Government of Nunavut

Wetlands Assessment, Sewage Treatment Wetlands, Hamlet of Repulse Bay, NU

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Executive Summary

The Government of Nunavut (GN), Department of Community and Government Services (CGS) retained **exp** Services Inc. (**exp**) to prepare a Screening Level Environmental Assessment (SLEA) under the *Canadian Environmental Assessment Act* (CEAA) in order to complete the detailed planning design for the sewage system upgrade for the Hamlet of Repulse Bay, Kivalliq Region, Nunavut, hereinafter referred to as the 'Site'.

In addition, the project included an assessment of the suitability of the existing wetland sewage treatment area to achieve further reduction of contaminants and pathogens before reaching Hudson Bay.

The purpose of the Wetlands Assessment is to determine if the Hamlet's existing wetland sewage treatment area is in compliance with the requirements of the Nunavut Water Board, water license number NWB3REP0409 – Hamlet of Repulse Bay.

The Wetlands Assessment revealed that the existing sewage treatment system for the Hamlet of Repulse Bay will likely not reduce the contaminants and pathogens of effluent waters before discharging into Hudson Bay in the long-term.

The observation of some declines of BOD, pathogens and total oil and grease between the truck discharge point and the wetland outlet confirm that phytoremediation is occurring, as expected. However, the levels of contaminants and pathogens remain high throughout the Site; any reductions observed are low; there was an increase in the amount of TSS observed at the wetland outlet; and, visible sheen was noted at various surface water bodies throughout the Site. Due to the low decline of the majority of contaminants, the performance of the wetland to assimilate sewage cannot be confirmed. This interpretation may identify that the assimilative capacity of the wetlands results in the release of water to Hudson Bay with moderate concentrations of contaminants.

The vegetation survey and water sampling program conducted at the Site indicated that the existing wetland community may not be functioning effectively as a sewage treatment system; and, will likely fail in the long-term.

Therefore, it is recommended that mitigation measures be implemented at the Site to improve the performance of the sewage treatment wetlands in the long-term, with the construction of a sewage lagoon at the sewage inlet point.

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Chapter 1 – Introduction

1 Introduction

The Government of Nunavut (GN), Department of Community and Government Services (CGS) retained **exp** Services Inc. (**exp**) to prepare a Screening Level Environmental Assessment (SLEA) under the *Canadian Environmental Assessment Act* (CEAA) in order to complete the detailed planning design for the sewage system upgrade for the Hamlet of Repulse Bay, Kivalliq Region, Nunavut, hereinafter referred to as the 'Site'.

In addition, the project included an assessment of the suitability of the existing wetland sewage treatment area to achieve further reduction of contaminants and pathogens before reaching Hudson Bay.

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1.1 Background

The Hamlet of Repulse Bay (Hamlet) is the proponent and Responsible Authority (RA) of the project, and as such, triggers the requirement for a screening level environmental assessment for the project under section 5(1)a of the *Canadian Environmental Assessment Act*. Due to the size and location of the proposed project(s) (i.e. leaving a footprint >25 m^2), it cannot be excluded under *CEAA*, and an environmental assessment as per *CEAA* must be completed prior to any physical work completed by the proponent. The Stakeholders for this project are the Hamlet of Repulse Bay, the Government of Nunavut and the Nunavut Water Board.

The Hamlet utilizes a sewage disposal facility located approximately 400 m to the northeast of the edge of the community. The sewage disposal facility is located at the solid waste disposal facility, and consists of a simple truck offload discharge area, which is directed to a natural wetlands area. The effluent at this wetlands area proceeds downstream along a 1,400 m flow path through a series of wetlands and surface water bodies, situated within a valley, until finally discharging to the marine environment entering Hudson Bay. The total area of the natural wetlands area is approximately 64,000 m^2. Refer to Figure 1 in Appendix A for the Site Location Plan.

Repulse Bay is a hamlet located at the shore of Hudson Bay, Kivalliq Region. The total area is approximately 425 km^2 (GN, 2009), with an estimated population of 999 in 2011 (95% Inuit, 5% non-Inuit) (RB, 2011). Repulse Bay lies directly on top of the Arctic Circle in central Nunavut (RB, 2011). The Inuktitut name for Repulse Bay is Naujaat, which translates to "nesting place for seagulls". The name comes from the actual nesting grounds located on cliffs approximately 5 km north of the Hamlet; and, every June, thousands of seagulls occupy the area, as well as snow birds, loons, eider ducks, longtail ducks and jaegers (RB, 2011).

Repulse Bay is situated in the Northern Arctic Terrestrial Ecozone, and is characterized by continuous permafrost 90 to 100 % of the year. The Hamlet receives an average of 150 mm of rainfall, 130 cm of snowfall and 285 mm of precipitation, per year. Average daily temperatures range from a low of approximately -30°C in January and February to a high of approximately 9.3°C in July.

The subsurface stratigraphy at the Site is within the continuous permafrost zone, and is expected to comprise glacial till with lacustrine deposits of unconsolidated sand and gravel.

Due to the current population and trend for expansion, it is necessary to assess the suitability of the Hamlet's existing wetland sewage treatment area. This suitability is determined through the analysis of the current and required assimilative capacity. The determination of assimilative capacity requires an analysis of the total volume of wetland available to treat effluent, along with the consideration of total expected effluent volumes. If the existing wetlands are demonstrated to substantially reduce the loads of

different contaminants that drain to Hudson Bay, then the assimilative capacity of the wetland will be confirmed. If the wetlands are unable to reduce the load of different contaminants that drain to Hudson Bay, then mitigation measures will need to be identified and implemented.

The Hamlet's existing wetland sewage treatment area is located approximately 400 m to the northeast of the edge of the community. It is comprised of a simple truck offload discharge area, which is directed to a natural wetlands area, as shown in Figure 2 (Appendix A). The wetlands area is approximately 64,000 m^2. It is expected to treat effluent and include the removal of total suspended solids (TSS), biological oxygen demand (BOD), nutrients and pathogens.

The subject property has a Sewage Disposal Facility license (NWB3REP0409), which provides effluent quality limits for five (5) chemical parameters; including TSS, BOD, pH, fecal coliforms, and total oil and grease. The effluent quality limits at the downgradient location prior to discharging to Hudson Bay must meet the compliance guidelines for TSS of 100 mg/L; BOD of 80 mg/L; pH between 6.0 and 9.0; fecal coliforms of 10,000 CFU per 100 mL; and, no visible sheen related to total oil and grease.

1.2 Objectives

The objective of the Wetlands Assessment is to evaluate the efficiency of the wetlands area, as part of the existing wetland sewage treatment area of the Hamlet, and its ability to effectively reduce contaminants and pathogens of effluent waters before discharging into Hudson Bay.

Chapter 2 –
Repulse Bay Wetlands Area

2 Repulse Bay Wetlands Area

A Site visit was undertaken by **exp** staff from September 6th through 8th, 2012 to carry out a vegetation survey of the wetlands area, to survey the Site and collect surface water samples. All areas of the Site were accessible during these Site visits.

2.1 Vegetation Community

Repulse Bay is situated in the Northern Arctic Terrestrial Ecozone, directly on the Arctic Circle line, and is characterized by continuous permafrost 90 to 100 % of the year. The Hamlet receives an average of 150 mm of rainfall, 130 cm of snowfall and 285 mm of precipitation, per year. Average daily temperatures range from a low of approximately -30°C in January and February to a high of approximately 9.3°C in July.

The Northern Arctic Terrestrial Ecozone is characterized by long cold winters and short cool summers. The harsh temperatures result in a shorter growing season, when compared with regions south of the Arctic Circle. This region also contains numerous surface water bodies and wetlands that serve as important wildlife habitat. Permafrost is continuous throughout the area, but there are active surface soil layers that partially thaw in the summer.

The wetlands area, located between the truck discharge point and Hudson Bay, is vegetated with Arctic tundra and wetland species, ranging in height from ground cover species to grasses up to approximately 60 cm tall. This vegetation occurs in depressions (poorly drained low-lying areas) between rock outcrops on both sides of the wetlands, which provide some protection from wind.

A vegetation survey was carried out during the Site visit in September 2012, and is presented in Table 2-1. It should be noted that a complete plant list is not available, given that the current survey only reflects the late summer season flora only; the spring species are absent or not fully represented.

Table 2-1: Plant Species Observed at the Wetlands Complex

Family	Common Name	Scientific Name
Aster (Asteraceae)	Arctic daisy	*Chrysanthemum articum*
Birch family (Betulaceae)	Dwarf birch	*Betula nana*
Heath family (Ericaceae)	Northern Labrador tea	*Rhododendron tomentosum*
	White arctic heather	*Cassiope tetragona*
Lichen	Worm lichen	*Thamnolia subuliformis*
Lichen (Cladoniaceae)	Reindeer lichen	*Cladonia rangiferina*
Lichen (Parmeliaceae)	Yellow lichen	*Cetraria tilesii*
Lichen (Teloschistaceae)	Jewel lichen	*Xanthoria elegans*
Lichen (Umbilicariaceae)	Rock tripe	*Umbilicari spp.*
Moss (Bryophytae)	Moss	*Sphagnum sp.*
	Alpine club moss	*Lycopodium alpinum*
Rose family (Rosaceae)	Mountain avens	*Dryas integrifolia*
Sedge family (Cyperaceae)	Arctic cotton	*Eriophorum callitri*

Family	Common Name	Scientific Name
Willow family (Salicaceae)	Willows	*Salix sp.*
	Feltleaf or Alaska willow	*Salix alaxensis*
	Arctic willow	*Salix arctica*

Various grasses were also observed at the wetlands area, most of which were heavily grazed by migrant birds. A list of potential species of grasses, sedges and rushes expected to be at the wetlands complex is presented in Table 2-2.

Table 2-2: Potential Grasses, Rushes and Sedges Expected at the Wetlands Complex

Family	Common Name	Scientific Name
Arrow-grass (Juncaginaceae)	Seaside arrow-grass	*Triglochin maritimum*
	Marsh arrow-grass	*Triglochin palustris*
Grass (Poaceae)	Fisher's tundra-grass	*Dupontia fisheri*
	Lyme-grass	*Elymus arenarius*
	Narrow alkali-grass	*Puccinellia contracta*
	Creeping alkali-grass	*Puccinellia phryganodes*
	Sheathed alkali-grass	*Puccinellia vaginata*
	Alpine foxtail	*Alopecurus alpinus*
Rush (Juncaceae)	Wire rush	*Junicus balticus*
	Wood rush	*Luzula sp.*
Sedge family (Cyperaceae)	Bog sedge	*Kobresia sp.*
	Sedges	*Carex sp.*
	Cotton-grass	*Eriophorum sp.*

The core of the wetlands complex was predominantly of swamp-like composition, consisting of moss and heavily-grazed grasses, sedges and rushes. Occasional willow, birch, rose, and heath species were also found at the wetlands, often nestled in between or beneath any rocks to receive shelter from the wind. An abundance of lichens of various sizes and colour were also present across the Site, predominantly growing on the rock outcrops both at the wetlands area and on both flanking sides.

It is noted that considerable evidence of wildlife grazing/foraging and nesting was observed throughout the wetlands complex.

Species richness was relatively consistent throughout the wetlands area, which is to be expected given the overall large surface area, in addition to the combination of various habitats including terrestrial, semi-aquatic and aquatic environments. Major portions of the wetlands area were also protected from the wind by adjacent rock outcrops flanking both sides; and, the amount of species present at a given area were reduced where there was little to no protection from the wind. In general, the majority of the Site was covered by moss, heavily-grazed grasses, sedges and rushes, and other low-lying vegetation typical of a swamp/wetland region of the Arctic.

It should be noted that a feltleaf willow (*Salix alaxensis*), specifically a single large specimen, was observed at the central portion of the wetlands area, approximately 100 m downgradient of the sewage inlet. A sample was returned to the laboratory and the identification was confirmed. However, this species is not to be mistaken for the felt-leaf willow (*Salix silicicola*), which is designated as a special concern species by COSEWIC (2012). It is unlikely that the special concern felt-leaf willow species is present at the Site, given that it is endemic and restricted almost exclusively to the Athabasca Sand Dunes of Saskatchewan (COSEWIC, 2012).

Due to the time of the survey in the late summer, it was not feasible to prepare a complete plant list for the Site. As such, other plants species known to the Arctic Nunavut region are listed in Table 2-3. This list cannot be considered as exhaustive but rather representative of the expected flora of the area.

Table 2-3: Other Plant Species Known to the Area

Family	Common Name	Scientific Name
Aster (Asteraceae)	Mastodon flower	*Senecio congestus*
Buckwheat (Polygonaceae)	Mountain sorrel	*Oxyria digyna*
Buttercup (Ranunculaceae	Pygmy buttercup	*Ranunculus pygmaeus*
Evening primrose (Onagraceae)	River beauty	*Epilobium latifolium*
Ferns (Polypodiaceae)	Fragrant shield fern	*Dryopteris fragrans*
Figwort (Scrophulariaceae)	Arctic lousewort	*Pedicularis langsdorffii ssp. arctica*
Heath (Ericaceae)	Crowberry	*Empetrum nigrum*
	Mountain cranberry	*Vaccinium vitis-idaea*
Legume (Fabaceae)	Yellow oxytrope	*Oxytropis campestris*
Pink (Caryophyllaceae)	Moss Campion	*Silene acaulis*
	Arctic bladder campion	*Silene latifolia*
	Chickweed	*Stellaria media*
Poppy (Papaveraceae)	Arctic poppy	*Papaver gorodkovii*
Saxifrage (Saxifragaceae)	Alpine saxifrage	*Saxifraga nivalis*
	Purple saxifrage	*Saxifraga oppositifolia*
Willow (Salicaceae)	Least willow	*Salix herbacea*
	Net-veined willow	*Salix reticulata*
Willowherb (Onagraceae)	Fireweed	*Epilobium angustifolium*

All of the vegetation observed at the Site or expected to be present at the Site are highly adapted to the extreme conditions of the Arctic region. Various species are also adapted to disturbed Sites, including fireweed. As such, the composition of the vegetation community observed to be present at the Site is considered suitable for the proposed upgrade and expansion of the existing long term sewage treatment system for the Hamlet of Repulse Bay.

2.2 Water Quality

A Site visit was undertaken by exp staff in September 2012 to collect surface water samples from various locations of the sewage treatment system, which include:

- One (1) at the sewage truck discharge point (SW1);
- One (1) at the outlet of the first natural treatment pond (SW2);
- One (1) at the outlet of a natural treatment pond near the middle of the Site (SW3); and,
- One (1) at the outlet of a natural treatment pond near the discharge point (SW4).

The surface water sampling locations are presented in Figure 3, in Appendix A.

The findings and conclusions of the water quality investigation are presented in **exp's** report: *Water Sampling Letter Report, Sewage Treatment Wetlands, Hamlet of Repulse Bay, NU*, dated September 25, 2012.

The levels of TSS, BOD, nutrients and pathogens in the surface water samples taken throughout the sewage treatment system on September 8th, 2012 are presented in Table 2-4.

Table 2-4: Surface Water Results (September 8, 2012)

	Compliance Guidelines(1)	Truck Discharge Point (SW1)	Outlet of First Pond (SW2)	Outlet of Middle Pond (SW3)	Outlet of Downstream Pond (SW4)	Percent Removal(2)
Total suspended solids (mg/L)	100	45	92	190	49	-8.9 %(3)
Biological oxygen demand (mg/L)	80	51	68	42	45	12 %
Fecal coliforms (CFU/100 mL)	10,000	>200,000	>200,000	710	<10	99 %
pH	6.0 to 9.0	7.36	7.64	7.80	8.19	NA
Total oil and grease (mg/L)	No visible sheen	4.6	1.7	<0.50	**1.2**	74 %

(1) Compliance guidelines for effluent, as per the Sewage Disposal Facility license (NWB3REP0409)

(2) Concentration reduction between the wetland inlet and the wetland outlet

(3) There was no percent reduction; concentration increased at the wetland outlet compared to the inlet

Bold = Effluent concentration (at wetland outlet) in excess of compliance guideline; NA = not applicable

The surface water samples collected at the Site on September 8, 2012 revealed TSS, BOD, fecal coliforms, and pH levels were in compliance of effluent guidelines at the wetland outlet point, as per the Sewage Disposal Facility license (NWB3REP0409). However, measureable concentrations of total oil and grease were detected at the wetland outlet; but, no visible sheen was noted at the surface water sampling location during sample collection.

The percent reduction of contaminants from the truck discharge point (SW1) to the wetland outlet point (SW4) varied between tested parameters. Total suspended solids actually increased by 8.9 % at the wetland outlet; BOD slightly decreased by 12 %; fecal coliforms were non-detect at the wetland outlet, and achieved almost 100 % reduction; and, total oil and grease reduced by 74 % at the wetland outlet.

Chapter 3 –
Phytoremediation and Contaminants Removal

3 Phytoremediation and Contaminants Removal

3.1 Phytoremediation

Phytoremediation is the use of plants to remediate or decontaminate soil, water or air. Plants are able to contain, degrade or eliminate metals, pesticides, solvents, explosives, crude oil and its derivatives, and various other contaminants from environmental media. Constructed treatment wetlands with cattails and reeds, for example, are often used to treat landfill leachate, acid mine drainage, sewage, industrial effluents and agricultural run-off (Kadlec and Knight, 1996).

Vegetated wetlands with lower growing vegetation such as grasses and mosses have been reported as equally successful biofilters for a number of contaminants and excess nutrients, including nitrogen compounds, phosphates, salts, metals, organic contaminants and pathogenic bacteria and viruses (also see Kadlec and Knight, 1996).

The plant community present at the wetlands area of Repulse Bay can be described as typical of habitats in northern Arctic latitudes. That is, the dominant vegetation includes mosses, grasses, sedges, rushes, willow species and other low-lying species. These plants have been reported as suitable for the phytoremediation processes that will treat sewage and include the removal of TSS, BOD, nutrients and pathogens.

3.2 Contaminants Removal

In order for the Hamlet to meet the objectives of the Sewage Disposal Facility license, the effluent quality standards at the downgradient location prior to discharging to Hudson Bay must meet the compliance guidelines, as presented in Table 3-1.

Table 3-1: Effluent Quality Limits for Repulse Bay (Sewage Disposal Facility license NWB3REP0409)

Contaminant	Compliance Guidelines
Total suspended solids	100 mg/L
Biological oxygen demand	80 mg/L
Fecal coliforms	10,000 CFU/100 mL
pH	6.0 to 9.0
Total oil and grease	No visible sheen

3.2.1 Total Suspended Solids (TSS)

The majority of suspended solids are traditionally removed through sedimentation over time, such as in a sewage lagoon. The TSS remaining in the wastewater will subsequently enter the wetlands area where the solids will be trapped and settle along the route to Hudson Bay. Sewage biosolids are a source of organic matter which will be utilized by bacteria and plants to grow and reproduce (MOE, 1996).

As noted, recent observations during the September 2012 water sampling event indicated that TSS actually increased by 8.9 % at the wetland outlet when compared with the truck discharge point concentration; and, the level of TSS at the mid-Site location (SW3) was above the sewage disposal effluent criteria of 100 mg/L.

These observations suggest that TSS may be a concern beyond the boundaries of the sewage treatment system. As such, mitigation measures are recommended for the Site to reduce the amount of TSS present at the wetland outlet.

3.2.2 Biological Oxygen Demand (BOD)

Removal of BOD will greatly depend on the oxygen supply, or aerobic conditions, provided within the wetlands area. Increased aeration throughout the treatment system will increase BOD removal efficiency; however, anaerobic conditions are expected at the Site, especially if the ice persists, which will deplete oxygen levels and maintain BOD levels.

As noted, recent observations during the September 2012 water sampling event indicated that BOD slightly decreased by 12 % at the wetland outlet when compared with the truck discharge point concentration. It is also noted that the levels of BOD present in all effluent samples are below the sewage disposal effluent standard for BOD of 80 mg/L; and, the highest level of BOD was detected at the outlet of the first treatment pond (SW2) at 68 mg/L.

Although these observations show some reduction in the levels of BOD at the wetland outlet, the percent reduction is very low, and may suggest that BOD may be a concern beyond the boundaries of the sewage treatment system. As such, mitigation measures are recommended for the Site to reduce the amount of BOD present at the wetland outlet.

3.2.3 Pathogens

Pathogens present in sewage include fecal coliforms and *Escherichia coli*, which have a limited life span outside of their host organisms (i.e. warm-blooded animals). The majority of pathogen decline is expected in a typical sewage lagoon, where cell die off, sedimentation, filtration, absorption and predation greatly reduce coliform numbers (Martin and Johnson, 1995).

As noted, recent observations during the September 2012 water sampling event indicated that fecal coliforms and *E. coli* were non-detect at the wetland outlet, and achieved almost 100 % reduction. However, it should be noted fecal coliforms and *E. coli* were detected at all other sampling locations, upstream of the wetland outlet, including at the mid-Site location (SW3).

These observations suggest that pathogens, as represented by fecal coliforms, are currently not a concern beyond the boundaries of the sewage treatment system. However, given that pathogens were detected at all other sampling locations, pathogens may be a concern in the long-term. As such, mitigation measures are recommended for the Site to reduce the amount of pathogens present at the wetlands area.

3.2.4 Nutrients

Sewage effluent is high in nutrients such as phosphorus and nitrogen compounds. Nutrient-rich waters may lead to eutrophic conditions, which involves prolific growth of algae and other aquatic plants. Eutrophication may eventually lead to the depletion of the water's natural oxygen supply, which is detrimental to aquatic life.

It is noted, however, that the Arctic wetland region to which the Hamlet of Repulse Bay belongs is relatively nutrient poor, and nutrients are generally in short supply. Availability of additional nutrients is unlikely to result in significant eutrophication, where excess nutrients are in turn readily taken up by plants and metabolized. This will result in increased plant biomass and growth rates. As a consequence, more organic compounds will be available for bacteria in the rhizosphere. The presence of increased volumes of nutrients and organic compounds in the wetlands compared with surrounding habitats are thereby expected to increase bacterial growth and reproduction in the wetlands, and subsequently the

degradation rate of contaminants. It is therefore unlikely that the nutrients at the Site will be a concern beyond the boundaries of the sewage treatment system.

3.2.5 pH

The pH of the sewage treatment system remained relatively neutral, fluctuating between 7.36 and 8.19 during September 2012. The fluctuation of pH levels at the Site is not considered to be a significant concern beyond the boundaries of the sewage treatment system.

3.2.6 Total Oil and Grease

The surface water samples collected during the September 2012 sampling events did not contain any visible sheen. However, a walk-through of the Site, which was also conducted in September 2012, did identify occasions of sheen present at various surface water bodies throughout the entire Site, including at downstream locations. Furthermore, it is noted that total oil and grease were detected in surface water samples collected at the wetland outlet (SW4), but reduced by 74 % when compared to the concentration detected at the truck discharge point (SW1).

Although these observations show some reduction in the levels of total oil and grease at the wetland outlet, concentrations still remain at the downstream location, which may suggest that oil and grease may be a concern beyond the boundaries of the sewage treatment system. As such, mitigation measures are recommended for the Site to reduce the amount of total oil and grease present at the wetland outlet.

3.3 Interpretation

As noted, the Hamlet's existing wetland sewage treatment system is comprised of a simple truck offload discharge area, which is directed to a natural wetlands area. The wetland area shows plants that appear to be growing well. This plant community is composed of a range of some different species and morphologies. Water samples collected at the Site during September 2012 indicate that there is some reduction in BOD, pathogens and total oil and grease at the wetland outlet compared to the truck discharge point; however, these reductions are low, there was an increase in TSS observed, and visible sheen was noted at various surface water bodies throughout the Site.

Due to the low decline of the majority of contaminants, the performance of the wetland to assimilate sewage cannot be confirmed. This interpretation may identify that the assimilative capacity of the wetlands results in the release of water to Hudson Bay with moderate concentrations of contaminants.

These observations suggest that the existing sewage treatment system may not be effective at removing contaminants. Although the Hamlet's existing sewage treatment system is in general compliance with the requirements of the Nunavut Water Board License Number NWB3REP0409 – Hamlet of Repulse Bay, mitigation measures are recommended for the Site to improve the performance of the wetlands in the long-term.

Chapter 4 –
Conclusions and Recommendations

4 Conclusions and Recommendations

4.1 Conclusions

The Wetlands Assessment revealed that the existing sewage treatment system for the Hamlet of Repulse Bay will likely not reduce the contaminants and pathogens of effluent waters before discharging into Hudson Bay in the long-term.

The observation of some declines of BOD, pathogens and total oil and grease between the truck discharge point and the wetland outlet confirm that phytoremediation is occurring, as expected. However, the levels of contaminants and pathogens remain high throughout the Site; any reductions observed are low; there was an increase in the amount of TSS observed at the wetland outlet; and, visible sheen was noted at various surface water bodies throughout the Site. Due to the low decline of the majority of contaminants, the performance of the wetland to assimilate sewage cannot be confirmed. This interpretation may identify that the assimilative capacity of the wetlands results in the release of water to Hudson Bay with moderate concentrations of contaminants.

Therefore, these observations suggest that the existing sewage treatment system may not be effective at removing contaminants. Although the Hamlet's existing sewage treatment system is in general compliance with the requirements of the Nunavut Water Board License Number NWB3REP0409 – Hamlet of Repulse Bay, mitigation measures are recommended for the Site to improve the performance of the sewage treatment wetlands in the long-term.

4.2 Recommendations

The vegetation survey and water sampling program conducted at the Site indicated that the existing wetland community may not be functioning effectively as a sewage treatment system; and, will likely fail in the long-term.

Therefore, it is recommended that mitigation measures be implemented at the Site to improve the performance of the sewage treatment wetlands in the long-term, with the construction of a sewage lagoon at the sewage inlet point.

4.2.1 Construction of a Sewage Lagoon

The presence of a sewage lagoon at the sewage inlet point will greatly reduce the amount of contaminants, pathogens and nutrients discharging into the downgradient wetlands, and subsequently into Hudson Bay. Traditionally, a sewage lagoon will remove the majority of suspended solids through sedimentation over time; and, is also expected to significantly reduce the number of pathogens, where cell die off, sedimentation, filtration, absorption and predation greatly reduce coliform counts. The downstream wetlands will then receive the remaining wastewater percolating from the lagoon, and will trap any remaining solids and breakdown any remaining contaminants, along the route to Hudson Bay.

It is recommended that a sewage lagoon of sufficient size and lining be constructed at an upstream location of the sewage treatment system, where raw sewage is to be deposited. Various natural processes will then occur in the lagoon prior to the percolation of the remaining wastewater into the existing wetlands area. The construction and subsequent use of a sewage lagoon at the Site is expected to greatly improve the performance of the sewage treatment system in the long-term.

Chapter 5 –
General Limitations and Closure

5 General Limitations and Closure

The purpose of this report is to provide the Government of Nunavut with an evaluation of the efficacy associated with the existing sewage treatment system at the Hamlet of Repulse Bay; and, if the system is in compliance with the requirements of the Nunavut Water Board, water license number NWB3REP0409 – Hamlet of Repulse Bay.

The information presented in this report is based on information provided by others and visual observations as identified herein. Achieving the objectives stated in this report has required us to arrive at conclusions based upon the best information presently known to us. No investigative method can completely eliminate the possibility of obtaining partially imprecise or incomplete information; it can only reduce the possibility to an acceptable level. Professional judgment was exercised in gathering and analyzing the information obtained and in the formulation of the conclusions. Like all professional persons rendering advice, we do not act as absolute insurers of the conclusions we reach, but we commit ourselves to care and competence in reaching those conclusions.

This report was prepared for the Government of Nunavut and may not be reproduced in whole or in part, without the prior written consent of exp, or used or relied upon in whole or in part by other parties for any purposes whatsoever. Any use which a third party makes of this report, or any part thereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Exp Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The Wetlands Assessment was prepared based on the available site information and evaluated the potential effects posed on the environment based on the existing long term sewage treatment system for the Hamlet of Repulse Bay. Should additional Site information become available, the Wetlands Assessment should be re-evaluated to determine if the conclusions presented in the report are still valid.

Closure

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Yours truly,

exp Services Inc.

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Ecological Specialist

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Chapter 6 – References

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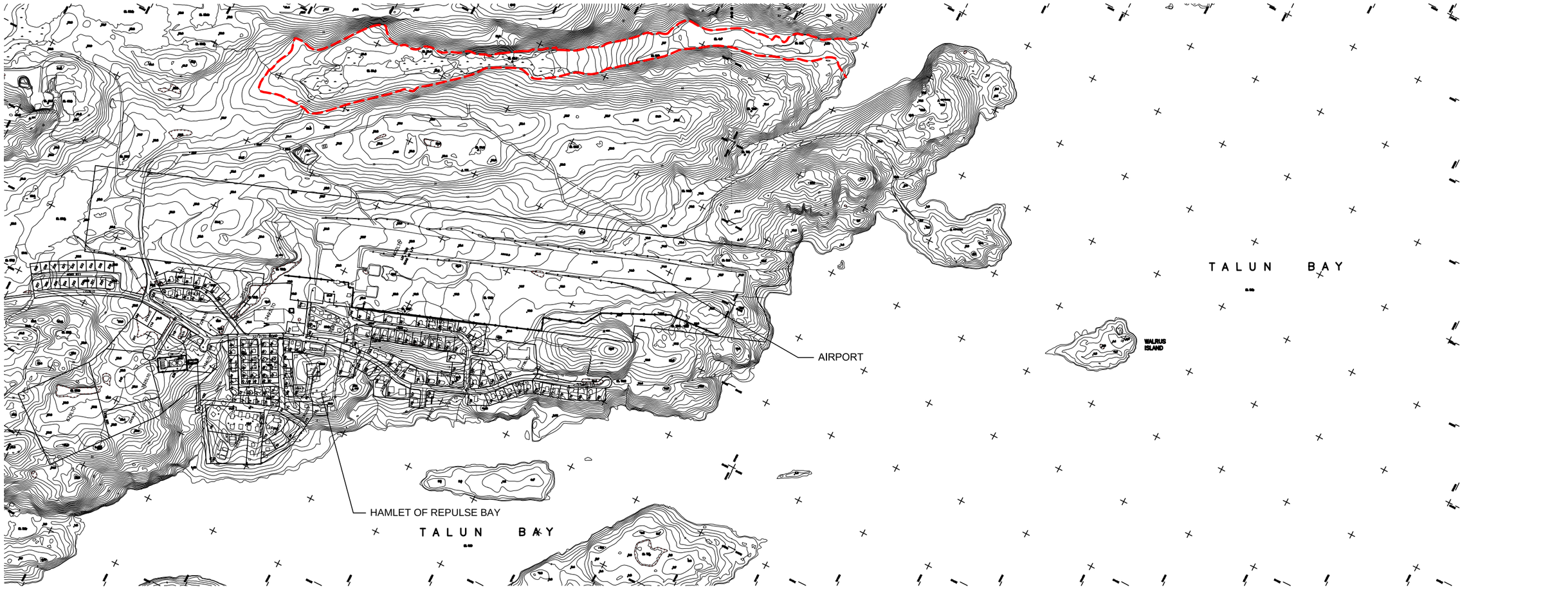
Appendix A – Figures



LEGEND:

APPROXIMATE SITE BOUNDARY

0 40 80 160 240 320 400 metres

CONTOUR INTERVAL: 0.5 METRES

exp Services Inc.
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PROJECT TITLE AND LOCATION:

WETLANDS ASSESSMENT
SEWAGE TREATMENT FACILITY
HAMLET OF REPULSE BAY, NU

DRAWING TITLE:

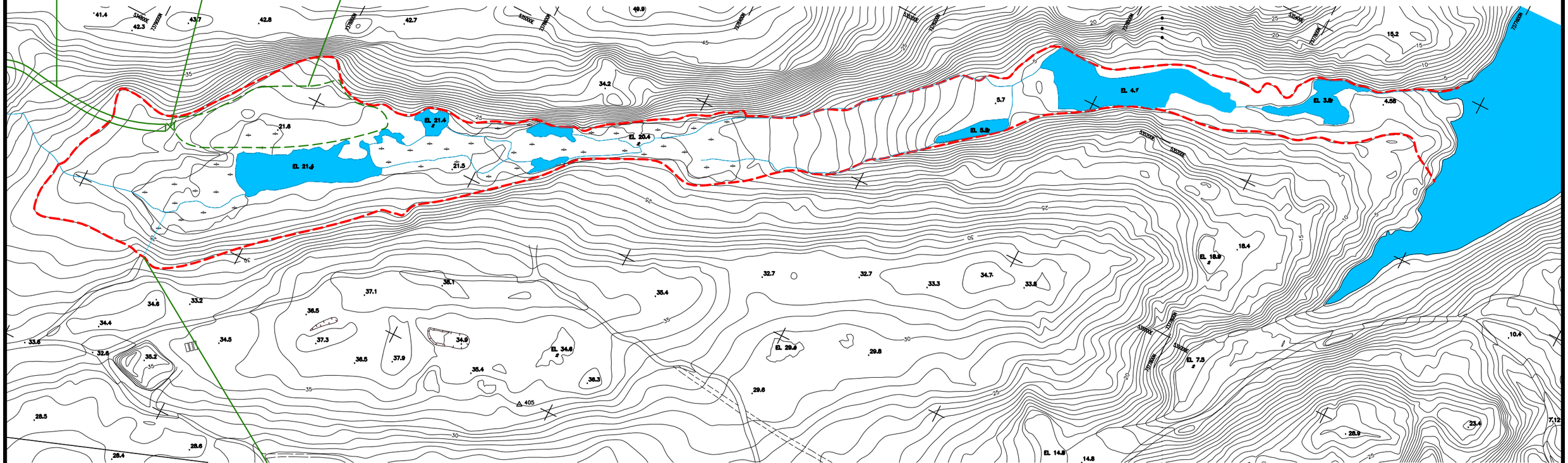
SITE LOCATION PLAN

PROJECT NO.: OTT-00207086-A0	DWN.: AZ
SCALE: AS NOTED	DWN.: EC
DATE: OCTOBER 2012	DWG. No.: 1

PROPOSED ROAD TO TRUCK DISCHARGE POINT

PROPOSED TRUCK DISCHARGE POINT

PROPOSED SEWAGE LAGOON LOCATION



CURRENT TRUCK DISCHARGE POINT

LEGEND:

- APPROXIMATE SITE BOUNDARY
- SURFACE WATER BODY
- WETLAND/SWAMP

0 20 40 80 120 160 200 metres

CONTOUR INTERVAL: 0.5 METRES

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HAMLET OF REPULSE BAY, NU

DRAWING TITLE:

SITE LAYOUT PLAN

PROJECT NO.: OTT-00207086-A0	DWN.: AZ
SCALE: AS NOTED	DWN.: EC
DATE: OCTOBER 2012	DWG. No.: 2

PROPOSED ROAD TO TRUCK DISCHARGE POINT

PROPOSED TRUCK DISCHARGE POINT

PROPOSED SEWAGE LAGOON LOCATION

SW1

SW2

SW3

SW4

CURRENT TRUCK DISCHARGE POINT

LEGEND:

- APPROXIMATE SITE BOUNDARY
- SURFACE WATER BODY
- WETLAND/SWAMP
- SW1 SURFACE WATER SAMPLE LOCATION (SEPTEMBER 2012)

0 20 40 80 120 160 200 metres

CONTOUR INTERVAL: 0.5 METRES

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PROJECT TITLE AND LOCATION:

WETLANDS ASSESSMENT
SEWAGE TREATMENT FACILITY
HAMLET OF REPULSE BAY, NU

DRAWING TITLE:

LOCATIONS OF SURFACE WATER SAMPLES
(SEPTEMBER 2012)

PROJECT NO.: OTT-00207086-A0	DWN.: AZ
SCALE: AS NOTED	DWN.: EC
DATE: OCTOBER 2012	DWG. No.: 3