WAPTUM
COMMUNITY DEVELOPMENT CONSULTING

Notice of Intent for Waste Incineration Plant in WEMINDJI

CREE NATION OF WEMINDJI

FINAL VERSION

Prepared and Reviewed by:

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1 OBJECT

The project in question is for waste incineration plant for the thermal decomposition (incineration) of the community of Wemindji's raw municipal waste.

According to the Environmental Quality Act (EQA), Schedule A, Section 1, all systems for the collection and disposal of residual materials, except mine tailings and hazardous materials, are automatically subject to the James Bay and Northern Quebec Agreement (JBNQA) and EQA, Section 22 review procedures.

The assessment shall follow the 5-step process outlined in Minister of Environment's brochure for the Environmental Assessment of Northern Projects[1] and all associated documents referred to therein. Accordingly, the present Notice of Intent has been prepared for submission to the Administrator, Mr. Isaac Voyageur, Regional Administrator, Cree Nation Government, ESIA Secretariat.

2 SUBJECT

2.1 PROPONENT

The Cree Nation of Wemindji is the sole proponent and legal landowner of the present project. A waste incineration plant is a public service facility operated by the Band for the purposes of treating the municipal wastes produced within the community's collection network.

The coordinates of the responsible parties representing the Proponent are:

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2.2 CONSULTANT

The Cree Nation of Wemindji hired the services of WAPTUM for the production of the present Notice of Intent (Project Notice) by Purchase Order SPF-014127.

The coordinates of the responsible parties representing the Consultant are:

Ms. Lauren Montpetit
Chief Executive Officer
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Ms. Geneviève Gagnon
Project Manager
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1 Environmental Assessment of Northern Projects, MDDELCC, *http://www.environnement.gouv.qc.ca/evaluations/mil-nordique/eval-nordique-en.pdf* last retrieved by WAPTUM online on 2019-07-31

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3 GOAL

The entire objective of the proposed project is to establish a new waste incineration plant, including a building, loading / unloading / circulation areas and site entrance.

The project is planned for construction as early as 2020, pending the completion of the ESIA study, design and tendering processes.

3.1 FUNCTION

Instead of direct landfilling, the community of Wemindji has been incinerating their municipal waste in a formal incineration plant since the early 2000's. It is estimated that the process of incinerating waste reduced waste volumes by approximately 85%, leaving only ash and unburned materials such as glass and metals for disposal at the local landfill.

The CNW's goal in incinerating wastes is to drastically reduce the volume of materials sent to landfill, which serves to protect their lands from unwanted development. For that reason, the CNW plans to construct a new waste incineration plant as early as 2020.

3.2 FUNDING

The project is planned to be funded in part by insurance claim. The community is in the process of identifying additional sources to complete their funding requirement.

4 PROJECT

The project consists of the construction of a waste incineration plant on Category IA lands of the Cree Nation of Wemindji to help satisfy the long-term waste disposal needs of the community. The site location of the proposed incineration plant is shown on the map from an air photo image is provided in Appendix A.

In the community of Wemindji, waste services include separate collection of recycling and household garbage (waste). Following the success of a pilot project in 2019, a community-wide composting collection program is expected to be rolled-out in the coming years to remove these materials from the waste stream.

The recycling collection program accepts plastics, glass, paper, cardboard and metals, which are exported for treatment in the south. According to a 2017 study[2], community participation in the program is estimated at 17%, which is very low (60% target). The remaining 83% of potentially recyclable materials are thus being incinerated as part of the general waste stream.

2 Stantec, 2017 – Waste Management Improvement – Characterization Study – Cree Nation of Wemindji.

Bulky wastes, including construction materials, household appliances, electronics, furniture, toys, tires and other materials are regrouped at the local eco-centre. The majority of these materials are shipped down south for recycling, recuperation or disposal. Scrap wood, concrete and asphalt are broken down for reuse as construction materials for community projects. Hazardous wastes, including batteries, paint, chemicals, used oils and other potentially toxic materials are regrouped at the eco-centre and shipped down south for safe disposal, or recycling when applicable.

All wastes that are not successfully diverted to the recycling or eco-centre programs become part of the general waste stream, which are sent for incineration. According to the 2017 study, Wemindji is estimated to incinerate 386.5 kilograms kg/person/year. When compared to the rest of the Province of Quebec, Wemindji produces significantly more garbage per person, with the exception of glass, cardboard, paper and organic materials.

The project is subject to the terms of Chapter 3 of the Environmental Quality Act's Burial and Incineration of Waste Materials regulation[3]. This regulation sets out the technical, operational and environmental monitoring requirements for incineration installations in Quebec.

4.1 SITING

A map of sites considered for the siting of the project is provided in Appendix B.

A study was done in order to evaluate feasible sites for the location of the waste incineration plant[4]. The study identified 3 potential sites for the facility. Following the study, a site option was retained, which is located approximately 1.3km north of the nearest sector of the community along a new access road referred to as the "Kakabat Road".

The proposed site is identified on the map as Option 2. The site is located approximately 1km south-east of the proposed new landfill and approximately 2km east of the proposed future wastewater treatment lagoons. The landfill and wastewater plant projects are the subject of ESIA studies which are now underway and for which Notice of Intent documents have been issued to COMEX[5,6].

It is relevant to note that the existing access road, referred to above as the Kakabat Road, is the object of a previous ESIA study done for a local granular material project.[7] According to CNW representatives, the ESIA which was approved by COMEX in 2017 and the detailed project design is underway.

For details on the site options, consultation and evaluation process, the reader is directed to the Site Selection study, provided in Appendix C. It is noted that the selected site Option 2 is located within the "airport protection radius" and should thus be cleared by Transport Canada.

3 EQA, Chapitre Q-2, r.19, 2019 – Règlement sur l'enfouissement et l'incinération des matières résiduelles

4 BC2, 2019 – Wemindji Community Incinerator Site Feasibility Study – Ref: 42191902

5 WAPTUM, 2019 – Notice of Intent for Wastewater Treatment Plans in Wemindji – Ref: 16-0010057

6 WAPTUM, 2019 – Notice of Intent for a New Landfill in Wemindji – Ref: 19-001113

7 WAPTUM (formerly TMS Inc.), 2017 – Kakabat Granular Material Deposit – Environmental and Social Impact Assessment.

4.2 SCOPING

The incineration process begins with the unloading of garbage on to the indoor loading floor of the facility. The waste is then loaded in to a primary combustion chamber where it undergoes thermal decomposition and rapid oxidization with the addition of air or oxygen. The smoke produced in the primary chamber is directed to a secondary chamber, commonly known as an afterburner, which reignites the smoke using oxygen injection to accelerate combustion in the chamber.

The outputs of the incineration process include exhaust, heat and ash. The exhaust is released from an exhaust stack to the natural environment. Without an energy recuperation system, heat is lost through dissipation to the natural environment. The ash material, including ash, metals and glass, are transported to the local landfill for burial. It is possible to remove ferrous metals using a magnet system.

The Wemindji incinerator is planned to be designed to meet the Regulatory requirements for a maximum of 1 tonne per hour capacity facility. No detailed study has been made, however our high-level estimates show that given the community's current waste generation rate, a higher capacity system (over 1 tonne per hour capacity) should not be necessary. In fact, according to incineration system supplier Eco-Waste Solutions Inc, Wemindji requires an incinerator system capacity of approximately 2-3 tonnes per day to meet current waste generation needs and up to 5 tonnes per day in the long-term (20 years). This is well within the requirements of a 1 tonne per hour batch incineration system.

The detailed specifications of the incineration system are not yet defined, thus a complete description of the scoping of the infrastructure is not possible at this time. Schematic design layouts of a comparable project located in Skagway, Alaska are cited by the CNW as reference documents which respond to their operational needs and reduces the risk of fire and improves overall operational health and safety. Specifically, the Skagway system utilises a multi-level loading, integrated ash recuperation and fire suppression system, which the community's previous system did not have.

It is not clear if the Skagway system example has a similar capacity to what would be needed for Wemindji, or if the design and operating systems meet the Regulatory requirements of the province of Quebec. The supplier, Eco-Waste Solutions, has provided a Regulatory conformity document confirming the potential of their technologies to meet regulatory requirements provided that particular contaminants are diverted from the waste feed[8]. This document is provided in Appendix E. Of particular relevance and concern are PVC plastics, batteries and electronics. It is noted that the incineration of these materials in excessive quantities results in unacceptable emissions of hydrogen chloride (PVC plastics) and mercury (batteries and electronics). It is thus necessary that these materials be diverted from the waste stream as much as possible.

It is understood that complete facility and component system details will be established during the detailed design phase of the project, which is planned to be done alongside or following the ESIA process in order to ensure the project design is done in conformity with

8 Eco-Waste Solutions, 2019 – EWS Meeting the Quebec Regulation.

environmental and social acceptability standards. As such, the layout plans provided for the Skagway system in Appendix D are for reference only.

4.3 OPERATION

The operation of the waste incineration plant is to be done exclusively by the Cree Nation of Wemindji's local staff who are tasked with the overall management of the facility under the direction of the local Director of Environment. Staff are responsible for the safe and effective operation of the systems, for environmental sampling and reporting and for ensuring conformity to the Regulatory requirements.

In the past, the community has relied on their incinerator manufacturer to provide technical support services to troubleshoot incineration issues and to perform specialized maintenance activities. The community seeks support from waste management professionals to diagnose operational issues and to provide planning and improvement advice.

5 ENVIRONMENT

For the purposes of this document, the "receiving environment" of the project is defined to include all parts of an ecosystem, tangible or otherwise, that may be touched either directly or indirectly by the project. An overview of the total receiving environment of the project is by is provided in the subsections that follow.

5.1 LAND

Situated on the Hudson Bay geologic platform, the James Bay coastal region is one of the most dynamic coastlines in the world. Following the retreat of the Laurentide Ice Sheet beginning about 20,000 years ago, the land has been rising continually under the force of isostatic rebound. During the time of its retreat, fluvio-glacial and post-glacial sediments were deposited, making up the deposits found on the surface today. Known for the abundance of lakes, rivers and swamps, the James Bay region represents, overall, a complex fresh water system interlaced with rocky hills and granular deposits.

The project areas are located on Category 1A land of the Cree Nation of Wemindji, which spans an area of 326.6 km^2 between the Old Factory river and the Paint Hills Lake[9]. The Category 1A land is within the boundary of a Cree trap line administered by the family Kakabat (VC11) defined on the following map[10].

9 http://www.rncan.gc.ca

10 http://www.creegeoportal.ca/cta/#

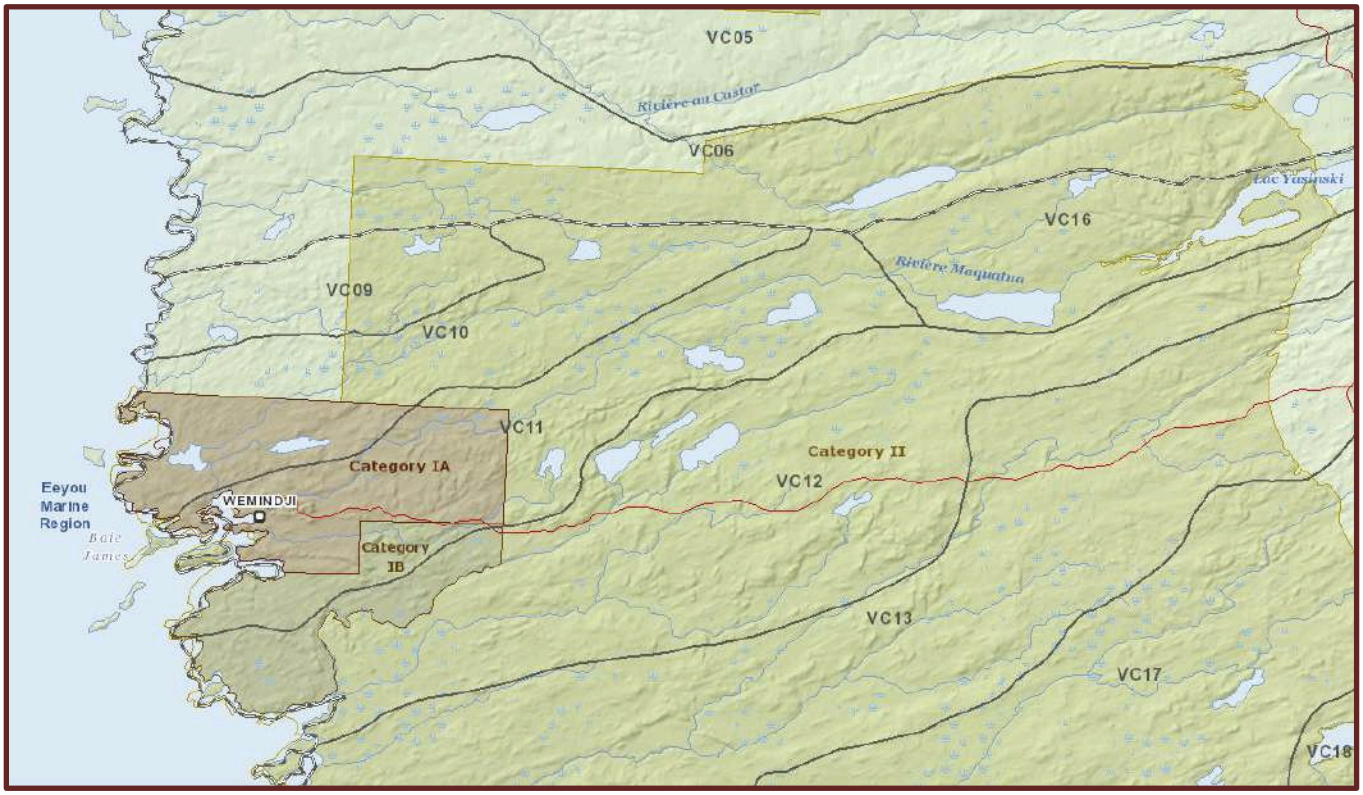


Figure 1: Eeyou Cree Traplines on Category 1A land of Wemindji (map from CTA[11])

5.2 FOREST

Wemindji is located in the taiga subzone of the boreal forest, characterized by its sparse spruce-lichen forest[11]. The forest has a low-density coniferous tree cover with extensive lichen groundcover. The diversity of vegetation varies due to multiple factors, including soil composition and depth, water and nutrient availability, drainage, temperature variation, wind exposure, topography, etc.

5.3 WATER

The Hudson Bay hydraulic basin is one of the largest fresh water reserves in the world. The east coast of James Bay is home to the mouths of several major rivers as well as to a variety of tributaries, lakes and wetlands. On a local scale, the receiving environment represents a large area to the north of the Maquatua River which drains surface water to James Bay along a series of watercourses, including the Jibaud River and Pike Creek and through numerous ponds, swamps and lakes.

11 https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/jpg/assess/2007/ch5/images/fig12_e.jpg

5.4 CLIMATE

The James Bay region of Quebec falls within the subarctic climate zone, characterized by long cold winters and very short warm summers[12]. For most of the year, the region receives dominant winds from the west over James Bay. The strongest and most frequent winds come from the northwest and southwest, with speeds up to 40 km/hr.

Overall climate conditions in the region have presented a warming trend over the past century. Data for the past 30 years showing average winter temperatures up to 3 degrees Celsius above the reference averages in the winter and up to 1.5 degrees Celsius in the summer[13]. Regional observations have further concluded changes in snow and ice conditions, changing weather patterns and extreme weather events causing a vast variety of environmental, ecological and human impacts[14].

5.5 WILDLIFE

The region is well-known for its wildlife. The presence of mammals like wolf, marten, otter, beaver, porcupine, fox, moose, bear are common. Fish species including pike, trout, walleye and white suckers are commonly identified in the lakes and streams. Bird species include White-Throated Sparrow, Hermit Thrush, Tetra of Canada, Gay of Canada, Sandpiper, Canada Tit and Ptarmagin. The area is also a migratory route for snow geese and Canada geese[15].

5.6 HUMAN

Numerous hunting and fishing spots in the region have been used by the Cree people since well before recorded history, and could potentially date back 4000 years, following glacial retreat. [16] Hunting and fishing camps are widely distributed over the land and have been established over generations.

The village of Wemindji is an urban development home to over 1,500 people. In order to permit its development, areas of the natural environment surrounding the community have been perturbed. Local sources of human environmental impacts include the local quarry and granular materials deposits, the wastewater treatment lagoons, the local landfill, and contamination from residential, commercial, institutional, municipal and industrial sources within the community.

The areas surrounding the community are accessible by access roads, rough seasonal trails and walking paths. Formal access roads often redirect the flow of surface water flow and cross intermittent or permanent watercourses.

12 https://www.britannica.com/science/Koppen-climate-classification

13 Ouranos, 2018 – State of Climate Change and Adaptation Knowledge for the Eeyou Istchee James Bay Territory, pp 22

14 Call to Action - Climate Change Adaptation in Waskaganish - https://www.youtube.com/watch?v=WKk5U8ECtXM

15 TMS Inc., 2017 – Kakabat Granular Material Deposit – Environmental and Social Impact Assessment.

16 http://www.dfo-mpo.gc.ca/Library/314704-Ch11.pdf

6 IMPACTS

The principal impacts of the waste incineration plant project can be appraised with a reasonable degree of confidence since the receiving environment is directly adjacent to sites studied during the ESIA process for the granular material and access road project referenced in section 4.2.

Based on a preliminary analysis, the development and operation of a waste incineration plant in the receiving environment can be expected to trigger the following potential impacts.

6.1 LAND

The principal impacts on the land are related to the deforestation of the site to accommodate the building, circulation areas and driveway connection to the access road. At present, we estimate to require approximately 15,000 to 20,000 square feet of land area will be required depending on the final size and configuration of the building and site.

6.2 FOREST

The project is expected to principally impact moss and lichen forest eco-systems which would require the removal of tree cover, lichen and plant species. Certain plant species found in the area are used for cultural, functional or medicinal uses, however the area is not a unique source and tend to be abundant in the region.

6.3 WATER

The runoff of rainwater collected from the roof of the building and in drainage ditches on the site is expected to result in minor erosion and turbidity. According to the Regulation, the building requires a trench for the collection of waste liquids, and the operation of the facility may result in the production of wastewater from cooling of residual materials or to suppress atmospheric emissions. These liquids must be collected and may not be released in to the environment without dilution or treatment to acceptable levels. The release of these liquids may have an impact on the quality of the water in the receiving environment.

6.4 CLIMATE

Waste incineration systems release significant volumes of CO_2 and other greenhouse gases as well as waste chemicals and particulate matter to the atmosphere. The Regulation sets out emission standards, the limits of which must be respected by the operator. In addition, the fueling of the incineration system itself is done using fossil fuels, which carry their own greenhouse gas emissions. The breathing of toxic exhaust is dangerous to human and animal health and fallout from the emissions may affect aquatic species and impact surface waterbodies.

6.5 WILDLIFE

The impact of the project on mammals, fish and bird species can be described by the combined impact of habitat destruction from deforestation, traffic from the circulation of waste collection and ash removal trucks, as well as erosion and contamination of the eco-system from emissions. Although these impacts could be considered to be of significance

over a large area or in areas of threatened species, the project area is small, thus wildlife are expected to be impacted very minimally overall.

As mentioned in Section 6.4, the breathing of toxic exhaust may be potentially dangerous to animals.

6.6 HUMAN

Land users rely on lands in the region for fishing, hunting, trapping, recreational and traditional activities. The 2017 ESIA study for the granular materials project noted the location of camps, hunting blinds, traditional sites and pristine environments / important eco-systems in the general area north of Wemindji.

An archaeological assessment was done on the site area in 2017 as part of a previous ESIA for the Kakabat Road project[17]. The study showed that certain sites of higher elevation, including the proposed incinerator site, could have been accessible to humans (above water) around 1100 years ago. However, the preliminary assessment did not identify any sites of interest on or near the area of the proposed incinerator.

Further study may be required in order to confirm the absence of important sites.

As mentioned in Section 6.4, the breathing of toxic exhaust may be potentially dangerous humans.

7 CONSULTATION

The consultation process for new projects in Wemindji begins with the proposal of sites and project scopes to the community's Director of Environment and then to the Chief and Council. With their support, the local Tallymen are consulted to gauge their support for the project and to receive their concerns. Only with the support of the Tallyman will be project proceed to the planning stages.

In the case of this project, following the support of Chief and Council, the Tallyman was consulted by the representatives of the local administration (the representatives of the Proponent identified in Section 2.1) who have reported the support of the Tallyman for the project. The community holds a local general assembly in August of each year, at which time the representatives of the local administration update the community members on local project planning and request feedback on project acceptability.

8 SCHEDULE

Due to the urgent need to remove the existing wastewater treatment lagoons from their existing location in a new development area, the construction of the new facility is a priority.

17 Cree Nation Government, 2017 – Archaeology Unit - Kakabat area granular material project: Preliminary assessment of archaeological potential and recommendations for archaeological inventory

The following schedule is proposed:

- ESIA Study – Fall to Winter, 2019-20
- Design of Plans & Specifications for Tender – 2020
- Tendering for Construction – 2020
- Construction – Fall 2020 to Summer 2021
- Operation – Starting in 2021 – Ongoing

9 CONCLUSION

The Cree Nation of Wemindji submits their Notice of Intent to develop a waste incineration facility to help satisfy the long-term waste disposal needs of the community. According to the Environmental Quality Act (EQA), Schedule A, Section 1, the project is automatically subject to the James Bay and Northern Quebec Agreement (JBNQA) and EQA, Section 22 review procedures.

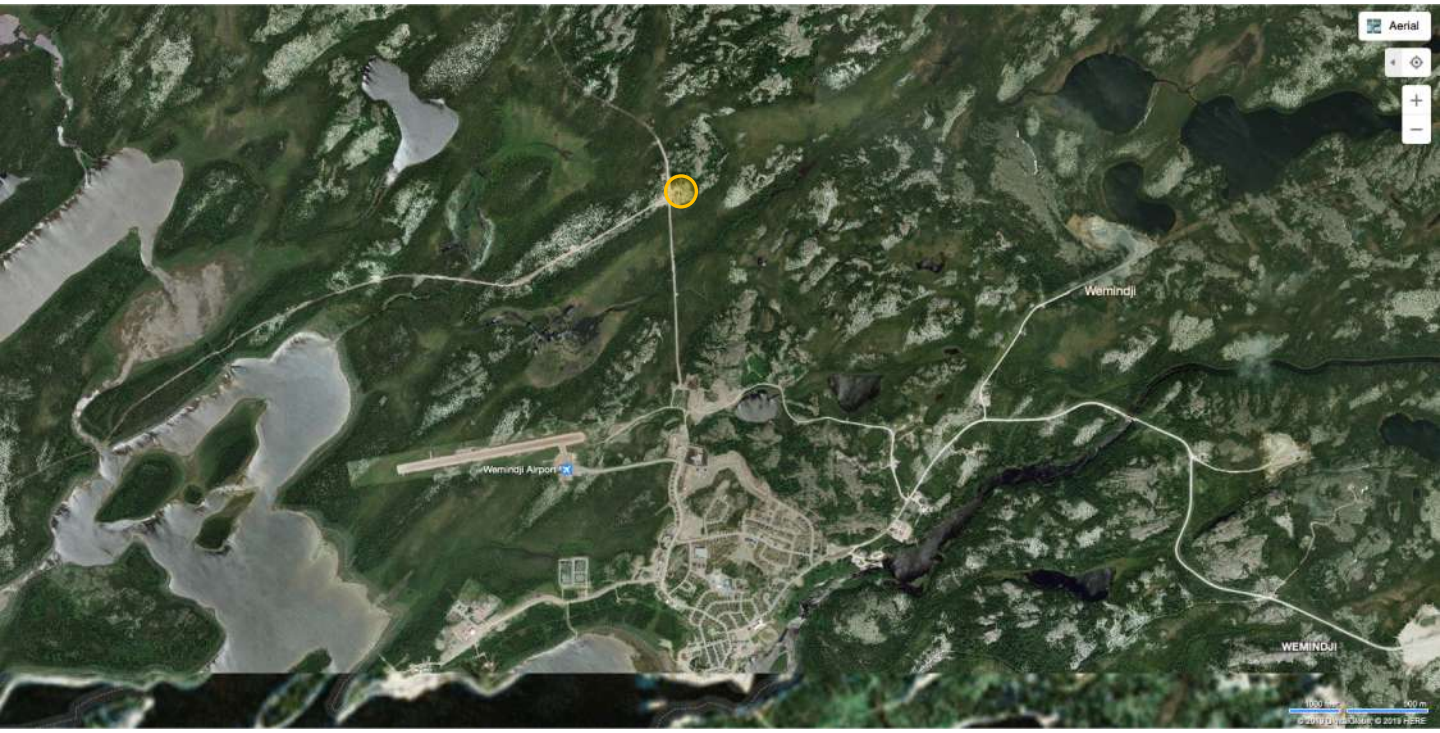
The project is planned for construction in 2020-21 in order for operation to begin in 2021.

Among 3 potential sites, Site 2 has been retained by the community. The site developed is expected to require 15,000 to 20,000 square feet of area and is located approximately 1.3 kilometres to the north of the community.

The principal impacts of the project include deforestation and emissions of greenhouse gas, waste chemicals and particulate matter.

The local Chief and Council and Tallyman have been consulted on the project and have shown their support.

Appendix A – Site Map from Air Photo Image



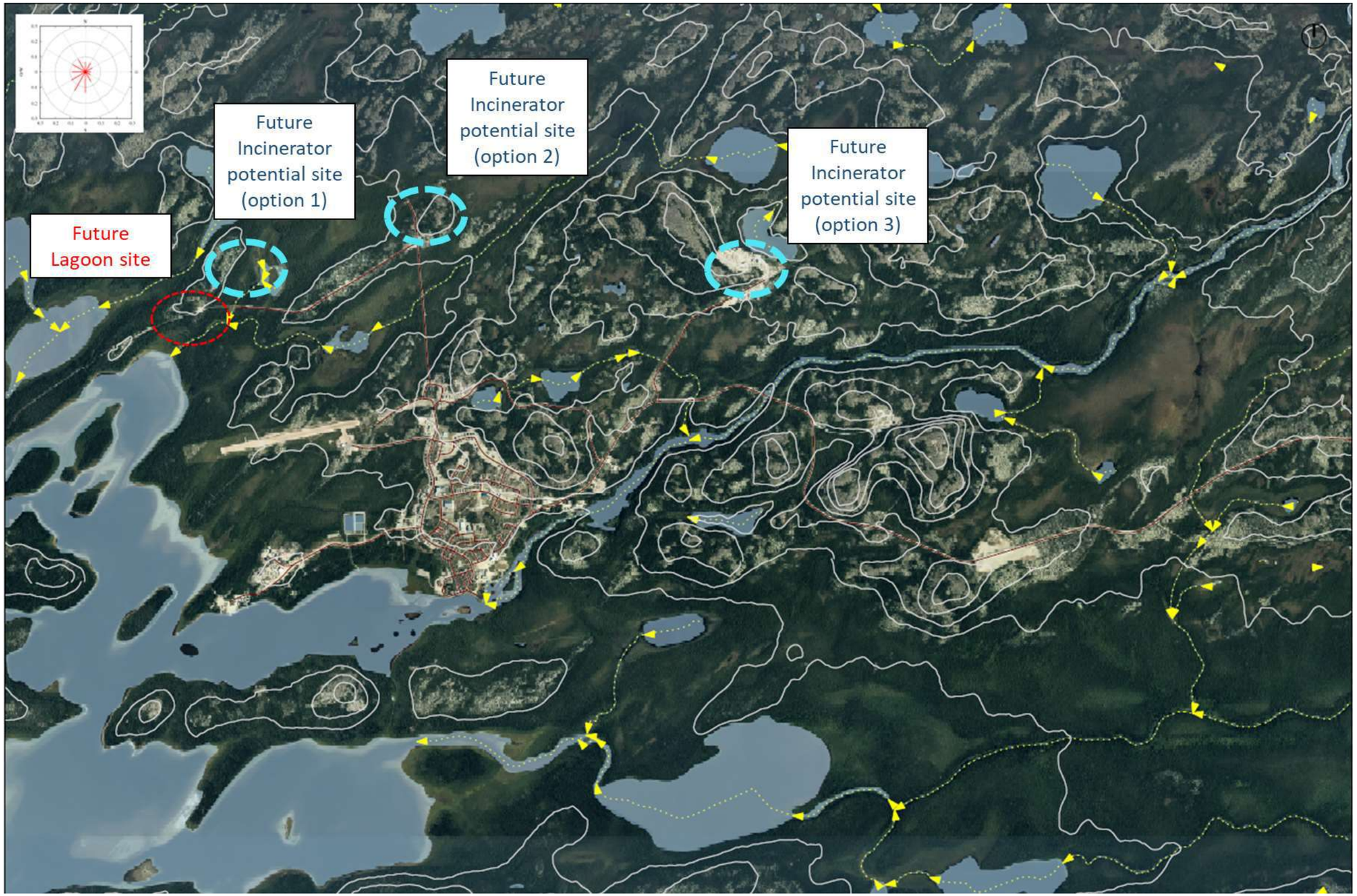
Map of Incinerator site in local context

Map of Incinerator site zoomed to show site details

Maps from https://www.bing.com/maps last accessed November 2019.
Modified by Waptum (site identification circles in yellow) November 2019.

Appendix B – Map of Sites Considered during the Selection Study by BC2

Figure 17 Map of the 3 potential sites



Appendix C – Site Selection Study by BC2

BC2
PLANNING
SPACES

The Cree Nation of Wemindji

WEMINDJI COMMUNITY INCINERATOR SITE FEASIBILITY STUDY

OCTOBER 16, 2019
PROJECT 42191902

OUR EXPERTS RECOGNIZE THAT ALL DEVELOPMENT PROJECTS HAVE A DIRECT IMPACT ON PEOPLE'S LIVES.
WE ARE COMMITTED TO PLANNING SPACES IN A COMPREHENSIVE AND SUSTAINABLE WAY

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INTRODUCTION

Like other coastal Cree Communities, the Cree Nation of Wemindji (CNW) has seen its population grow at a fast pace in recent years. In particular, this has increased the pressures of human activity on the territory.

The Cree Community of Wemindji is a leader among Cree communities in terms of waste management. In 2006, it initiated a recycling program, with the distribution of collection boxes for recyclable materials, for both residents and businesses. Then in 2009 an Eco-Centre was built close to the municipal incinerator, which had been in operation since the mid-1990s. This Eco-Centre is the first in Eeyou Istchee Territory.

However, the incinerator burned down and must be replaced, and the Cree Nation of Wemindji (CNW) sought professional services to conduct a feasibility study for the location and construction of a new incinerator.

This report identifies and analyzes 3 sites for the new incinerator, with a cost analysis for each potential site and a recommendation for one of the three locations.

The report includes:

- A description of the community;
- A documentation review;
- A description of the three potential sites for the incinerator;
- A report of consultations with the community;
- Recommendations for each of the three potential sites for the incinerator.

1 DESCRIPTION OF THE COMMUNITY

GEOGRAPHY

Category IA and IB lands for Wemindji cover a total area of 513 square kilometres. Category II lands cover a total of 6,822 square kilometres. Wemindji's neighbours are the Cree communities of Chisasibi and Eastmain, and the Non-Native community of Radisson.

Chisasibi is 270 kilometres north of Wemindji by road, whereas Eastmain is 370 kilometres south. The town of Radisson is located about 200 km away by road. Chisasibi, Wemindji and Eastmain are located on the east coast of James Bay. The distance from Wemindji to Val d'Or, by the road, is 1,008 kilometres, and the distance from Wemindji to Montreal is 1,418 kilometres.

Wemindji is accessible by road, air and water. A permanent road opened in September 1995, and connects Wemindji to the James Bay highway, which leads to Matagami and La Grande 2. This 96 km-long access road is located at Kilometre 518 of the James Bay highway. Wemindji also has a local airport and a small harbour. The Maquatua River connects Wemindji to James Bay.

POPULATION GROWTH

Like the other coastal Cree Communities, the Cree Nation of Wemindji (the Community) has seen its population grow at a fast pace in recent years. Statistics Canada evaluated that Wemindji had a total population of 1,444 inhabitants in 2016. The Cree Nation of Wemindji estimates that its population will be close to 1,800 inhabitants in 2019.

According to the 2016 census by Statistics Canada, the Wemindji population is expected to grow by 30.5% between 2016 and 2036. The population would therefore reach 2,058 residents in 2036. The increase in the population between 2016 and 2036 would represent 150 new dwelling units to be added, based on the average number of persons per unit in 2016 (4.1 persons/dwelling).

Table 1 Population Growth 1996-2016

	1996	2001	2006	2011	2016	Mean annual variation
Wemindji	1,013	1,095	1,215	1,390	1,444	1.79%

Source: Statistics Canada

Table 2 Population Forecast 2021-2036

	2021	2026	2031	2036	Mean annual variation
Wemindji	1,578	1,724	1,884	2,058	1.79%

Source: Statistics Canada

This number of new dwelling units to be added does not consider those already built that may have to be either rebuilt or retrofitted. Should the existing housing units be considered unsuitable for living or in need of major repairs, they would have to be added to the equation.

Unfortunately, the data regarding major repairs and unsuitable dwellings are not available for 2016. However, if we look at the data from the 2011 census, around 24% of the existing dwellings were unsuitable and 33% required major repairs. Assuming that these conservative numbers are approximately the same for 2016, around 50% of the 355 existing dwellings will have to be added.

According to Tawich Management Services and the Cree Nation of Wemindji, an average of 7.6 new houses per year have been built over the course of the last 6 years.

Table 3 Number of Houses Built 2011-2016

Year	Number of Houses Built
2011	4
2012	2
2013	0
2014	10
2015	14
2016	16

Source: The information was provided by Tawich Management Services and the Cree Nation of Wemindji.

In order to accommodate the population growth for the next 20 years, the current average of 7.6 houses built per year is reasonable, but if we consider the unsuitable houses and the ones that required major repairs, around 18 houses should be built every year until 2036.

FUTURE DEVELOPMENT OPTIONS

The growth of the Cree Nation of Wemindji has reached a point where the cost of developing new residential lots is high. There are also technical and health concerns with the sites surrounding the community. These elements are important to consider when planning the location of future waste management facilities. The location of such facilities should not interfere with the planned development of the community. The population growth also implies that more waste will also have to be managed.

In Wemindji, a Master Plan was drawn up in 2012 and updated in 2017[1] in order to evaluate the pertinence of areas spotted for further development.

The Cree Nation of Wemindji analyzed the potential areas surrounding the existing developed zone of the community. Five zones were identified:

- **Area 1** - West Village
- **Area 2** - South Tawich
- **Area 3** - Phases 2-4
- **Area 4** - South Shore
- **Area 5** - River Crossing

For each potential development area, an analysis was produced to evaluate the development potential in terms of housing units, the cost of infrastructure development and the limitations of the area for future growth.

The five zones identified for development are the next logical steps for the growth of the Community. Each zone presents interesting potential for new housing but all come with either functional or financial drawbacks. In most cases, compromises are necessary on both accounts.

The Cree Nation of Wemindji aims to keep the village compact. Compact communities reduce the cost of the municipal services, while increasing community cohesion and reducing the travel distances needed to access community services, commercial areas, schools, etc. Eventually, the population growth of Wemindji will justify a more spread-out development form.

[1] The Cree Nation of Wemindji/BC2 (2017). *Wemindji Master Plan Update*. Final Report, 78 p.

Table 4 Potential Residential Development Zones

However, the current size of the community population calls for a compact development in the short and medium terms. In that sense, the five identified areas already represent a wide perspective on the next potential development zones.

An extension of the village to the north will expose nearby residents to air and noise pollution (airport). The airstrip is made of gravel, which generates dust, and aircraft movements are a source of noise. Generally, noise and dust fade as the distance to the strip increases, but the intensity of the disturbance also depends on the wind direction and the type of aircraft. Even if air traffic today is low, the rapid expansion of the community and the extra air travel generated by the mining operations of the Éléonore mine will make this location problematic in the long term.

The development of the next area should thus be as close as possible to the existing village core. However, the potential development areas identified have drawbacks associated with high infrastructure investments.

Area 3 (phases 2-4) is already under development; therefore, it cannot be considered for the future development of the Community. It can be densified in the short term with houses by using preventative measures for radon and different type of foundations.

LOCAL AUTHORITIES INVOLVED

Cree First Nation Council

The Cree Nation Council of Wemindji is composed of its Chief Christina Gilpin and her six councillors. As they are responsible for the administration of the community's services, they assume the monetary costs of waste collection. They also approve or reject proposals and may adopt by-laws applicable to Category I lands. The Local Environment Administrator reports to the Council. Director of Operations Tony Gull is the head administrator who oversees the administration for Wemindji.

The Local Environment Administrator

Mr. Johnny Mark has been Wemindji's Local Environment Administrator (LEA) since 2001. The LEA is responsible for the environmental protection of Category I lands, and is the community liaison for development on Category II and III lands. Thus, the LEA, by making recourse to the Environmental Protection By-Law, can approve or reject any development resulting in an environmental or social impact on Category I lands. Consequently, the LEA plays a crucial role in any development projects subject to the JBNQA Section 22 Regime for Category I lands. The LEA is the person responsible for waste management matters. Indeed, his role consists of managing the Environmental Health Department (see next section). Since 2001, Mr. Mark has endeavoured to find solutions to the waste management issues in Wemindji. After the feasibility study and an impact assessment under Section 22 of the JBNQA, it was recommended that the incinerator project be approved: Mr. Mark therefore authorized the project in accordance with Section 22 and By-Law 90-42. He has also been a major proponent of the new recycling project that is being proposed for Wemindji.

Environmental Health Department

This department comprises the waste management employees who currently collect household waste and process it at the incinerator. Mr. John Ratt is the manager of this department, which has three full-time employees, namely Jeffery Kakabat, John William Natawapineskum and Darren Croxen. All four staff members collect the garbage from Wemindji's households on a daily basis. In the afternoon, they supervise the burning in the incinerator. Consequently, the new recycling program would be managed by Mr. Ratt under the supervision of the Local Environment Administrator, Mr. Johnny Mark, who reports to the Cree Nation Council of Wemindji.

2 DOCUMENTATION REVIEW

Groupe BC2 professionals compiled all the information gathered in order to evaluate the potential location areas for the new incinerator. Different locations were selected and evaluated (3 sites in total) in order to choose the most suitable location. This section presents:

- A short description of the existing waste management system with a map locating the main facilities;
- A short description of the community, its current and existing needs in terms of waste management;
- A short description of the proposed locations with an analysis.

Documents used for this step are described in the following table:

DOCUMENT
Dessau-Soprin (2007). *Waste Management Plan. Environmental Impact Study. Activity 600 – Impact Evaluation and Mitigation Measures. New Solid Waste Disposal Site*. Final Report, 105 p.
Dessau-Soprin (2004). *Wemindji Incinerator Heat Recovery Feasibility Study*. Final Report, 82 p.
Jean-François Luc Vachon (2005). *Integrated Waste Management of the James Bay Territory. A joint Pilot Project for the Development of a Sustainable Waste Management Plan for Wemindji*, 69 p.
Jean-François Luc Vachon (2009). *Profil de la gestion des débris de construction, rénovation et démolition (CRD) au Québec*. Final Report, 136 p.
Kativik Regional Government (2013). *Plan de Gestion des Matières Résiduelles du Nunavik*, Work document de travail, 135 p.
Mamianskum, R. (n.d.). *Wemindji Waste Disposal Overview*. Work Document, 6 p.
Recycling Poster
Domestic Waste Poster
Eco Waste Solutions Incineration Technology – Components and Functional Overview
Domestic Waste Pickup Schedule
Recycle Pickup Schedule
Map – Section I and Section II
Wemindji Recycle Guide
Cree Nation of Wemindji (2016). *Cree Nation of Wemindji – Population and Growth*. Work Document, 4 p.
Waptum (2019). *Composting Pilot Program. Cree Nation of Wemindji*. Final Report, 207 p.
Stantec/Tawich Management Services (2017). *Waste Management Improvement. Characterization Study*. Final Report, 121 p.

DOCUMENT
Stantec (2019). *Geotechnical Investigation Report. Kakabat Access Road and Bridge Structure Wemindji Quebec*. Final Report, 79 p.
Cree Nation of Wemindji (2019). *Waste Management Programs. Guidelines 2019-2020*. Document, s.p.

2.1 WASTE GENERATION

Waste generation in Northern communities in Canada is poorly understood due to minimal auditing and weigh scale data.

In Wemindji, the last waste characterization survey was conducted in 2017 by Tawich Management Services. The *Waste Management Improvement Characterization Study* provides valuable information on Wemindji's waste production, quantity and quality.

In 2007, Dessau-Soprin evaluated that a total quantity of 485 tons (2,694 cubic metres) was incinerated in Wemindji. An average of 1.1 kg per person per day was produced in the community, for an amount of approximately 400 kg/person/year (Dessau Soprin, 2007: 11), excluding construction, renovation and demolition waste (CRD).

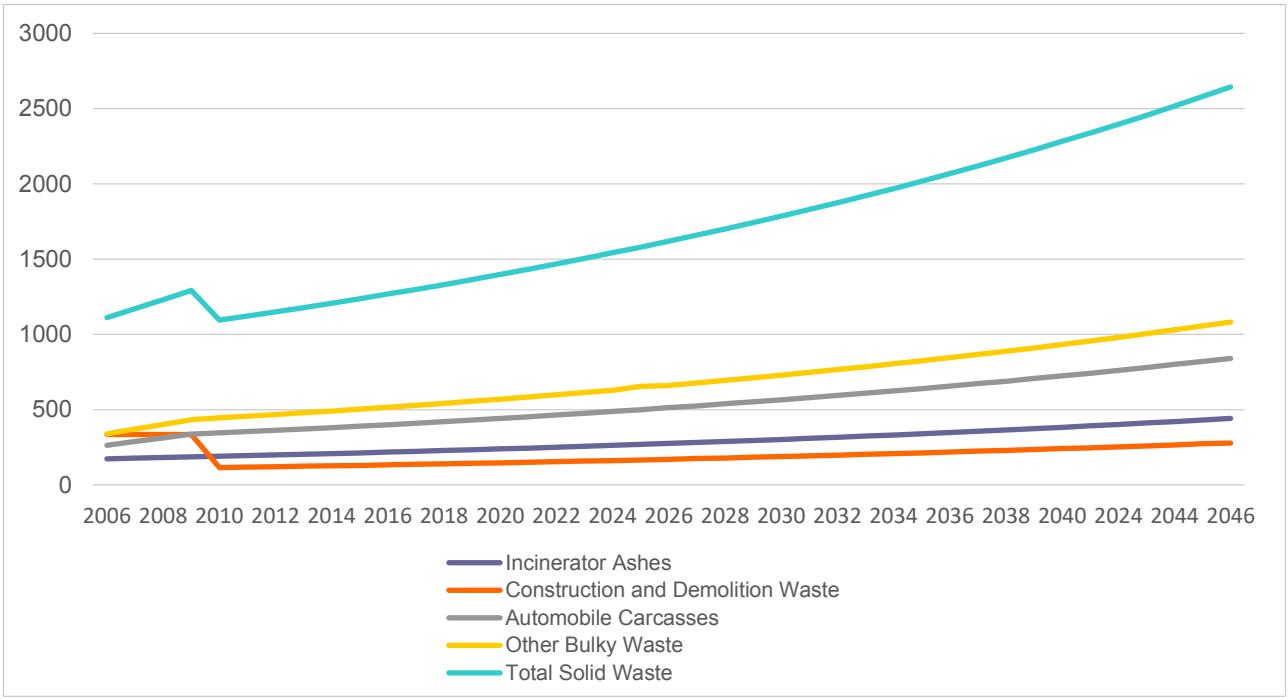
In 2017, Stantec evaluated that a total quantity of 589 tons was produced in Wemindji. An average of 1.1 kg/person/day was produced in the community for an amount of approximately 408 kg/person/year (Stantec, 2017: 39), excluding CRD waste.

In 2018, a waste characterization of the Northwest Territories analyzed medium-sized and small communities waste production.[2] Medium-sized communities (from 1,000 to 4,000 residents) had an average production of 633 to 1,028 kg/person/year, including construction and demolition waste.

Between 2006 and 2016, total waste production was expected to grow by +14% (+2.5% per year, according to Dessau-Soprin, 2007) (see following figure). However, it grew more slowly than the average population growth. Wemindji has a particular profile as the average amount of waste produced in the community is below the average for medium-sized northern communities.

[2] Golder (2018). *Waste Management in the Northwest Territories*. 2018 SWANA Northern Lights Conference, Edmonton, Alberta. 29 p. Online: https://swananorthernlights.org/wp-content/uploads/2017/05/Paul-Dewaele-NWT-Presentation-SWANA-Edmonton-2018-Draft-LPH-002-1.pdf, accessed June 4 2019.

Figure 1 Solid waste volume projections by type (cubic metres) 2006-2046



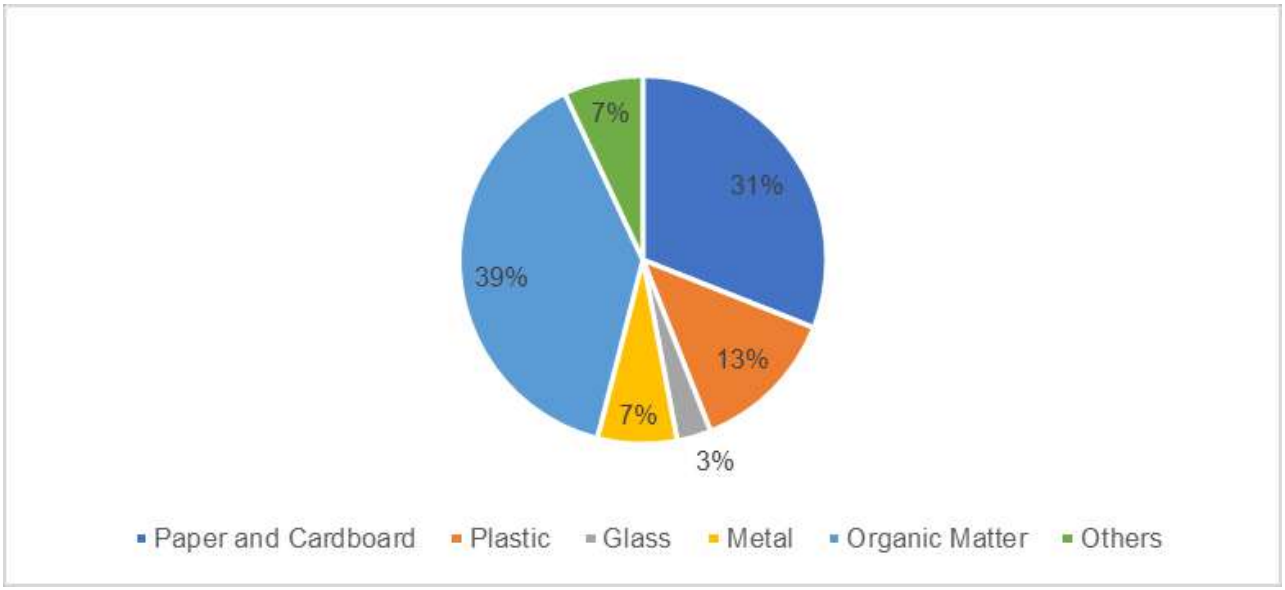
Source: Dessau-Soprin, 2007.

2.2 WASTE COMPOSITION

MUNICIPAL WASTE

The waste characterization surveys of 2000 and 2017 provide information on solid waste composition and its evolution in Wemindji. The waste characterization surveys included residential and commercial waste, the composition of which is quite similar.

Figure 2 Wemindji solid waste composition – 2000

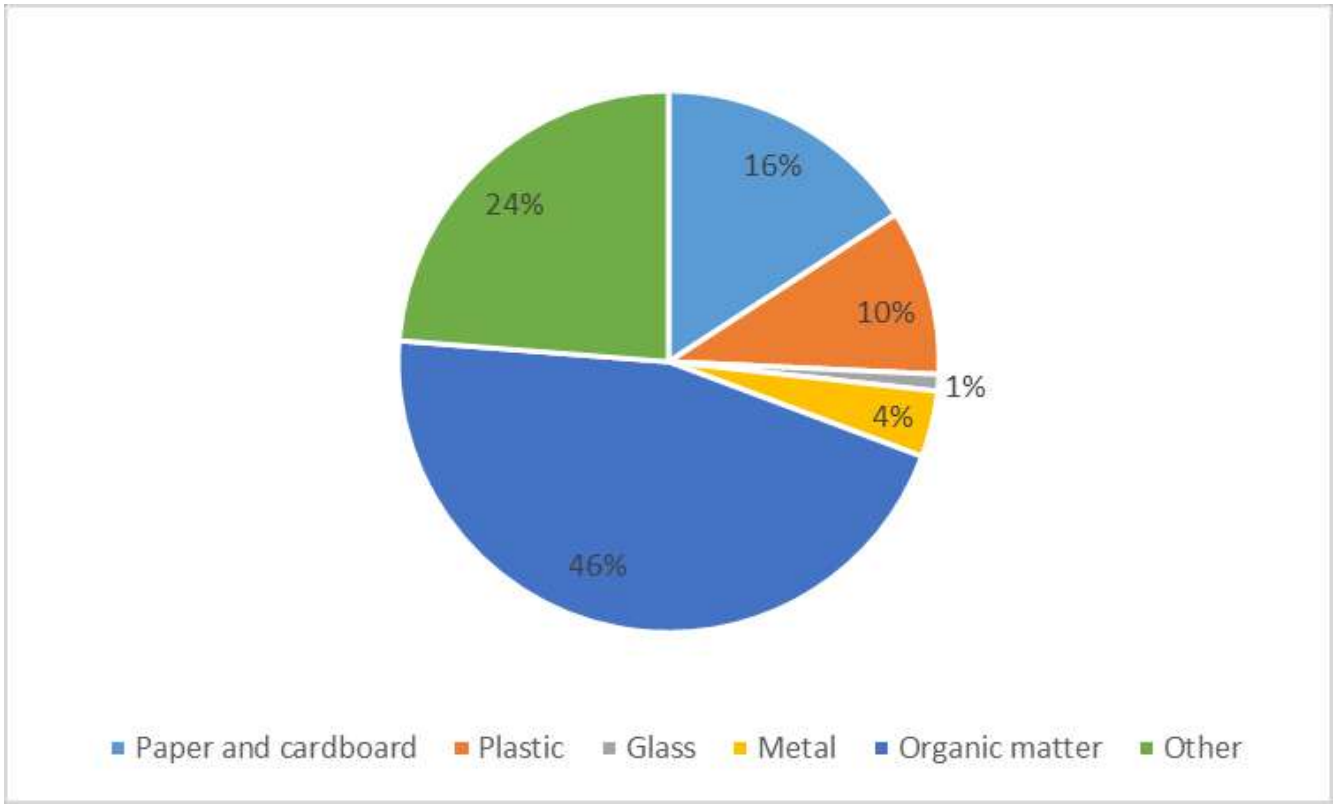


Source: Dessau-Soprin, 2007.

In 2000, organic matter (39%) and paper and cardboard (31%) represent a large share of solid waste in Wemindji.

In 2017, organic matter (45%) still represented a large share of solid waste in Wemindji. The organic matter share increased between 2000 and 2017. The recyclable materials also represented an important share of the waste composition. In the Stantec study, various types of cardboard, paper, plastics and metals are described, with more attention paid to the available recycling options. The “Other materials” share also increased. This category includes sanitary products, diapers, Pyrex glass, toys, dishes, textiles, etc. (Stantec, 2017: 39).

Figure 3 Wemindji solid waste composition – 2017



Source: Stantec, 2017.

CONSTRUCTION AND DEMOLITION WASTE

The Dessau-Soprin study (2007) also mentions that 36 tons of CRD waste per year had to be expected in Wemindji in 2016. The village then planned for the production of more CRD waste (90 tons/year) as 36 new houses per year were to be built between 2005 and 2008.

As new sectors will soon be developed in the village, construction and demolition waste may soon increase again. Moreover, as mentioned by Dessau-Soprin (2007), it has to be considered that the potential for reusing construction and demolition waste material is lower in isolated communities.

In 2009, the *Profil de la gestion des débris de construction, rénovation et démolition (CRD) au Québec* indicated that the North-of-Quebec region produces little construction and demolition waste (143 kg/person/year). Less than 6,000 tons of construction and demolition waste per year would have been generated in the region. In 2006, no construction and demolition waste would have been recycled. As a matter of fact, no recycling unit exists in the region, though the document also states that all metals would be recycled through a container service in all Cree and James Bay communities. Some recyclers even extracted metal from in-trench deposits to exploit them in Abitibi.

Long distances prevent recycling initiatives. Recycling low-density material (such as wood) is not profitable. Local solutions could be developed if adequate equipment were bought by the communities. The Nunavik Residual Materials Management Plan also encourages the northern communities to recycle CRD waste.

Otherwise, some recyclers from Abitibi-Témiscamingue possess mobile crushing units and could travel to northern communities to exploit materials such as wood and concrete.

The CRD waste recycling sector has the highest performance among all recycling sectors in Quebec, with 70% of materials getting recycled. For example, chipped wood is transformed into panels, and roofing tiles are used to make asphalt.[3] In Wemindji, Groupe Ungava provides roll-off containers to recycle metals.[4]

[3] https://www.lapresse.ca/environnement/pollution/201808/22/01-5193823-residus-de-construction-et-demolition-lautre-crise-du-recyclage.php, accessed June 6 2019.
[4] http://groupeungava.com/expertise-mandats/, accessed June 3 2019.

2.3 WASTE MANAGEMENT PROGRAMS AND FACILITIES

Since 1996, the Cree Nation of Wemindji (CNW) has been making efforts to improve its waste management scheme and close the old disposal site, which exceeded its capacity that year and is still located some 2 km from the village:

- In 2003, a waste incinerator from the company EcoWaste Solutions in Ontario was purchased and installed;
- In 2006, the Cree Nation of Wemindji (CNW) initiated a recycling program, with the distribution of collection boxes for recyclable materials, for both residents and businesses;
- In 2007, a new landfill was opened at Kilometre 3 and began to receive ashes from the incinerator as well as other materials waiting to be recycled (metals, wood, bulky material, etc.);
- In 2009 an Eco-Centre was built close to the municipal incinerator;
- In 2018, the incinerator burned down and all the non-recyclable waste was redirected to the landfill, formerly used for the disposal of the ashes;
- In 2019, the Cree Nation of Wemindji initiated a composting pilot project.

The following section provides details on those programs and facilities. The facilities are indicated on the following map.

Figure 4 Locations of waste management facilities

Source: BC2/Cree Nation of Wemindji, 2019.

BUDGET AND STAFF

In 2019, the Environmental Health Department has an annual budget of approximately $1 million, which represents 8% of the Cree Nation of Wemindji's annual budget. In 2005, this budget was $300,000, which means that the budget has tripled since then.

This includes all collection costs as well as the costs related to the operation and maintenance of the landfill (labour, garbage truck, energy, contracted services).

In order to receive waste collection and water services, each household must pay an annual user fee of $200. This annual user fee has not changed since 2005.

The waste management staff includes:

- 7 employees at the Eco-Centre and – formerly – at the incinerator;
- 2 shifts of 3 employees for garbage and recyclable pick-up.

RECYCLABLE AND NON-RECYCLABLE WASTE PICK-UP

The Environmental Health Department is responsible for the pick-up of waste and recyclable materials using the containers provided. In 2016, these services are provided to approximately 350 households in Wemindji. The pick-up service also includes institutions, businesses and industries.

In 2006, the Cree Nation of Wemindji initiated a recycling program with the distribution of collection boxes for recyclable materials, for all residents (sections 1 and 2), institutional buildings and businesses.

- **Recycling containers (blue):** paper (no carbon paper), plastic, cardboard, cans, etc. Recycling pick-up is performed between 9 a.m. and 3 p.m. on Monday, Tuesday, Thursday and Friday. On Wednesday, pick-up is performed between 9 a.m. and 12 noon. From 3 p.m. until 6 p.m. employees do truck maintenance, except on Wednesday. On Wednesday afternoon, Eco-Centre cleaning is performed. Pick-up is performed twice a week for Commercial Section I and once a week for Residential Section I, Residential Section II and Commercial Section II.
- **Household waste containers (green):** Pick-up is performed between 9 a.m. and 5 p.m. on Monday, Tuesday, Thursday and Friday. On Wednesday, yard clean-up and bulk delivery at Km 3 are done, as well as grease pick-up for all restaurants. Garbage pickup is performed twice a week for Residential Section I and Residential Section II. Garbage collection from public buildings is performed from 3 p.m. to 6 p.m.

Small non-recyclable goods, and anything that does not fit in the containers, have to be brought to the Eco-Centre. This includes hazardous waste such as batteries, fluorescent lights, oils, paint cans and propane tanks.

Figure 5 Recycle and garbage pick-up routine

BLUE (recycle) Container Pick Up Routine

Time	Monday	Tuesday	Wednesday	Thursday	Friday
9:00	Commercial Section I	Residential Section 1	Commercial Section I	Residential Section II	Commercial Section II
10:00	Commercial Section I	Residential Section 1	Commercial Section I	Residential Section II	Commercial Section II
11:00	Commercial Section I	Residential Section 1	Commercial Section I	Residential Section II	Commercial Section II
12:00	L	U	N	C	H
1:00	Commercial Section I	Residential Section 1	Eco-center Yard Cleaning	Residential Section II	Commercial Section II
2:00	Commercial Section I	Residential Section 1	Eco-center Yard Cleaning	Residential Section II	Commercial Section II
3:00	Truck Maintenance	Truck Maintenance	Eco-center Yard Cleaning	Truck Maintenance	Truck Maintenance
4:00	Truck Maintenance	Truck Maintenance	Eco-Center Yard Cleaning	Truck Maintenance	Truck Maintenance
5:00	Truck Maintenance	Truck Maintenance	Eco-Center Yard Cleaning	Truck Maintenance	Truck Maintenance

Green (garbage) Container Pick Up Routine

Time	Monday	Tuesday	Wednesday	Thursday	Friday
9:00	Incinerated Maintenance & Burn	Incinerated Maintenance & Burn	Yard Clean-up & Bulk Delivery KM3	Incinerated Maintenance & Burn	Incinerated Maintenance & Burn
10:00	Residential Section 1	Residential Section 2	Yard Clean-up & Bulk Delivery KM3	Residential Section 1	Residential Section 2
11:00	Residential Section 1	Residential Section 2	Yard Clean-up & Bulk Delivery KM3	Residential Section 1	Residential Section 2
12:00	L	U	N	C	H
1:00	Residential Section 1	Residential Section 2	Yard Clean-up & Bulk Delivery KM3	Residential Section 1	Residential Section 2
2:00	Residential Section 1	Residential Section 2	Yard Clean-up & Bulk Delivery KM3	Residential Section 1	Residential Section 2
3:00	Public Buildings	Public Buildings	Yard Clean-up & Bulk Delivery KM3	Public Buildings	Public Buildings
4:00	Public Buildings	Public Buildings	Grease pick up for all Restaurants	Public Buildings	Public Buildings
5:00	Public Buildings	Public Buildings		Public Buildings	Public Buildings

Source: Cree Nation of Wemindji, 2019.

Figure 6 Domestic and Recycle Waste Poster

Source: Cree Nation of Wemindji, 2019.

COMPOSTING PILOT PROJECT

The Cree Nation of Wemindji also initiated a composting pilot project between November 2018 and April 2019. A composting collection service was provided for a sample population of 44 residences over a 12-week period starting on January 30th, 2019.[5]

The pilot project report states that to prepare for the program, 5 composters, 40 kitchen bins and 80 roller bins were purchased at JORA Composting and USD Global. Bin composters were purchased and installed on a concrete slab inside a mini-dome structure at the Municipal Garage.

Operators were given training on the operation of the composters to produce black soil for landscaping and gardening. In order to improve the success rate of the program, pamphlets and radio announcements were prepared to provide information about the program and its importance.

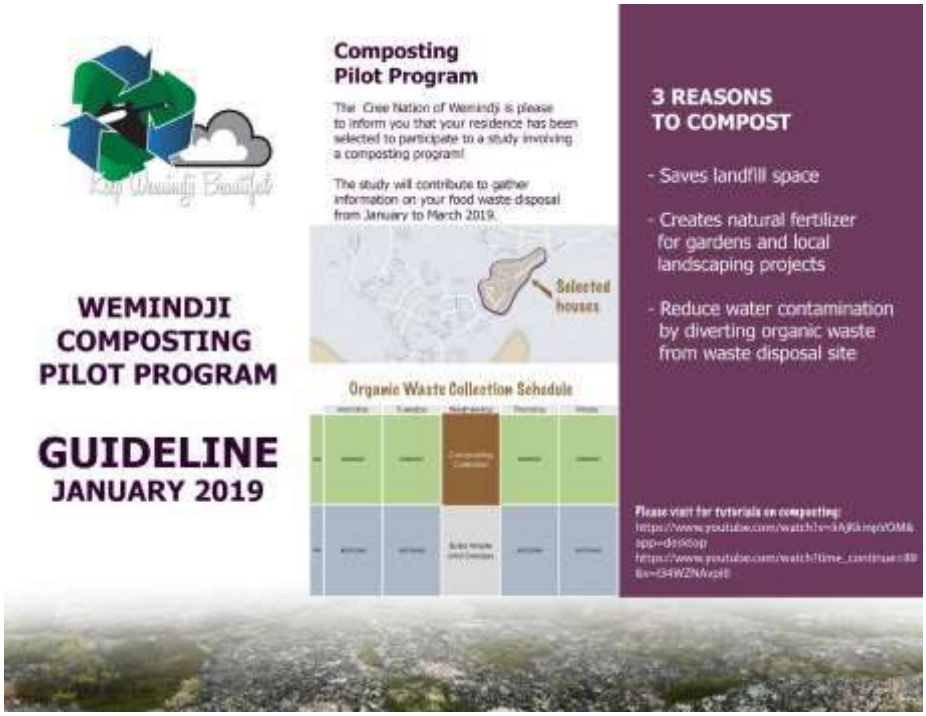
A survey was distributed in week 9 of the pilot program and provided great participation results. The results of the survey show that almost ¾ of the selected community members participated in the pilot program and well understood that diverting organic waste through a composting program reduced waste disposed at the landfill.

82% of the population were enthusiastic about a new composting program in Wemindji and almost everyone (91%) thought it was a good initiative to introduce the knowledge of composting at school for education purposes.

The information received during the composting pilot program reveals that 30% of the waste was diverted and that the project could be extended on a community scale.

[5] Waptum (2019). *Cree Nation of Wemindji – Composting Pilot Program*. Final Report, 106 p.

Figure 7 Wemindji Composting Pilot Program



Source: Waptum (2019). *Cree Nation of Wemindji – Composting Pilot Program*. Final Report, p.16-17.

INCINERATOR

Until 2018, solid waste (domestic and from institutions, businesses and industries) was incinerated. In 2018, the incinerator burned down and the waste has been temporarily disposed of at the current landfill site since then.

The incinerator was purchased in 2003 in order to eliminate environmental impacts from long-distance hauling and threats to water and air from leaching garbage and open burning in the community.

The equipment used a two-stage batch process. It was equipped with two primary chambers and a secondary chamber to complete the oxidation of combustion gases. Dessau-Soprin (2007: 5) indicates that:

> "*The two primary chambers operate five days a week, with the burning cycles taking place during the evening and overnight. One burning cycle per chamber is carried out per operating day. The operator starts the cycle before leaving the building at the end of the day. The next morning, doors are open to accelerate cooling of the ashes. Once cooled, ashes are transferred into a maritime container located outside the building and the container is eventually put on a truck and emptied at the in-trench ashes disposal site located at km 4*."

The equipment type was an Eco Waste Oxidizer, from the company EcoWaste. Its capacity was three tons per day. Dessau-Soprin calculated that the incinerator burned 0.96 tons per day per chamber, that is, well under its capacity. Dessau-Soprin also calculated that the average volume of ashes generated by the incinerator would range from 173 cubic metres per year in 2006 to 445 cubic metres per year in 2046.[6]

The ashes were placed in a covered container next to the incinerator building. Once about three-quarters full, this container was taken and emptied into the open trench at the current waste disposal site.

Figure 8 The incinerator building and facility in 2017

Source: Marie-Pierre McDonald, 2017.

[6] Dessau-Soprin (2007*). ibid*., page 15-16.

RECYCLING BUILDING

Recycled goods such as paper, plastics, cardboard and aluminium (cans) are sorted, baled and stored in the recycling building. Once approximately 30 or 40 bales have been stored, pick-up is arranged with Transport GMGL (Chibougamau) and Legault (Rouyn-Noranda).

The Wemindji Waste Management Plan (2005) mentioned that the community expected to recycle 100 tons per year during the first year of the recycling program implementation. In 2018, community participation in the program was very low (17% versus 60% in southern Quebec).[7]

Initial funding for the Wemindji program was considered essential for the start-up of this recycling program. It was first recommended to begin with glass and metal pick-up, storage and recycling combined with a hazardous waste storage shed (used oil, used paint, soda cans, rechargeable batteries and tires).

Transport GMGL was positively identified in 2005 in the *Wemindji Waste Management Plan*. The company was willing to travel to Wemindji to pick up its recyclables. They proposed to provide empty containers for the storage and shipping of recyclable material bales. The company paid $35 per ton of recyclables. This option would cost $48,800 for the first year and $18,800 in the following years.[8]

Transport GMGL is part of Groupe Ungava, a regional company in charge of waste management and based in Chibougamau. Groupe Ungava provides a range of services to public and private customers. Groupe Ungava collects recyclable and non-recyclable waste, restaurant grease, metals, batteries, etc.[9]

Figure 9 The recycling building

Source: Marie-Pierre McDonald, 2017.

[7] Stantec (2017). *Waste Management Improvement. Characterization Study*. Final Report, 121 p.
[8] Vachon, J.-F. (2005). *Wemindji Waste Management Plan*. Final Report, page V.
[9] http://groupeungava.com/expertise-mandats/, accessed June 3 2019.

ECO-CENTRE (CITIZEN DROP-OFF POINT)

This point was built in 2009, close to the municipal incinerator and the recycling building. This Eco-Centre is the first in Eeyou Istchee Territory. It is open 24 hours a day, 7 days a week. 4 large shipping containers are provided for public use:

- **Wood:** container reserved for items made completely of wood, such as pallets, old timber, trees, etc.;
- **Construction and Demolition Waste:** Waste from construction sites and demolition work such as gyprock, concrete, gravel, plaster, shingles, bricks, etc.;
- **Metals:** All metal items should be deposited in this container, including bed frames, bicycles, metal studs, rebar, major appliances, etc. The Environmental Health Department partners with Legault Metal Inc. (Amos) for metal pick-up and recycling;
- **Bulky non-metallic waste:** All bulky waste that does not fit into other containers, including old furniture, electronics, toys, mattresses, textiles, etc.

Except for metals, the Environmental Health Department is currently studying several possibilities for the regular removal of these materials.

Two smaller containers are also available at the Eco-Centre in case regular pick-up was missed or was insufficient:

- **Household waste – green container:** same non-recyclable materials as those for the green household containers;
- **Recyclable materials – blue containers:** same materials as for the blue household containers.

The Environmental Health Department partners with Recyc-Québec to offer a **tire collection program**. The public should transport all of their used tires to the Eco-Centre. The new Solid Waste Disposal Site also has a designated area for tires once the pile becomes too large at the Eco-Centre.

The Environmental Health Department also offers a **small container for glass.** Wemindji is currently studying different options concerning glass.

The Eco-Centre also provides a small container for hazardous waste (batteries, fluorescent lights, oils, paint cans and propane tanks). Wemindji is currently studying different proposals to ensure the safe, cost-effective disposal of these wastes.

Figure 10 The Eco-Centre

Source: Marie-Pierre McDonald, 2017.

CURRENT WASTE DISPOSAL SITE

The current solid waste disposal site consists of a trench landfill and a bulky waste storage platform. This site is closed to the public to ensure that waste is placed in the proper areas and handled according to the necessary guidelines.

In 2003 Dessau-Soprin was commissioned by the Cree Nation of Wemindji to conduct inventories and recommend a permanent site for the disposal of incineration wastes.

Following approval of recommendations put forward in the report *Cree Nation of Wemindji, Waste Management plan, New Site Inventory and Feasibility study for Incineration Waste Disposal, Final Report* (Dessau-Soprin, 2004), it was decided that part of a borrow pit located at KM 3 could be used for that purpose.

Arrangements were immediately made with Tawich Construction, the operator of the borrow pit, to make sure that no further granular material would be taken from the area being considered for the construction of the waste disposal site. The Band Council came to an agreement with Mr Atsynia (the tallyman who harvests trapline no VC-11) to allow for the permanent use of this portion of his trapline for the disposal of ashes.

Implementation of this new waste disposal site in Wemindji was subject to the evaluation process under the terms of Article 5 (b) of Appendix 1 of the Chapter 22 of the *James Bay and Northern Quebec Agreement* (JBNQA). The environmental assessment reported that environmental effects associated with the project would occur during the construction and operation phases. However, all of the effects were considered insignificant or negligible provided that all prevention, mitigation and compensation measures as well as all monitoring and follow-up activities listed in the present report are applied.[10]

The site presents an open surface of approximately 60,000 m². It had to be divided into two main areas – the in-trench disposal site and the bulky waste storage site. Since the groundwater was found to be close to the surface of the natural terrain in the lower south portion of the site, this area was determined to be better suited for the bulky waste storage site, due in part to the fact that this storage area does not require any excavation below the natural ground surface.

The northern plateau is at a higher elevation, and, according to the Hydro geological and Geotechnical Study, the ground water is found at a greater depth than in the southern section. This plateau is the area proposed for the construction of the in-trench ash disposal site.

The disposal trenches were designed for the incinerator ashes. A pile of clean soil is available to ensure that a thin layer is placed on the ashes each time a load is placed in the trenches, in order to eliminate windblown scattering.

[10] Dessau-Soprin (2007), p.1: The decrease in soil stability during construction activities; the risk of soil, groundwater or surface water contamination through the infiltration, leaching or runoff of polluting substances in the event of accidental or uncontained discharge of polluting substances or mismanagement of the waste disposal sites; the risk of modification of the drainage and infiltration patterns; the increase in noise, and production of dust and exhaust fumes during construction activities; presence of odours, pests and blowing litter if disposal sites are mismanaged; alteration of the surrounding habitats; reuse of an already disturbed site (positive impact); improvement of the quality of life of the Wemindji population (positive impact); local economic spin-offs (positive impact); possible risks of work accidents associated with construction works and handling of toxic substances; loss of archaeological artefacts; alteration of the visual environment.

The bulky waste platform is designed as a temporary storage area, with designated areas for the following types of waste:

- Wood
- Construction and demolition waste
- Metals
- Non-metallic bulky waste
- A used tire drop-off

Groundwater and surface water at the site are tested three times a year, according to the Quebec Environment Ministry guidelines, which ensures that the waste does not impact the surrounding area.

Since 2018, the landfill has also temporarily received municipal waste (domestic and from institutions, businesses and industries) as the incinerator burned down and is no longer in operation.

Figure 11 The lower (CRD waste, tire storage) and upper (bulky waste) areas of the landfill

Source: Marie-Noëlle Carré, 2019.

OLD WASTE DISPOSAL SITE

The old waste disposal site is located in the north-eastern part of the community, close to a gravel pit. The old dump site was rejected as a proposed site for future development during the consultations for the Wemindji Community Master Plan Review (2017), due to environmental limitations and soil stability issues.

Figure 12 The old disposal site and the gravel pit

Source: Marie-Noëlle Carré, 2019.

2.4 FUTURE WASTE MANAGEMENT INFRASTRUCTURE

WASTE DISPOSAL SITE

The Cree Nation of Wemindji plans to build a new waste disposal site to replace the existing one. Though the capacity and stability of this site are considered to be good, it is located at the entrance to the community.

Given the important tourism potential of the James Bay Road, next to which the existing waste management site is located, the community thinks that moving this facility to a more remote area of the territory would allow for a better landmark image for visitors.

This landfill would receive solid waste ashes as well as other materials, such as metal automobile carcasses, bulky waste etc.

LAGOON

The Cree Nation of Wemindji has identified the area surrounding the current sewage lagoons as the next development zone for the community. A portion of this area falls within the “protection radius” around the present sewage lagoons.

However, in order to move forward with the development of a residential area, the lagoons will need to be relocated. A new site on the north side of the airport has been identified for the future lagoon and is currently under study.

The current study will have to consider the lagoon relocation and examine the possibility of combining solid and liquid waste treatment infrastructure. For example, in the Northwest Territories, waste facilities typically combine landfills with segregated CRD Waste, Wastewater, Land-farming, Sludge and Bulky material.

Figure 13 A solid and liquid waste treatment complex in the Northwest Territories

Source: Golder (2018). Waste Management in the Northwest Territories. 2018 SWANA Northern Lights Conference, Edmonton, Alberta. p.26. Online: https://swananorthernlights.org/wp-content/uploads/2017/05/Paul-Dewaele-NWT-Presentation-SWANA-Edmonton-2018-Draft-LPH-002-1.pdf, accessed June 4 2019.

INCINERATOR

A few years ago, the Cree Nation of Wemindji had the opportunity to visit the incineration facilities in the community of Skagway (Alaska). This incinerator was built in 1997 and is located north of the community. It was also provided by EcoWaste Solutions.

Skagway has 1,041 inhabitants. However, it is an important tourism stop for cruises to Alaska and along the Pacific Coast. During peak season, Skagway can receive up to 15,000 people per day, with significant impacts on waste production in restaurants, businesses and institutions. In order to respond adequately to the peak season's waste production, the incinerator in Skagway is larger than the incinerator that Wemindji had until 2018.

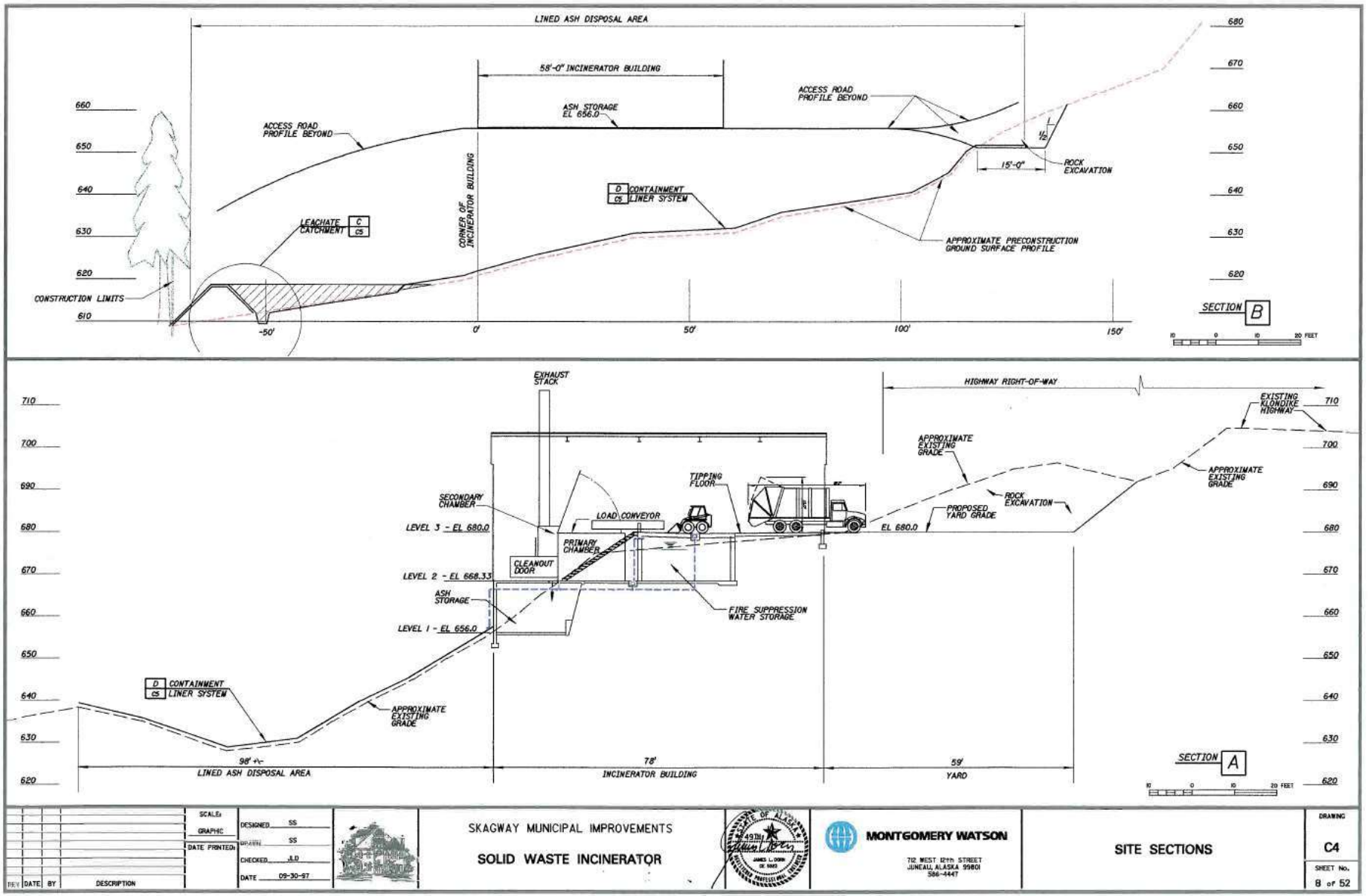
Figure 14 The Skagway incinerator

Source: Google Maps, 2019.

In addition, the design of the Skagway incinerator is considered by the Cree nation of Wemindji as pertinent for its own waste management.

The following figure shows that the incinerator components are organized in a series of steps. This includes water storage for fire suppression.

Figure 15 Skagway solid waste incinerator - profile



Source: City of Skagway, 1997.

2.5 ENERGY RECOVERY

In 2004, Dessau-Soprin conducted a study in Wemindji to determine the feasibility of recovering energy from the Wemindji incinerator to heat a future greenhouse installed in an area located 100 metres from the incinerator plant.

Based on the data obtained from the Wemindji incinerator and based on the average consumption of energy in a normal greenhouse, it was determined that the installation of a recovery boiler could save $42,500 per year on the energy costs required to operate a greenhouse (i.e. half the energy costs, calculated to be close to $70,000 in 2004).

This idea would be worth considering for the future incinerator facility. Waste-to-energy incineration systems are now available at lower costs and some companies have even adapted their greenhouse technologies to northern climatic conditions.

In addition to partly solving waste management issues, the implementation of a waste-to-energy facility with a greenhouse could benefit the community in various ways, such as:

- **Food security:** many northern communities are experiencing food security issues. Remoteness, together with the decline in traditional activities (hunting, fishing, berry-picking) and employment issues, make it difficult for the communities to access healthy and affordable food. Local production of fruit and vegetable makes it possible for the community to access a diversity of fresh products year-round;
- **Education and training:** the greenhouse could be a place of education and training for students and adults. Waste management awareness and/or gardening activities could be organized depending on the vocation of the greenhouse – commercial or community;
- **Local production:** the Cree Nation of Wemindji is currently developing a composting program. Depending on the quality of the compost, the Cree Nation could develop local production circuits and benefit local economy products sold at the community store).

THE EXAMPLE OF KUUJJUAQ

The northern village of Kuujjuaq is a leader in Quebec for fresh fruit and vegetable production and waste to energy conversion.

A first greenhouse in Kuujjuaq started as a Université Laval research project 20 years ago, with funding from the Kativik Regional Government's Department of Research and Economic Development. The greenhouse is now managed by the community and volunteers, and serves as a community garden during the summer. The 21 garden plots grow a range of products that includes peppers, beans, tomatoes, carrots and herbs.

In 2017, the Société du Plan Nord provided funding and coordinated the implementation of a waste-to-energy plant and a second greenhouse, dedicated to commercial production. A sum of $5 million, spread over three years, is currently being used to design and build a thermal waste-to-energy processing system and then a commercial greenhouse heated by this system.

These innovative facilities must contribute to solving three major issues in northern communities:

- Access to fresh fruit and vegetable in the largest community in Nunavik (3,000 residents)
- Energy costs and use of renewable energy
- Waste management

Through waste combustion and energy recovery, the community found an original, cost-effective and environmentally efficient solution to the open-air burning of waste materials.

A $350,000 budget was allocated for the purchase of one hydroponic growing container from the Ottawa-based company Growcer. The company Growcer targets isolated northern communities. Their services and their technology were developed with those particular factors in mind.

The Arctic Growing System (AGS) has upgraded heating performance to combat the cold Arctic temperatures and offers the use of heating oil for cost savings. It has been designed for low infrastructure environments, and is connected to satellites for remote connectivity. The Arctic Growing System is capable of operating from -52°C to 22°C.[11]

The Growcer system consists of a 40-foot insulated container in which plants on shelves are fed by a constant flow of nutrient-rich water. Another container holds a large furnace specially designed to use recycled waste oils from the local garage. Hot air from the furnace is pushed into the growing container, while another duct brings air back into the furnace. The lights in the greenhouse operate for 18 hours a day.

Newviq'vi Dépanneur Inc. operates the hydroponic systems and also distributes the food it produces. Around 70% of the produce will be sold on their shelves in-store, with the other 30% distributed among community organizations, such as Elder homes and daycares.[12]

The greenhouse will eventually be able to produce up to 400 plants per week, enough to cover most of the demand in Kuujjuaq. A 2016 study by the Cree Board of Health and Social Services of the James Bay (CBHSSJB) found that the cost of basic nutritious foods is higher in Eeyou Istchee than in any other studied region of Quebec. It found that nutritious food choices are quite limited in certain communities, and that access to a variety of low-cost nutritious foods is difficult, especially in smaller stores.

[11] https://www.thegrowcer.ca/, accessed June 5 2019.
[12] http://nationnews.ca/health/a-year-round-greenhouse-is-growing-produce-north-of-the-55th-parallel/, accessed June 5 2019.

Figure 16 Hydroponic container in Kuujjuaq

Source: http://nationnews.ca/health/a-year-round-greenhouse-is-growing-produce-north-of-the-55th-parallel/, accessed June 5 2019.

PROJECTIONS ON A WASTE-TO-ENERGY GREENHOUSE

Some years ago, the Cree Nation of Waskaganish was interested in converting its old arena into a greenhouse. A brief economic study evaluated the potential revenues associated with the conversion of the facility.

It is possible to plan for a commercial operation of the greenhouse with the objective of selling the production to local community shops. In this case, the building might have higher operating costs, but will also generate revenues from the sale of agricultural products.

A literature review of different studies of crop production in a greenhouse indicates potential production revenue and costs per square metre (m^2) for different types of crops. The values presented below are from a study by the Government of Alberta on the economic performance of the province's greenhouses in 2010. It shows the relative performance of different crops in greenhouse production.

Table 5 Potential production revenue and costs per square metre

	Cucumbers	Tomatoes	Peppers
Revenues ($/$m^2$)	84.98	108.45	94.13
Costs ($/$m^2$)	75.84	96.31	76.63
Margin ($/$m^2$)	15.77	21.45	26.42

Source: Cree Nation of Waskaganish/BC2, 2016.

With a production area of 1,620 m^2, the greenhouse in Waskaganish could generate $175,000 in gross revenue annually for tomato production. This estimate implies that the planned greenhouse is able to function with the same efficiency level as a greenhouse in southern parts of Canada.

Another approach to evaluate the potential revenues of a greenhouse in Waskaganish is to estimate the potential production in kilograms. Data from Alberta greenhouses suggests a production of 50 to 60 kg/m^2 for tomato plants.[1] This would represent a total 81,000 kg of tomatoes per year. Results of a northern climate greenhouse of 1,500 m^2 in northern Sweden show a production of 1,000,000 kg of tomatoes per year with 3,700 tomato plants representing an annual revenue of $450,000. It should be noted that the Swedish greenhouse is particularly productive.

3 POTENTIAL SITES FOR THE FUTURE INCINERATOR

Three sites have been identified to locate the future waste incineration facilities. In this first phase, Groupe BC2 professionals compiled all the information gathered (i.e., existing site conditions plan, location of services) in order to evaluate the potential location areas for the new incinerator.

The analysis also considers the potential concentration of waste facilities in the same area (landfill, lagoon, Eco-Centre, greenhouse, etc).

POTENTIAL SITES

The following pages present:

- One map of the potential sites
- One table with the description, advantages and drawbacks of the 3 potential sites.

Figure 17 Map of the 3 potential sites

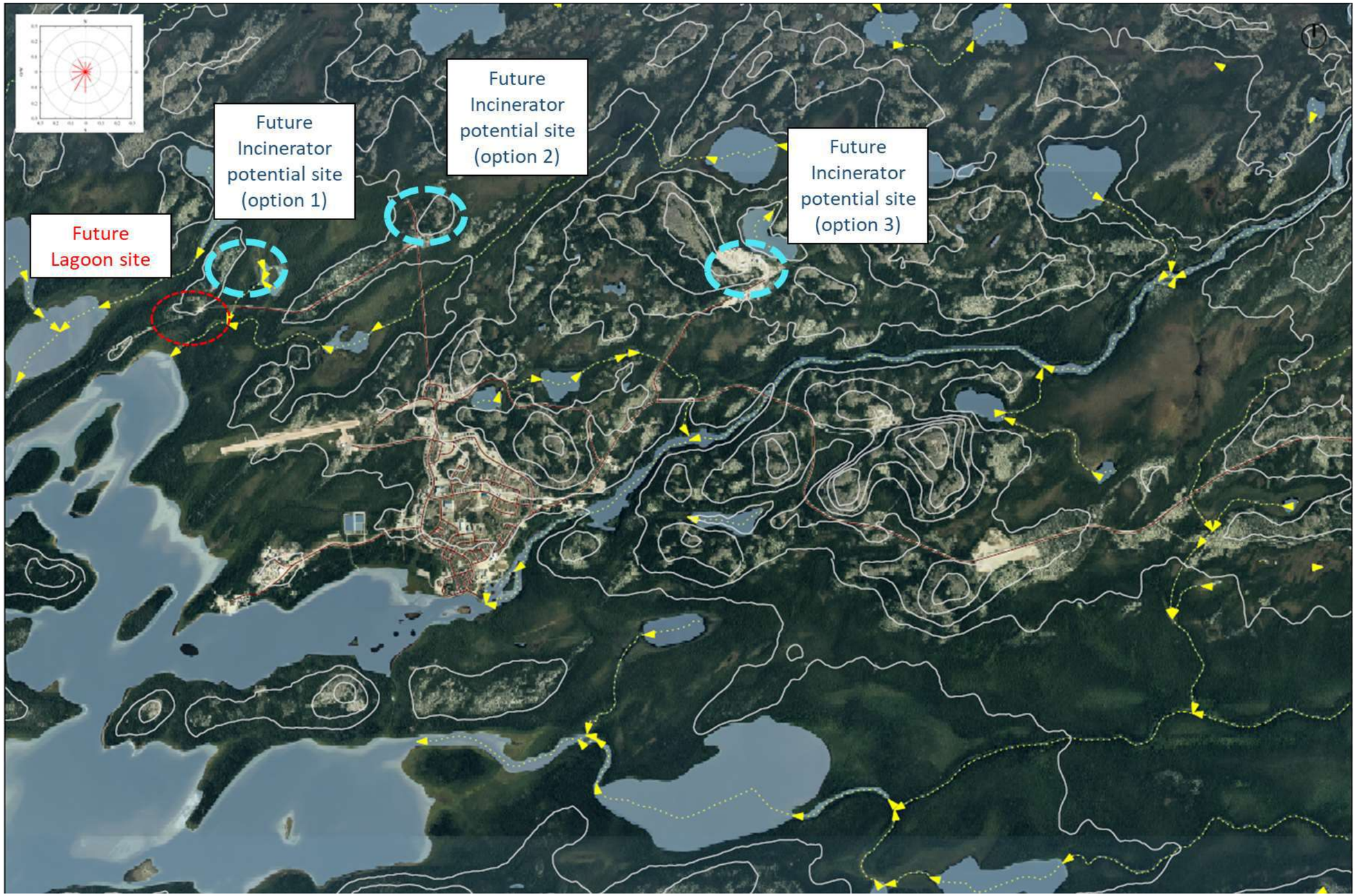


Table 6 Potential sites for the future incinerator

Potential location	Description	Advantages and Drawbacks
Site 1 - Kakabat Road	**Soil conditions:** sandy, with patches of swampy areas **Hydrographic survey:** between two watersheds that flow into James Bay. **Topography:** mostly flat, with light elevation **Road network:** the Kakabat is under construction. **Building location:** no existing buildings on the site. The incinerator building could be located on the northern side of the road **Infrastructure:** no water, no power line. Future lagoon and sewage system	**Advantages** Dominant south-westerly winds (no odours or smoke blowing towards the community) No interference with the community Master Plan Concentration of impacting activities Good accessibility to the site by Kakabat Road Close connection to the sewage and electrical system **Drawbacks** Within the airport “protection radius” Minor road work needed Far from the future waste disposal site Far from the community. (Important travel distance from the community will have a direct impact on fuel consumption, equipment/machinery maintenance costs and labour charge. (more driving time) Emergency response time is reduced The connection to the water system is at a far distance (3.75 km) This site is the second most expensive option
Site 2 - Kakabat Road/Maquatua Road	**Soil conditions:** mostly sandy, bedrock **Hydrographic survey:** between two watersheds that flow into James Bay **Topography:** regular surface with an elevation **Road network:** good, minor accessibility work needed, Maquatua Road **Building location:** no existing buildings on the site. The incinerator building could be located on the upper level of the site **Infrastructure:** Maquatua Road. No water, no power lines. Future sewage system	**Advantages** Dominant south-westerly winds (no odours or smoke blowing towards the community) Good accessibility by Maquatua Road Closer connection to municipal infrastructure (water,sewage and electricity) No interference with the community Master Plan Closer to the community (lower transportation cost, better emergency response time) Closer to the future waste disposal site This site is the less expensive option **Drawbacks** Minor road work needed Within the airport “protection radius”

		The connection to the water system is at a far distance (1.7 km)
Site 3 - Gravel Pit	**Soil conditions:** bedrock, backfilling, swampy area (lakeshore) **Hydrographic survey:** lake **Topography:** flat terrain at the bottom of the quarry **Road network:** good condition **Building location:** one mobile home for the gravel pit operations. The incinerator building could be installed on the existing bedrock: no water and sewage system and no power line The Hydro-Québec power line runs close to site 3 but no electrical transformer is currently installed. The gravel pit will still be in operation for at least 2 to 3 years	**Advantages** Dominant south-westerly winds (no odours or smoke blowing towards the community) Outside of the airport “protection radius” No road work is needed Good accessibility from the community No interference with the community Master Plan **Drawbacks** The nearby Hydro-Québec power line. No electrical equipment may be installed within 15 metres from the centre of the power line. Other elements must be considered. It is strongly recommended to contact Hydro Québec to get the necessary authorization for any development project near such a power line. Other restrictions may apply. Gravel pit still in operation Very far from the future waste disposal site Swampy area close to the lakeshore (Septic tank installation constraint) Far from the community. Important travel distance from the community will have a direct impact on fuel consumption, equipment/machinery maintenance costs and labour charge. (more driving time) Emergency response time is reduced All the municipal infrastructure connection is at a far distance. Water (3.3 km) and sewage (3.2 km) and power line (2.8 m) is needed. This site is the most expensive option

4 CONSULTATION AND SITE SURVEY

Meetings were organized from June 10th to June 13th, 2019 with Cree Nation of Wemindji officials, the local tallymen, the community and other important stakeholders, in order to have their input on the project.

In addition, a visit to the potential sites and the former incinerator site was made to provide a base plan with clear data that represents the site conditions, and to reduce risks in the design phase.

This exhaustive visual survey was undertaken to identify the potential opportunities and limitations arising from the site-specific conditions.

61 people participated in the consultation process. Important topics to be considered were identified by the participants. The following chart summarizes the discussions.

At the end of the consultation, the participants were invited to vote for the future incinerator site they preferred. The results are as follows:

- **Site 1** (close to the future lagoon site): 4 votes
- **Site 2** (Maquatua road/future Kakabat Road): 44 votes
- **Site 3** (gravel pit): 7 votes

Figure 18 Community Consultation

Source: Marie-Pierre McDonald, 2017.

Table 7 Consultation Report

Topic	Comments
	Environment
Watersheds	The community wants reassurance that the incinerator will be put at a sufficient distance from waterways and watersheds. The first incinerator was close to the water intake, which caused uncertainty and fear. This concern is even more important for the community if all (or part of) the waste facilities are concentrated in one area. Site 1 is considered less adequate as many fishnets are located in the small bay south of the trail. Site 3 is also considered less adequate as the lake close to the gravel pit is famous for its clear water and important for fishing activities.
Wildlife	The community has concerns about the potential disturbances caused by the incinerator. Wildlife – and thus hunting and trapping activities – might be disturbed, especially in sites 2 and 3. They asked whether the tallymen had been consulted for this project. The two tallymen who participated in the meeting with Wemindji's officials did not express any concern about the location of the incinerator.
Cultural activities	Some berry-picking was reported in the area close to Site 2.
	Characteristics of the facility
Building	The community feels concerned by the size of the building.
Greenhouse	Most of the community is favourable to the implementation of a greenhouse. Younger residents see it as an opportunity to access healthy food at lower costs.
	Risk management
Fire	Fires regularly occur in the south-eastern part of the Wemindji region. Site 3 is closer to this area.
Wind	Dominant south-westerly winds. However, the community fears that northerly winds may bring smoke and odours over the built area. Site 3 appears to be better located than sites 1 and 2.
Accessibility	The community was daunted by the incinerator fire. It is important for the incinerator to be well connected to emergency services (firemen). The Cree Nation of Wemindji officials also consider that accessibility is important in order to save transportation costs.
Airport	The Wemindji officials mentioned that the airport security radius would have to be checked before selecting any of the potential sites.

5 COMPARATIVE ANALYSIS OF THE SITES

Transportation Cost

Waste transportation is done in two phases. After the door-to-door collection, the waste materials are transported to the incinerator. With the current schedule, this operation happens 4 times a week. Also, after the burning cycle, the remaining ashes are removed from the incinerator and relocated to the future waste disposal site; this operation is required 3 times a week[13].

For the purpose of this transportation cost analysis, the following parameters have been used:

- Diesel fuel cost at $1.5 per litre;
- Fuel consumption of a garbage truck at 53 litres per 100 km (4.4 miles per gallon[14]).

As a baseline scenario, the estimate is compared to the cost of bringing waste materials directly to the current waste disposal site.

Table 8 Transportation cost estimates for each proposed incinerator sites compared to the current waste disposal site

	Waste disposal site	Proposed incinerator sites		
	(Current)	Option 1	Option 2	Option 3
Transportation from the community to the Incinerator				
Average distance from the community (km)	4.4	4.7	3.2	3.9
Cost per round trip ($)	7.1	7.5	5.1	6.2
Cost per year (4 trips per week) ($)	1470.7	1555.4	1058.6	1279.9
Transportation of ash to the future waste disposal site				
Distance to the future waste disposal site (km)	-	2.673	0.686	6.561
Cost per one-way trip ($)	-	2.1	0.5	5.2
Cost per year (3 trips per week) ($)	-	331.5	85.1	813.7
Total transportation cost				
Total cost per year ($)	1470.7 Reference	1886.9 (28%)	1143.7 (-22%)	2093.6 (42%)

[13] Dessau Soprin, 2007, page 12
[14] Sandhu Gurdas, 2015, In-use activity, fuel use, and emissions of heavy-duty diesel roll-off refuse trucks, Journal of the Air & Waste Management Association, volume 65, Issue 3 https://www.tandfonline.com/doi/full/10.1080/10962247.2014.990587

The proximity of the community to Site 2 and also to the future waste disposal site makes this site option 22% more cost effective than the baseline scenario.

Since Option 3 is the furthest from the future waste disposal site compared to the other sites, this option is 42% less cost effective than the baseline scenario.

The annual cost analysis only includes the fuel expenses. It is important to consider that any additional travel distance generates extra vehicle maintenance and workforce costs.

Figure 19 Map of the Travel distance along the road network for each incinerator Cree Nation of Wemindji site option

5.1 MUNICIPAL INFRASTRUCTURE CONNECTION

Macogep assessed the costs of the scenarios for each site. The analysis and estimate for connecting each site to municipal infrastructure (road, sewage, water, water well, septic tank, electricity) were based on the data and documents listed in the full report (Appendix 1).

Specific technical considerations and recommendations are available in the full report.

PARAMETERS

Class D cost estimates were calculated for each of the three sites. The accuracy of Class D cost estimates is in the range of plus or minus 25%. However, all the scenarios were assessed based on the same assumptions, with the following results:

- The probable value of the work to service each site is evaluated;
- The amounts are before taxes;
- The amounts include direct and indirect costs and are expressed in Canadian dollars during the 3rd quarter of 2019.

Two options were envisioned for each site:

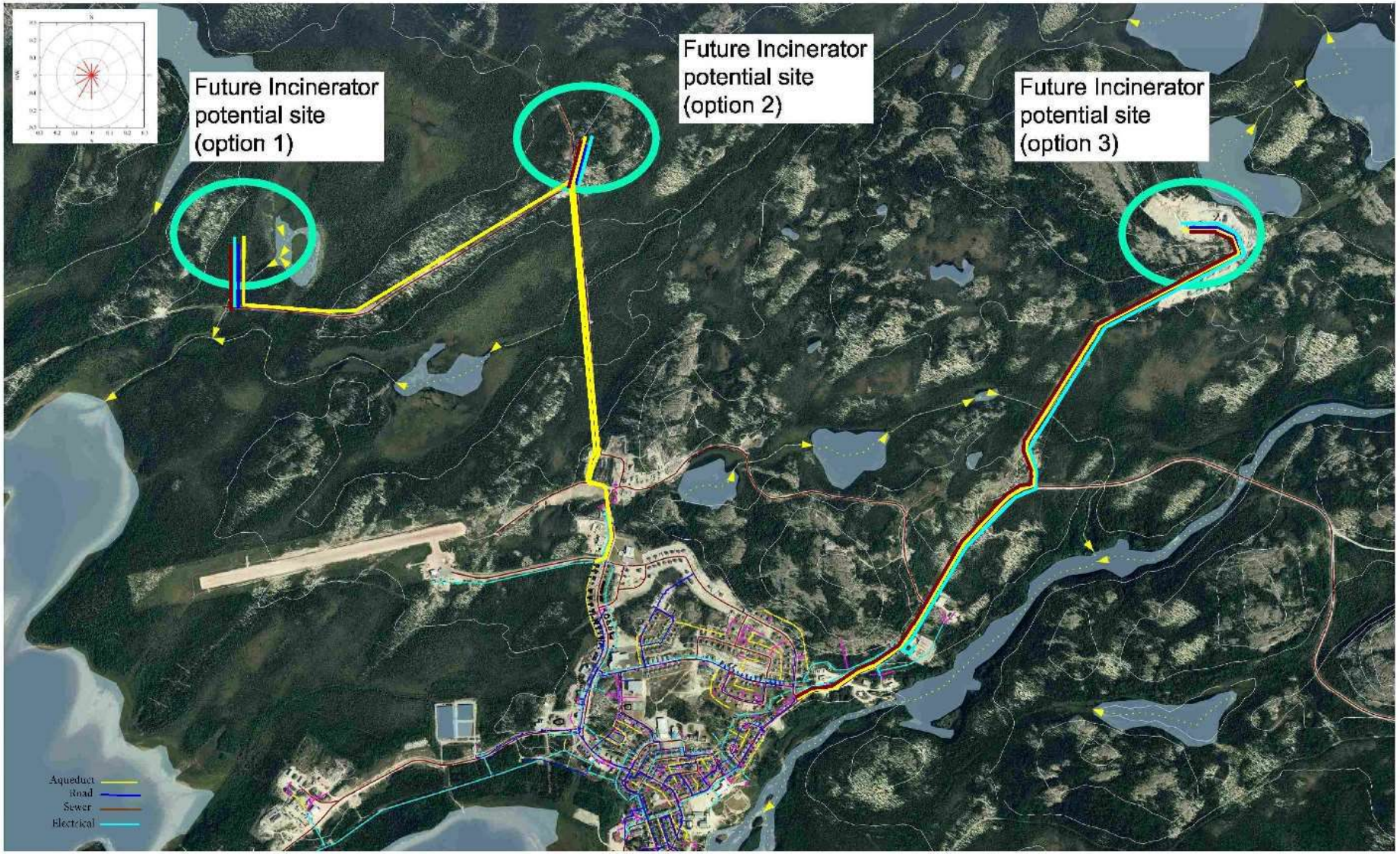
- **Option A:** Connecting the site to the municipal watermain and sewer system;
- **Option B:** Drilling an artesian well to supply water to the site, and installing a septic tank for sanitation.

The following map shows an overview of the itinerary for each site (water, sewage, road infrastructure, electricity).

The construction cost of the Kakabat Road extension was not considered in the estimate, as it is already included in the municipal budget.

Moreover, since the sewer and electrical systems will be installed on Kakabat Road for the future wastewater treatment plant, only the connection from the future incinerator site to the road has been considered for the cost analysis of the options 1 and 2.

Figure 20 Overview of the municipal infrastructure connection



COST ESTIMATES

Site 1 - Option 1

This site is located approximately 285 m from the Kakabat Road. The planned electrical connection is 312 m from the site, the distance to the sewer is 287 m and the municipal watermain is located about 3.75 km from the site. The total duration of the works for Site 1 is 4 months for Option 1A (connecting to municipal watermain) and 3 months for Option 1B (drilling an artesian well).

Site 2 - Option 2

This site is located approximately 185 m from the Kakabat Road. The planned electrical connection is 220 m from the site, the distance to the sewer is 218 m and the municipal watermain is located about 1.7 km from the site. The total duration of the works for Site 2 is 3 months for Option 2A (connecting to municipal watermain) and 2 months for Option 2B (drilling an artesian well).

Site 3 - Option 3

This site is located approximately 300 m from the old road. The planned electrical connection is 2.8 km from the site, the distance to the sewer is 3.2 km and the municipal watermain is located about 3.3 km from the site. The total duration of the work for Site 3 is 10 months for Option 3A (connecting to municipal watermain) and 7 months for Option 3B (drilling an artesian well).

The following table shows the costs of both options for sites 1, 2 and 3.

Table 9 Class D cost estimates for options A and B – sites 1, 2 and 3

Site 1	**Option 1**	
Option 1A	Access Road with watermain and sewer	$5,463,689.00
Option 1B	Access Road with water well and septic tank	$828,455.50
Site 2	**Option 2**	
Option 2A	Access Road with watermain and sewer	$2,823,495.00
Option 2B	Access Road with water well and septic tank	$606,946.00
Site 3	**Option 3**	
Option 3A	Access Road with watermain and sewer	$8,966,110.00
Option 3B	Access Road with water well and septic tank	$1,489,606.50

According to the estimate, Option 2B (with artesian well and septic tank) is the most economical and least complex. Its cost is evaluated at **$606,946.00.**

However, it is important to mention that in the long term, this option can become more expensive due to the need for regular maintenance and the short life expectancy of the well and the septic tank.

Option 2A is also the most economical among the three estimates for Option A. Connecting to the municipal watermain and sewer is evaluated at **$2,823,495.00.**

BUILDING CONSTRUCTION COSTS

Although the cost analysis was based only on the municipal infrastructure connection and not on the building, some technical and economic information was requested in order to provide a rough estimate of the construction costs for an incinerator.

Considering that the Skagway incinerator is the size and shape similar to the equipment targeted by the community of Wemindji, we decide to use this project for the building cost analysis.

The cost of the Skagway incinerator project in 1997 was: US$1,789,000.00.

With inflation, in Canadian dollars, and considering that the equipment in Wemindji could be slightly larger, the cost of such an incinerator in 2019 would be roughly **CAN$3,810,174.**

(US$1,789,000.00 in 1997 x 59.9%[15] = US$2,859,847 in 2019 x conversion rate (US$ to CAN$)[16] = CAN$3,810,174 in 2019).

This total doesn't include geotechnical work and site preparation that could increase the total cost of the project.

[15] https://www.usinflationcalculator.com/, accessed August 21st, 2019.
[16] https://www.banqueducanada.ca/taux/taux-de-change/convertisseur-de-devises/?lookupPage=lookup_currency_converter_2017_fr.php&startRange=2009-08-21&rangeType=range&selectToFrom=from&convert=2+859+847%2C00&seriesTo%5B%5D=FXUSDCAD&seriesFrom=Dollar+%28Canadien%29&rangeValue=1.w&dFrom=&dTo=&submit_button=Convert, accessed August 21st, 2019.

6 FINAL RECOMMENDATIONS

Based on the results of the scenarios and cost estimates, this section summarizes the recommendations, advantages and drawbacks of the feasibility for each of the 3 selected sites. Site 2 is recommended for its adequacy and its economical construction and operating costs.

SITE 1

Site 1 presents geographical advantages such as dominant southwest winds, preventing odours or smoke from blowing towards the community. The site is easily accessible (Maquatua Road and the future Kakabat Road) and will benefit from the connections to municipal networks (sewer, electricity) on Kakabat Road.

There is no interference with the community Master Plan, and the proximity of the future wastewater treatment plant may provide a welcome concentration of impacting activities in a delimited area.

Site 1 also presents a number of drawbacks. It is located within the airport's "protection radius". It is also located far from the community. This will result in higher waste transportation costs (+28%) compared to the current situation. Costs for accessing the infrastructure networks are also expensive for this reason. Site 1 has the second-highest costs after Option 3: $5,463,689.00 (municipal infrastructure connection) and $828,455.00 (water well and septic tank).

Including the building construction but excluding geotechnical works and site preparation, the development of Site 1 could range from **$4,828,455.00 to $9,463,689.00.**

This estimate does not include the energy savings that could result should a greenhouse be connected to the incinerator, or the revenues that could result from the sale of local vegetables and fruit in the local grocery store.

Site 1 is an interesting choice for its location in the community. However, if selected, Site 1 may prove expensive, both for the construction and the operation (transportation), and may fall under constraints (airport protection radius).

SITE 2

Preferred by the community members, site 2 presents geographical advantages, such as dominant southwest winds, preventing odours or smoke from blowing towards the community. The site is easily accessible from Maquatua Road, with minor road works needed. It will benefit from the connections to municipal infrastructure networks (sewer, electricity) on the Kakabat Road.

There is no interference with the community Master Plan, and the proximity to the community is an advantage for reducing transportation costs (-22% compared to the current situation).

Site 2 also presents some drawbacks. It is located within the airport's "protection radius" and the costs for connecting to the water line will be higher. However, since the sewer and electrical systems will be installed on Kakabat Road for the future wastewater treatment plant, it reduces significantly the total cost of the project.

For this reason, Site 2 is the most economical option: $2,823,495.00 (municipal infrastructure connection) and $606,946.00 (water well and septic tank).

Including the building construction but excluding geotechnical works and site preparation, the development of Site 2 could range from **$4,606,946.00 to $6,823,495.00.**

This estimate does not include the energy savings that could result should a greenhouse be connected to the incinerator, or the revenues that could result from the sale of local vegetables and fruit in the local grocery store.

Site 2 is an interesting choice both for its location in the community, and construction, connection and operating (transportation) costs. Although more expensive, connecting the future incinerator to the water system is recommended for greater fire safety.

SITE 3

Site 3 presents geographical advantages, such as dominant southwest winds, preventing odours or smoke from blowing towards the community. The site is easily accessible, with no road works needed and good access from the community. It is located outside of the airport's "protection radius" and does not interfere with the Community Master Plan.

Site 3 also presents a number of drawbacks. A minimum distance of 15 metres from the Hydro-Québec power line needs to be respected. Also, the gravel pit is still in operation, and the area is swampy, close to the lakeshore.

It is located at a distance from the community, with a significant impact on waste transportation costs (+42%, compared to the current situation) and connection to the municipal infrastructure (approximately 3 km). For this reason, this site is also the most expensive to develop: $8,966,110.00 (municipal infrastructure) and $1,489,606.50 (water well and septic tank). In addition, environmental constraints could apply in regard to the feasibility of the septic tank (swampy area).

Including the building construction and excluding geotechnical works and site preparation, the development of Site 3 could range from **$5,489,605.00 to $12,966,110.00.**

This estimate does not include the energy savings that could result should a greenhouse be connected to the incinerator, or the revenues that could result from the sale of local vegetables and fruit in the local grocery store.

Site 3 is an interesting choice both for its location close to the community and its accessibility. However, the selection of this site may prove expensive in the short term (construction) and in the medium to long term (transportation). Construction may also be delayed due to the current gravel extraction activities.

APPENDIX 1 MACOGEP REPORT

MACOGEP
Gouvernance et maîtrise des projets

FINAL REPORT

10 septembre 2019

Wemindji Community Incinerator: Site Feasibility Study

Class « D » Estimation

Internal project N° : R190627

Client project N° :

Presented to : Groupe BC2

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Internal project N° : R190627	
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Presented to : Groupe BC2	
Prepared by :	Reviewed by :
Erick DJOI, Eng. M.Eng. ECC (OIQ n° 142241)	Claude LÉGER, Eng., LL.B (OIQ n°33331)

EXECUTIVE SUMMARY

Cree Nation of Wemindji (CNW) is in need for a new incinerator following the accidental destruction of the current one. To plan and choose the foreseen location of the incinerator, CNW needs to consider the most appropriate site and the costs associated to the accessibility to the site later during its operational phase.

Cree Nation of Wemindji, the sponsor of the project, retained the services of Groupe BC2 to validate the choice of a site of the future incinerator. Groupe BC2 in turn hired Macogep to assess the costs of the scenarios of each site.

The analysis and estimation of each site's access to municipal infrastructure and electricity was made from the data and documents provided by BC2 listed in report. Other design criteria have been used and are listed in this report.

After analysis, we are of the opinion that the most appropriate site in terms of cost of realization of infrastructures is Site 2 with Option 2B: Access road with water well and septic tank.

The table below presents an overview of the value of execution of the infrastructure of each site/option.

CREE NATION OF WEMINDJI
WEMINDJI COMMUNITY INCINERATOR - SITE FEASIBILITY STUDY

SUMMARY TABLE OF INFRASTRUCTURE COSTS

Site	DESCRIPTION	TOTAL AMOUNT
Site 1		
	OPTION 1A: ACCES ROAD WITH WATERMAIN AND SEWER	5 463 689,00 $
	OPTION 1B: ACCES ROAD WITH WATER WELL AND SEPTIC TANK	828 455,50 $
Site 2		
	OPTION 2A: ACCES ROAD WITH WATERMAIN AND SEWER	2 823 495,00 $
	OPTION 2B: ACCES ROAD WITH WATER WELL AND SEPTIC TANK	606 946,50 $
Site 3		
	OPTION 3A : ACCES ROAD WITH WATERMAIN AND SEWER	8 966 110,00 $
	OPTION 3B : ACCES ROAD WITH WATER WELL AND SEPTIC TANK	1 489 606,50 $

This estimation does not include inflation, soil decontamination, groundwater quality assessments, and the tests required for the establishment and proper operation of an artesian well.

The presence of radon in Wemindji requires ventilation of the storage pond and maintenance of the stored water. These parameters are excluded from our estimate

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1 SCENARIO

Leader in terms of waste management in indigenous territories, Wemindji is in need for a new incinerator since the current incinerator got out of service in 2018. To plan the construction of the new incinerator, CNW retained the services of Groupe BC2 to validate the choice of an appropriate site for the future incinerator. Groupe BC2 in turn hired Macogep to assess the costs of the scenarios of each site.

Three sites have been proposed. Sites 1 and 2 are located to the North of Wemindji Airport and benefit from the proximity the future site of the construction of the water treatment plant. Site 3 is located near a gravel quarry to the north of the village.

The three sites must be estimated to determine the most suitable and cost effective option.

2 THE PROJECT

According to the 2016 census of Statistics Canada, the Wemindji population would grow by 30,5% between 2016 and 2036. The population would therefore reach to 2,058 residents in 2036. The growth of the population between 2016 and 2036 would require some 150 new dwelling units to be added based on the average number of persons per unit in 2016.

The project consists of construction of access roads to the sites, as well as their supply with potable water, sewer and electricity. The construction of the incinerator building, and its operation depends on the success of this project. The figure below shows the sites under consideration for this project.

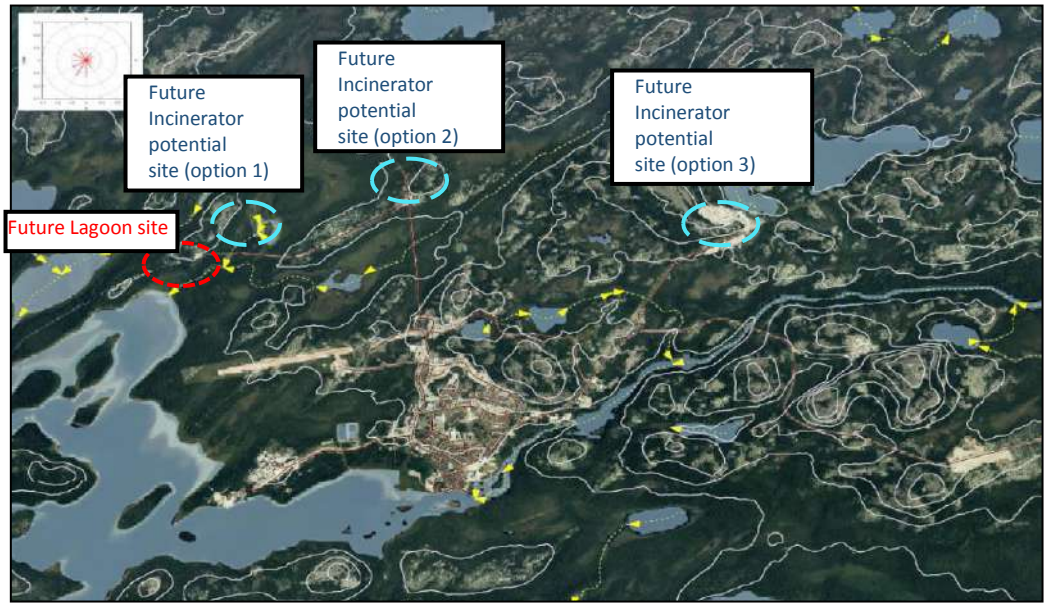


Figure 2.1 – Future Incinerator potential sites

The three sites will be analyzed taking into account available data and some design criteria.

3 MACOGEP'S MANDATE

CNW retained the services of Groupe BC2 to validate the choice of a site for the future incinerator. Groupe BC2 in turn hired Macogep to analyze potential sites and estimate costs related to the accessibility and operation of sites. The initial mandate was:

- Analyze the characteristics of the three sites
- Estimate costs related to the road infrastructure
- Analyze the option of using the municipal aqueduct versus drilling an artesian well
- Analyze the electricity needs of the site
- Analyze and estimate the connection costs to the main electrical power supply for each site
- Estimate the total construction cost of each site

4 INPUT DATA

The following documents were received, analyzed and considered:

- 42191902_20190610_PPT_Consultation.pdf
- C1_Basemap of Wemindji_global.pdf
- C2_Basemap of Wemindji_zoom.pdf
- Wemindji General_community_Plan.dwg
- Wemindji new Incinerator 1997_concept.pdf
- Wemindji_annexe7_copie_cd.pdf
- Attachment 1-6 Cree of Wemindji.pdf
- WEM12001 - 47-D23-0001_0003.dwg
- 53-wemindji-rough-merge.dwg
- Geotechnical work in Wemindji - Kakabat bridge and Access Road. 158100270 final_rpt_20190530_signed.pdf
- Attachment 1-6 Cree of Wemindji.pdf

5 METHODOLOGY

The methodology used for this study is the following:

- Kick-off meeting with The Client.
- Workshop with The Client about assumptions and estimation criteria.
- Quantity takeoff based on available drawings.
- Research and definition of assumptions for undefined elements.
- Estimation, follow up, validation, and control of costs for each of the three sites.
- Preliminary presentation of the results to The Client for review and comments.
- Compilation of the preliminary report.
- Collection of comments and suggestions.
- Compilation of the final report.

6 ASSUMPTIONS

The following assumptions were considered:

- Existing water and electrical networks do possess the capacity to serve any of the proposed sites.
- Aqueduct: Pipe of 200 mm diameter, single trench; Gate valve at every 400 m and one fire hydrant on the site.
- Option 1: Sewer pipe of 300 mm diameter, single trench; manhole at every 100 m for site 1 and 2, and every 120 m on site 3.
- Option 2: supply and installation of septic tank
- Electrical network and sewer will be connected to the kakabat road for sites 1 and 2.
- Electrical connection: 25 KV 3P and electric pole every 150 ft.
- Granular material is readily available near the community.
- Width of the road's right-of-way: 15 m with 8 m carriageway and side ditches on each side.
- Topsoil thicknesses ranging from 100 mm to 400 mm.
- The groundwater level was recorded at a depth of approximately 2.2 m to 9 m
- Local rural road (Type F): 100 vehicles.

- No service on existing roads (stormwater, and aqueduct).
- We consider that the sanitary and electrical network will be available on the Kakabat road.
- Gravel road with lower foundation on granular material MG-112, 600 mm thickness and upper foundation on crushed stone MG20, 300mm thickness
- Drainage culvert in TTOG; D: 450mm
- Well drilling at 10 m depth and located at 10 m from the building
- Pipe steel drilling; D: 200 mm; Th: 15,9 mm
- Fire water storage tank with capacity 73 cubic meters (12'x14'x16 ') or 19 285 US gallons
- Submersible pump type STA-RITES STEP Plus series: 1 HP 30 gpm discharge up to 130 ft (40m), assembled diameter of the pump 3 7/8 '' (10 cm) discharge pipe 1 1/4 '' (2.54 cm)
- Commercial water softener type WS Duplex 2.0in QC EE Metered 180k model EWS SD2MQC180
- Commercial filter type WF Simplex Carbon CS 2.0in EE QC 6.0 cuft model EWS FS2MQCCS6
- No geotechnical study for Site 3

7 COSTS ESTIMATE

It must be understood that these estimates are Class D, meaning that their accuracy is in the range of plus or minus 25%. Despite that, since all the scenarios are assessed based on the same assumptions, we consider that:

The probable value of the work is evaluated to serve each site. The amounts are before taxes. The amounts include direct and indirect costs and are expressed in Canadian dollars during the 3rd quarter of 2019.

Two options are envisioned for each site:

Option A: Connection of the site to the municipal aqueduct and sewer

Option B: Drilling of an artesian well to supply water to the site and septic tank for sanitary. The results are shown below.

Overview of the itinerary of each site are presented in Appendix A.

Details of the quantity takeoff of each site are presented in Appendix B.

7.1 SITE 1: OPTION 1 COST

This site is located approximately 285 m from the Kakabat road. The electrical connection is planned 312 m from the site, sewer from 287 m and the municipal aqueduct is located about 3.75 km from the site. The total duration of the works related to Site 1 is 4 months for Option 1A (connection to municipal aqueduct) and 3 months for Option 1B (drilling of an artesian well).

The following table shows the costs of both options for the Site 1:

Table7.1 – Summary cost for Option 1: Site 1

CREE NATION OF WEMINDJI WEMINDJI COMMUNITY INCINERATOR - SITE FEASIBILITY STUDY		
SUMMARY TABLE OF INFRASTRUCTURE COSTS		
Site	**DESCRIPTION**	**TOTAL AMOUNT**
SITE 1	**OPTION 1**	
	OPTION 1A: ACCES ROAD WITH WATERMAIN AND SEWER	**5 463 689,00 $**
1A.1	General expenses (Acces road)	696 000,00 $
1A.2	Site preparation (Acces road)	42 500,00 $
1A.3	Aqueduct	4 049 585,00 $
1A.4	Sewer	326 150,00 $
1A.5	Road infrastructure	168 704,00 $
1A.6	Miscellaneous (Acces road)	180 750,00 $
	OPTION 1B: ACCES ROAD WITH WATER WELL AND SEPTIC TANK	**828 455,50 $**
1B.1	General expenses (Acces road)	293 100,00 $
1B.2	Site preparation (Acces road)	42 500,00 $
1B.3	Well	105 174,00 $
1B.4	Septic tank system	38 227,50 $
1B.5	Road infrastructure	168 704,00 $
1B.6	Miscellaneous (Acces road)	180 750,00 $

7.2 SITE 2: OPTION 2 COST

This site is located approximately 185 m from the Kakabat road. The electrical connection is planned 220 m from, the site, sewer from 218 m and the municipal aqueduct is located about 1,7 km from the site. The total duration of the works related to Site 2 is 3 months for Option 2A (connection to municipal aqueduct) and 2 months for Option 2B (drilling of an artesian well).

The following table shows the costs of both options for the Site 2:

Table7.2 – Summary cost for Option 2: Site 2

CREE NATION OF WEMINDJI WEMINDJI COMMUNITY INCINERATOR - SITE FEASIBILITY STUDY		
SUMMARY TABLE OF INFRASTRUCTURE COSTS		
Site	**DESCRIPTION**	**TOTAL AMOUNT**
	OPTION 2A: ACCES ROAD WITH WATERMAIN AND SEWER	**2 823 495,00 $**
2A.1	General expenses (Acces road)	438 100,00 $
2A.2	Site preparation (Acces road)	19 500,00 $
2A.3	Aqueduct	1 883 900,00 $
2A.4	Sewer	260 600,00 $
2A.5	Road infrastructure	111 395,00 $
2A.6	Miscellaneous (Acces road)	110 000,00 $
	OPTION 2B: ACCES ROAD WITH WATER WELL AND SEPTIC TANK	**606 946,50 $**
2B.1	General expenses (Acces road)	235 500,00 $
2B.2	Site preparation (Acces road)	19 500,00 $
2B.3	Well	105 174,00 $
2B.4	Septic tank system	38 227,50 $
2B.5	Road infrastructure	98 545,00 $
2B.6	Miscellaneous (Acces road)	110 000,00 $

7.3 SITE 3: OPTION 3 COST

This site is located approximately 300 m from the old road. The electrical connection is planned 2,8 km from the site, sewer from 3,2 km and the municipal aqueduct is located about 3,3 km from the site.

The total duration of the works related to Site 3 is 10 months for Option 3A (connection to municipal aqueduct) and 7 months for Option 3B (drilling of an artesian well).

The following table shows the costs of both options for the Site 3:

Table7.3 – Summary cost for Option 3: Site 3

CREE NATION OF WEMINDJI WEMINDJI COMMUNITY INCINERATOR - SITE FEASIBILITY STUDY		
SUMMARY TABLE OF INFRASTRUCTURE COSTS		
Site	**DESCRIPTION**	**TOTAL AMOUNT**
SITE 3	**OPTION 3**	
	OPTION 3A : ACCES ROAD WITH WATERMAIN AND SEWER	**8 966 110,00 $**
3A.1	General expenses (Acces road)	1 312 000,00 $
3A.2	Site preparation (Acces road)	63 300,00 $
3A.3	Aqueduct	3 582 955,00 $
3A.4	Sewer	3 463 000,00 $
3A.5	Road infrastructure	177 980,00 $
3A.6	Miscellaneous (Acces road)	366 875,00 $
	OPTION 3B : ACCES ROAD WITH WATER WELL AND SEPTIC TANK	**1 489 606,50 $**
3B.1	General expenses (Acces road)	759 000,00 $
3B.2	Site preparation (Acces road)	63 300,00 $
3B.3	Well	105 174,00 $
3B.4	Septic tank system	38 227,50 $
3B.5	Road infrastructure	157 030,00 $
3B.6	Miscellaneous (Acces road)	366 875,00 $

For all the options studied, the construction of the water storage tank is not included in our estimate.

8 ITEMS EXCLUDED FROM THE ESTIMATE

The following items are not included in our estimate and must be verified and analyzed by others.

- Transmission of fire alarm system by radio or cellular wave (support by building).
- The construction of the fire water storage tank.
- Artesian well water treatment and storage pond maintenance.
- Operation and treatment system costs of the artesian well.
- Financing and indexation costs.
- The costs associated with the drilling permit and other environmental authorizations.

9 CONSIDERATIONS AND RECOMMENDATIONS

For our estimate, we considered:

- The installation of two pumps per site. The flow rate of each pump is 30 gal / min. resulting in around 5.5 hours to fill the storage tank.
- We consider the flow at the outlet of the aqueduct connection pipe is 35 l/s. Given the length of the main watermain serving each site, particularly for site 3, pressure drops are generated. It is recommended to take them into account when calculating the flow of water at the exit of each site.
- The artesian well must respect certain distances from septic installations. It is important to know the location of these installations on the site before deciding where to drill.
- For septic tank:
    - Never install the septic tank in clay.
    - The septic tank should never be installed if the permanent water table is higher than the base of the pit.
    - All septic systems must be drained every 2 to 5 years according to municipal standards.
    - Never drive with a heavy vehicle on the septic tank and on the septic field.
    - The emptying must always be done on the side of solids.
    - In winter, never remove or compact the snow, as this serves as an insulating blanket
- A soil investigation of each site is required for the choice of the drilling spot and septic tank system

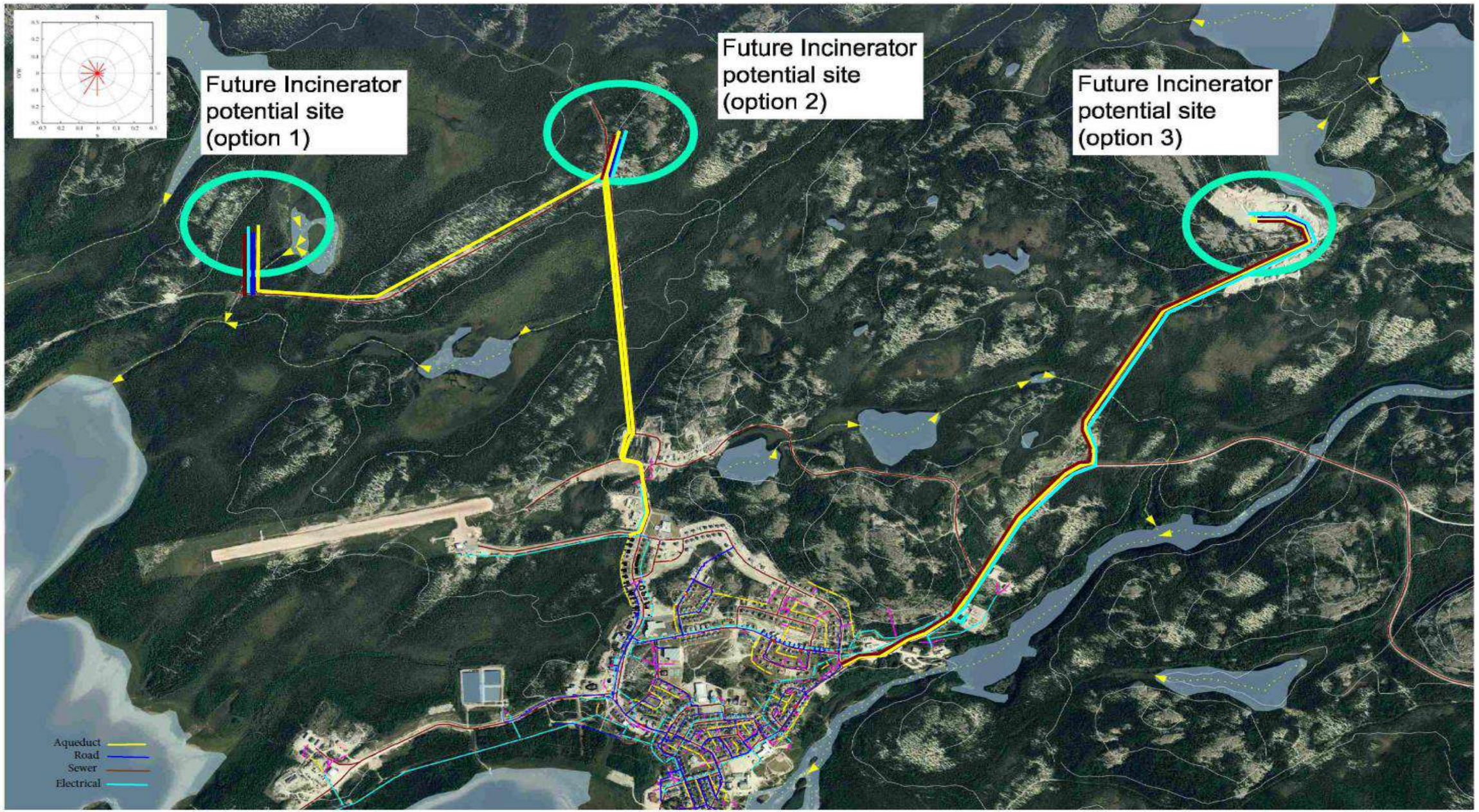
10 CONCLUSION

According to our estimation, option 2B (Site 2 with artesian well and septic tank) is the best choice being the most economical and least complex. Its cost is evaluated at **606,946.50 $.**

Moreover, this site is located near the Kakabat road and away from the future wastewater treatment plant.

Finally, the estimation details are presented in Appendix C.

Appendix A – Overview of the itinerary of each site


Future Incinerator potential site (option 1)
Future Incinerator potential site (option 2)
Future Incinerator potential site (option 3)
Aqueduct
Road
Sewer
Electrical

Appendix B – Details of the quantity takeoff of each site

Wemindji Takeoff

R190627

Bid No. 616

No.	Name	Height	Area	Quantity1	UOM1	Quantity2	UOM2	Quantity3	UOM3
Option 1									
(unassigned)									
5	Aqueduc	0 mm	(unassigned)	3,750	m	0		0	
7	HQ	0 mm	(unassigned)	312	m	0		0	
14	Sewer	0 mm	(unassigned)	287	m	0		0	
16	route	0 mm	(unassigned)	285	m	0		0	
Option 2									
(unassigned)									
4	Aqueduc	0 mm	(unassigned)	1,721	m	0		0	
6	HQ	0 mm	(unassigned)	220	m	0		0	
13	Sewer	0 mm	(unassigned)	218	m	0		0	
15	Longueur route	0 mm	(unassigned)	183	m	0		0	
Option 3									
(unassigned)									
3	Aqueduc	0 mm	(unassigned)	3,307	m	0		0	
8	HQ	0 mm	(unassigned)	2,847	m	0		0	
9	Longueur route	0 mm	(unassigned)	302	m	0		0	
12	Sewer	0 mm	(unassigned)	3,259	m	0		0	

Appendix C – Details of estimations

ART.	DESCRIPTION	UNIT	UNIT PRICE a	APPROX. QUANTITY b	TOTAL AMOUNT c=a x b
1A	**OPTION 1A with watermain and sewer**				
1A.1	**General expenses (Acces road)**				
1A.1.1	Mobilization and freight	Lump Sum	$ 105 000,00	1	$105 000,00
1A.1.2	Camp	Lump Sum	$ 141 000,00	1	$141 000,00
1A.1.3		Lump Sum	$ 405 000,00	1	$405 000,00
1A.1.4	Demobilization	Lump Sum	$ 45 000,00	1	$45 000,00
	Sub-total of mobilization				***$696 000,00***
1A.2	**Site preparation (Acces road)**				
1A.2.1	Clearing and Grubbing	m^2	$ 3,00	4000	$12 000,00
1A.2.2	Tree felling	Lump Sum	$ 7 500,00	1	$7 500,00
1A.2.3	Leveling	m^2	$ 2,00	4000	$8 000,00
1A.2.4	Maintenance during work	Lump Sum	$ 15 000,00	1	$15 000,00
	Sub-total of site preparation				***$42 500,00***
1A.3	**Aqueduct**				
1A.3.1	Watermain insulated, single trench				
a.	Diameter 200 mm, PVC including UIP process insulation (50 mm)with urecon	m	$ 1 050,00	3750	$3 937 500,00
b.	Gate valve pré-insulated with curb-valve box and permanent valve stem 200 mm Ø	un	$ 4 800,00	10	$48 000,00
1A.3.2	Diameter 2,5 mm of heating cable system	m	$ 10,50	3770	$39 585,00
1A.3.3	Fire hydrant, including adjacent valve insulated				
a.	Diameter 150 mm	un	$ 12 500,00	1	$12 500,00
1A.3.4	Service connection,				
a.	Diameter 150 mm, cast iron isolated with urecon	un	$ 2 500,00	1	$2 500,00
b.	Connection to the existing watermain	un	$ 4 500,00	1	$4 500,00
1A.3.5	Investigation	un	$ 5 000,00	1	$5 000,00
	Sub-total of Aqueduct				***$4 049 585,00***
1A.4	**Sewer**				
1A.4.1	Supply and installation of PVC DR35, 300 mm Ø. Including UIP process insulation (50 mm)	m	$ 950,00	287	$272 650,00
1A.4.2	Prefabricated concrete sanitary sewer manhole(900 mm Ø) including external insulation (80 mm), external polyethylene coating, off road frame, and inlet cover (775 mm Ø) and insulated weather stripping cover	un	$ 12 500,00	3	$37 500,00
1A.4.3	Service connection,				$0,00
a.	Sanitary sewer connection, PVC 150 mm Ø.	un	$ 3 500,00	1	$3 500,00
b.	Connection to the existing sewer	un	$ 7 500,00	1	$7 500,00
1A.4.4	Investigation	un	$ 5 000,00	1	$5 000,00
	Sub-total of Sewer				***$326 150,00***
1A.5	**Road infrastructure**				
1A.5.1	Excavation to infrastructure and platform preparation	m^3	$ 18,00	1600	$28 800,00
1A.5.2	Geotextile membrane solmax 7609	m^2	$ 4,75	3000	$14 250,00
1A.5.3	Ditch digging and reprofilling	m	$ 16,50	576	$9 504,00
1A.5.4	Cross culvert on access road TTOG 450 mm Ø	m	$ 600,00	8	$4 800,00
1A.5.5	Culvert including treated wood cut-off and stone protective covering	u	$ 1 500,00	2	$3 000,00
1A.5.6	Lower foundation, granular material MG-112, 600 mm thickness	m^3	$ 45,00	1400	$63 000,00
1A.5.7	Upper foundation, crushed stone MG20, 300 mm thickness	m^3	$ 50,00	700	$35 000,00
1A.5.8	Preparation of granular surface	m^2	$ 4,50	2300	$10 350,00
	Sub-total of road infrastructure				***$168 704,00***
1A.6	**Miscellaneous (Acces road)**				
1A.6.1	Stabilization of slopes and ditches with topsoil (100 mm thickness)	Lump Sum	$ 5 000,00	1	$5 000,00
1A.6.2	Mandatory excavations	un	$ 2 500,00	1	$2 500,00
1A.6.3	Provision for open cut bedrock excavation	m^3	$ 425,00	350	$148 750,00
1A.6.4	Overhead electrical connection system	Lump Sum	$ 24 500,00	1	$24 500,00
	Sub-total of miscellaneous				***$180 750,00***
	TOTAL option 1A				**$5 463 689,00**

ART.	DESCRIPTION	UNIT	UNIT PRICE a	APPROX. QUANTITY b	TOTAL AMOUNT c=a x b
1B	**OPTION 1B with well and septic tank**				
1B.1	**General expenses (Acces road)**				
1B.1.1	Mobilization and freight	Lump Sum	$ 82 500,00	1	$82 500,00
1B.1.2	Camp	Lump Sum	$ 105 600,00	1	$105 600,00
1B.1.3	Insurance and bonding	Lump Sum	$ 65 000,00	1	$65 000,00
1B.1.4	Demobilization	Lump Sum	$ 40 000,00	1	$40 000,00
	Sub-total of mobilization				***$293 100,00***
1B.2	**Site preparation (Acces road)**				
1B.2.1	Clearing and Grubbing	m^2	$ 3,00	4000	$12 000,00
1B.2.2	Tree felling	Lump Sum	$ 7 500,00	1	$7 500,00
1B.2.3	Leveling	m^2	$ 2,00	4000	$8 000,00
1B.2.4	Maintenance during work	Lump Sum	$ 15 000,00	1	$15 000,00
	Sub-total of site preparation				***$42 500,00***
1B.3	**Well**				
1B.3.1	Pile drilling				
a.	Supply and installation Pipe steel drilling 200 mm diam. 15,9 mm thichness, 10 m deph	un	$ 7 500,00	2	$15 000,00
b.	Supply and installation of Pump STA-RITE S.T.E.P Plus Series 30 gpm of capacity, 130 pi head, 1,5 HP	un	$ 7 000,00	2	$14 000,00
c.	Supply and installation ABS Pipe (Type IPEX) 1 1/4 inch insulated	m	$ 350,00	50	$17 500,00
d.	Diameter 2,5 mm of heating cable system	m	$ 10,50	90	$945,00
e.	Supply and installation ABS Pipe (Type IPEX) 2 inch insulated	m	$ 350,00	30	$10 500,00
f.	Supply and installation ABS 45° Wye 1 1/4 x 1 1/4 x 2 inch (Type IPEX) insulated	un	$ 125,00	1	$125,00
1B.3.2	Supply and installation of water Softener Duplex ,2 inch, EWS SD2MQC Metered 180k	un	$ 13 529,00	1	$13 529,00
1B.3.3	Supply and installation of water Filter actif simplex Carbon of 2 inch serie EWSF2SMQCCS6	un	$ 8 575,00	1	$8 575,00
1B.3.4	Service connection,				
a.	Connection to the building	un	$ 10 000,00	1	$10 000,00
b.	Investigation	un	$ 7 500,00	2	$15 000,00
	Sub-total of water system				***$105 174,00***
1B.4	**Septic tank system**				
1B.4.1	Excavation for septic tank	m^3	$ 45,00	25	$1 125,00
1B.4.2	Supply and installation of septic tank plastic xactics prefilter 2000 gallons	un	$ 15 500,00	1	$15 500,00
a.	Plastic cover 20" diam.	un	$ 120,00	2	$240,00
b.	Fireplace 20" diam, x 24" height	un	$ 120,00	2	$240,00
c.	Supply and installation of perforated plastic pipe 4" diam.	m	$ 16,00	60	$960,00
c.	Supply and installation of non-perforated plastic pipe 4" diam.	m	$ 15,50	75	$1 162,50
e.	Supply and installation on crushed stone including geotextile	m^2	$ 25,00	60	$1 500,00
1B.4.3	Connection to the building	un	$ 7 500,00	1	$7 500,00
1B.4.4	Investigation	un	$ 5 000,00	2	$10 000,00
	Sub-total septic thank system				***$38 227,50***
1B.5	**Road infrastructure**				
1B.5.1	Excavation to infrastructure and platform preparation	m^3	$ 18,00	1600	$28 800,00
1B.5.2	Geotextile membrane solmax 7609	m^2	$ 4,75	3000	$14 250,00
1B.5.3	Ditch digging and reprofilling	m	$ 16,50	576	$9 504,00
1B.5.4	Cross culvert on access road TTOG 450 mm Ø	m	$ 600,00	8	$4 800,00
1B.5.5	Culvert including treated wood cut-off and stone protective covering	u	$ 1 500,00	2	$3 000,00
1B.5.6	Lower foundation, granular material MG-112, 600 mm thickness	m^3	$ 45,00	1400	$63 000,00
1B.5.7	Upper foundation, crushed stone MG20, 300 mm thickness	m^3	$ 50,00	700	$35 000,00
1B.5.8	Preparation of granular surface	m^2	$ 4,50	2300	$10 350,00
	Sub-total of road infrastructure				***$168 704,00***
1B.6	**Miscellaneous (Acces road)**				
1B.6.1	Stabilization of slopes and ditches with topsoil (100 mm thickness)	Lump Sum	$ 5 000,00	1	$5 000,00
1B.6.2	Mandatory excavations	un	$ 2 500,00	1	$2 500,00
1B.6.3	Provision for open cut bedrock excavation	m^3	$ 425,00	350	$148 750,00
1B.6.4	Overhead electrical connection system	Lump Sum	$ 24 500,00	1	$24 500,00
	Sub-total of miscellaneous				***$180 750,00***
	TOTAL option 1B				**$828 455,50**

ART.	DESCRIPTION	UNIT	UNIT PRICE a	APPROX. QUANTITY b	TOTAL AMOUNT c=a x b
2A	**OPTION 2A with watermain and sewer**				
2A.1	**General expenses (Acces road)**				
2A.1.1	Mobilization and freight	Lump Sum	$ 82 500,00	1	$82 500,00
2A.1.2	Camp	Lump Sum	$ 105 600,00	1	$105 600,00
2A.1.3	Insurance and bonding	Lump Sum	$ 210 000,00	1	$210 000,00
2A.1.4	Demobilization	Lump Sum	$ 40 000,00	1	$40 000,00
	Sub-total of mobilization				***$438 100,00***
2A.2	**Site preparation (Acces road)**				
2A.2.1	Clearing and Grubbing	m^2	$ 3,00	2600	$7 800,00
2A.2.2	Tree felling	Lump Sum	$ 2 500,00	1	$2 500,00
2A.2.3	Leveling	m^2	$ 2,00	2600	$5 200,00
2A.2.4	Maintenance during work	Lump Sum	$ 4 000,00	1	$4 000,00
	Sub-total of site preparation				***$19 500,00***
2A.3	**Aqueduct**				
2A.3.1	Watermain insulated, single trench				
a.	Diameter 200 mm, PVC including UIP process insulation (50 mm)with urecon	m	$ 1 050,00	1730	$1 816 500,00
b.	Gate valve pré-insulated with curb-valve box and permanent valve stem 200 mm Ø	un	$ 4 800,00	5	$24 000,00
2A.3.2	Diameter 2,5 mm of heating cable system	m	$ 10,50	1800	$18 900,00
2A.3.3	Fire hydrant, including adjacent valve insulated				
a.	Diameter 150 mm	un	$ 12 500,00	1	$12 500,00
2A.3.4	Service connection,				
a.	Diameter 150 mm, cast iron isolated with urecon	un	$ 2 500,00	1	$2 500,00
b.	Connection to the existing watermain	un	$ 4 500,00	1	$4 500,00
2A.3.5	Investigation	un	$ 5 000,00	1	$5 000,00
	Sub-total of Aqueduct				***$1 883 900,00***
2A.4	**Sewer**				
2A.4.1	Supply and installation of PVC DR35, 300 mm Ø. Including UIP process insulation (50 mm)	m	$ 950,00	218	$207 100,00
2A.4.2	Prefabricated concrete sanitary sewer manhole(900 mm Ø) including external insulation (80 mm), external polyethylene coating, off road frame, and inlet cover (775 mm Ø) and insulated weather stripping cover	un	$ 12 500,00	3	$37 500,00
2A.4.3	Service connection,				$0,00
a.	Sanitary sewer connection, PVC 150 mm Ø.	un	$ 3 500,00	1	$3 500,00
b.	Connection to the existing sewer	un	$ 7 500,00	1	$7 500,00
2A.4.4	Investigation	un	$ 5 000,00	1	$5 000,00
	Sub-total of Sewer				***$260 600,00***
2A.5	**Road infrastructure**				
2A.5.1	Excavation to infrastructure and platform preparation	m^3	$ 18,00	1100	$19 800,00
2A.5.2	Geotextile membrane solmax 7609	m^2	$ 4,75	1700	$8 075,00
2A.5.3	Ditch digging and reprofilling	m	$ 16,50	370	$6 105,00
2A.5.4	Cross culvert on access road TTOG 450 mm Ø	m	$ 600,00	8	$4 800,00
2A.5.5	Culvert including treated wood cut-off and stone protective covering	u	$ 1 500,00	2	$3 000,00
2A.5.6	Lower foundation, granular material MG-112, 600 mm thickness	m^3	$ 45,00	900	$40 500,00
2A.5.7	Upper foundation, crushed stone MG20, 300 mm thickness	m^3	$ 50,00	450	$22 500,00
2A.5.8	Preparation of granular surface	m^2	$ 4,50	1470	$6 615,00
	Sub-total of road infrastructure				***$111 395,00***
2A.6	**Miscellaneous (Acces road)**				
2A.6.1	Stabilization of slopes and ditches with topsoil (100 mm thickness)	Lump Sum	$ 5 000,00	1	$5 000,00
2A.6.2	Mandatory excavations	un	$ 2 500,00	1	$2 500,00
2A.6.3	Provision for open cut bedrock excavation	m^3	$ 425,00	200	$85 000,00
2A.6.4	Overhead electrical connection system	Lump Sum	$ 17 500,00	1	$17 500,00
	Sub-total of miscellaneous				***$110 000,00***
	TOTAL option 2A				**$2 823 495,00**

ART.	DESCRIPTION	UNIT	UNIT PRICE a	APPROX. QUANTITY b	TOTAL AMOUNT c=a x b
2B	**OPTION 2B well and septic tank**				
2B.1	**General expenses (Acces road)**				
2B.1.1	Mobilization and freight	Lump Sum	$ 75 000,00	1	$75 000,00
2B.1.2	Camp	Lump Sum	$ 70 500,00	1	$70 500,00
2B.1.3	Insurance and bonding	Lump Sum	$ 50 000,00	1	$50 000,00
2B.1.4	Demobilization	Lump Sum	$ 40 000,00	1	$40 000,00
	Sub-total of mobilization				***$235 500,00***
2B.2	**Site preparation (Acces road)**				
2B.2.1	Clearing and Grubbing	m^2	$ 3,00	2600	$7 800,00
2B.2.2	Tree felling	Lump Sum	$ 2 500,00	1	$2 500,00
2B.2.3	Leveling	m^2	$ 2,00	2600	$5 200,00
2B.2.4	Maintenance during work	Lump Sum	$ 4 000,00	1	$4 000,00
	Sub-total of site preparation				***$19 500,00***
2B.3	**Well**				
2B.3.1	Pile drilling				
a.	Supply and installation Pipe steel drilling 200 mm diam. 15,9 mm thichness, 10 m deph	un	$ 7 500,00	2	$15 000,00
b.	Supply and installation of Pump STA-RITE S.T.E.P Plus Series 30 gpm of capacity, 130 pi head, 1,5 HP	un	$ 7 000,00	2	$14 000,00
c.	Supply and installation ABS Pipe (Type IPEX) 1 1/4 inch insulated	m	$ 350,00	50	$17 500,00
d.	Diameter 2,5 mm of heating cable system	m	$ 10,50	90	$945,00
e.	Supply and installation ABS Pipe (Type IPEX) 2 inch insulated	m	$ 350,00	30	$10 500,00
f.	Supply and installation ABS 45° Wye 1 1/4 x 1 1/4 x 2 inch (Type IPEX) insulated	un	$ 125,00	1	$125,00
2B.3.2	Supply and installation of water Softener Duplex ,2 inch, EWS SD2MQC Metered 180k	un	$ 13 529,00	1	$13 529,00
2B.3.3	Supply and installation of water Filter actif simplex Carbon of 2 inch serie EWSF2SMQCCS6	un	$ 8 575,00	1	$8 575,00
2B.3.4	Service connection,				
a.	Connection to the building	un	$ 10 000,00	1	$10 000,00
b.	Investigation	un	$ 7 500,00	2	$15 000,00
	Sub-total of Aqueduct				***$105 174,00***
2B.4	**Septic tank system**				
2B.4.1	Excavation for septic tank	m^3	$ 45,00	25	$1 125,00
2B.4.2	Supply and installation of septic tank plastic xactics prefilter 2000 gallons	un	$ 15 500,00	1	$15 500,00
a.	Plastic cover 20" diam.	un	$ 120,00	2	$240,00
b.	Fireplace 20" diam, x 24" height	un	$ 120,00	2	$240,00
c.	Supply and installation of perforated plastic pipe 4" diam.	m	$ 16,00	60	$960,00
c.	Supply and installation of non-perforated plastic pipe 4" diam.	m	$ 15,50	75	$1 162,50
e.	Supply and installation on crushed stone including geotextile	m^2	$ 25,00	60	$1 500,00
2B.4.3	Connection to the building	un	$ 7 500,00	1	$7 500,00
2B.4.4	Investigation	un	$ 5 000,00	2	$10 000,00
	Sub-total septic thank system				***$38 227,50***
2B.5	**Road infrastructure**				
2B.5.1	Excavation to infrastructure and platform preparation	m^3	$ 18,00	1100	$19 800,00
2B.5.2	Geotextile membrane solmax 7609	m^2	$ 4,75	1700	$8 075,00
2B.5.3	Ditch digging and reprofilling	m	$ 16,50	370	$6 105,00
2B.5.4	Cross culvert on access road TTOG 450 mm Ø	m	$ 600,00	8	$4 800,00
2B.5.5	Culvert including treated wood cut-off and stone protective covering	u	$ 1 500,00	2	$3 000,00
2B.5.6	Lower foundation, granular material MG-112, 600 mm thickness	m^3	$ 45,00	770	$34 650,00
2B.5.7	Upper foundation, crushed stone MG20, 300 mm thickness	m^3	$ 50,00	310	$15 500,00
2B.5.8	Preparation of granular surface	m^2	$ 4,50	1470	$6 615,00
	Sub-total of road infrastructure				***$98 545,00***
2B.6	**Miscellaneous (Acces road)**				
2B.6.1	Stabilization of slopes and ditches with topsoil (100 mm thickness)	Lump Sum	$ 5 000,00	1	$5 000,00
2B.6.2	Mandatory excavations	un	$ 2 500,00	1	$2 500,00
2B.6.3	Provision for open cut bedrock excavation	m^3	$ 425,00	200	$85 000,00
2B.6.4	Overhead electrical connection system	Lump Sum	$ 17 500,00	1	$17 500,00
	Sub-total of miscellaneous				***$110 000,00***
	TOTAL option 2B				**$606 946,50**

ART.	DESCRIPTION	UNIT	UNIT PRICE a	APPROX. QUANTITY b	TOTAL AMOUNT c=a x b
3A	**OPTION 3A with watermain and sewer**				
3A.1	**General expenses (Acces road)**				
3A.1.1	Mobilization and freight	Lump Sum	$ 285 000,00	1	$285 000,00
3A.1.2	Camp	Lump Sum	$ 350 000,00	1	$350 000,00
3A.1.3	Insurance and bonding	Lump Sum	$ 665 000,00	1	$665 000,00
3A.1.4	Demobilization	Lump Sum	$ 12 000,00	1	$12 000,00
	Sub-total of mobilization				***$1 312 000,00***
3A.2	**Site preparation (Acces road)**				
3A.2.1	Clearing and Grubbing	m^2	$ 3,00	8160	$24 480,00
3A.2.2	Tree felling	Lump Sum	$ 7 500,00	1	$7 500,00
3A.2.3	Leveling	m^2	$ 2,00	8160	$16 320,00
3A.2.4	Maintenance during work	Lump Sum	$ 15 000,00	1	$15 000,00
	Sub-total of site preparation				***$63 300,00***
3A.3	**Aqueduct**				
3A.3.1	Watermain insulated, single trench				
a.	Diameter 200 mm, PVC including UIP process insulation (50 mm)with urecon	m	$ 1 050,00	3310	$3 475 500,00
b.	Gate valve pré-insulated with curb-valve box and permanent valve stem 200 mm Ø	un	$ 4 800,00	9	$43 200,00
3A.3.2	Diameter 2,5 mm of heating cable system	m	$ 10,50	3310	$34 755,00
3A.3.3	Fire hydrant, including adjacent valve insulated				
a.	Diameter 150 mm	un	$ 12 500,00	1	$12 500,00
3A.3.4	Service connection,				
a.	Diameter 150 mm, cast iron isolated with urecon	un	$ 2 500,00	1	$2 500,00
b.	Connection to the existing watermain	un	$ 4 500,00	1	$4 500,00
3A.3.5	Investigation	un	$ 5 000,00	2	$10 000,00
	Sub-total of Aqueduct				***$3 582 955,00***
3A.4	**Sewer**				
3A.4.1	Supply and installation of PVC DR35, 300 mm Ø. Including UIP process insulation (50 mm)	m	$ 950,00	3260	$3 097 000,00
3A.4.2	Prefabricated concrete sanitary sewer manhole(900 mm Ø) including external insulation (80 mm), external polyethylene coating, off road frame, and inlet cover (775 mm Ø) and insulated weather stripping cover	un	$ 12 500,00	28	$350 000,00
3A.4.3	Service connection,				$0,00
a.	Sanitary sewer connection, PVC 150 mm Ø.	un	$ 3 500,00	1	$3 500,00
b.	Connection to the existing sewer	un	$ 7 500,00	1	$7 500,00
3A.4.4	Investigation	un	$ 5 000,00	1	$5 000,00
	Sub-total of Sewer				***$3 463 000,00***
3A.5	**Road infrastructure**				
3A.5.1	Excavation to infrastructure and platform preparation	m^3	$ 18,00	1780	$32 040,00
3A.5.2	Geotextile membrane solmax 7609	m^2	$ 4,75	2860	$13 585,00
3A.5.3	Ditch digging and reprofilling	m	$ 16,50	610	$10 065,00
3A.5.4	Cross culvert on access road TTOG 450 mm Ø	m	$ 600,00	8	$4 800,00
3A.5.5	Culvert including treated wood cut-off and stone protective covering	u	$ 1 500,00	2	$3 000,00
3A.5.6	Lower foundation, granular material MG-112, 600 mm thickness	m^3	$ 45,00	1480	$66 600,00
3A.5.7	Upper foundation, crushed stone MG20, 300 mm thickness	m^3	$ 50,00	740	$37 000,00
3A.5.8	Preparation of granular surface	m^2	$ 4,50	2420	$10 890,00
	Sub-total of road infrastructure				***$177 980,00***
3A.6	**Miscellaneous (Acces road)**				
3A.6.1	Stabilization of slopes and ditches with topsoil (100 mm thickness)	Lump Sum	$ 5 000,00	1	$5 000,00
3A.6.2	Mandatory excavations	un	$ 2 500,00	3	$7 500,00
3A.6.3	Provision for open cut bedrock excavation	m^3	$ 425,00	375	$159 375,00
3A.6.4	Overhead electrical connection system	Lump Sum	$ 195 000,00	1	$195 000,00
	Sub-total of miscellaneous				***$366 875,00***
	TOTAL option 3A				**$8 966 110,00**

ART.	DESCRIPTION	UNIT	UNIT PRICE a	APPROX. QUANTITY b	TOTAL AMOUNT c=a x b
3B	**OPTION 3B well and septic tank**				
3B.1	**General expenses (Acces road)**				
3B.1.1	Mobilization and freight	Lump Sum	$ 285 000,00	1	$285 000,00
3B.1.2	Camp	Lump Sum	$ 350 000,00	1	$350 000,00
3B.1.3	Insurance and bonding	Lump Sum	$ 112 000,00	1	$112 000,00
3B.1.4	Demobilization	Lump Sum	$ 12 000,00	1	$12 000,00
	Sub-total of mobilization				***$759 000,00***
3B.2	**Site preparation (Acces road)**				
3B.2.1	Clearing and Grubbing	m^2	$ 3,00	8160	$24 480,00
3B.2.2	Tree felling	Lump Sum	$ 7 500,00	1	$7 500,00
3B.2.3	Leveling	m^2	$ 2,00	8160	$16 320,00
3B.2.4	Maintenance during work	Lump Sum	$ 15 000,00	1	$15 000,00
	Sub-total of site preparation				***$63 300,00***
3B.3	**Well**				
3B.3.1	Pile drilling				
a.	Supply and installation Pipe steel drilling 200 mm diam. 15,9 mm thichness, 10 m deph	un	$ 7 500,00	2	$15 000,00
b.	Supply and installation of Pump STA-RITE S.T.E.P Plus Series 30 gpm of capacity, 130 pi head, 1,5 HP	un	$ 7 000,00	2	$14 000,00
c.	Supply and installation ABS Pipe (Type IPEX) 1 1/4 inch insulated	m	$ 350,00	50	$17 500,00
d.	Diameter 2,5 mm of heating cable system	m	$ 10,50	90	$945,00
e.	Supply and installation ABS Pipe (Type IPEX) 2 inch insulated	m	$ 350,00	30	$10 500,00
f.	Supply and installation ABS 45° Wye 1 1/4 x 1 1/4 x 2 inch (Type IPEX) insulated	un	$ 125,00	1	$125,00
3B.3.2	Supply and installation of water Softener Duplex ,2 inch, EWS SD2MQC Metered 180k	un	$ 13 529,00	1	$13 529,00
3B.3.3	Supply and installation of water Filter actif simplex Carbon of 2 inch serie EWSF2SMQCCS6	un	$ 8 575,00	1	$8 575,00
3B.3.4	Service connection,				
a.	Connection to the building	un	$ 10 000,00	1	$10 000,00
b.	Investigation	un	$ 7 500,00	2	$15 000,00
	Sub-total septic thank system				***$105 174,00***
3B.4	**Septic tank system**				
3B.4.1	Excavation for septic tank	m^3	$ 45,00	25	$1 125,00
3B.4.2	Supply and installation of septic tank plastic xactics prefilter 2000 gallons	un	$ 15 500,00	1	$15 500,00
a.	Plastic cover 20" diam.	un	$ 120,00	2	$240,00
b.	Fireplace 20" diam, x 24" height	un	$ 120,00	2	$240,00
c.	Supply and installation of perforated plastic pipe 4" diam.	m	$ 16,00	60	$960,00
c.	Supply and installation of non-perforated plastic pipe 4" diam.	m	$ 15,50	75	$1 162,50
e.	Supply and installation on crushed stone including geotextile	m^2	$ 25,00	60	$1 500,00
3B.4.3	Connection to the building	un	$ 7 500,00	1	$7 500,00
3B.4.4	Investigation	un	$ 5 000,00	2	$10 000,00
	Sub-total septic thank system				***$38 227,50***
3B.5	**Road infrastructure**				
3B.5.1	Excavation to infrastructure and platform preparation	m^3	$ 18,00	1780	$32 040,00
3B.5.2	Geotextile membrane solmax 7609	m^2	$ 4,75	2860	$13 585,00
3B.5.3	Ditch digging and reprofilling	m	$ 16,50	610	$10 065,00
3B.5.4	Cross culvert on access road TTOG 450 mm Ø	m	$ 600,00	8	$4 800,00
3B.5.5	Culvert including treated wood cut-off and stone protective covering	u	$ 1 500,00	2	$3 000,00
3B.5.6	Lower foundation, granular material MG-112, 600 mm thickness	m^3	$ 45,00	1270	$57 150,00
3B.5.7	Upper foundation, crushed stone MG20, 300 mm thickness	m^3	$ 50,00	510	$25 500,00
3B.5.8	Preparation of granular surface	m^2	$ 4,50	2420	$10 890,00
	Sub-total of road infrastructure				***$157 030,00***
3B.6	**Miscellaneous (Acces road)**				
3B.6.1	Stabilization of slopes and ditches with topsoil (100 mm thickness)	Lump Sum	$ 5 000,00	1	$5 000,00
3B.6.2	Mandatory excavations	un	$ 2 500,00	3	$7 500,00
3B.6.3	Provision for open cut bedrock excavation	m^3	$ 425,00	375	$159 375,00
3B.6.4	Overhead electrical connection system	Lump Sum	$ 195 000,00	1	$195 000,00
	Sub-total of miscellaneous				***$366 875,00***
	TOTAL option 3B				**$1 489 606,50**

MONTREAL
85 ST. PAUL STREET, SUITE 300
MONTREAL (QUEBEC) H2Y 3V4
514 507 3600

QUEBEC
622 ST. JOSEPH STREET, SUITE 300
QUEBEC (QUEBEC) G1K 3B9
418 914 1508

SHAWINIGAN
5582 DES HÊTRES BOULEVARD
SHAWINIGAN (QUEBEC) G9N 4W1
1 866 380 0513

MAGOG
790 PRINCIPALE STREET W.
MAGOG (QUEBEC) J1X 2B3
1 819 640 2267

BC2

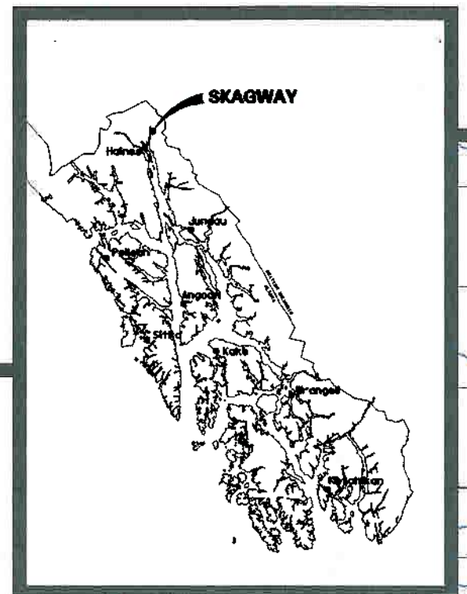
URBAN PLANNING
URBAN DESIGN
LANDSCAPE ARCHITECTURE
ENVIRONMENT
STRATEGY

GROUPE**BC2**.COM

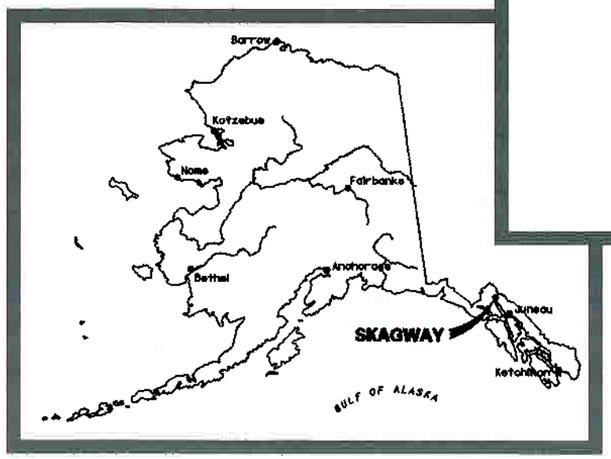
Appendix D – Sample Project Plans from Skagway, Alaska

City of Skagway

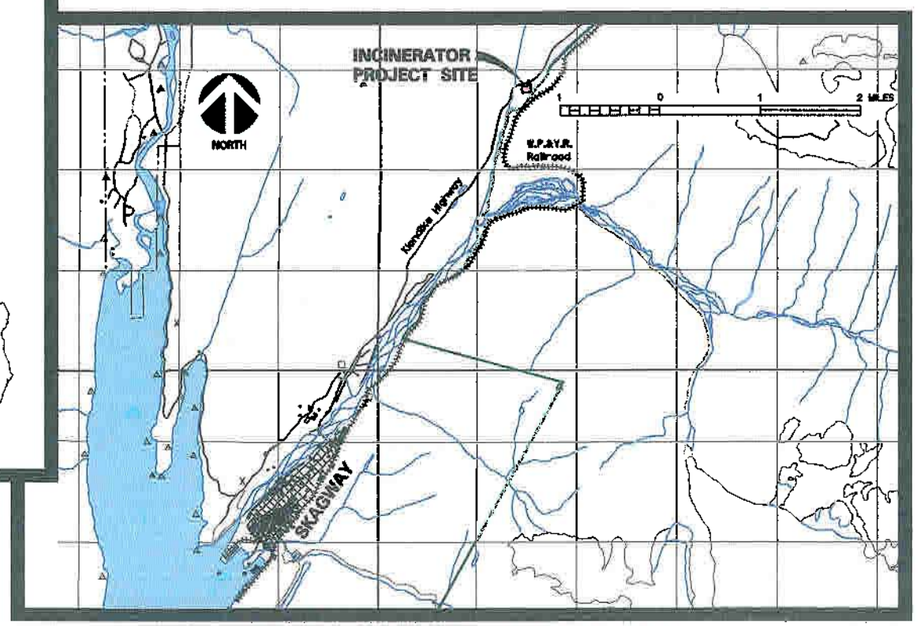
SOLID WASTE INCINERATOR



S.E. ALASKA



ALASKA



SKAGWAY VICINITY

MONTGOMERY WATSON
Serving the World's Environmental Needs
712 WEST 12th STREET
JUNEAU, ALASKA 99801
(907) 586-4447

with
MURRAY & ASSOCIATES, P. C.
CONSULTING ENGINEERS
P. O. BOX 21081
JUNEAU, ALASKA 99802
(907) 586-6622

and
HAIGHT & McLAUGHLIN, INC.
CONSULTING ENGINEERS
418 HARRIS STREET
JUNEAU, ALASKA 99801
(907) 586-9788

78'-0". OVERALL
44'-0". LEVEL 3
46'-0". LEVEL 2
17'-0". LEVEL 1
NORTH
1 0 5 10 FEET
GLASS CRUSHER HATCH 22 C8
DN
GLASS CRUSHER BY OTHERS
RECYCLE BIN
RECYCLE BIN
RECYCLE BIN
RECYCLE BIN
BY OTHERS
BY OTHERS
FLOOR TRENCH DRAIN
7'-6"
3'-0"
3'-0" x 6'-8" MAIN ENTRANCE
22'-0"
58'-0"
ASH DUMP OPENING
PRIMARY BURN CHAMBER NO. 1
FD
LEVEL 3 TIPPING FLOOR NOM. EL. 680.0'
RECYCLER (BALER) BY OTHERS
DOUBLE 3'-0"x6'-8" DOORS, THRESHOLD 3'-6" ABOVE FLOOR
SECONDARY CHAMBER
E SUPPRESSION WATER STORAGE
(BELOW LEVEL 3 FLOOR)
EXHAUST
MUNICIPAL GARBAGE TRUCK BY OTHERS
14'x14' OVERHEAD DOOR
14'-0"
WATER TANK ACCESS HATCH 23 C8
LADDER 8 C8
LEVEL 1 ASH STORAGE NOM. EL. 656.0'
ASH DUMP OPENING
PRIMARY BURN CHAMBER NO. 2
FD
BATTERY RECYCLE AREA
WATER/MECH ROOM & STORAGE (BELOW LEVEL 3 FLOOR)
FLOOR TRENCH DRAIN
EMERGENCY SHOWER
UTILITY SINK
OFFICE AND CONTROL ROOM
9'-11"
LEVEL 2 INCINERATOR NOM. EL. 668.33'
DN
3'-0" x 6'-8" EMERGENCY EXIT
RAMP
4' SQUARE LANDING
POTABLE WATER TANK FILL PIPE
3'-0" x 6'-8" EMERGENCY EXIT

Path/File Name: t:\mod\skagway\lincln\fndsn\g4.dgn
Date Plotted: 30 SEP 97
Time Plotted: 14:02:00

REV	DATE	BY	DESCRIPTION

SCALE: GRAPHIC
DATE PRINTED:
DESIGNED SS
DRAWN SHH
CHECKED JLD
DATE 09-30-97

SKAGWAY MUNICIPAL IMPROVEMENTS

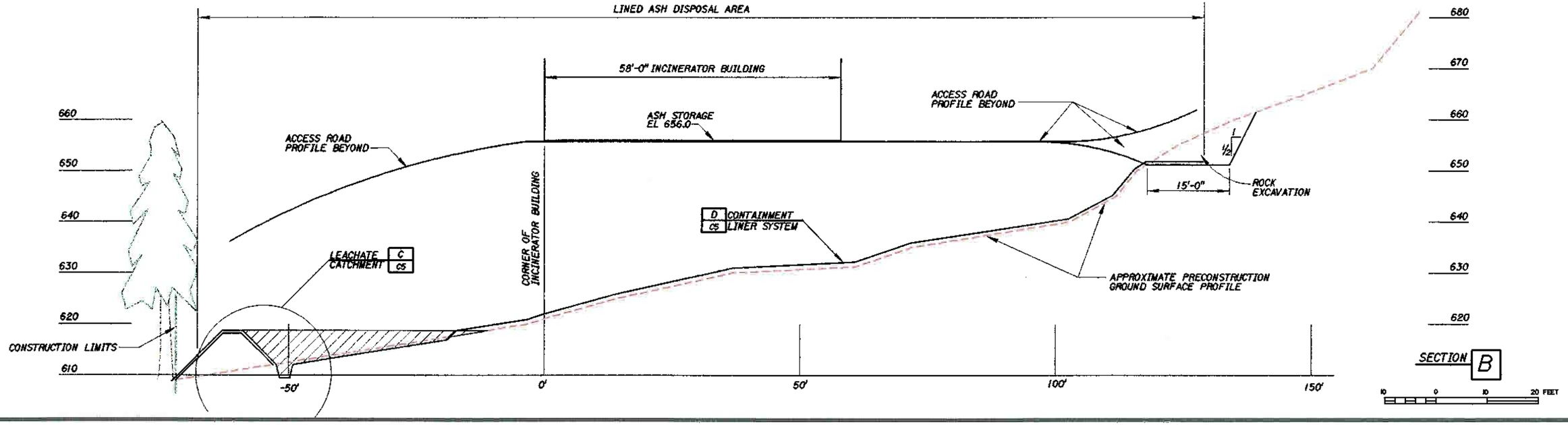
SOLID WASTE INCINERATOR

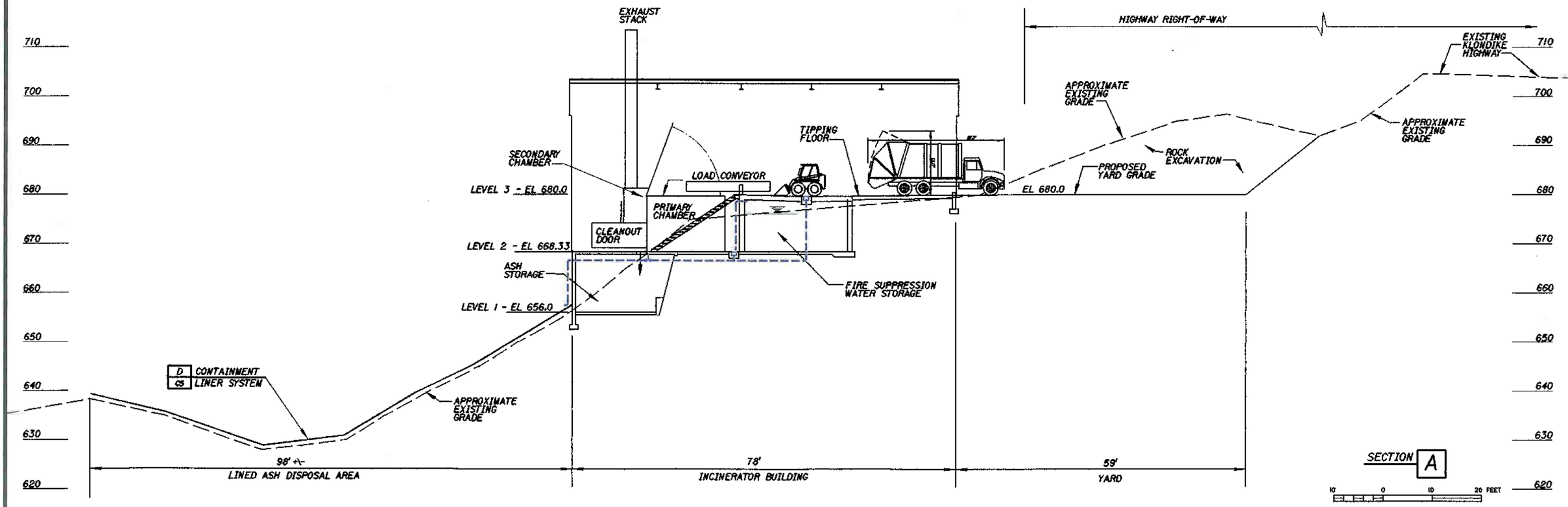
STATE OF ALASKA 49TH JAMES L. DORR CE 5362 REGISTERED PROFESSIONAL ENGINEER

MONTGOMERY WATSON
712 WEST 12th STREET
JUNEAU, ALASKA 99801
586-4447

GENERAL ARRANGEMENT

DRAWING G4
SHEET No. 4 of 52





REV	DATE	BY	DESCRIPTION

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DATE PRINTED:
DESIGNED SS
DRAWN SS
CHECKED JLD
DATE 09-30-97

SKAGWAY MUNICIPAL IMPROVEMENTS

SOLID WASTE INCINERATOR

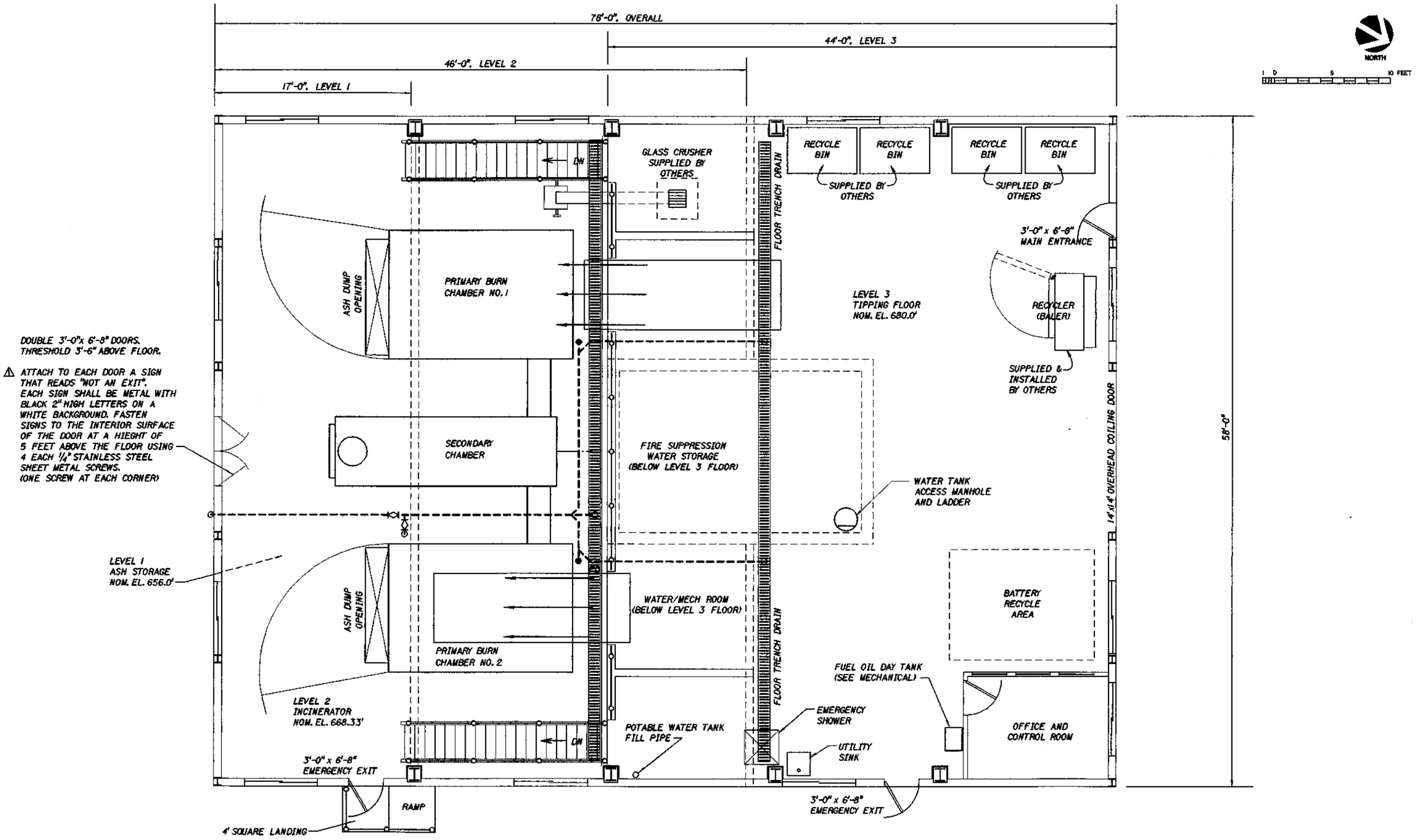
STATE OF ALASKA 49TH JAMES L. DORN 9363 REGISTERED PROFESSIONAL ENGINEER

MONTGOMERY WATSON
712 WEST 12th STREET
JUNEAU, ALASKA 99801
586-4447

SITE SECTIONS

DRAWING C4

SHEET No. 8 of 52



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⚠	1/29/98	TBC	ADDED "NOT AN EXIT" SIGNS TO DOUBLE DOORS

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DATE PRINTED:
DESIGNED SS
DRAWN EHH
CHECKED JLD
DATE 09-30-97

SKAGWAY MUNICIPAL IMPROVEMENTS

SOLID WASTE INCINERATOR

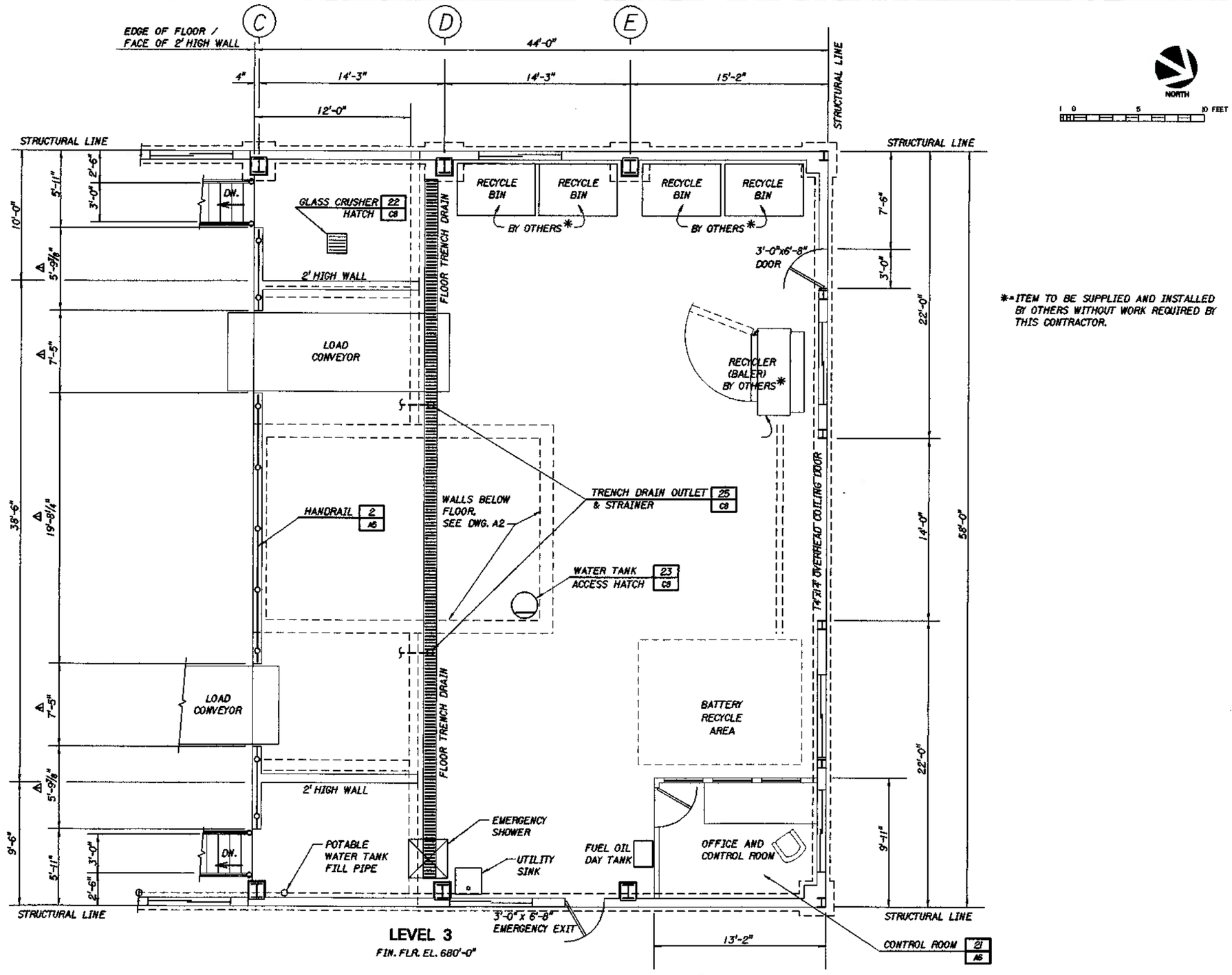
STATE OF ALASKA — 49TH — JAMES L. DORN — OR 5323 — REGISTERED PROFESSIONAL ENGINEER

MONTGOMERY WATSON
712 WEST 12th STREET
JUNEAU, ALASKA 99801
586-4447

ARCHITECTURAL FLOOR PLAN

DRAWING REVISED A1

SHEET No. 14 of 52



***ITEM TO BE SUPPLIED AND INSTALLED BY OTHERS WITHOUT WORK REQUIRED BY THIS CONTRACTOR.**

REV	DATE	BY	DESCRIPTION
1	10/30/98	TDC	WIDENED WALL OPENING AT LOAD CONVEYOR

SCALE: GRAPHIC
DATE PRINTED:

DESIGNED: SS
DRAWN: EHH
CHECKED: JLD
DATE: 09-30-97

SKAGWAY MUNICIPAL IMPROVEMENTS

SOLID WASTE INCINERATOR

STATE OF ALASKA — 49TH — JAMES L. DORN — DC 9963 — REGISTERED PROFESSIONAL ENGINEER

MONTGOMERY WATSON
712 WEST 12th STREET
JUNEAU, ALASKA 99801
586-4447

ARCHITECTURAL FLOOR PLAN
LEVEL 3 – TIPPING FLOOR

DRAWING REVISED: A3
SHEET No.: 16 of 52

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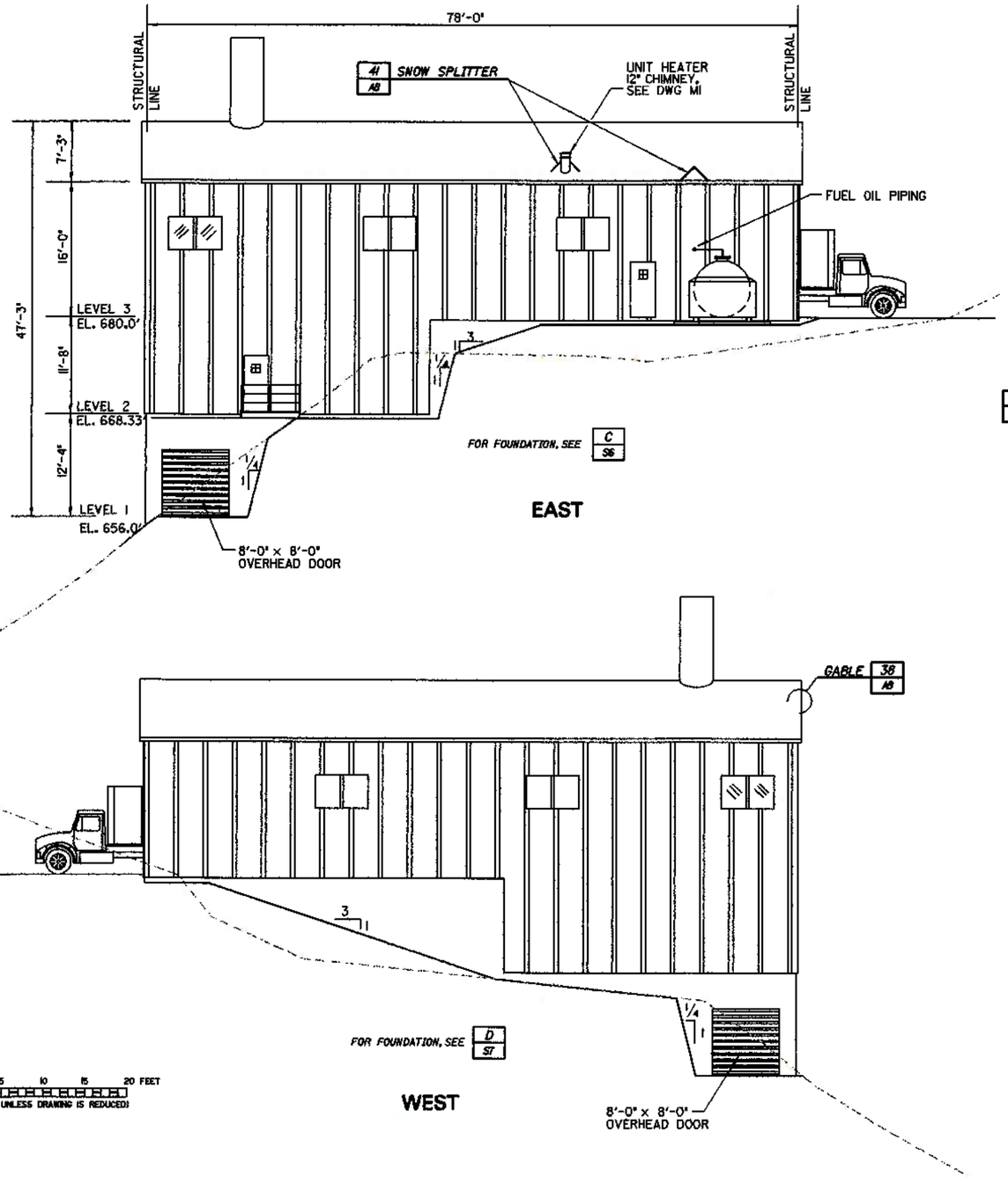
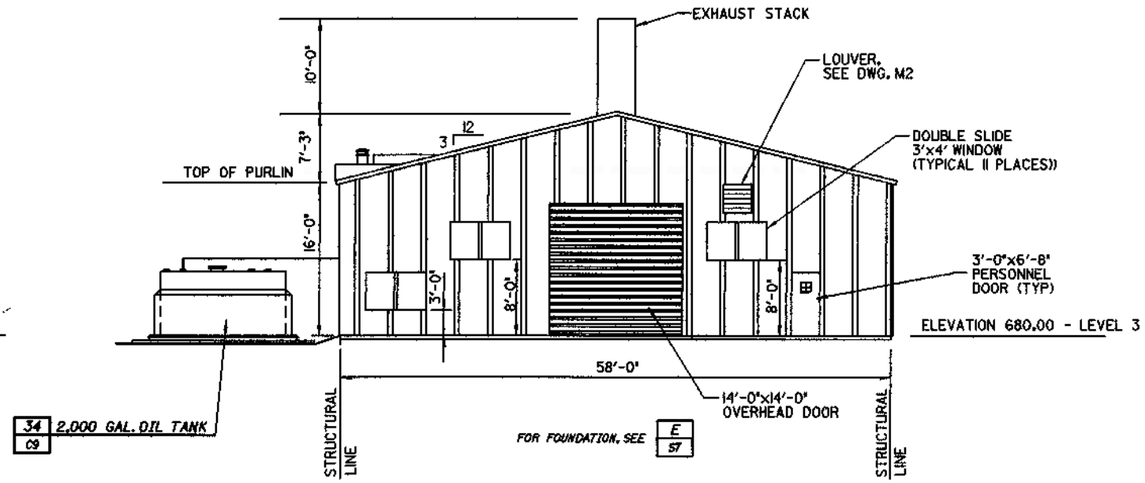


EAST



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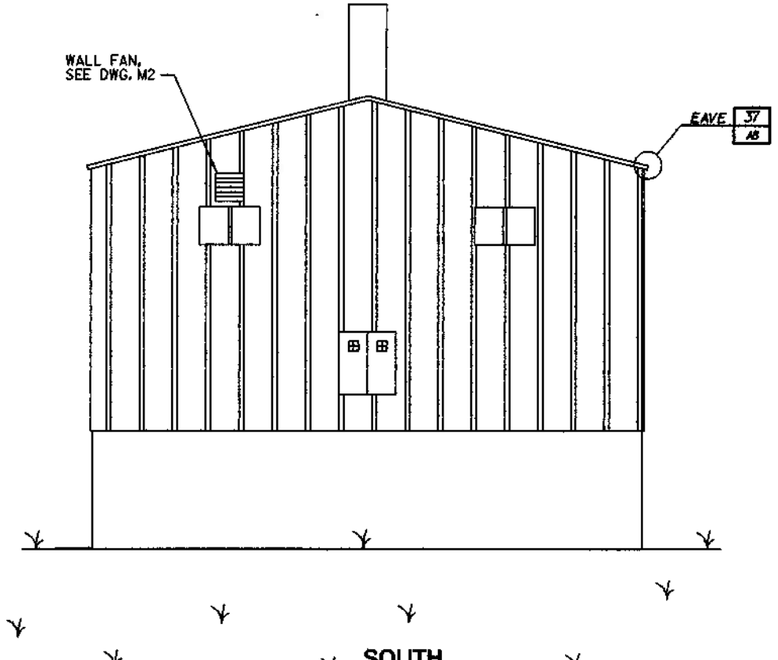

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DATE PRINTED:
DESIGNED SS
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CHECKED JLD
DATE 09-30-97

SKAGWAY MUNICIPAL IMPROVEMENTS

SOLID WASTE INCINERATOR

STATE OF ALASKA 49TH — JAMES L. DORR — 12 1963 — REGISTERED PROFESSIONAL ENGINEER

MONTGOMERY WATSON
712 WEST 12th STREET
JUNEAU, ALASKA 99801
586-4447

ELEVATIONS

DRAWING A4

SHEET No. 17 of 52

Path/File Names: t:\local\skagway\lincln\fridan\c4.dgn
Date Plotted: 30 SEP 97
Time Plotted: 09:08:10

Appendix E – Eco-Waste Solutions regulatory conformity document

ECO WASTE SOLUTIONS

Eco Waste Solutions (EWS) systems are designed to meet regulations such as the Province of Quebec as well as the Environment Canada Technical Document for Batch Incineration (January 2010). EWS has taken all efforts to ensure that the requirements, recommendations and/or guidelines, outlined in the documents referenced above, have been factored into the equipment design and operations of the unit, to follow the spirit of the guidelines while providing the best possible outcomes in Environmental Performance.

The following information is provided to assist those planning an incinerator in Quebec. Most questions we receive relate to the requirements for equipment for pollution control and monitoring. Therefore, we have summarized the regulatory information and added some input on meeting those regulations based on our 25+ years of experience.

Government of Quebec Regulations

Chapter Q-2, r.19: Respecting the Landfilling and Incineration of Residual Materials, Environment Quality Act, Chapter III (July 1, 2019)
Chapter Q-2, r.4.1: Clean Air Regulation (July 1, 2019)

Table 1: Maximum Permissible Emission Limits as Prescribed in Regulations related to MSW Incineration

Pollutant	Incinerator Capacity <1 tonne waste/hour	Incinerator Capacity >1 tonne waste/hour
Particulate Matter (PM)	50 mg/m3	20 mg/m3
Hydrogen Chloride (HCl)	100 mg/m3	50 mg/m3
Carbon Monoxide (CO)	57 mg/ m3	57 mg/m3
Dioxins/Furans (PCDD/F)	80 pg/ m3 TEQ	80 pg/m3 TEQ
Mercury (Hg)	20 µg/ m3	20 µg/m3

Table 2: Continuous Emissions Monitoring Systems (CEMS) Requirements

Parameter	Incinerator Capacity <1 tonne/hour	Incinerator Capacity >1 tonne/hour	Incinerator Capacity > 2 tonne/hour and burns Halogenated Materials
Temperature at outlet	√	√	√
CO and O2	√	√	√
Opacity	Not required	√	√
HCl	Not required	Not required	√

√ Denotes that this parameter must be continuously measured and recorded

Compliance

Eco Waste Solutions recommends that any party wishing to operate an incinerator in compliance with the regulations first complete a thorough waste audit and implement a waste segregation and diversion plan.

Waste materials containing Heavy Metals such as Mercury and those composed of Chlorides – such as PVC plastics must be diverted away from the incinerator waste feed. The EWS batch incinerator system (rated capacities up to 12 tonnes per day) can meet the permissible limits outlined in Table 1. However, if an effective program to divert inappropriate materials cannot be reliably implemented then an Air Pollution Control (APC) scrubber must be installed.

EWS can provide an APC and Continuous Emissions Monitoring System (CEMS) to meet the requirements as a fully integrated feature of any of our incineration systems.

Mercury

Waste incineration does not "treat" heavy metals. If heavy metals cannot be avoided then an Air Pollution Control (APC) scrubber must be included with the incinerator in order to guarantee that the incinerator will always be in compliance.

Hydrogen Chloride

Hydrogen Chloride is a combustion by-product created when chlorinated materials (typically plastics) are burned. It is best to avoid processing chlorinated plastics. If these materials cannot be avoided then an APC to neutralize acid gases is required. An APC designed to control other pollutants such as Dioxins and Furans may also be required if the chloride levels are very high.

Particulate Matter and Dioxins and Furans

These pollutants are primarily a function of incinerator design. EWS will provide an emission guarantee for these pollutants when processing MSW, provided the system is properly operated and maintained. At the limits provided in Table 1, no air pollution control system is required.

Air Pollution Control and Waste Diversion

Table 1 below compares two similar EWS incinerator models processing similar waste types (domestic/municipal solid waste).

The test data shown as "2010 Nunavut Mine" meets the Quebec Air Emission Limits. This mine has a good program of source separation and meets the regulations without an Air Pollution Control (APC).

By contrast the "2003 Demonstration Test", which processed waste from apartment buildings, has excessive Mercury and Hydrogen Chloride emissions. This is not unexpected as these dwellings tend to have the lowest rate of source-separation and lowest diversion of Household Hazardous Waste (HHW). It is for this reason that EWS recommends that any residential waste incineration project includes an APC.

Table 3: EWS Incinerator Emissions Testing Examples

Pollutant	2003 Demonstration Test[1] (Apartment Buildings, unsorted waste)	2010 Nunavut Mine Test[2] (camp waste)
Particulate Matter (PM)	10.5 mg/m^3	38.4 mg/m^3
Hydrogen Chloride (HCl)	157 mg/m^3	43.9 mg/m^3
Carbon Monoxide (CO)	4.12 mg/m^3	3.44 mg/m^3
Dioxins/Furans (PCDD/F)	38.9 pg/m^3 TEQ	28.29 pg/m^3 TEQ
Mercury (Hg)	29.4 $\mu g/m^3$	0.09 $\mu g/m^3$

1. Source: Environment Canada, "Characterization of Emissions From the Eco Waste Solutions Thermal Waste Oxidizer, Burlington, Ontario" (enclosed)
2. Source: Exova, Confidential Client Report, "Sampling Report Atmospheric Emissions Outlet of Incinerator"

Note: All measurements and referenced limits in this document are given at Reference Conditions @ 25 °C, 101.3 kPa and dry basis and corrected to 11% Oxygen.

In conclusion, Operators who can effectively control their waste and implement an effective waste separation and diversion program may be able to avoid the additional capital and operating costs associated with an APC. However, EWS cannot control how waste is managed at a particular site and therefore can only guarantee compliance of the regulations if an APC is included. Please contact us for further information.