# Resolute Bay: Interim Sewage Management Plan for Discussion

## Problem Summary

The airport sewage lagoon in Resolute Bay is undersized and does not meet the requirements of the trucked sewage services. Every winter the lagoon overflows and the sewage freezes in the wetland treatment area between the lagoon and the ocean. There are future plans of discharging the trucked sewage to the new wastewater treatment plant which is anticipated to start construction in 19/20. Community and Government Services (CGS) has developed several interim trucked sewage management options to present to all stakeholders for further discussion.

## Background

The residents of Resolute Bay are serviced by both a trucked water and sewer delivery service and a town core piped water and sewer distribution system. The wastewater from the trucked sewage is discharged to the airport lagoon which exfiltrates into a 1.5 km long wetland treatment area prior to final discharge to the ocean.

The wastewater from the piped system flows through a macerator building and outfall pipe discharges to the marine environment. This effluent is heavily diluted in the utilidor system as a result of the requirement to bleed the system which facilitates flow in dead end portions of the system, ensures adequate flow goes to the sanitary system and acts to keep the pipes unfrozen.

In 2010 CGS initiated a project to upgrade the entire water and sewer service system for Resolute Bay. This project included a full replacement of the water and sewer pipeline, upgrades to the water treatment plant and construction of a new wastewater treatment plant. The project was tendered in 2013 but came in over budget and therefore was split into phases based on priority. Currently the first phase is under construction which includes a full replacement of all the water and sewer lines. The wastewater treatment plant is anticipated to begin construction in 19/20 dependent on funding approval. The upgrades to the wastewater treatment plant include receiving the trucked sewage which is currently disposed of at the airport lagoon.

The airport lagoon is regulated by the water license 3BM-YRB0308. On December 14$^{th}$, 2015 a letter of non-compliance was issued by Indigenous and Northern Affairs Canada. The letter identified the airport sewage treatment facility requires upgrades or modifications to meet the obligations of the water license.

New lagoons typically range from $5,000,000 to $8,000,000 and upgrades range from $2,000,000 to $3,000,000. At this time, CGS is not in a financial position to invest this amount of funding into the airport lagoon considering it will no longer be required once the new wastewater treatment plant is operational. CGS is committed to working with all stakeholders to develop an agreed upon path forward for interim sewage management.

## Current Sewage Treatment

Three options have been developed for discussion with regulators and other stakeholders. These are further described below. To better understand the implications of each option it is prudent to understand the degree of treatment that is taking place in the airport lagoon/wetland system and the effluent quality leaving the utilidor discharge pipe. For context Table 1 presents the current water licence requirements for Resolute Bay.

**Table 1: Effluent quality standards as required in the water licenses**

| License # | Sample Location | BOD (mg/L) | TSS (mg/L) | pH | Faecal Coliform (CFU/100mL) |
|---|---|---|---|---|---|
| **3B-YRB0308** | **YRB-3** | 120 | 180 | 6-9 | 1.00E+06 |
| **3B-RUT1520** | **RUT-2 (600 lcpd)** | 80 | 70 | 6-9 | TBD |
| **3B-RUT1520** | **RUT-2 (150-600 lpcd)** | 120 | 80 | 6-9 | TBD |

### Current Treatment of Airport Lagoon/Wetland System

The sewage lagoon overflows each winter and it is assumed as the sewage overflows it freezes beyond the lagoon in the wetland area. This frozen sewage melts during spring thaw and flows 1.5 km through the wetland. During the summer, sewage discharged to the lagoons has a very short retention time and exfiltrates through the berms and into the wetland treatment area.

As presented in Table 2, the average $BOD_5$ and TSS concentrations entering the lagoon are 643 mg/L and 203 mg/L respectively. The average $BOD_5$ and TSS concentrations leaving the lagoon are 637 mg/L and 166 mg/L respectively. The faecal coliform levels entering the lagoon are $1.9 \times 10^6$ CFU/100 ml and leaving the lagoon is $4.6 \times 10^6$ CFU/100mL. This indicates very little treatment is taking place in the lagoon; there is a 1% reduction in $BOD_5$, an 18% reduction in TSS and a 59 % increase in faecal coliform levels.

Unfortunately there is only one sampling event for the wetland treatment and it is believed the samples were taken about 200 m downstream of the lagoon. The results indicated a water quality of <3 mg/L of both $BOD_5$ and TSS and $9.6 \times 10^3$ CFU/100. These results are not typical for a 200 m wetland treatment area so need to be used with caution.

**Table 2: Mean lagoon effluent quality of samples taken over a 3 year period**

| Location | $BOD_5$ (mg/L) | TSS (mg/L) | pH | Faecal Coliform (CFU/100mL) |
|---|---|---|---|---|
| **Truck (raw sewage)** | 643 | 203 | 7.3 | 1.88E+06 |
| **Lagoon discharge** | 637 | 166 | 7 | 4.57E+06 |
| **Wetland*** | 3 | 3 | 8.03 | 9.60E+03 |

*Effluent quality based on only one sampling event

Recent scientific research in Nunavut has indicated that natural wetland areas are capable of achieving acceptable levels of wastewater treatment. Specifically, through the International Polar Year programme and Environment Canada, the Centre for Alternative Wastewater Treatment (CAWT) conducted site investigations at 13 tundra wetland locations in Nunavut and the NWT during the summer of 2008. These results have been drawn on as a means to gauge the level of treatment that can be predicted for the Resolute Bay wetland system. Of the 13 wetlands studied by CAWT Baker Lake, Chesterfield Inlet and Repulse Bay are the three most representative sites for the wetland in Resolute Bay. Similarly to Resolute Bay these sites receive wastewater that receives minimal to no pre-treatment (note the studies were completed prior to the upgrades to the Baker Lake and Chesterfield Inlet lagoons). The concentration of $cBOD_5$ entering these systems ranged from 550-1000mg/L.

**Table 3: NU Wetland Treatment Summary**

| Community | % reduction $cBOD_5$ | % reduction TSS | % reduction e.*Coli* | Wetland length (m) at point of sampling | Wetland Watershed (ha) | Daily volume discharged (m3/day) |
|---|---|---|---|---|---|---|
| **Baker Lake** | 99 | 99 | >99 | 70m | 1.1 | 167 |
| **Chesterfield Inlet** | 94 | 86 | >99 | 700m | 55 | 36 |
| **Repulse Bay** | 93 | 82 | 100 | 1.4m | 9.5 | 66 |
| **Average** | **95** | **89** | **>99** | | | |

## Current Effluent Quality from Utilidor Outfall Pipe

Raw sewage entering the utilidor system is mixed with the bleed water and as a result is diluted. This does not constitute treatment however the effluent entering the marine environment does meet the effluent quality criteria set out in the water license as shown in Table 1.

The piped water and sewer system is currently being fully replaced and construction is anticipated to be complete by October 2016. These upgrades will reduce the requirement of bleeding the system which will reduce the amount of dilution occurring in the system.

**Table 4: Current and predicted utilidor flow and effluent quality**

| Location | Utilidor flow rate (l/d) | $BOD_5$ (mg/L) | TSS (mg/L) | Faecal Coliform (CFU/100mL) |
|---|---|---|---|---|
| **Current Utilidor Outfall** | 1,173,897* | 12 | 10 | 7.78E+03 |
| **Predicted Utilidor Outfall** | 221,184** | 64 | 53 | 4.13E+04 |

*Based on 2015 Annual Report

**Based on exp New Utilidor Design Report

# Interim Sewage Management

Three options have been developed for discussion with regulators and other stakeholders. These are further described below.

## Option 1: Status Quo

Option 1 involves maintaining the current practice of sewage disposal. All of the wastewater collected by the trucks will continue to be discharged to the airport lagoon. The lagoon will continue to overflow in the winter and the wastewater would freeze in the areas downstream of the lagoon.

### *Anticipated Effluent Quality*

Discharging to the lagoon allows for some settling of suspended solids as well as removal of solids during exfiltration through the lagoon berms. The majority of the treatment would take place in the wetland area when it becomes active. It is assumed the wastewater discharged throughout the winter will freeze and then thaw during spring melt. While not receiving treatment, there will be a dilution effect for this early melt effluent that flows before the wetland is active. Table 5 presents the anticipated effluent quality that would be entering the marine environment. This assumes no treatment is achieved in the lagoon and therefore the raw truck data as presented in Table 2 ($BOD_5$ 643mg/L, TSS 203mg/L, and FC 1.88E+06) was used as the influent loading concentration onto the wetland.

**Table 5: Option 1 Anticipated Effluent Quality Entering the Marine Environment**

| | $cBOD_5$ | TSS | e.Coli | Wetland length (m) at point of sampling | Wetland Watershed (ha) | Daily volume discharged (m3/day) |
|---|---|---|---|---|---|---|
| **Literature values** | 95% reduction | 89% reduction | 89% reduction | 1.5km* | 56* | 11.5 |
| **Effluent Quality** | 32mg/L | 22mg/L | 1.88E+04 | | | |

% reductions are based on CAWT data as presented in Table 3

*Based on Google earth imagery

**Based on 2015 Annual Report

Note: the wetland watershed and length in Resolute Bay are equal to or greater than those in the 3 representative wetlands. The daily volume discharged is significantly less than the 3 representative wetlands

## Option 2 and 3: Discharge Trucked Wastewater to the Piped System

Options 2 and 3 involve discharging a portion of the trucked wastewater (Option 2) or all of the trucked wastewater (Option 3) to the piped sewer system. This would reduce/eliminate the likelihood of the lagoon overtopping in the winter months. A truck discharge point would be constructed with a small holding tank (sufficient to hold the volume of at least one truck load). This would be connected to the current sewer main and released at a rate as to not surcharge the system to cause backflow into the homes.

### *Anticipated Effluent Quality- Option 2*

The portion of the wastewater trucked to the piped sewer system would not receive treatment however it would be diluted. The degree of dilution would depend on the flow rate into the sewer main and the flow rate through the sewer main. Table 6 presented the anticipated effluent quality entering the marine environment.

In addition to the assumed parameters outlined in previous sections, the following assumptions were made:

- One truckload is discharge into the pipe network a day (12,500L)
- Release the trucked sewage slowly into piped system over a period of 6 hrs or 12 hours
- Using the equation: $\mathrm{Qin\ truck} \times \mathrm{Cin\ truck} + \mathrm{Qin\ pipe} \times \mathrm{Cin\ pipe} = \mathrm{Qout} \times \mathrm{Cout}$

**Table 6: Option 2 Anticipated Effluent Quality Entering the Marine Environment**

| Predicted Effluent Quality | $BOD_5$ (mg/L) | | TSS (mg/L) | | Fecal Coliform (CFU/100mL) | |
|---|---|---|---|---|---|---|
| | 6 hr rate | 12 hr rate | 6 hr rate | 12 hr rate | 6 hr rate | 12 hr rate |
| | 170 | 123 | 81 | 68 | 3.80E+05 | 2.28E+05 |

### *Anticipated Effluent Quality – Option 3*

As with Option 2 the wastewater trucked to the piped sewer system would not receive treatment however it would be diluted. The degree of dilution would depend on the flow rate into the sewer main and the flow rate through the sewer main. Table 7 presented the anticipated effluent quality entering the marine environment.

In addition to the assumed parameters outlined in previous sections, the following assumptions were made:

- All trucked sewage is diverted to the utilidor system
    - Based on the 2015 Annual Report this averages 11,500 L/ day; however during months of higher facility use this is upwards of 17,800 L/day
- Release the trucked sewage slowly into piped system over a period of 6 hrs or 12 hours
- Using the equation: $\mathrm{Qin\ truck} \times \mathrm{Cin\ truck} + \mathrm{Qin\ pipe} \times \mathrm{Cin\ pipe} = \mathrm{Qout} \times \mathrm{Cout}$

**Table 7: Option 3 Anticipated Effluent Quality Entering the Marine Environment**

| Predicted Effluent Quality | $BOD_5$ (mg/L) | | TSS (mg/L) | | Fecal Coliform (CFU/100mL) | |
|---|---|---|---|---|---|---|
| | 6 hr rate | 12 hr rate | 6 hr rate | 12 hr rate | 6 hr rate | 12 hr rate |
| **Average daily volume** | 164 | 118 | 79 | 67 | 3.59E+05 | 2.15E+05 |
| **Maximum daily volume** | 205 | 144 | 90 | 74 | 4.89E+05 | 2.96E+05 |

DATA:

| | Date (month-year) | sample location | BOD (mg/L) | TSS (mg/L) | pH | Faecal Coliform (CFU/100mL) |
|---|---|---|---|---|---|---|
| Utilidor | Sep-12 | Utilidor | n/a | 10 | 7.86 | n/a |
| | Oct-12 | Utilidor pipe | 8 | 6 | 7.6 | 20000 |
| | Jul-13 | wastewater | 13 | 13 | 2.69 | 800 |
| | May-14 | Discharge pipe | 16 | 3 | 7.87 | 5700 |
| | Sep-14 | RUT-2 | 10 | 8 | 7.76 | 10400 |
| | Dec-14 | Discharge pipe | 11 | 18 | 7.03 | 2000 |
| | | **Average** | **12** | **10** | **6.80** | **7.78E+03** |
| Truck | Aug-13 | Truck | 374 | 168 | 8.43 | 3200000 |
| | Oct-13 | Truck | 164 | 136 | 7.76 | 1600000 |
| | Dec-14 | Truck | 1390 | 304 | 5.71 | 830000 |
| | | **Average** | **643** | **203** | **7.3** | **1.88E+06** |
| Sewage Lagoon | Sep-12 | lagoon | 620 | 128 | 7.56 | <20 |
| | Oct-12 | airport lagoon | 430 | 272 | 7.36 | 26000000 |
| | Aug-13 | airport lagoon | 448 | 112 | 7.48 | 800000 |
| | Oct-13 | sewage lagoon | 1240 | 340 | 7.57 | 2600000 |
| | Aug-14 | start of decant | 674 | 140 | 7.65 | 660000 |
| | Aug-14 | middle of decant | 372 | 64 | 7.68 | 670000 |
| | Aug-14 | end of decant | 382 | 72 | 7.69 | 750000 |
| | Dec-14 | lagoon | 933 | 196 | 6.78 | 480000 |
| | | **Average** | **637** | **166** | **7** | **4.57E+06** |
| wetland | Sep-12 | wetland | 3 | 3 | 8.03 | 9600 |
| | | **Average** | **3** | **3** | **8.03** | **9.60E+03** |
| License | 3B-YRB0308 | YRB-3 | 120 | 180 | 6-9 | 1.00E+06 |
| | 3B-RUT1520 | RUT-2 (600 lcpd) | 80 | 70 | 6-9 | TBD |
| | " | RUT-2 (150-600 lpcd) | 120 | 80 | 6-9 | TBD |