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AKLAVIK, NWT – SOLID WASTE PLANNING STUDY

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Abstract: The Hamlet of Aklavik is a 100 year old community within the Mackenzie Delta region of the Northwest Territories (NWT), and was originally was established as a fur trading post. The community's solid waste disposal facility has been experiencing operational problems in the recent years, related to the river floods in the spring, and drainage issues. In response to these issues, the Hamlet initiated a study to identify a new solid waste site. A scoping study identified 15 potential waste sites within 16 kilometers of the community, all situated along a seasonal access road. Waste generation for the community was estimated to be 200,000 m^3 for a 40 year horizon. This volume, with a 3 to 1 compaction ratio, produced a 66,000 m^3 volume requirement, and was rationalized to a 66,000 m^2 area requirement. Of the 15 original sites from the scoping study, 9 had sufficient area, which included a 50 m site buffer from the operating area to the adjacent pond areas. The estimated capital cost to develop these sites range from $11.7 million to $25.2 Million, based upon substantially long access roads, and the site development features. Based upon the planning analysis it was recommended to investigate 2 of the 9 sites further. Along with the planning analysis, a review of the existing site was completed, and it was recommended that the redevelopment of the existing site is a should be considered to obtain additional operating capacity for the facility (up to a 12 year period), improved regulatory compliance, and to achieve additional time for the implementation of a new site.

Keywords: - solid waste, planning, Northwest Territories, Aklavik

1 Introduction

1.1 Community Information

The Hamlet of Aklavik is located on the Peel Channel of the Mackenzie River Delta, 113 km south of the Arctic Coast, and 55 kilometers west of Inuvik. Its geographic coordinates are 68.219916 N latitude and -135.007788 W longitude. Aklavik has a population is 670 in 2015, and the majority of the residents are Inuvialuit and Gwich'in. The community falls into two different land claim settlement regions, the Inuvialuit Settlement Region (ISR) and the Gwich'in Settlement Region (GSR). The community has limited access, which is by air and barge only during the summer months, and by ice road from Inuvik during the winter months.

Aklavik is within the Boreal forest zone, with vegetation that includes white spruce (upper delta) or balsam, poplar and black spruce (lower delta) on high ground, and willows, alders, marshy vegetation and muskeg in the low lying areas. Aklavik is approximately seven meters above sea level, and is subject to

periodic flooding. The lands which comprise the municipality fall within a Flood Risk Area under the Canada-NWT Flood Damage Reduction and Flood Risk Mapping Agreement.

Aklavik is within the delta region and is characterized by alluvial deposits of fine sand, and silt, and is situated in an area of discontinuous permafrost. The climate of Aklavik is characterized by cool summers, and long, cold winters. The daily average temperature of the warmest month in Aklavik is 13.9ºC and the coldest month is -26.3ºC. The annual precipitation as rainfall is 12.8 millimeters and 136.3 centimeters of snow.

1.2 Study Background

A report commissioned by the Hamlet of Aklavik in 2009 estimated that the existing solid waste site, immediately adjacent to the community, had a remaining service life of about five years. The disposal facility has also been experiencing operational problems in the recent years related to the river flooding in the spring, and runoff management issues. The 2009 report stated that “a new landfill outside of the floodplain in the area of the Richardson Mountains is the preferred option to be further evaluated by the community”.

The Hamlet did not accept this recommendation, and identified their own future site within the delta; approximately 7 kilometers west of the community along the winter road to a gravel source. The identification of this alternate site prompted the Hamlet to advance a planning study to consider additional landfill sites within the delta area west of the community.

The Hamlet retained Stantec Consulting Ltd. based upon a proposal that included a scoping study that identified and presented preliminary assessments of 15 potential solid waste sites. The scope of work then advanced with a screening of these 15 waste sites, and analyses to develop a short list of sites for consideration by the community.

1.3 Ground Conditions

The alluvial deposits of fine sand and silt beneath Aklavik are stratified layers that extend to about 11 meters below the surface. The discontinuous permafrost has an active layer of 300 to 900 mm. Borehole information to a depth of 9.1 m below the surface identified soil stratigraphy of gravel and sand layers, layers of organics mixed with sand, over layers of silt. The gravel and sand layer is generally 600 mm thick and consists of gravel graded up to 100 mm in size and course- and fine-grained sand with some fines. The sand is brown to dark brown in color and contains small ice crystals.

The organic sand below the gravel and sand is a layer about 1.5 m thick, and contains various amounts of frozen and very moist organic materials. The moisture content near surface is about 10%, increasing with depth to about 36%. The silt below the organic sand extends to at least 9 meters, and consists of some clay with trace of fine grained sand and gravel.

2 Scoping Study for Initial Site Identification

2.1 Selection and Analysis for Scoping Study

Satellite imagery was used to identify the winter road access to the granular deposits to the west of the community. Along the winter road, a 2 kilometer corridor on each side of the road was identified as a reasonable limit to potential sites. Fifteen potential sites were identified (see Figure 1) for further analysis with each site having a 200 meter separation from the center of site to the adjacent open water. It was recognized from the Scoping Study that most of the sites were within the delta area, and potentially subject to flooding. Sites 1 and 2 are at the edge of the delta and would not have the same flood risk as the remainder of the sites.

2.2 Initial Analysis of Selected Sites from Scoping Study

An initial analysis of the 15 sites tabulated areas ranging from 90,000 m^2 to over 200,000 m^2. Access roads to the sites were identified off the existing winter road. The access to the sites would involve a combination of an all-weather access road along the existing winter road, and a new site access road. The site access roads varied in length from less than 100 meters to 2,000 meters. The existing winter road would require upgrading to an all-weather road to accommodate site access.

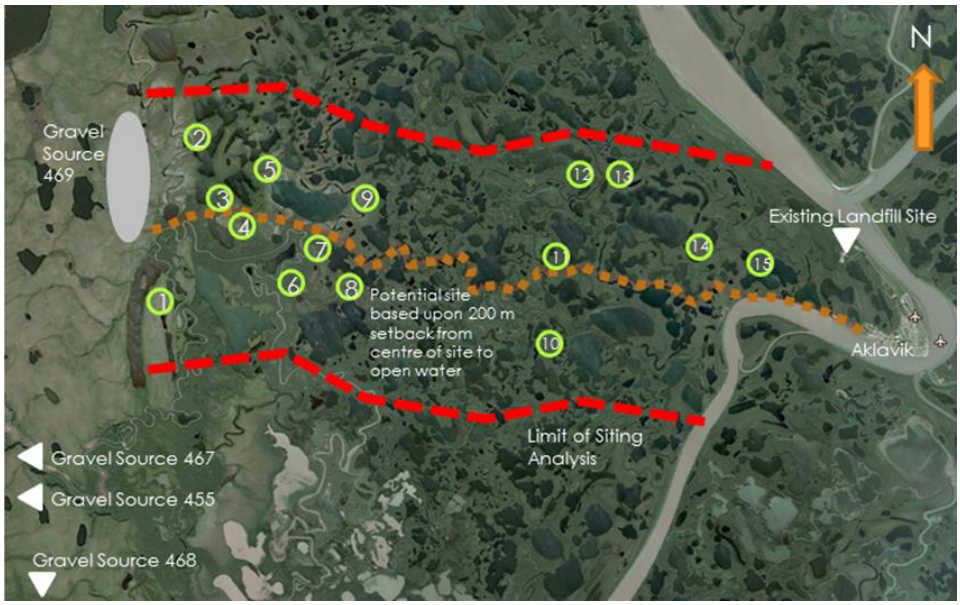

Figure 1: Fifteen sites identified as part of scoping study for new landfill in Aklavik

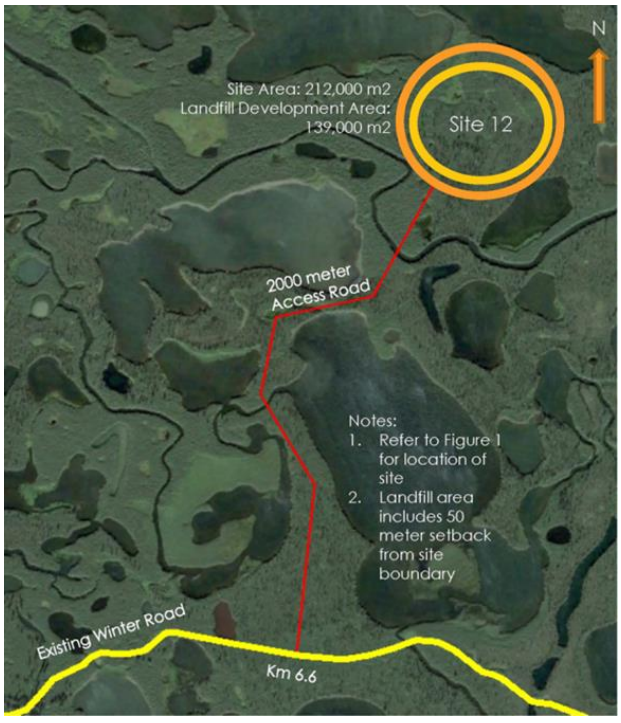

Figure 2: Access to Site 12 from winter access road to gravel sources

3 Waste Generation

3.1 Population Projection

The predicted population values were obtained from the Government of the Northwest Territories (GNWT) Bureau of Statistics. The design horizon for solid waste management in the NWT is 40 years, which recognizes the tremendous effort required in the implementation of a new landfill site. Population projections were available up to 2031, and values were extrapolated from this date estimated the population up to 2054, with a population of 710 people.

3.2 Capacity Requirements

To estimate the solid waste generation a standard GNWT waste generation rate was applied. The generation rate of 0.014 m^3 / (p*d), was applied with a one percent population growth rate and a starting population of 668. The total amount of solid waste generation over a 40 year planning horizon was estimated to be 200,000 m^3. A waste compaction rate of 3 to 1 was applied to the waste generated in the 40 year planning horizon to generate an anticipated waste volume of 66,000 m^3. This compaction ratio is appropriate to northern landfills in consideration of the frequency of compaction and the available equipment.

4 Site Development and Area Requirements

4.1 Site Development and Sustainability

The general features of the anticipated site development of a new site include areas for bulky waste, hazardous or special waste, recycled waste (waste diversion), and landfilled waste. There is no significant use of honey bags (bagged sewage), therefore a provision for a honey bag disposal area was not included. A honey bag disposal area would require special considerations because it would be a biohazardous waste. The site configuration may also include fencing, and drainage management features, for both on site drainage and off site drainage.

Although provisions for recycled waste and hazardous waste will be included in the site development, this aspect of sustainability is an ongoing challenge for small northern communities. Community capacity issues associated with operational funding, and human resources makes this activity impractical, particularly due to the transportation costs associated with waste materials either to a market for recycling or a facility for hazardous waste treatment. In most cases the recycled and hazardous waste are accumulated without any long term removal plan.

The operational site development for landfilled waste is cells that would have cross sections of 10 to 15 meters wide, and berms with a height of 1 to 1.5 meters on either side of the cell. The waste deposition in the working area of each cell would be accomplished in an active area that would be periodically consolidated and then compacted. Intermediate cover would be added to the compacted area, and compacted. Working areas and intermediate cover would provide the opportunity to isolate segments of the waste in order to reduce the opportunity for the contamination of on-site runoff, and fire protection to minimize the size of a potential landfill fire.

4.2 Area Requirements

The anticipated waste generation for a 40 year planning horizon is 200,000 m^3, and with a compaction ratio of 3 to 1, the needed capacity of the site would be 66,000 m^3. In applying the waste cell configuration with 66,000 m^3 for a 1.5 meter berm height, and developing a second phase of the landfill on top of the initial phase (3.0 meters in total height) it was determined that the landfilling area for household waste would be approximately 22,000 m^2.

For the purpose of site screening, and to accommodate the area requirements for bulky waste, hazardous waste, recycled waste, and cover material, the needed landfilling area was tripled for a total area requirement of 66,000 m^2. This area would also needs to accommodate an operator building, signage,

miscellaneous storage, and internal roads on the site. The tripling of the was also based upon the general observation of the current landfill operating areas that have been developed by the Hamlet, and it also adds an additional conservative factor for the site selection process.

4.3 Earth Management

The soil requirements for the site will include material for an access road, material for internal roads on the site, material for berm construction, and material for intermediate cover, and ultimately final cover. Granular material is required for the site access road, and the internal roads, but granular material is not necessarily needed for berm construction and cover materials. The Hamlet has access to non-granular material from a borrow site at the east end of the community.

Berms may consist solely of non-granular material, as a less expensive alternative. A well planned earth management strategy for the new landfill will reduce the need for “higher quality” granular material, and create an opportunity to use poor quality borrow sources that are closer to the new landfill site.

4.4 Climate Change Considerations

Climate change should be considered during the development of the new solid waste facility. A report by the National Research Council (2011) confirms that the assumption of hydrological consistency and designing for this is no longer valid or practical. Deforestation, changes to wetlands, community growth, hydro projects, and other water diversions are a few examples of anthropogenic land cover changes that have a significant impact on the duration and intensity of floods and droughts. The changes highly impact downstream hydrology. This means that development within the Mackenzie River basin will have to be managed with a greater deal of uncertainty than in the past.

This same perspective applies to the Hamlet of Aklavik and any new landfill located within the delta area. There is a greater uncertainty in the river flooding with respect to frequency, duration, and extent of any flooding. Landfill facilities inherently apply berm structures as part of the facility development; therefore provisions for erosion protection may be a needed improvement in the construction. Since flooding is elevation dependent, building up the landfill area above the anticipated flood level may also be a mitigation opportunity.

5 Assessment of Solid Waste Sites

5.1 Assessment Criteria

The 15 sites identified in the scoping study were assessed with very limited information on terrain, geology, and the local environment to screen the sites to a short list for discussion with the community, and for future detailed evaluation based upon site reconnaissance. The evaluation criteria for the 15 sites included: available areas, geological features, topography, hydrology, and hydrogeology, setbacks, and accessibility. The available site information did not include any site specific topographic and hydrogeologic information, and therefore this information was excluded from the planning analyses.

5.2 Screening of Sites

Of the 15 potential sites considered for landfill development based upon the scoping study, Sites 5, 6, 11, 13, 14, and 15 were not considered further because they do not meet the active landfill area requirements of 66,000 m^2. This was determined by measuring the usable site area then adding a 50 m buffer to provide a considerable distance from the adjacent water bodies.

In addition, Site 15 was not considered for further analysis given its proximity to the airport of less than 3 km. A separation of less than 3 kilometers presents a bird hazard to aircraft from the potential movements of birds scavenging at the waste management area. Although the Canadian Manual of Airport Bird Hazard Control developed by Transport Canada recommends that activities such as landfills and lagoons pose a hazard to aircraft if located within 8 km, the GNWT adopted a 3 km setback requirement.

6 Cost Development for Solid Waste Sites

6.1 Basis of Opinion of Probable Cost (Capital Cost) for Landfill Development

The capital costs were developed from all the required components of an active landfill area. The components include: primary road cost (all season access road), secondary road cost (site access road from all season access road), bulky, recycled and landfilled waste area, hazardous waste storage, carcass, and burn pit cells, site operating structures, blowing debris control, on- and off-site drainage management, perimeter fencing, double swing gate, site signage, and engineering and contingency allowance (40% of capital cost).

The cost estimates were developed from an estimation of unit values for each of the elements presented above based upon the general site configuration for a 40 year development area of 66,000 m^2. Unit costs to apply to each of the unit values are based upon solid waste, and transportation related work from in house data base for work in the Mackenzie Delta, and the Kitikmeot region of Nunavut. The 40% Engineering and Contingency Allowance is an overall contingency allowance for construction and engineering applied to the conceptual level of costing.

6.2 Capital Costs and Life Cycle Cost of Solid Waste Sites (Table)

The cost estimates for the landfill sites remaining from the initial screening are summarized in Table 1. Sites 10 and 12 have the lowest capital costs by margins of $7 million because of the significantly lower cost of upgrading the winter access road to an all-weather road.

Table 1: Example table caption

Site Number	Total Capital Cost	Annual O&M
1	$25,620,796	$512,416
2	$24,509,119	$490,182
3	$22,311,202	$446,224
7	$19,585,251	$391,705
8	$20,291,282	$405,826
9	$19,393,881	$387,878
10	$12,728,853	$254,577
12	$23,339,433	$246,789

*Note: The O&M costs per year are estimated based on 2% of capital cost.

6.3 Life Cycle Cost Evaluation

A Life Cycle Cost Evaluation (40 year) was also prepared for the sites remaining from the screening process. As a sample, the life cycle operation and maintenance costs for the sites with the lowest capital (Sites 10 and 12), were the same with a value of $3.2 million.

7 Discussion

In the planning analysis context, a number of issues need to be considered in conjunction with the discussion, and ultimately the recommendation of potential waste management sites. For the development of the Hamlet of Aklavik solids waste facility, the following issues should be considered: access to site, proximity issues (human activities, natural features, and local receptors), site configuration, potential environmental or public health impacts, estimated capital cost to develop site, and estimate operation and maintenance costs.

Other issues including surface materials, snow accumulation, local hydrology, and vegetation should also be considered, although they are not taken into account at this stage due to the limited information available. The remaining sites from the screening process included sites 1, 2, 3, 7, 8, 9, 10 and 12. These sites provide an adequate site area, and active landfilling area.

An overriding issue associated with the development of a new solid waste for Aklavik is the site development in the delta area adjacent to the community instead of a development outside the delta area, which was recommended in a previous planning study. A risk of flooding exists for any facility within the delta area; however the risk is diminished to some degree with a location that is not immediately adjacent to the Peel Channel. As part of the subsequent phases of investigation, flood risk and flood proofing of any site must be considered in order to address anticipated regulatory concerns.

The process for the development of any landfill site, beyond the planning stage, takes a considerable amount of time and effort associated with biophysical studies, and regulatory reviews and approvals. In consideration of this time requirement, the redevelopment of the existing site is a reasonable step to obtain additional operating capacity for the facility. A concept for the redevelopment of the existing site is presented in Figure 3, which includes the provision for waste diversion and on-site drainage management. These provisions will also address existing compliance issues with the regulatory authorities. A key element in the redevelopment is the application of landfill cells instead of an open dumping area, which provides improved overall management, and may accommodate an ultimate operating height of 4 to 5 meters.

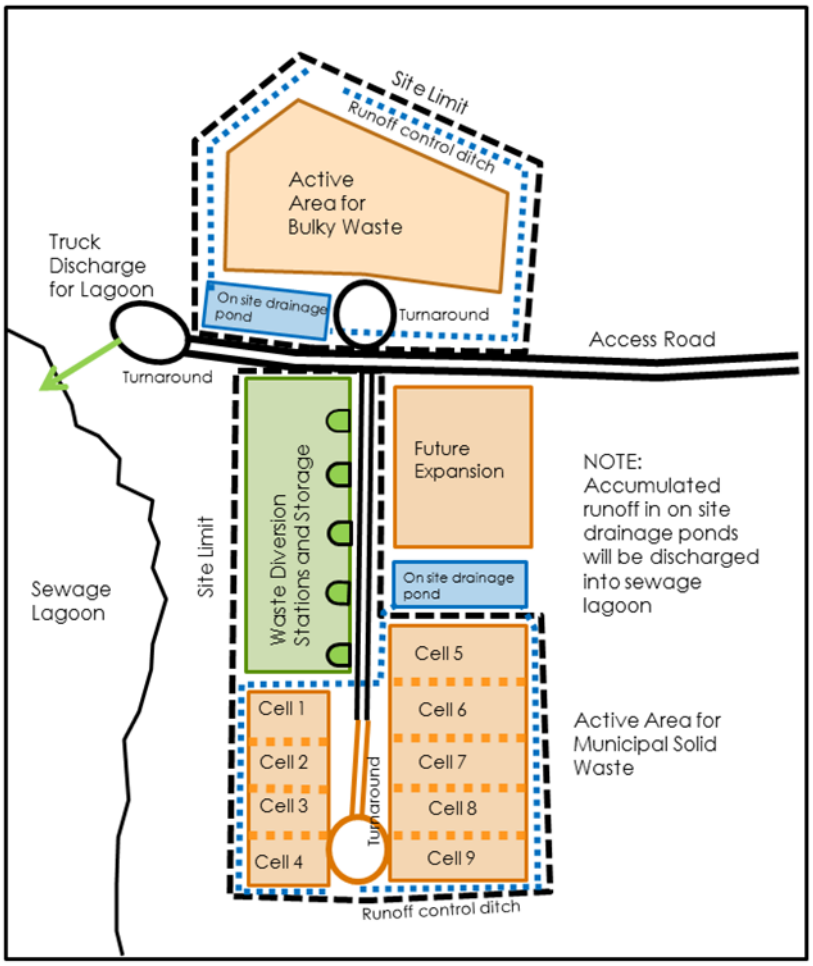

Figure 3: Redevelopment concept for existing landfill site

8 Conclusions

The waste generated over a 40 year planning horizon for the Hamlet of Aklavik is 200,000 m^3, and with a 3 to 1 compaction ratio, this results in 66,000 m^3 of solid waste. The area requirement for the waste generation is 22,000 m^2 for an ultimate site development with a 3 meter high site. In order to make sure

there is adequate space waste diversion activities, site operating activities, and for cover material as part of proper waste disposal, the minimum area requirement was tripled, resulting in a minimum active landfill area of 66,000 m^2 for a 40 year operating horizon.

Limited information was available for a detailed consideration of the sites for topographic, hydrogeological, and biophysical characteristics as part of the planning analysis. The planning analysis was primarily based upon geographic characteristics of land areas, pond areas, and proximity to existing access.

Of the 15 original sites from the scoping study, 8 have sufficient area greater than 66,000 m^2, which included a 50 m site buffer from the operating area to the adjacent pond areas. These sites are 1, 2, 3, 4, 7, 8, 9, 10, and 12. The Opinion of the Probable Cost for the Capital Cost to develop these 8 sites range from $11.7 Million for Site 12, to $25.2 Million for Site 1. The operation and maintenance costs for the 8 sites range from $0.6 Million to $1.2 Million. The cost to each of the sites is the majority of the cost capital cost.

The least expensive sites to develop are Site 10 and 12 based upon Capital and O&M Costs. Development details for Site 12 is presented in Figure 4. Redevelopment of the existing site is a reasonable consideration to obtain additional operating capacity for the facility, and achieve additional time for the planning, engineering, and construction of a new site.

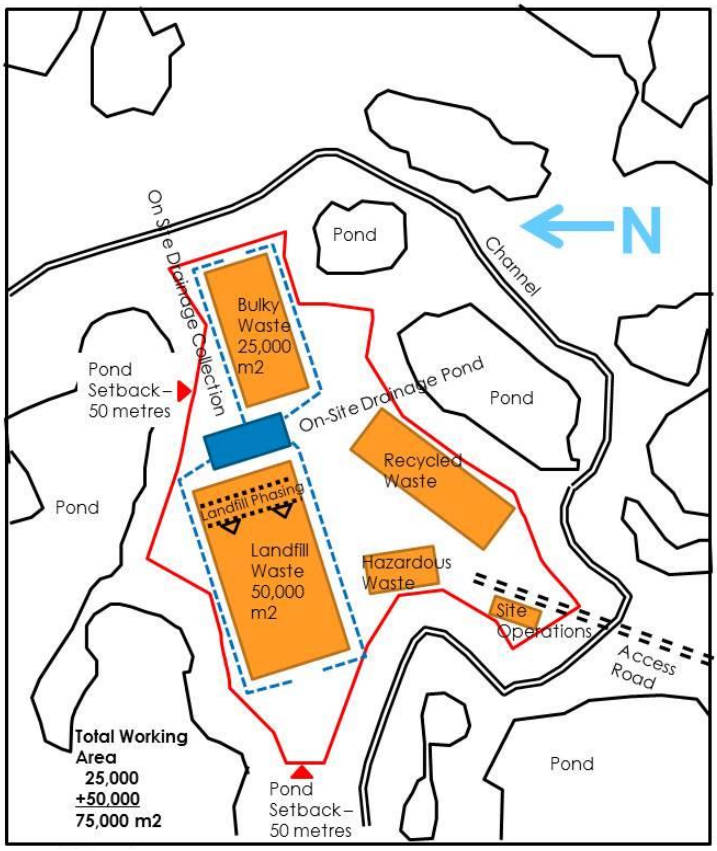

Figure 4: Site Development Concept for Site 12

9 Recommendations

Based upon the limited analysis, Sites 10 and 12 should be investigated further. These sites are recommended because they meet all of the selection criteria for site area, active landfilled area, and have

the lowest capital and O&M costs. Further site investigations to be completed on Sites 10 and 12 should include topographic, hydrogeological, geotechnical biophysical analyses, and flood risk analyses.

The Hamlet of Aklavik should engage a discussion with the regulators based upon the planning study results in order to develop the potential scope of the detailed investigations. The Hamlet should anticipate a strong reluctance for the regulators to consider waste management sites in the delta area in consideration of the flooding issues that may develop.

Cost sharing with an all-weather access to the granular sites should be considered and advanced by the Hamlet. This would be a good opportunity to share the enormous costs associated with the development of an all-weather access road. Site 10, with a site area of 137,000 m^2, and an active landfill area of 79,000 m^2, has a total capital cost of $12.7 million, and annual operation and maintenance cost of $254,500. Site 12, with a site area of 211,600 m^2, and an active landfill area of 138,600 m^2 has a total capital cost of $12.3 million, and annual operation and maintenance cost of $246,800.

In consideration of the potential timeframe to develop a new solid site, Aklavik should advance the redevelopment of the existing solid waste site to increase the capacity and operating horizon, address regulatory compliance issues associated with drainage management, waste diversion, and operating areas.