – 126	7.6 – 8.5	Note 3
1999	11		73 – 144	7.7 – 8.3	110 – 130
2000	3		94 – 104	7.4 – 8.1	100 – 120
2001	Note 2				
2002	12		95 – 124	6.6 – 7.2	104 – 119
2003	10	Note 4	94 – 140	6.6 – 8.0	106 – 135
2004	12	0.1 – 0.7	100 – 119	6.9 – 8.0	104 – 130
2005	12	0.1 – 1.4	94 – 112	7.0 – 9.0	110 - 124
2006	12	0.1 – 0.3	93 - 111	7.1 - 8.25	107 - 124
2007	12	0.1 – 1.0	102 - 114	7.4 – 8.2	107 - 118
2008	7	0.145 – 6.4	99 - 104	8.0 – 8.2	102 - 104

Notes to Table 3.3

1. *No testing*
2. *No records found for 2001*
3. *TDS testing new in 1999*
4. *Turbidity testing new in 2004*

3.10 Personnel Counts

Table 3.4 shows the personnel counts for the years noted.

Table 3.4 – Personnel Counts			
	2006	**2007**	**2008**
JAN	96	90	75
FEB	116	95	85
MAR	130	90	84
APR	196	140	108
MAY	140	105	112
JUN	157	100	147
JUL	195	90	133
AUG	186	90	102
SEP	163	140	83
OCT	136	74	72
NOV	128	87	74
DEC	125	81	incomplete
Average	147	98	97

3.11 Water Use and Sewage Generation

Appendix B shows water use data that is collected now. All the water distributed becomes sewage. The system uses between 165,000 and 185,000 litres per day regardless of the month and number of personnel on Station.

Table 3.5 – 2008 Water Consumed			
	Personnel	**Daily Water Consumed (liters)**	**Per Capita Water Consumption (litres)**
JAN	75	No data	
FEB	85	No data	
MAR	84	No data	
APR	108	No data	
MAY	112	179860	1600
JUN	147	179860	1220
JUL	133	185310	1390
AUG	102	179860	1760
SEP	83	163510	1970
OCT	72	185310	2570
NOV	74	185310	2500

3.12 DND Commitments

3.12.1 Water Use Reduction

Although not a direct reflection of use by people, rather from systemic use, currently per capita water use is high. There are several initiatives and building renovation/refurbishment projects planned for CFS Alert that, as spin-off, may allow systemic water use to be reduced.

Given the current projects planned, DND commits to:

- A reduction of bleeder use by 25% by 2015; and
- A review of water use and sewage production with the goal of reducing water use.

4. The Sewage System

4.1 General

The sewage collection and discharge system is similar to the water system, designed and operated conservatively to prevent freeze ups of all the service lines. L-A28-9305-413 in Appendix E shows the site schematic drawing of the sewage collection and discharge system.

4.2 Sewage Quality

There is no activity or waste source at CFS Alert that would suggest anything other than a normal domestic waste loading. The sewage contains general residential-type waste, faeces, and domestic cleaning compounds.

Waste food is garburated and disposed in the sewer. Food Services[2] advises that the amount of waste generated in the kitchen is perhaps slightly more than a standard commercial kitchen.

There is no other commercial or industrial type waste generated on the Station.

Station personnel are quite cognizant of the environment in which they work and the fact that there is no sewage treatment plant. Hazardous materials are not permitted to be disposed in the sewer.

4.3 Collection

There are several different piping arrangements for the sewage collection system. The support buildings have a single sewage line that connects all three before crossing the compound at the southeast end to discharge to the sewage outfall line.

The main complex has a separate sewage pipe that collects sewage from the complex then discharges it to the sewage outfall pipe.

Other buildings connected separately to the sewage outfall pipe include: the incinerator, the gymnasium, and the water treatment plant.

4.4 Sewage Treatment

Currently, sewage is untreated and is discharged to an outfall located some 250 metres from the receiving body, Parr Inlet, in an area that has a significant slope.

When FSC visited CFS Alert in December 2008, the sewage outfall could not be reached safely to view. Concerns were for falling, getting wet in the -35° weather and, if the outfall was actually reached without injury, not being able to climb back.

[2] Chef Jeff Renaud, pers com, December 7, 2008

4.5 Sewage Treatment Project

4.5.1 Premble

FSC undertook a study in December 2008 to look at various options for sewage treatment. The timing was an important consideration and left no illusions as the isolation, extreme climate and other salient factors that input to the options analysis.

Of the various mechanical and other options considered, overland flow was chosen as a system with the greatest potential to deal with varying flows, and to respect the competing interests at the station.

The site has been used by the Canadian Wildlife Service for important avian studies for 25 years, representing a significant body of continuous data. The present wastewater contains macerated untreated kitchen waste that attracts the birds. Pretreatment of the wastewater would remove this attractant, and a CWS representative has opined that this would destroy the opportunity to continue these important studies. Dr. Morrison's opinion is shown in Section 6.2.

4.5.2 Design Concept for Alert Overland Flow

Overland flow is a viable treatment process well proven in Canada's far North. During the winter, wastewater is stored as ice in the disposal location. As the ice thaws in the spring, water is distributed in a thin film over the lands surface where it is treated by evaporation, by mechanical filtration, biologically by soil organisms, and disinfected by UV radiation from the 24 hour per day sunlight.

The purpose of this design is to ensure the wastewater takes a slow, circuitous route to the receiving body, depositing solids along the way while resident bacteria consumes dissolved organic matter. Shown in Appendix E – FSC C1 &C2, the design further strives to protect against short-circuiting and erosion.

The wastewater treatment area at CFS Alert has historically been a steep sloped granular area above the marine area - Parr Inlet. This design concept is to provide a series of terraces in the slope to trap and delay the wastewater on its route to the Parr Inlet.

Four engineering constraints exist in the concept:

- The slope is as steep as 40% or more in some places;
- Snow accumulates in the area;
- The active layer is very shallow, less than 300mm; and
- The size of equipment on-site is limited to a D6 bulldozer.

In this design, untreated wastewater containing macerated kitchen waste will be directed into terraces that are designed to trap the waste particle and slow the travel of the water.

This slowing is accomplished by decreasing the slope within the terrace to less than 2% and by installing flow attenuation berms within the terrace at several points.

To continue moving, the water will have to either filter through the flow attenuation berm or over top it while the wastewater undergoes treatment within the terrace. This will occur in each of five terraces, as the now treated water flows toward Parr Inlet. To further reduce potential velocities, the outfall will be moved from its present location to one where the land is more gently sloped.

The new outfall location will have safe and reliable year-round access, winter storm events notwithstanding.

Ice rejects solids as it freezes. In warm weather, accumulated solids are part of the "first flush" of liquid from the treatment area as the ice melts. The terraces will lower velocities and also provide mechanical filtration to prevent solids from being flushed to the receiving body.

A 3 metre high snow fence located above the terraces is proposed to capture drifting snow primarily driven by northwest winds. It will be approximately 250 metres in length and will capture approximately 10,000 cubic metres of snow. The fence is located so that, when it melts, much of the accumulated snow will drain away from the treatment area, thus, removing this potential hydraulic loading and reducing additional flushing and contamination of the snow/water. Snow fencing will be monitored annually to optimize location, orientation, height, number of courses, and ensure that all the snow melts.

After the last terrace, the slope becomes gentler. The water will be directed into a crescent shaped flow attenuation berm designed for the purpose of reducing velocity and spreading the water into a very thin film. This film will not cause erosion, and will be more readily evaporated, treated, and disinfected by natural sunlight. Annual monitoring will take place and repairs made should the water begin to channel or cause erosion. A weir box or similar structure will be field engineered and installed as a final compliance monitoring point. Safe and reliable access will be established to this point.

A diversion berm provides protection for a laid-on-the-ground communication cable near the shoreline.

Treatment within the terraces should improve over time as native flora and bacteria grow and acclimatize to the wastewater. Over time, the flora will provide additional mechanical filtration of the wastewater while providing additional support media for bacterial growth similar to a trickling filter.

Any contaminants remaining in the wastewater will be discharged to the receiving body over a wide area instead of a focused point source. This will allow for rapid assimilation into the environment.

Raw wastewater quality will be managed at source by the selection and use of biodegradable cleaning agents, and preventing industrial waste type contaminants from being discharged to sewer.

Residents will undergo an orientation program upon arrival, and activities and potential contaminants will be constantly monitored. See Section 4.6 for DND's commitment to reducing contaminants of emerging concern.

Construction should begin in the latter stages of the warm weather season; approximately August 1, 2010. As well, this date may also be the least disruptive to the CWS avian studies. Survey and lay out should commence with Terrace 1. It is expected that there is some 300mm of active layer each year.

Terrace 1 will require additional depth to install the geotextile (approximately 60mm) and riprap. Removing the active layer then returning after working on the remaining terraces will allow additional thaw in Terrace 1. Terrace alignments may require adjusting in the field to conform to topography.

4.5.3 Research Opportunities

With the proposed alterations to the overland flow treatment area at CFS Alert, there exists an opportunity to study the development of an overland flow system to treat raw sewage from its beginning to its maturation in one of the harshest and remote areas of the planet. Nowhere else in the north is such an opportunity available. All the other "communities" already have established treatment systems.

Discussions have begun with the Northern Working Group of Environment Canada who shows interest in a joint venture with DND.

4.6 DND Commitments

4.6.1 Sewage Treatment

DND commits to:

- Meeting the spirit and intent of the National Compliance Standards for effluent quality understanding that the overland treatment system will take several years to acclimatize, develop and mature;
- Completing the design and construction of the overland flow treatment by October 2010; and
- Working with Environment Canada to test this new system.

4.6.2 Contaminants of Emerging Concern

Not in the current National Performance Standard, or Federal Facilities Guidelines, but rising in importance as discussions with Health Canada continue, are contaminants of emerging concern. A partial list relevant to CFS Alert includes:

- Pharmaceutical and personal care products;
- Surfactants – surface active agents;
- Organic solvents; and
- Anti-bacteria agents.

These contaminants are not removed by conventional sewage treatment. Their fate in the proposed treatment process is unknown. CFS Alert will show leadership by addressing these concerns and committing to:

- Ensuring procedures are in place to prevent sewer disposal of waste pharmaceutical drugs and personal care products. Rather, these items are disposed by incineration prior to landfilling or shipped south for disposal;
- Notwithstanding the need for personal hygiene and station cleanliness, selecting cleaners that are biologically compatible with the sewage treatment process and the environment;
- Not disposing organic solvents or such materials in the sewer; and
- Restricting anti-bacteria agents --- such agents are found in so-called anti-bacteria and the like. They are weak bactericides that do not kill all the bacteria. Those surviving can mutate and are stronger from the experience.

  All soaps are anti-bacterial as they can disrupt the cell wall of the bacteria. Those surviving are unlikely to mutate to a stronger form. Soaps and other products with so-called anti-bacteria agents will be restricted as much as possible at CFS Alert.

  DND believes that this is important and wishes CFS Alert to continue as a site for on-going avian and other arctic research. The birds are there in numbers for the particles in the sewage area. It is known that there are organisms that will cross between birds and people. Therefore, it is prudent to reduce the numbers of mutated anti-biotic resistant organisms in the area.

5. Solid Waste Issues

5.1 General

There are many animals around the station, but garbage is strictly managed to prevent animals from eating any waste. Personnel receive an orientation program each time they come to the station.

5.2 Landfills

Sketch NRC Figure 3 shows the location of the landfills. There are four landfill sites:

a. The Battery Dump;
b. The Millionaire's Dump;
c. The Main Station Landfill; and
d. Dump 3.

Millionaire's Dump is used for larger metals and bulky wastes.

Dump 3 contains old vehicle parts, wire, and other metallic objects.

Waste oils and lubricants are used in the waste oil burner to heat the garage.

5.3 Garbage

Garbage is collected daily in sealed containers and plastic bags. All combustible garbage is taken to the incinerator building and incinerated as required.

Once cool, only ashes and clinker are disposed in the Main Station Landfill. This landfill site was designed to manage surface water runoff and eliminate surface and subsurface contamination. Surface water that appears outside the disposal area is routed around the berms. The dump is covered as time/equipment is available.

Sketch FSC C1 shows the location of incinerator building

There is a recycling program for cans, bottles, and hazardous materials such as batteries. All recyclable materials are shipped to Trenton, Ontario for further processing.

5.4 Hazardous Materials

All hazardous materials generated at the Station are collected, stored in HazMat overpacks and shipped south for management and disposal.

Past practices did not always meet today's standards, and there are several areas of contamination. RMC has had a delineation program in place and it is understood that the Station is moving toward an appropriate cleanup.

5.5 Abandoned Solid Waste Sites

There are no abandoned solid waste sites.

6. Wildlife Issues

6.1 General

While one might think of the very high arctic as a frozen, barren land; it is not, and many forms of flora and fauna live there year-round. There are many more visitors.

A discussion of all the wildlife is outside the scope of this project; however, the information collected suggests that there needs to be some discussion as it pertains to the sewage outfall as competing interests exist. This follows.

6.2 Birds

Dr. R.I.G. Morrison of the Canadian Wildlife Service has been coming to Alert for 25 years to set catch nets along the line of the outfall. There is a plaque on the wall outside Ladner Hall commemorating his 25th year.

CWS volunteers at the Station report there is a high concentration of various important bird species that feed on the particles in the upper portion of the overland outfall. Further, numerous seals are seen feeding on the fish that are attracted where the effluent enters the water.

An opinion from Dr. R.I.G. Morrison, Environment Canada follows.
Also see Appendix A.

> **Wildlife/Shorebird Research at Alert**
>
> Studies on shorebird and other bird populations at Alert constitute one of the longest running bird research programs conducted by Environment Canada in the Arctic. Work started in the 1970s, running from 1974-1976, and has continued from 1986 to the present with 2008 bring the 25th field season.
>
> Research focuses mostly on shorebirds, principally Red Knots and Ruddy Turnstones, with additional studies on Long-tailed Jaegers and Ivory Gulls. Long-term studies include work on migration, survival, and return rates of individually marked birds; studies of energy metabolism using doubly-labelled water; ecophysiological studies of dynamics and functions of body stores using stable isotopes; relations between climate change and shorebird breeding and distribution; interactions of predators, lemming cycles, and weather with breeding success; orientation at high latitudes; relationships between blood metabolites and migratory/breeding states; stress responses in High Arctic birds; and various other topics.

Results from the work have made important contributions of both biological and conservational interest. For instance, it was discovered that body stores which the birds accumulate during migration and which are brought to the breeding grounds are not used for egg formation but are likely essential for physiological transformation from a state suitable for migration to one suitable for breeding.

Work has also shown that when the birds are unable to accumulate suitable amounts of body stores, there is a severe penalty in reduced survival. This important finding has provided an understanding of the reasons for the drastic declines and lower survival rates of North American populations of Red Knots, which have recently been designated as Endangered.

Over the years, the military at CFS Alert has provided outstanding support for this research, as have staff at the Environment Canada Weather Station and GAW laboratory.

The facilities at Alert provide a unique and important opportunity for studying birds and wildlife at the most northerly limits of land in the world. There is no other site in the Arctic where it would be possible to catch, band, and carry out field and laboratory studies on shorebirds in the numbers required for scientific sampling. The unique nature of Alert is related at present to the sewage outfall stream, which attracts shorebirds and other birds early in the summer after their arrival when much of the landscape is still covered with snow, as well as later in the summer, when birds are preparing for their migration south.

The birds gather at the stream not to feed on the sewage, but to feed on the small food particles that result from left-over food being garburated in the kitchen and flushed down the stream.

It seems certain that if a sewage treatment facility were to be installed that resulted in kitchen waste food particles being removed from the water, so that no particles were discharged into the stream, that the birds would be highly unlikely to gather in any numbers at the stream, and the opportunities for studies involving banding significant numbers of birds would be destroyed.

> Since there is ongoing interest by Environment Canada and university scientists in continuing this work, and building on the results accumulated over the past quarter century, it would be a major loss if the installation of a sewage treatment facility resulted in the destruction of Alert as an area where the most northerly shorebird research in the world could be carried out.
>
> Dr. R.I.G. Morrison, Environment Canada, Science and Technology, Wildlife Research

6.3 Wolves

There is a resident population of wolves at the Station. The wolves are there of their own accord and are neither encouraged nor discouraged by station personnel. The wolves do not appear to be aggressive and it appears that only the pups are curious enough to come close to a person.

The presence of resident wolves is a source of pride for many station members. At the initial orientation and continuing daily, personnel are warned to be cautious, manage their wastes in the prescribed manner, and not to feed the wolves.

The wolves often leave the Station for days and even weeks at a time, presumably to hunt, as hare are frequently seen in the area around Dumbell Lake, and other prey species also exist in the vicinity[3].

The wolves are important to the morale of the Station, and those people who are familiar with the Station and/or have been there over the years, would be saddened if the wolves were culled or eliminated. Wolves also have a starring role in several YouTube selections on life at CFS Alert.

Dr. Morrison also reports that CFS Alert is something of an attraction for the wolves. He advises that they do visit the effluent stream, though he has never seen them catch a bird (they would take an injured or exhausted one, no doubt, if the chance occurred). They sometimes lounge around the stream but he doesn't think they use it for any purpose.

[3] Terry Gibbons, "Trashman", pers com, December 7, 2008

6.4 DND Commitments

DND is proud of the unique relationship CFS Alert has with its environmental stewardship, and with the resident and visiting wildlife at CFS Alert.

DND is also very proud of the collegial relationship it has maintained with Environment Canada for many years.

DND commits to:

- Maintaining an environment conducive to the preservation and enhancement of local wildlife; and
- Maintaining and fostering additional opportunities for arctic study and research with Environment Canada, universities, and others.

7. Sewage Sampling

7.1 Sampling Constraints

CFS Alert is a very isolated post currently receiving only one scheduled military flight per week. The military flight does not always return promptly to the south.

Weather and the other vagaries of high arctic travel makes it difficult, if not impossible at times, to have water samples reach a CAEAL approved laboratory routinely without violating QA/QC wait times.

7.2 National Compliance Standards

CFS Alert is considered to be a Very Small Facility with a continuous discharge.

Table 7.1. Monitoring for Substances and Test Groups for Initial Characterization

Facility Size[1]	TRC[2] (or dechlorination agent)	cBOD5, TSS, Pathogens Nutrients [3]	Substances and Test Groups[4]	Acute Toxicity	Chronic Toxicity
Very Small	Daily	Monthly	n/a	n/a	n/a

Notes to Table 7.1

1. Facilities that discharge less than 10 m3/day are not required to complete initial characterization.

2. Only required if chlorine is used in the wastewater facility.

3. Nutrients include total ammonia nitrogen, TKN (ammonia + organic N) and total phosphorus. Temperature and pH must also be measured to determine the level of toxicity of ammonia. Pathogens could include E.Coli.

4. Substances and test groups will include the following: Fluoride, Nitrate, Nitrate + Nitrite, Total Extractable Metals and Metal Hydrides (full range), COD, Organochlorine Pesticides, PCBs, PAHs, Cyanide (total), pH, Volatile Organic Compounds, Mercury, Phenolic compounds, Surfactants, plus other substances specifically associated with industrial or commercial activities that discharge into the sewer system.

Table 7.2. Compliance Monitoring and Toxicity Testing Requirements for Continuous Discharge Facilities

Facility Size	Flow (m3/day)	TRC[1] (or dechlorination agent)	TSS and cBOD5	Acute Toxicity	Chronic Toxicity
Very Small	≤ 500	Daily	Monthly[2]	n/a	n/a

Notes to Table 7.2

1. Only required if chlorine is used in the wastewater facility.

2. May be reduced to quarterly for lagoons and any facility with an average daily flow of less than 100 m3/day.

3. Very small and small wastewater facilities which have industrial input associated with municipal wastewater are to be treated as medium wastewater facilities.

Table 7.3. Compliance Averaging Periods for CBOD5/TSS

Facility Size	Annual Average Daily Flow (m3/day)	Averaging Period for cBOD5/TSS
Very Small[1]	≤ 500	Quarterly[1]

Notes to Table 7.3

1. *Lagoons and any facility with an average daily flow < 100 m3/day, that are testing quarterly, must meet an annual average.*

7.3 DND Commitments

DND commits to meeting the spirit and intent of the National Compliance Standards for sampling and compliance.

7.4 DND Compliance Proposal

7.4.1 Proposed Characterization

Given the current effluent conditions, it is our opinion that a sampling program will provide erroneous results that will cloud the interpretation of any attempted unit process analysis and treatment efficiencies. As previously noted, the sewage is typical of municipal type sewage with the additional component of a garburated food from a commercial kitchen.

Table 7.4 shows the effect of population and the high water use on BOD for example (including a factor for kitchen waste) with a typical[4] BOD loading of 113398 mg/person/day (0.18 lbs/person/day + 0.07 lbs/person/day for garburated food).

[4] Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, pg 182, McGraw Hill, 2003.

Table 7.4 - Estimated Raw Sewage BOD Based on Engineering Design Normals; includes garburated food			
Population	**Flowrate (litres/day)**	**Lpcd**	**Resultant Raw Sewage BOD (mg/L)**
50 (SOW stated minimum)	165,000	3,300	34
114 (last 3 year average)	165,000	1,447	78
200 (SOW stated maximum)	165,000	825	137
50	185,000	3,700	31
114	185,000	1,623	70
200	185,000	925	123

It is our opinion that until per capita water use, population, and systemic water use can be more closely linked, then characterization sampling will not provide useful results. Instead, Engineering normals should be used to estimate the raw sewage quality.

7.4.2 Schedule

As previously discussed, at the present time it is not safe for station staff to sample at the outfall during cold weather months. Compliance monitoring can begin once the new facility is constructed with safe and reliable access to the compliance point. Compliance monitoring should begin in 2011.

7.4.3 COD and cBOD

One of the research items recommended at the Yellowknife Workshop in March 2009 was developing a relationship between COD and cBOD site specifically. Given the difficulty getting compliance samples to the lab from remote locations, this seems a prudent consideration.

COD is a parameter that can be done on site inexpensively with a Hach kit. Hach tests are designed to reduce the influence of inexperienced users. Contract WEF-Tech Operators employed at CFS Alert routinely use Hach test kits and are skilled in their use.

Monthly effluent compliance sampling could become as simple as a grab sample at the final point of compliance for a single parameter such as COD.

Engineering normals also exist for a COD/BOD relationship.

7.4.4 Compliance Proposal

Once a COD/cBOD relationship is established, NWB should allow COD alone as a compliance test instead of cBOD and TSS.

DND will undertake to establish a COD/cBOD/TSS relationship during the first year of compliance, 2011. This relationship will be established by taking monthly samples from the effluent during times of flow from the final compliance point at the lower terrace.

DND will have the samples analyzed at a CAEAL approved laboratory and compare those results with COD testing completed by station staff. A relationship will be established and provided to the NWB for the final effluent. Such relationships should available by December 2011.

After that DND will submit compliance results to the NWB based on COD alone completed by CFS Alert staff. As much as possible, DND will collect an annual QA/QC sample to be tested at a CAEAL approved laboratory.