# RANKIN INLET SOLID WASTE STUDY

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**Prepared for the Municipality of Rankin Inlet**
**By Stanley Consulting Group and**
**NorthTech Consulting Nunavut Ltd.**

Stanley

# FINAL REPORT

NorthTech
Consulting

# 1.0 Introduction

## 1.1 INTRODUCTION

Stanley consulting Group (Stanley) was retained by the Community of Rankin Inlet in 1997 to prepare an evaluation of possible solid waste options for the community.

Field work in support of this report was carried out by Stanley in the summer of 1997, with this report completed in 1998.

Stanley contracted to NorthTech Consulting Ltd. (NorthTech) to complete the report in the spring of 1998.

## 1.2 SCOPE OF WORK

The principal objectives of this study may be described as:

- identify a location for waste disposal to serve the long term needs of the hamlet and confirm its suitability.
- develop a concept for the construction of a facility to provide for the disposal of solid waste generated by the community over the next 20 years.
- Examine the advantages and disadvantages of incineration as an alternative to conventional landfilling.
- develop operational guidelines for site operations by hamlet staff.
- estimate costs for the construction and operation of the various options over its life span.
- make recommendations as to the preferred course of action for the community.

# 2.0 Background

## 2.1 GENERAL

The settlement of Rankin Inlet is located in the Northwest Territories, 62 degrees 49 minutes North, 92 degrees 05 minutes West, on the west coast of Hudson Bay. It is situated some 1088 km east of Yellowknife.

The existing community solid waste disposal facility is located to the east of the community, adjacent to Melvin Bay, of Hudson's Bay. See Figure 1.1. It is a source of concern in the community, being viewed as both an eyesore, and additionally as a potential health hazard. It is unlined, and functions in the main as a Dump rather than as a sanitary or unsanitary landfill. See Section 5.0 for information on the differing solid waste options

## 2.2 POPULATION PROJECTIONS

The population of Rankin Inlet in 1990 was approximately 1500 persons. MACA calculations in that year for the design population for the year 2010, used in sizing the Waste Water Treatment Plant in the community were 3250. This report will assume a 20 year population of 3500.

# 3.0 Solid Waste Quantities & Character

## 3.1 GENERAL

The quantities and types of wastes generated within the hamlet provide an estimate of the size and type of future disposal area needed. Waste generation characteristics for Rankin Inlet are considered to be typical communities in the Northwest Territories and consist mainly of domestic wastes. Estimates of waste generation have been developed by the Government of the Northwest Territories and these have been used for predicating waste quantities.

The practice of burning refuse at the Rankin Inlet landfill is recognized and results in significant reductions in landfill volume requirements. The total volume required for the site design life is based on the assumption that refuse burning will not be practiced in the future. The result of waste quantities being greater or lesser than those assumed in this report will be that the sites operating life will be lengthened or shortened or that the site area and depth requirements are modified. Such an eventuality is recognized and is accommodated in the development of site design and operations concepts. While the design life of the existing landfill site was 20 years, the actual operating life of the site because of continued burning for volume reduction and control of wind-blown litter is expected to be longer than 20 years in total.

## 3.2 WASTE QUANTITIES

The rate of refuse generation based on the GNWT guidelines is 0.014 m^3 /cap*day. The 1998 population is estimated to be 2,500. The 1998 waste generation rate is thus estimated to be 35 m^3 /day, for a total years volume of 12,800 m^3. This volume is based on collected uncompacted refuse.

Because of waste compaction in place by landfill equipment, the actual volume occupied in a waste disposal site will be significantly lower. The level of compaction achieved with typical non specialized earthmoving equipment is approximately 25%. This produces a final compacted in place value of waste of 9,600 m^3/year in 1998.

Given the assumed final population figure of 3,500 at the 20 year planning horizon, the compacted in place waste volume for that year would be 13,400 m^3/year.

For the purposes of sizing a facility, the assumed volume over the life of the facility will be the average of those two values, or 11,500 m^3/year. That gives a 20 year total volume of waste, compacted in place, of 230,000 m^3.

## 3.3 SOLID WASTE CHARACTERISTICS

In the absence of a detailed solid waste survey, the characteristics of the municipal - type solid waste in Rankin Inlet were assumed to be similar to the Characteristics of Solid Waste as classified by the 1990 MACA Guidelines.

**Table 3.1** - Data Summary of Waste Composition for NWT Communities

| Component | Iqaluit | Pangnirtung | Broughton Island | Average |
|---|---|---|---|---|
| Food | 21.4 | 19.3 | 15.9 | 18.9 |
| Cardboard | 14.4 | 12.1 | 9.3 | 11.9 |
| Newsprint | 5.0 | 0.4 | 0.3 | 1.9 |
| Other Paper Products | 18.5 | 15.2 | 14.0 | 15.9 |
| Cans | 5.4 | 5.5 | 5.0 | 5.3 |
| Other Metal Products | 4.0 | 3.9 | 6.5 | 4.8 |
| Plastic, Rubber , Leather | 13.3 | 8.8 | 8.9 | 10.3 |
| Glass, Ceramics | 3.1 | 2.6 | 1.7 | 2.5 |
| Textiles | 3.5 | 4.1 | 3.3 | 3.6 |
| Wood | 4.5 | 13.4 | 20.0 | 12.6 |
| Dirt | 3.4 | 3.1 | 4.8 | 3.8 |
| Diapers | 3.5 | 11.6 | 10.3 | 8.5 |
| | | | | |
| Totals | 100.0 | 100.0 | 100.0 | 100.0 |

Solid wastes generated in most small NWT communities are primarily domestic in character. Table 3.1 shows that the major components of the refuse are food, cardboard, other paper products and plastic. Disposable diapers and construction wood are also major components in two of the three sampled communities.

We have further broken down the waste stream by Subcategories of Combustible, Incombustibles and Moisture Content.

In the absence of a detailed solid waste survey, the characteristics of the municipal - type solid waste in Rankin Inlet were assumed to be similar to a Type 2 Waste as classified by the Incinerator Institute of America.

Type 2 Waste is labeled "refuse" and consists of paper, rags, wood, plastic, metal, and organic wastes. Typical composition of Type 2 Waste is:

Combustible (wood, paper, etc.) 43% by weight

| | |
|---|---|
| Incombustibles (metal, etc.) | 7% by weight |
| Moisture | 50% by weight |

Type 2 waste has a typical assumed weight of 240 kg / m ^ 3. This figure is used in evaluating the Incineration options.

## 3.4 SEWAGE SLUDGE AND HONEYBAG WASTE

In addition to the above waste stream, Rankin Inlet has a source of waste which must be separately handled.

The Waste Water Treatment Plant (WWTP) generates a significant amount of waste screening, which must be disposed of. Currently, the plant produces on trailer load of waste per day, approximately. This waste is wet, incombustible, and septic. At present, a fenced area at the existing landfill site is used to dispose of these tailings. As data becomes available on the quantities of tailings, provision must be made in any new waste disposal system for this waste.

A new landfill site outside of the community would present a problem in dealing with this waste material. Currently, trailers are used to move the screenings from the WWTP to the disposal area. These trailers would possibly not be acceptable if a new site further away from the plant was chosen. If that was the case, a different and likely more costly method of handling these wastes would have to be chosen.

# 4.0 Present Waste Collection & Disposal

## 4.1 GENERAL

This section is intended to be a brief recap of existing practices in the Community. This will be used to assist in comparisons with the differing alternatives presented in following sections.

## 4.2 COLLECTION

The Hamlet of Rankin Inlet currently collects the municipal solid waste in the community. Collection is with a dedicated 9.2 $m^3$ packer truck, operated by municipal employees. One collection is completed per week.

## 4.3 EXISTING DISPOSAL

### 4.3.1 General

The present facility in use in the community is an open dump / landfill, with some burning practiced. This is the most common form of solid waste disposal in the north. Operation and maintenance of the waste disposal site is also the responsibility of the Hamlet. The waste is spread with a bulldozer weekly or more often as required. It is currently covered with granular material infrequently.

Granular material is available west of the community for cover. Thus the operation of the waste disposal site could be converted to a sanitary or modified landfill, if desired. The cost of hauling this material the approximately 9 km from to the existing site from the granular pits regularly is currently prohibitive. Thus, the infrequent nature of the covering operations currently.

Burning of the waste is practiced by the Hamlet, to reduce volumes of waste and extend the life of the facility.

### 4.3.2 Remaining Lifespan of Facility

As shown in Figure 4-1, the existing open dump / landfill has an unused area of approximately 24,000 $m^2$. With an average berm height of 3.3 m, this is equivalent to 79,000 $m^3$ of capacity remaining. Given the estimated existing fill rate of 9,500 $m^3$ compacted in place, the existing facility has an estimated future lifespan of 8.3 years. This lifespan is without any cover material being imported.

If covering is imported twice yearly, once in spring and once in fall, the lifespan would be reduced, by the volume of the additional cover material.

This volume would be approximately 3,600 m ^ 3 / year. This additional volume reduces the life of the facility by approximately 2.3 years to 6.0 years.

See Table 4.1 following.

### 4.3.3 Cost of Operating Existing Facility as a Modified Landfill

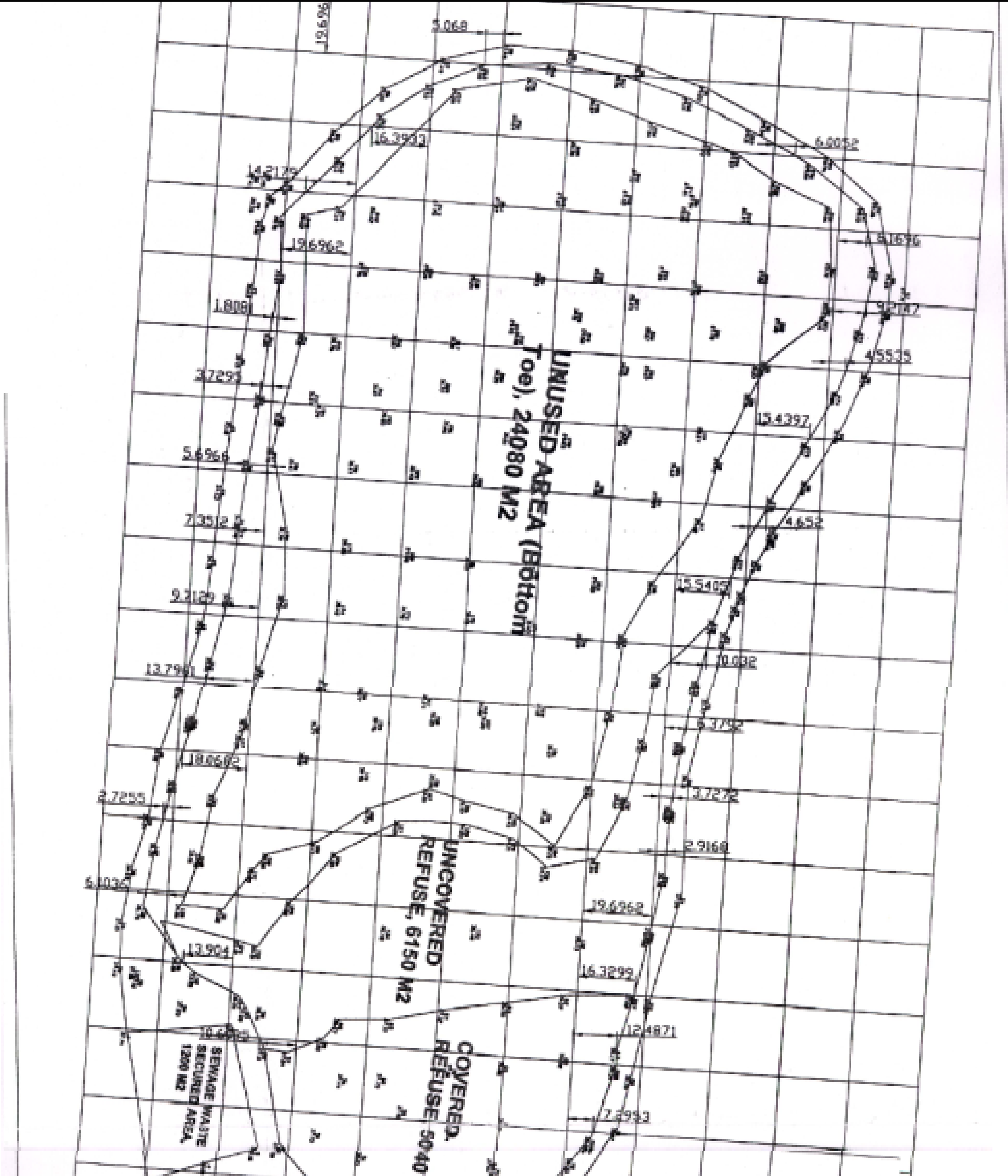
The operating cost breakdowns for the existing site operating as a modified landfill is based on the following assumptions:

- Solid waste is continued to be hauled to the site using the existing 9.3 m ^ 3 truck, with two employees at $30 / hr. The truck is able to average 50 km / hr travel speed to the site.
- The site is covered with a 0.3 m thick granular cover twice per year, in the spring and in the fall. The waste is compacted at that time.
- 10 additional times per year, one day is taken to level and compact material using earthmoving equipment.
- There are no other day to day requirements for operator at the facility.
- Assume a price for earthmoving equipment with operator to be $150 / hr
- Assume a price for granular pit run material for cover to be $30 / m ^ 3

It must be noted that this operating costs presented is extremely sensitive to the price of granular material used. Variations up or down in costs assigned to the pit run granular material, will dramatically shift the operating costs.

**Table 4.1** - Existing Operating Costs

| | |
|---|---|
| Annual Volume Of Waste | 10,500 m ^ 3 |
| | |
| Driving Distance from Hamlet Office | 1 km |
| Average Speed | 50 km/hr |
| Travel Time two ways | 0.0hr |
| Average Wage for Waste Collectors | $28.00 |
| Labour Cost for Travel Time | $1.12 |
| Size of Waste Truck | 15.3 m ^ 3 |
| Number of Trips / Year | 686 |
| Labour Trip Cost / Year | $769 |
| | |
| Number of Times Waste is Compacted | 12 |
| Hours Equipment Time per Compaction | 8.0hr |
| Cost per Equipment Hour | $100 |
| Total Cost per Year for Waste Compaction | $9,600 |
| | |
| Thickness of Cover Blanket | 0.3 m |
| Slopes of Working Face of Waste X:1 | 4 |
| Depth of Cell | 3.3 m |
| Width of working Face | 150.0 m |
| Annual Cover Required | 3,134 m ^ 3 |
| Cost Of Fill In Place | $11 |
| Total Annual Cost Of Cover Material | $34,470 |
| | |
| Total Annual Operating Cost | $44,839 |




# RANKIN INLET, N.W.T.
## 1997, Solid Waste Disposal Site

# 5.0 Disposal Options

## 5.1 GENERAL

There are several options available for disposal of solid waste, several of which are in use in the NWT and Nunavut. These options include:

- Open dump / landfill
- Modified Landfill
- Sanitary Landfill
- Landfill with Burning
- Incineration
- Compaction/Baling

We will examine each of the above concepts in the following sections.

## 5.2 LANDFILLING

### 5.2.1 Open dump / landfill

The present facility in use in the community is an open dump / landfill, with some burning practiced. This is the most common form of solid waste disposal in the north. It is not a classical modified or sanitary landfill as discussed in the next sections, but it is not a simple unmanaged open dump either.

It is regularly compacted by bulldozer or other heavy equipment, but is not regularly covered with cover material as in the other landfill types.

Open dump / landfills are appropriate for small communities, of less than approximately 1000 people.

### 5.2.2 Modified Landfill

The modified landfill is distinguished from the open dump / landfill by being operated on a specific plan and engineering of its operations.

It is regularly compacted and covered with granular cover material, but is not covered daily as in the sanitary landfill.

In the north, the frequency of covering operations varies significantly, with location with lower cost cover material receiving more covering operations vs. locations with higher cost cover material. The lowest recommended frequency of cover is once yearly, in late August or September. For the purposes of this study, we assume two 0.3 m thick covers are placed yearly.

Modified landfills are appropriate for well managed communities of less than 5000 people.

### 5.2.3 Sanitary Landfill

The sanitary landfill is distinguished from the modified landfill by being daily compacted and covered with cover material.

Sanitary landfills are appropriate for well managed communities of greater than 5,000 to 10,000 people, where adequate cover material is available.

### 5.2.4 Landfill with Burning

This is an undesirable form of landfilling which combines an open dump with periodic burning, to reduce volume. It is undesirable due to concerns with safety of the dump workers and of the public, issues with air pollution due to the incomplete combustion of differing materials in the waste stream, and due to the nuisance factor of a regular, long lasting smoke plume from the burning waste. This smoke plume is both a danger to aircraft, when it impinges on the airport flight path, but also a cause of complaints from the public.

The existing dump / landfill has been operated as a landfill with burning in the past. This burning has increased the lifespan of the facility, but at the cost of numerous complaints from the public due to smoke and ash from unauthorized burning.

Any new option will not allow unauthorized burning on site.

## 5.3 INCINERATION

### 5.3.1 Background Information

Incineration is defined as a combustion process in which solid and semi-solid wastes are ignited and oxidized to carbon dioxide, water vapour and residue containing little or no combustible material. Open burning is not considered to be incineration because the combustion is incomplete and therefore the residue contains a significant amount of combustible material.

For the purposes of this report, consideration was only given to equipment which provides incineration as defined previously. Two types are thought to have possible applications for the incineration of solid waste in Rankin Inlet.

### 5.3.2 Pit Incinerators (Figure 4)

Pit incinerators are single chamber refractory lined boxes equipped with a blower to supply overfire and underfire air. A door is provided on the side for charging the incinerator and for cleaning out the residue. These units are classified as either open-pit or closed-pit.

In the open-pit incinerators, a fly ash screen is installed directly on the fire box, while closed pit incinerators have a stack and fly ash screen.

Pit incinerators are relatively simple to install, requiring only a foundation and an electrical service. In permafrost areas, it would be advisable to install the box on an elevated foundation to allow air circulation underneath and thereby maintain the ground in a frozen condition. A closed-pit incinerator could be installed in a building with the stack penetrating the roof as long as adequate ventilation is provided.

Depending on the size of the incinerator it would be charged using shovels or a front end loader. Electricity is required for the fan and fan controls.

Operation of a pit incinerator is as follows.

- Residue from the previous day is cleaned out
- Pit is filled approximately 60% full
- Waste is ignited
- After burn has started, fan is turned on
- More waste is added as the fire burns down

### 5.3.3 Controlled Air Incinerators (See Appendix)

Controlled air incinerators consist of two refractory lined chambers each equipped with a burner and an air induction system. Two sealed doors are usually provided; one for charging and the other for removing the residue.

In the primary chamber, the waste is ignited by the primary burner (ignition burner) in a starved-air environment ie: the fan supplies less than the theoretical air required for combustion. This produces volatile gases and smoke which enter the secondary chamber.

In the secondary chamber, this gas is mixed with additional induced air and the secondary burner (afterburner) quickly oxidizes the gas to carbon dioxide and water vapour. The secondary burner is thermostatically controlled to maintain a certain temperature range in the exhaust stack.

Controlled air incinerators are commercially available in package units which include all the controls. It is preferable to install them indoors, especially in cold environments, to ensure the reliability of the control systems. The systems can be batch charged using a front end loader or shovel.

Numerous options are available including ram chargers for automatic waste loading, automatic ash removal, and waste heat recovery equipment. These options add to the cost of the basic unit and also require a larger building.

Operation of a controlled air incinerator is as follows.

- Residue from previous day is removed
- Primary chamber is charged
- Start button is pressed to initiate the following automatically:
  - afterburner preheats stack for 30 to 60 minutes
  - ignition burner and both fans start simultaneously after tile pre-heating period
  - burners and fans shut down automatically by timer

### 5.3.4 Waste Heat Recovery

There are various alternatives available for a waste heat recovery system. The hot flue gases can be used to produce hot water, steam, hot air, or electricity. The alternative chosen depends on the markets for the heat, especially if retro-fitting is to be done on an existing building. When there is no demand for the heat thus produced, it would be wasted to the atmosphere and the Incinerator would provide volume and weight reduction only.

The heating system must have provision for being fired by a supplemental fuel (oil in the case of Rankin Inlet) when the heat demand exceeds the heat produced. Numerous waste heat recovery products are commercially available. They can handle flue gas flows from 0.2 cu. m./sec to 12.0 cu. m./sec at temperatures up to 1600 degrees Celsius. Typical operating efficiency for these units is in the area of 50%.

Waste heat recovery requires a controlled air incinerator for efficient use.

## 5.4 BALING

Baling is a technology which is used in combination with landfilling, to address the following issues:

- Decreasing the amount of cover material required at a landfill.
- Increasing the density of material in the landfill
- Extending the useful life of a landfill by the above measures.
- Making recycling a more attractive proposition by allowing the baling of recyclable for shipping.

It consists of a baler machine, usually located inside a plant building. Solid waste is pushed from an upper level into the baler, compacted with a hydraulic ram into bales, tied with wire, and pushed out the lower level, usually onto a truck bed. These bales are then placed into the landfill as 'building blocks', which require limited and infrequent cover operations.

# 6.0 Analysis of Options

## 6.1 GENERAL APPROACH TO ANALYSIS

By necessity, this report will examine each of these alternatives in a concise manner. Each of the methods of waste disposal to be examined will be reduced to a single option based on the known advantages and disadvantages, and then each method shall be evaluated in Sections 7 and 8 to arrive at the recommendation.

## 6.2 LANDFILLING

### 6.2.1 Advantages

Landfilling has the following advantages:

- it is a familiar process, requires limited training to operate successfully
- No mechanical systems required for day to day operations
- Typically low capital cost for start up

### 6.2.2 Disadvantages

Landfilling has the following disadvantages:

- Lack of cover material or expensive cover material promotes inadequate covering of waste. This leads to issues such as wind blown garbage, and disease.
- Poor aesthetics. Landfills, particularly those where regular covering is not practice often have odor problems. In addition, if they are located near the community they are generally considered to be eyesores.
- Air pollution due to uncontrolled burning if allowed on site.
- Bird control problems leading to possible bird strikes if located too close to airport or flight paths.

### 6.2.3 Preferred Landfill Option

The preferred landfill option for Rankin Inlet is the modified landfill. This is due to the smaller size of Rankin Inlet which makes a daily cover operation unnecessary, and due to the high cost of cover material in Rankin Inlet.

## 6.3 INCINERATION

### 6.3.1 Advantages

Incineration has the following advantages:

- Waste is reduced by approximately 90 % by volume. This reduction in volume would greatly extend the life of the existing landfill, or require a much smaller new landfill be developed.
- This lowered volume of waste requires much less cover material to provide adequate covering of waste..
- Better aesthetics. A properly managed incinerator produces little smoke or odor from the burning of waste materials. The primary odor issues relate to the pre burned waste drop off or collection side of the facility.
- Air pollution is low due to the use of controlled burning.
- Few if any bird control problems.

### 6.3.2 Disadvantages

Incineration has the following disadvantages:

- it is an unfamiliar process, requires training and experience to operate successfully.
- Requires specialized mechanical systems for day to day operations.
- High capital start up cost.
- High operating cost.

### 6.3.3 Preferred Incineration Option.

The preferred incineration option would a controlled air incinerator. This is because the pit incinerator, while simpler to operate, cannot be located inside the community due to incomplete burning producing smoke and residue. Any remote location requiring regular winter access for daily operation and maintenance is a problem in Rankin Inlet due to the severe winter storms.

Secondly, the controlled air incinerator is significantly more efficient at reducing waste volumes than the pit type incinerator. This requires a smaller ash disposal area, extending the life of the existing area.

Finally, if waste heat recovery is to be carried out, a location adjacent to or within the community is required. In addition, for waste heat recovery the higher the efficiency the incinerator the better.

## 6.4 INCINERATION WITH HEAT RECOVERY

### 6.4.1 Advantages

Incineration with heat recovery shares all of the advantages of normal incineration, and has the following additional advantages:

- Recovery of some percentage of the operating cost due to use of heat of combustion of the waste material. A possible use of this heat recovered would be district heating, or water system heating.

### 6.4.2 Disadvantages

Incineration with heat recovery shares all of the disadvantages of normal incineration, and has the following additional disadvantages:

- Higher capital start up cost than standard incineration.
- Higher operating costs than standard incineration.
- Uncertain availability of heat supply requires 100 % back up heating for user of recovered heat.

### 6.4.3 Preferred Waste Heat Recovery Option.

The preferred waste heat recovery option would be that option which produces the best return on investment. That will be examined further in Section 8.

## 6.5 BALING

### 6.5.1 Advantages

Compared with standard landfilling, baling has the following advantages:

- Waste is reduced by approximately 50% by volume. This reduction in volume would greatly extend the life of the existing landfill, or require a much smaller new landfill be developed.
- This lowered volume of waste requires much less cover material to provide adequate covering of waste.
- Balefill operation produces fewer bird control problems, less wind blown debris, less scavenging by animals, much lower risk of uncontrolled burning.

### 6.5.2 Disadvantages

- it is an unfamiliar process, requires training and experience to operate successfully.
- Requires specialized mechanical systems for day to day operations.
- High capital start up cost.
- High operating cost.

### 6.5.3 Baling Recommendation

Baling is an operation which is viable where traditional landfilling is either impossible or uneconomical, due to site concerns. For example, Stanley designed the sole operating baler facility in the north, at the Yellowknife landfill. It's function there is primarily to extend the lifespan of the existing landfill, in the absence of other immediate options for alternative landfill sites.

Its cost, in addition to the requirement for a landfill requiring day to day equipment operations, make it unattractive for Rankin Inlet.

Baling will not be examined in closer detail in this report.

# 7.0 Specific Alternatives and Costing

## 7.1 GENERAL

In evaluating these alternatives, a field investigation was carried out to determine the most promising sites for possible development of a new land fill facility. In addition, alternatives including Incineration.

### 7.1.1 Costing Principals

In compliance with the Terms of Reference, we have prepared cost estimates for the differing proposals to allow proper evaluations of alternatives.

In each case assumptions were made as to the availability and cost of materials, and as to the final size and shape of the facilities in question.

The cost figures presented following fall into the category of a Class D estimate, an initial estimate made to quantify possible options.

### 7.1.2 Proximity to Airport and Flightpaths

The issue of proximity to an airport or to airport flightpaths is important to most northern communities plans for waste handling facilities.

A specific ruling from Transport Canada's "Manual of Airport Bird Hazard Control" applies to the locating of a solid waste facility. The ruling is that "Garbage dumps containing food garbage should not be located within an 8-km radius of an airport." See Appendix B for details.

Despite the ruling which requires an 8.0 km separation, it has generally been accepted by Transport Canada that a relaxed requirement of 3.0 km is appropriate for the north. On a specific case by case basis a 3.0 km separation is generally approved.

It should be noted that the existing dump is within the 3.0 km zone of the airport, and directly under the flightpath. It would not be accepted if proposed today to be constructed in its current location.

## 7.2 LANDFILLING

### 7.2.1 General Issues

As noted in Section 6.2.3., a modified landfill system was chosen for evaluation. For modified landfills, three main types exist, the trench method, the area method, and the depression method. Given the availability of a depression or gravel pit, the depression method is the preferred choice.

A survey of the available locations around Rankin Inlet was carried out in the summer of 1997. Three sites were considered to present possibilities for use as a depression method modified landfill. These sites have been designated Site S1, S2 and S3.

Each of these sites are located to the north west of the community, in the watershed draining to Cyget Lake and to Melvin Bay.

They are located beyond the 3.0 km boundary of the airport, but within the 8.0 km boundary.

See Figures 7-1 and 7-2 following.

### 7.2.2 Landfill Design Concept

All modified landfill concepts include the following items

- Access Road
- Excavation Drainage Ditch
- Site Perimeter Berms
- Bulky Waste Storage Area

The access road will be constructed from the existing Meladine access road to the new sites. It will be constructed at least 1.0 m above the existing grade, have 2:1 side slopes, 7.0 m top width, and incorporates culverts and ditching as required for existing drainage.

A snow drifting study should be used to determine the road location.

The excavation drainage ditch will be constructed with on site equipment during construction of the facility. It will be approximately 0.75 m deep and 3.0 m wide.

The site perimeter berm will be constructed either completely around the site, or in the case of Site S2 will close off the lower portion of the site. It will have a 3.0 m wide top, 2:1 side slopes.

The bulky waste storage area will be for the purposes of costing only assumed to be 100 m x 100 m by 1.0 m deep.

The construction cost breakdowns in each of the following sites is based on the following assumptions:

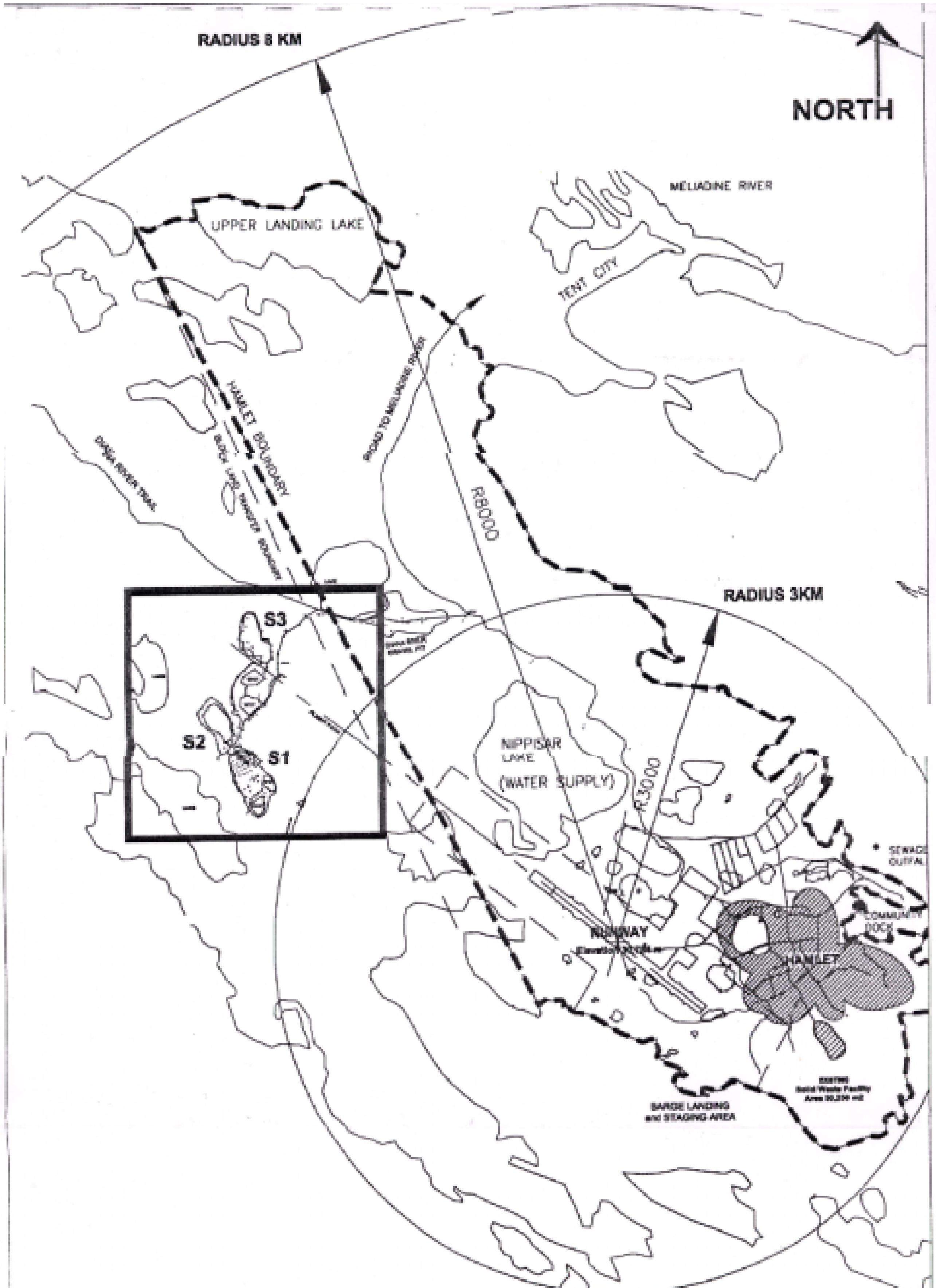
- Constructing the access road to the new site as noted above.

- Constructing a berm as noted above around the site to the height calculated earlier to be the required elevation to give a 20 year capacity at the site.
- Constructing the bulk goods laydown area
- Constructing a 1.8 m high chain link fence around the area.
- Assume a price for crushed granular material for construction to be $50 / m ^ 3

The operating cost breakdowns in each of the following sites is based on the following assumptions:

- Solid waste is continued to be hauled to the site using the existing 15.3 m ^ 3 truck, with two employees at $28 / hr. The truck is able to average 50 km / hr travel speed to the site.
- The site is covered with a 0.3 m thick granular cover twice per year, in the spring and in the fall.
- 10 additional times per year, one day is taken to level and compact material using earthmoving equipment.
- There are no other day to day requirements for operator at the facility.
- Assume a price for earthmoving equipment with operator to be $150 / hr
- Assume a price for granular pit run material for cover to be $11 / m ^ 3

It must be noted that both the capital and operating costs presented are extremely sensitive to the price of granular material used. Variations up or down in costs assigned to the different granular materials, will dramatically shift the construction and operating costs.

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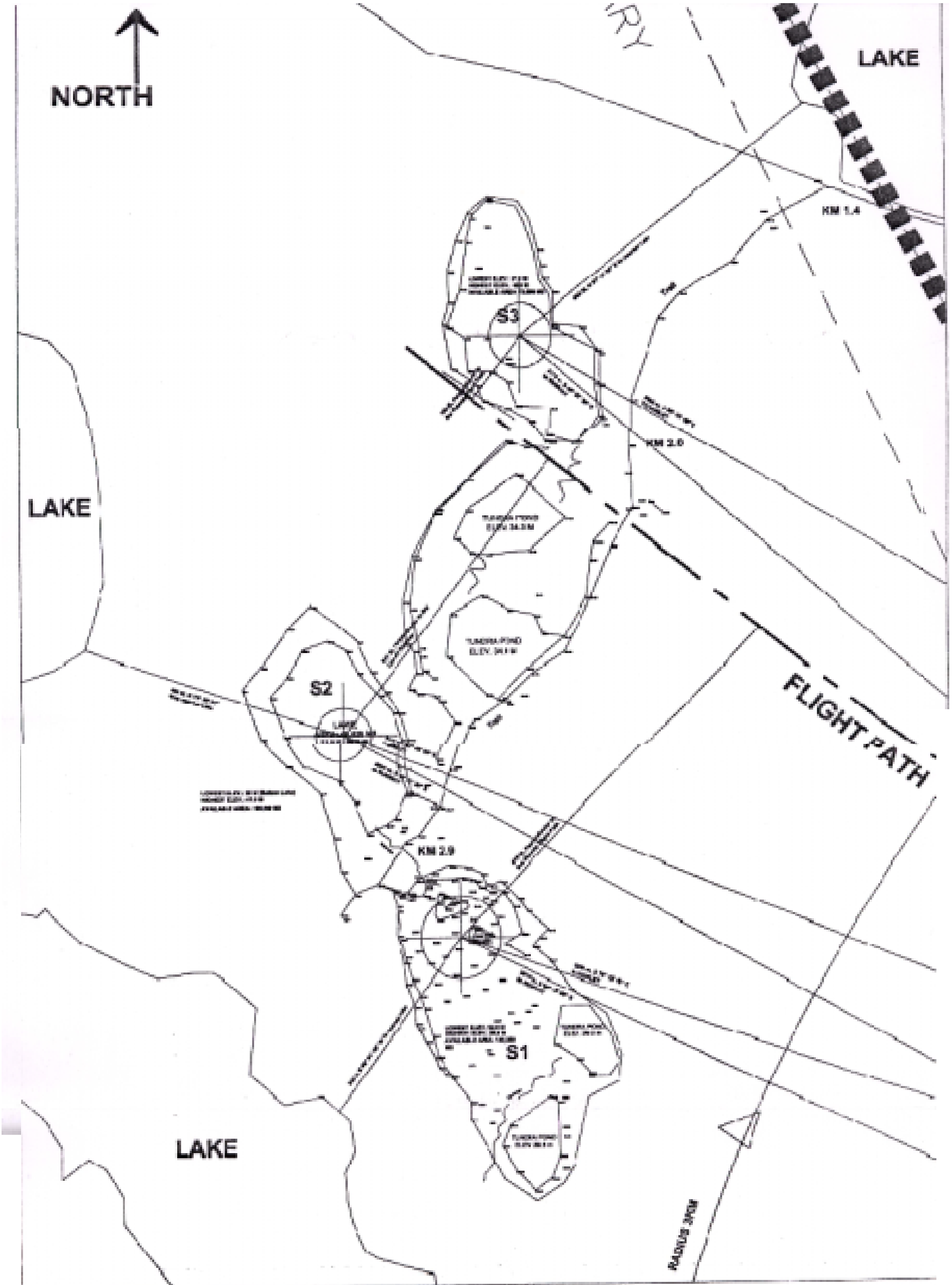
**Location Plan**

**RANKIN INLET, N.W.T.**

**1997, Proposed Future Solid Waste Sites: S1, S2, S3**

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**Location Plan**

**RANKIN INLET, N.W.T.**

**1997, Proposed Future Solid Sites**

Stanley

Drawn by: M.B.

### 7.2.3 Site S1

7.2.3.1 General Information

Site S1 is located 5230 m from the Hamlet office, 3619 m from the runway center point, 619 m perpendicular to the runway flightpath, and 342 m from the nearest lake. It is also approximately 2.9 km driving off the road to Meladine River, and a total of approximately 7.7 km driving from the Hamlet office.

It is currently the site of a sloping depression between several rock outcrops, and include two small ponds at the lower edge of the depressed area. It covers an area of 143,000 m ^ 2.

To meet the requirements of the 20 year compacted in place volume of 230,000 m ^ 3 site S1 would be required to be filled to an average operating depth of 1.6 m.

See Figure 7-3 following.

#### 7.2.3.2 Construction Cost Breakdown

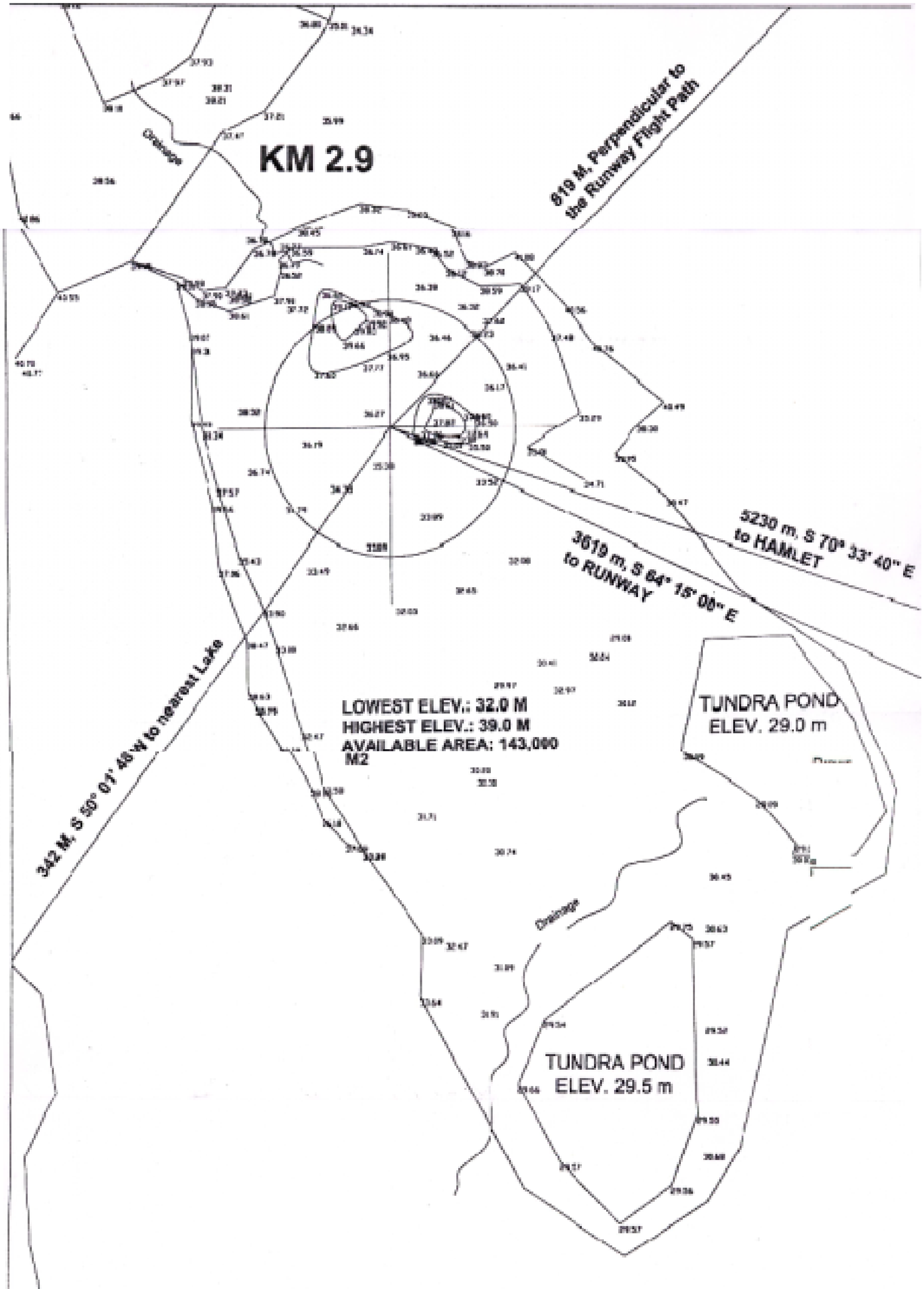
**Table 7.1** - Site S1 Construction Cost Breakdown

| | |
|---|---|
| Length Of Access Road Required | 2,900 m |
| Average Height Of Access Road Required | 1.0 m |
| Side Slopes X:1 | 2 |
| Top Width | 7.0 m |
| Amount Of Fill Required | 26,100 m^3 |
| Cost Of Fill In Place | $11.00 |
| Total Cost Of Access Road | $287,100 |
| | |
| Length Of Drainage Ditch Required | 30.0 m |
| Average Depth Of Drainage Ditch Required | 0.8 m |
| Ditch Width | 3.0 m |
| Amount Of Excavation Required | 68 m^3 |
| Cost Of Excavation | $25.00 |
| Total Cost Of Drainage Ditch | $1,688 |
| | |
| Length Of Perimeter Berm Required | 1,510 m |
| Average Height Of Perimeter Berm Required | 1.6 m |
| Side Slopes X:1 | 2 |
| Top Width | 3.0 m |
| Amount Of Fill Required | 12,080 m^3 |
| Cost Of Fill In Place | $11.00 |
| Total Cost Of Access Berm | $132,880 |
| | |
| Area Of Bulky Waste Storage Required | 10,000 m^3 |
| Average Height Of Bulky Waste Storage Required | 1.0 m |
| Amount Of Fill Required | 10,000 m^3 |
| Cost Of Fill In Place | $11.00 |
| Total Cost Of Bulky Waste Storage | $110,000 |
| | |
| Fencing Required | 1,300 m |
| Unit Cost of Fencing / lm | $50.00 |
| Total Cost of Fencing | $65,000 |
| | |
| Total Construction Cost | $596,668 |

#### 7.2.3.3 Operating Cost Breakdown

**Table 7.2** - Site S1 Operating Cost Breakdown

| | |
|---|---|
| Annual Volume Of Waste | 11,500 m^3 |
| | |
| Driving Distance from Hamlet Office | 8 km |
| Average Speed | 50 km/hr |
| Travel Time two ways | 0.3hr |
| Average Wage for Waste Collectors | $28.00 |
| Labour Cost for Travel Time | $17.25 |
| Size of Waste Truck | 15.3 m^3 |
| Number of Trips / Year | 752 |
| Labour Trip Cost / Year | $12,964 |
| | |
| Number of Times Waste is Compacted | 24 |
| Hours Equipment Time per Compaction | 8.0hr |
| Cost per Equipment Hour | $150 |
| Total Cost per Year for Waste Compaction | $28,800 |
| | |
| Thickness of Cover Blanket | 0.3 m |
| Slopes of Working Face of Waste X:1 | 4 |
| Depth of Cell | 1.6 m |
| Width of working Face | 200.0 m |
| Annual Cover Required | 5,104 m^3 |
| Cost Of Fill In Place | $11.00 |
| Total Annual Cost Of Cover Material | $56,145 |
| | |
| Total Annual Operating Cost | $97,910 |




Stanley

**S1, PROPOSED**

Scale: 1:2000

### 7.2.4 Site S2

7.2.4.1 General Information

Site S2 is located 5165 m from the Hamlet office, 3980 m from the runway center point, 617 m perpendicular to the runway flightpath, and 492 m from the nearest lake. It is approximately 2.9 km driving off the road to Meladine River, and a total of approximately 7.7 km driving from the Hamlet office.

It is currently the site of a small lake, which covers an area of 49,700 m ^ 2.

To meet the requirements of the 20 year compacted in place volume of 230,000 m ^ 3 site S2 would be required to be filled to an average operating depth of 4.6 m.

See Figure 7-4 following.

7.2.4.2 Construction Cost Breakdown

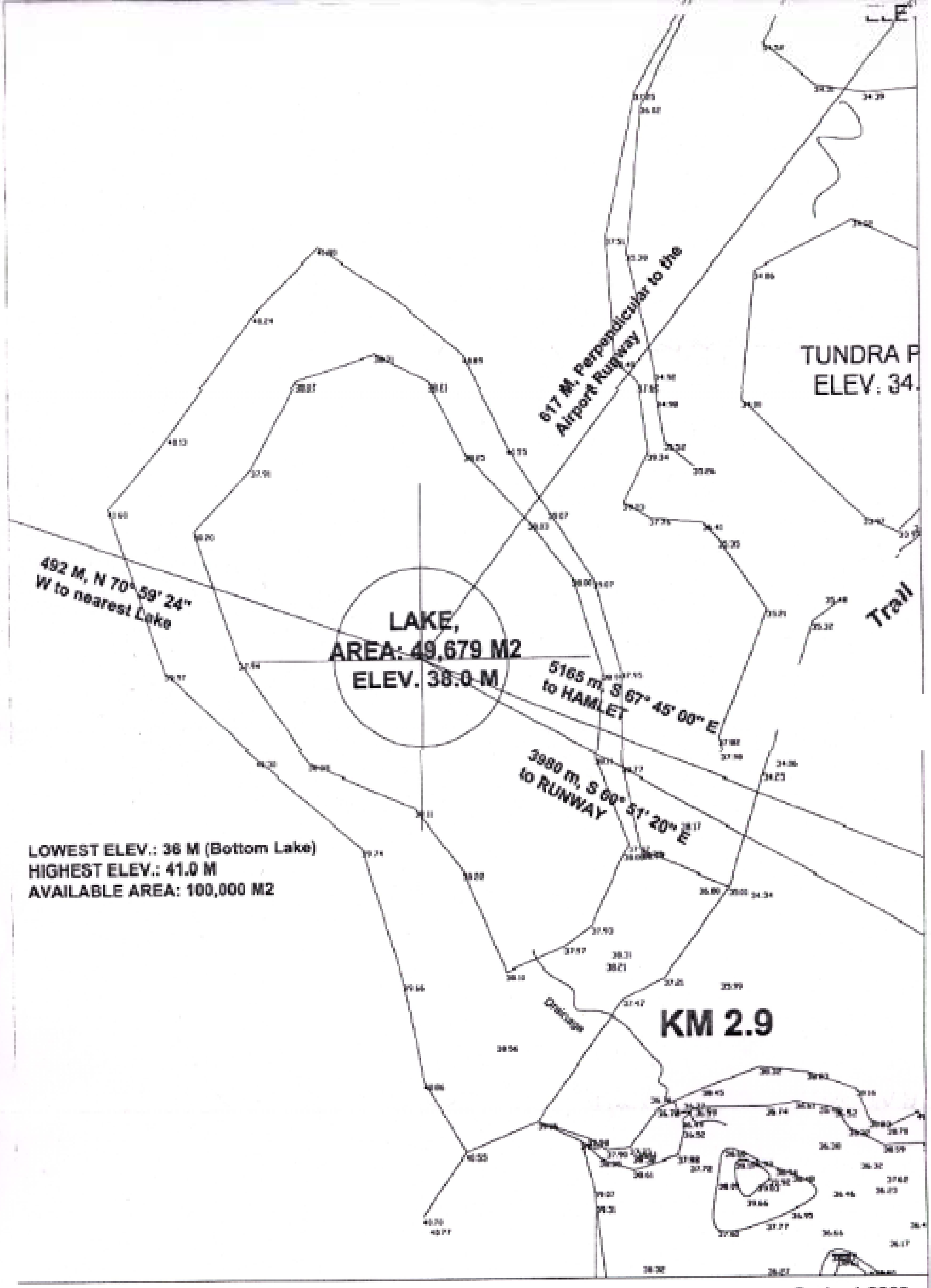
**Table 7.3** - Site S2 Construction Cost Breakdown

| | |
|---|---|
| Length Of Access Road Required | 2,900 m |
| Average Height Of Access Road Required | 1.0 m |
| Side Slopes X:1 | 2 |
| Top Width | 7.0 m |
| Amount Of Fill Required | 26,100 m ^ 3 |
| Cost Of Fill In Place | $11.00 |
| Total Cost Of Access Road | $287,100 |
| | |
| Length Of Drainage Ditch Required | 30.0 m |
| Average Depth Of Drainage Ditch Required | 0.8 m |
| Ditch Width | 3.0 m |
| Amount Of Excavation Required | 68 m ^ 3 |
| Cost Of Excavation | $25.00 |
| Total Cost Of Drainage Ditch | $1,688 |
| | |
| Length Of Perimeter Berm Required | 1,350 m |
| Average Height Of Perimeter Berm Required | 2.3 m |
| Side Slopes X:1 | 2 |
| Top Width | 3.0 m |
| Amount Of Fill Required | 15,525 m ^ 3 |
| Cost Of Fill In Place | $11.00 |
| Total Cost Of Access Berm | $170,775 |
| | |
| Area Of Bulky Waste Storage Required | 10,000 m ^ 3 |
| Average Height Of Perimeter Berm Required | 1.0 m |
| Amount Of Fill Required | 10,000 m ^ 3 |
| Cost Of Fill In Place | $11.00 |
| Total Cost Of Bulky Waste Storage Road | $110,000 |
| | |
| Fencing Required | 1,900 m |
| Unit Cost of Fencing / lm | $11.00 |
| Total Cost of Fencing | $20,900 |
| | |
| Total Construction Cost | $590,463 |

#### 7.2.4.3 Operating Cost Breakdown

**Table 7.4** - Site S2 Operating Cost Breakdown

| | |
|---|---|
| Annual Volume Of Waste | 11,500 m ^ 3 |
| | |
| Driving Distance from Hamlet Office | 8 km |
| Average Speed | 50 km/hr |
| Travel Time two ways | 0.3hr |
| Average Wage for Waste Collectors | $28.00 |
| Labour Cost for Travel Time | $17.25 |
| Size of Waste Truck | 15.3 m ^ 3 |
| Number of Trips / Year | 752 |
| Labour Trip Cost / Year | $12,964 |
| | |
| Number of Times Waste is Compacted | 24 |
| Hours Equipment Time per Compaction | 8.0hr |
| Cost per Equipment Hour | $150 |
| Total Cost per Year for Waste Compaction | $28,800 |
| | |
| Thickness of Cover Blanket | 0.3 m |
| Slopes of Working Face of Waste X:1 | 4 |
| Depth of Cell | 2.3 m |
| Width of working Face | 200.0 m |
| Annual Cover Required | 4,138 m ^ 3 |
| Cost Of Fill In Place | $11.00 |
| Total Annual Cost Of Cover Material | $45,518 |
| | |
| Total Annual Operating Cost | $87,282 |


TUNDRA P
ELEV. 34.
617 M, Perpendicular to the Airport Runway
LAKE,
AREA: 49,679 M2
ELEV. 38.0 M
492 M, N 70° 59' 24" W to nearest Lake
5165 m, S 67° 45' 00" E to HAMLET
3980 m, S 60° 51' 20" E to RUNWAY
Trail
LOWEST ELEV.: 36 M (Bottom Lake)
HIGHEST ELEV.: 41.0 M
AVAILABLE AREA: 100,000 M2
Drainage
KM 2.9
Scale: 1:2000

S2, PROPOSED

### 7.2.5 Site S3

7.2.5.1 General Information

Site S3 is located 5585 m from the Hamlet office, 4115 m from the runway center point, 152 m perpendicular to the runway flightpath, and 653 m from the nearest lake. It is approximately 2.0 km driving off the road to Meladine River, and a total of approximately 6.8 km driving from the Hamlet office.

It is currently the site of a small lake, which covers an area of 76,000 m ^ 2.

To meet the requirements of the 20 year compacted in place volume of 230,000 m ^ 3 site S1 would be required to be filled to an average operating depth of 3.0 m.

See Figure 7-5 following.

#### 7.2.5.2 Construction Cost Breakdown

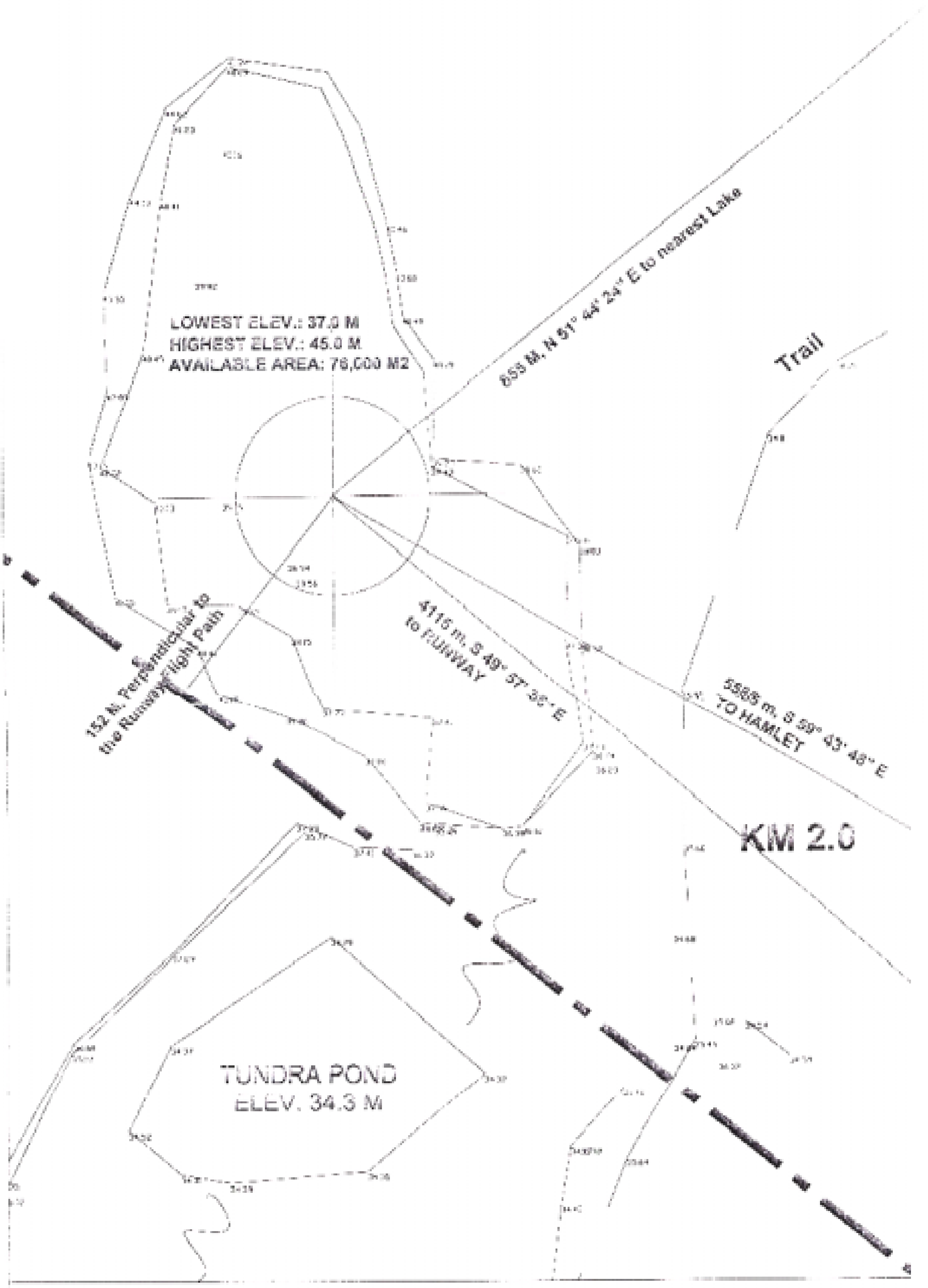
**Table 7.5** - Site S3 Construction Cost Breakdown

| | |
|---|---|
| Length Of Access Road Required | 2,000 m |
| Average Height Of Access Road Required | 1.0 m |
| Side Slopes X:1 | 2 |
| Top Width | 7.0 m |
| Amount Of Fill Required | 18,000 m^3 |
| Cost Of Fill In Place | $11.00 |
| Total Cost Of Access Road | $198,000 |
| | |
| Length Of Drainage Ditch Required | 30.0 m |
| Average Depth Of Drainage Ditch Required | 0.8 m |
| Ditch Width | 3.0 m |
| Amount Of Excavation Required | 68 m^3 |
| Cost Of Excavation | $25.00 |
| Total Cost Of Drainage Ditch | $1,688 |
| | |
| Length Of Perimeter Berm Required | 1,100 m |
| Average Height Of Perimeter Berm Required | 3.0 m |
| Side Slopes X:1 | 2 |
| Top Width | 3.0 m |
| Amount Of Fill Required | 16,500 m^3 |
| Cost Of Fill In Place | $11.00 |
| Total Cost Of Access Berm | $181,500 |
| | |
| Area Of Bulky Waste Storage Required | 10,000 m^3 |
| Average Height Of Bulky Waste Storage Required | 1.0 m |
| Amount Of Fill Required | 10,000 m^3 |
| Cost Of Fill In Place | $11.00 |
| Total Cost Of Bulky Waste Storage | $110,000 |
| | |
| Fencing Required | 1,400 m |
| Unit Cost of Fencing / lm | $50.00 |
| Total Cost of Fencing | $70,000 |
| | |
| Total Construction Cost | $561,188 |

### 7.2.5.3 Operating Cost Breakdown

**Table 7.6** - Site S3 Operating Cost Breakdown

| | |
|---|---|
| Annual Volume Of Waste | 11,500 m ^ 3 |
| | |
| Driving Distance from Hamlet Office | 7 km |
| Average Speed | 50 km/hr |
| Travel Time two ways | 0.3hr |
| Average Wage for Waste Collectors | $28.00 |
| Labour Cost for Travel Time | $15.23 |
| Size of Waste Truck | 15.3 m ^ 3 |
| Number of Trips / Year | 752 |
| Labour Trip Cost / Year | $11,449 |
| | |
| Number of Times Waste is Compacted | 24 |
| Hours Equipment Time per Compaction | 8.0hr |
| Cost per Equipment Hour | $150 |
| Total Cost per Year for Waste Compaction | $28,800 |
| | |
| Thickness of Cover Blanket | 0.3 m |
| Slopes of Working Face of Waste X:1 | 4 |
| Depth of Cell | 3.0 m |
| Width of working Face | 200.0 m |
| Annual Cover Required | 3,784 m ^ 3 |
| Cost Of Fill In Place | $11.00 |
| Total Annual Cost Of Cover Material | $41,627 |
| | |
| Total Annual Operating Cost | $81,876 |




Scale: 1:200

S3, PROPOSED

Stanley

Drawn by: M.

## 7.3 INCINERATION WITHOUT HEAT RECOVERY

### 7.3.1 General Issues

As noted previously, a controlled air incinerator was chosen for evaluation.

A number of different incinerator types were examined for this report. Should incineration be recommended as the appropriate method of dealing with solid waste, a specific model would be chosen at that time. For the purposes of costing this report, a Model CY-200-CA "D" incinerator from Westland Incinerator Company Ltd. of Edmonton was chosen. To meet the capacity requirements of Rankin Inlet, and to provide on line redundancy in operations, a four unit quad redundant installation was chosen.

### 7.3.2 Costing

The construction cost breakdown is based on a generic controlled air type of incinerator installation. Costs are based on those for recent projects in Rankin Inlet, with the building being approximately the size of the Waste Water Treatment Plant.

The operating cost assumes the following:

- Three full time operators
- operating 16 hr per day, 300 days per year.
- Each Incinerator uses 44.0 l per hour of heating oil to fire its auxiliary burners. These burners run 75% of the operating day.
- The waste ash is assumed to be placed in the existing landfill, and covered with a 0.3 m thick cover once per year.
- Building heat is assumed to be required only on non operating days, during the heating season. While the incinerator is operating, excess heat from the incinerator will be required to be wasted to the outside by automatically operating vents and fans. During the 8 hour off cycle, the building will be kept warm by the residual heat in the incinerators. Thus no addition heating should be required

#### 7.3.2.1 Construction Cost Breakdown

**Table 7.7** - Incineration w/o Recovery Construction Cost Breakdown

| | |
|---|---|
| Building | $400,000 |
| Mechanical / Electrical | $150,000 |
| Incinerator - Each Inc. Shipping | $75,000 |
| Number Of Incinerators Required | 4 |
| Cost Of Incinerators | $300,000 |
| | |
| Site Work | $100,000 |
| Water Main Extension | $86,000 |
| Engineering | $103,600 |
| Contingencies | $155,400 |
| | |
| Total Capital Cost | $1,295,000 |

#### 7.3.2.2 Operating Cost Breakdown

**Table 7.8** - Incineration w/o Recovery Operating Cost Breakdown

| | |
|---|---|
| Average Annual Uncompacted Volume Of Waste | 15,330 m ^ 3 |
| Average Annual Uncompacted Mass Of Waste | 3,066,000 kg |
| | |
| Operating Cycle per Day | 16.0hr |
| Days Per Year Operating | 300 |
| Person Years Required | $3.00 |
| Average Wage Inc. Benefits | $53,332.00 |
| Labour Cost Year | $159,996.00 |
| | |
| Auxiliary Fuel for Firing Incinerator | 633,600 l |
| Cost of Fuel / Litre | $0.72 |
| Cost of Fuel Per Year | $456,192 |
| | |
| Cost of Building Heat | $3,000 |
| Misc. Building Upkeep | $5,000 |
| Replacement of Equipment / Main Reserve. | $30,000 |
| | |
| Thickness of Cover Blanket | 0.3 m |
| Slopes of Working Face of Waste X:1 | 4 |
| Depth of Cell | 3.3 m |
| Width of working Face | 150.0 m |
| Annual Cover Required | 752 m ^ 3 |
| Cost Of Fill In Place | $11.00 |
| Total Annual Cost Of Cover Material | $8,268 |
| | |
| Total Annual Operating Cost | $662,456 |

## 7.4 INCINERATION WITH HEAT RECOVERY

### 7.4.1 Recovery Methods

The primary difference between the two incineration options is the heat recovery of this option. All other items are substantially the same.

There are a number of methods of recovering the waste heat, which involve either a modified type of incinerator with heat exchangers built into the walls of the unit, or an add on heat exchanger in the burned gas stream from the incinerator(s). All though either has application, the decision between them is better subject to a design level decision. As such, to simplify the analysis, we will assume the use of the same incinerators as the previous option, with an add on heat exchanger, producing a hot water heat stream.

### 7.4.2 Use of Waste Heat

The issue of what use the recovered heat is given is a more difficult question. There appear to be two clear uses for the recovered heat in Rankin Inlet. One would be to provide heat for an extension of the district heating system. The second would be to provide heat to keep the water system from freezing in the winter. This could be used to either heat the water in the mains, or to preheat the water flowing from Nipissar Lake to the Williamson Lake pumphouse.

In either case, an issue of siting of the plant comes into play. To provide heat to an extended district heating system would require that the plant be located on or near the loop. As any incineration plant requires a local holding area for waste materials, it must not be located near residential or commercial buildings. This limits or eliminates most of the possible locations for the plant. In addition, because of the cyclical nature of the heat produced by the plant, adding it to the existing district heating system would introduce substantial complications to the operation of the system.

Because of these concerns, we will assume that the recovered heat is used to provide heat to the municipal water system.

To provide heat to the water system, the plant must be located near the water mains in some location. It would be advantageous to be located near the pumphouse at Williamson Lake, but the nature of the surrounding uses makes that undesirable.

We will assume that a location is possible within 200 m of the existing underground mains, which would be suitable for the placement of the plant.

### 7.4.2 Costing

The construction cost breakdown is based on a generic controlled air type of incinerator installation. Costs are based on those for recent projects in Rankin Inlet, with the building being modeled after the Waste Water Treatment Plant in size.

Water Pipeline additions are based on the unit costs for the Nipissar Water Pipelines.

The operating cost assumes the following:

- Three full time operators
- operating 16 hr per day, 300 days per year.
- Each Incinerator uses 44.0 l per hour of heating oil to fire its auxiliary burners. These burners run 75% of the operating day.
- The waste ash is assumed to be placed in the existing landfill, and covered with a 0.3 m thick cover once per year.
- Building heat is assumed to be required only on non operating days, during the heating season. While the incinerator is operating, excess heat from the incinerator will be required to be wasted to the outside by automatically operating vents and fans. During the 8 hour off cycle, the building will be kept warm by the residual heat in the incinerators. Thus no addition heating should be required

#### 7.4.2.1 Construction Cost Breakdown

**Table 7.9** - Incineration with Recovery Construction Cost Breakdown

| | |
|---|---|
| Building | $400,000 |
| Mechanical / Electrical | $150,000 |
| Incinerator - Each Inc. Shipping | $75,000 |
| Number Of Incinerators Required | 4 |
| Cost Of Incinerators | $300,000 |
| | |
| Waste Heat Recovery Equipment | $100,000 |
| Installation and Set up of Incinerators | $80,000 |
| | |
| Site Work | $100,000 |
| Water Main Extension | $86,000 |
| Engineering | $121,600 |
| Contingencies | $182,400 |
| | |
| Total Capital Cost | $1,520,000 |

7.4.2.2 Operating Cost Breakdown

**Table 7.10** - Incineration with Recovery Operating Cost Breakdown

| | |
|---|---|
| Average Annual Uncompacted Volume Of Waste | 15,330 m^3 |
| Average Annual Uncompacted Mass Of Waste | 3,066,000 kg |
| | |
| Operating Cycle per Day | 16.0hr |
| Days Per Year Operating | 300 |
| Person Years Required | $3.00 |
| Average Wage Inc. Benefits | $53,332.00 |
| Labour Cost Year | $159,996.00 |
| | |
| Auxiliary Fuel for Firing Incinerator | 633,600 l |
| Cost of Fuel / Litre | $0.72 |
| Cost of Fuel Per Year | $456,192 |
| | |
| Cost of Building Heat with Heat Recovery | $3,000 |
| Misc. Building Upkeep | $5,000 |
| Replacement of Equipment / Main Reserve. | $40,000 |
| | |
| Heat in Waste Stream | 13.1E+9 kcal |
| Recovery Percentage | 50% |
| Heat Recovered | 6.5E+9 kcal |
| Equivalent litres of Oil from Heat | 725,600 l |
| Economic Value of Recovered Heat | 90% |
| Gross Value of Recovered Heat | ($522,432) |
| Percentage of Year When Recovered Heat is Required | 67% |
| Net Value of Recovered Heat | ($348,288) |
| | |
| Thickness of Cover Blanket | 0.3 m |
| Slopes of Working Face of Waste X:1 | 4 |
| Depth of Cell | 3.3 m |
| Width of working Face | 150.0 m |
| Annual Cover Required | 752 m^3 |
| Cost Of Fill In Place | $11.00 |
| Total Annual Cost Of Cover Material | $8,268 |
| | |
| Total Annual Operating Cost | $324,168 |

# 8.0 Conclusions and Recommendations

## 8.1 SUMMARY OF OPTIONS

### 8.1.1 Landfilling

Three landfilling options were examined, at new sites S1, S2, and S3. They have estimated costs of construction and operations as follows.

**Table 8.1** - Summary of Landfill Costs

| Option | Construction Cost | Operating Cost |
|---|---|---|
| Site S1 | $596,668 | $97,910 |
| Site S2 | $590,463 | $87,282 |
| Site S3 | $561,188 | $81,876 |

The preferred landfilling option is Site S3. Although each of these sites have similar construction costs, Site S3 has both the lowest construction cost and the lowest operating cost.

Site S2 is less advantageous due to it's significantly higher operating cost.

The second highest rated site is S1. It should be noted that by increasing the height of the berms, Site S1 could easily handle in excess of 20 years of waste, while the other sites already have berms at the upper limit of economical construction height.

Site S1 is also the farthest from the airport flight path, although the closest to the airport.

### 8.1.2 Incineration

Two incineration options were examined, incineration without waste heat recovery and incineration with waste heat recovery. They have estimated costs of construction and operations as follows.

**Table 8.2** - Summary of Incineration Costs

| Option | Construction Cost | Operating Cost |
|---|---|---|
| Incineration With Waste Heat Recovery | $1,295,000 | $662,456 |
| Incineration Without Waste Heat Recovery | $1,520,000 | $324,168 |

The preferred incineration option uses waste heat recovery. This site presents a higher construction cost at $1,520,000, but has annual operating cost significantly lower than the other option, at $324,168. This is due to the recovery of heat from the incineration being used to preheat the water in the community water main system.

## 8.2 DISCUSSION AND ANALYSIS

### 8.2.1 Landfilling vs. Incineration

Either landfilling or incineration provide an adequate method of dealing with the solid waste produced in the community.

The preferred landfilling option, Site S1, with a construction cost of $678,838 is significantly less costly to construct than the preferred heat recovery incineration option. It costs, however, $240,868 less annually to operate than the incineration option.

In addition to the lower operating cost for the landfill option, it must be recognized that the incineration option depends on there being a paying user for the heat generated, who would require all of the heat produced in the incineration. Without that cost recovery, incineration's yearly operating costs of $662,456 dwarf that of the landfill option.

The landfill option does produce less employment, with the only employment being generated is that of the monthly compaction and the twice yearly covering with fill. Incineration, on the other hand, requires three full time employees to operate the four incinerators necessary to get rid of the waste.

Incineration does have the addition benefit of not requiring separate measures be taken to dispose of screenings from the waste water treatment plant. The existing landfill could continue to be used for that purpose.

The landfill option, however, does fulfill a primary concern in the community, that of moving the current objectionable facility far enough away from the community to not be a concern to residents.

The incinerator requires both the continuing use of the existing dump as a ash receptacle, and requires all solid waste to be hauled to and dumped at the incinerator facility. Thus it would be a continuing source of odors and complaint about birds, blowing garbage, etc. It cannot be easily moved farther out of town, owning to the requirement to be close to the water lines.

## 8.3 RECOMMENDATIONS

Given the above reasons, the recommended solution for Rankin Inlet's solid waste requirements is to construct a new landfill at the Site S3.

The existing landfill will perform adequately for the next few years, until the new road and landfill site can be completed.