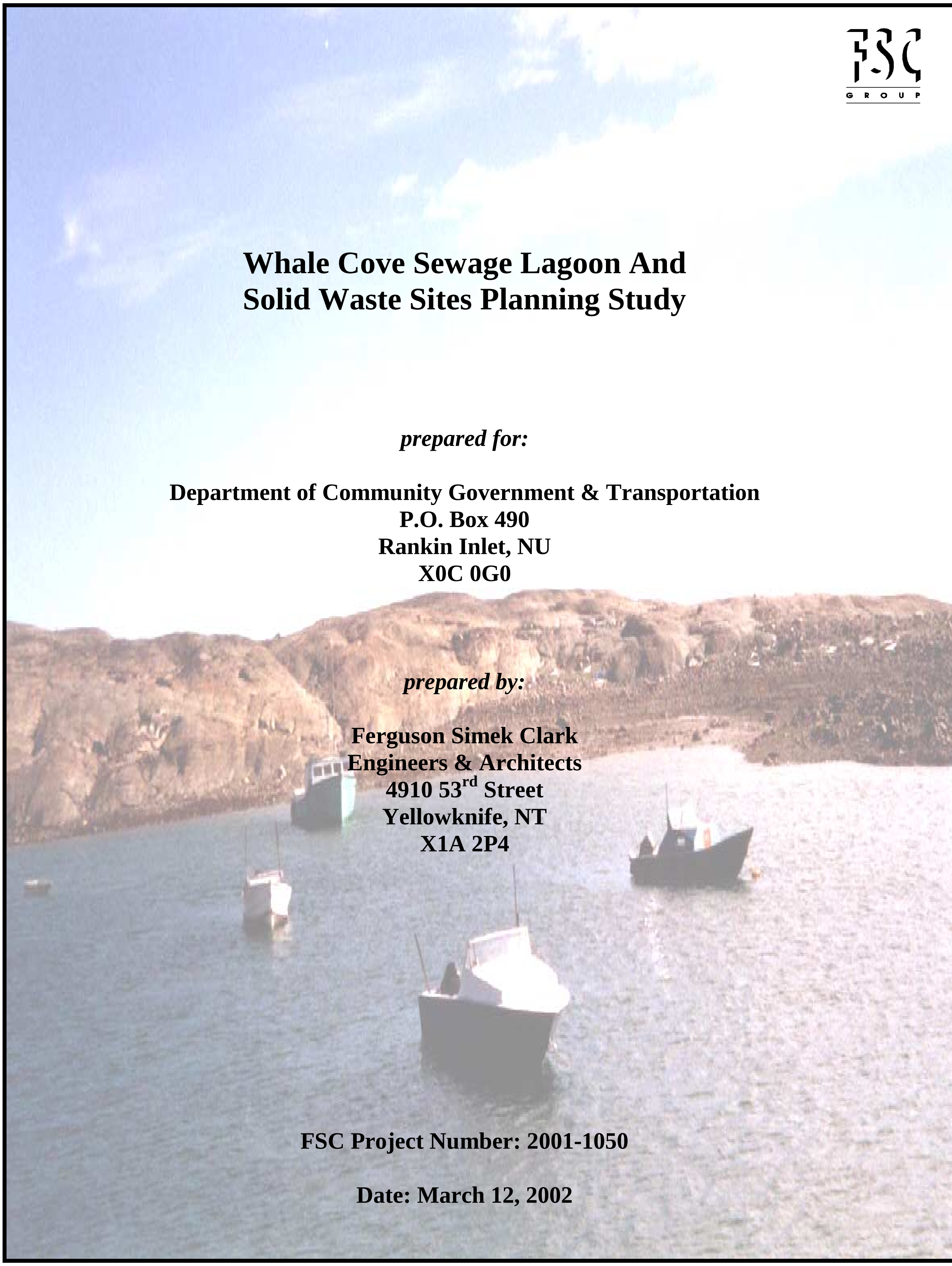

Whale Cove Sewage Lagoon And Solid Waste Sites Planning Study

prepared for:

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1. INTRODUCTION

1.1 PROJECT UNDERSTANDING

Ferguson Simek Clark was contracted to complete a planning study for the Whale Cove Sewage Treatment Systems and Solid Waste Disposal Sites for Community Government and Transportation, Government of Nunavut. The following examines the purpose of this study as per its division into three sections:

1. Sewage Lagoon:

- The determination of use of the gravel source on the ocean side of the landfill
- Sampling of the lagoon and the resulting seepage from it
- Preparation of a preliminary plan and cost estimate for making the lagoon impervious
- Recommendations regarding whether the lagoon should be made impervious and/or whether re-channelization of the ocean side of the effluent flow path is required

2. Existing Solid Waste Site:

- Water sampling as required
- Preparation of preliminary cost estimates for two options
    - Upgrading the existing solid waste site to bring it into conformance with regulatory requirements
    - Construct a new site and close out the existing site
- Determine whether the existing site should be upgraded or whether it should be closed out and a new site constructed

3. Abandoned Solid Waste Disposal Site:

- Develop a close-out plan and cost estimate for the abandoned solid waste site
- Submission of the plan to regulatory authorities

1.2 SITE VISIT

On August 22, 2001 Kelly Henderson, B.Tech. (Env.) of FSC arrived in Whale Cove with Wade Lovell of Community Government and Transportation, Rankin Inlet.

1.2.1 SEWAGE LAGOON

The lagoon was visited and it was determined that it had originally been a natural pond or lake. The water is almost clear in areas and it is suspected that the natural pond had not been emptied of water before the sewage started being added. There is natural drainage towards the ocean. The community is aware not to use the water from the ponds that are located down slope from the lagoon. This water is considered to be contaminated by lagoon seepage.

There was definite seepage from the lagoon on the ocean side. It was impossible to see if there was piping on the berm because of the amount of vegetation covering it. It is approximately 640 metres between the lagoon and the ocean.

It appeared like there could be leakage from the lagoon towards the town. There are two main ponds between the lagoon and the community. These are down slope from the lagoon. It looks like there is run-off from the lagoon into the first pond. This pond is approximately 100 m from the lagoon. The closest building from the point of the pond that is met by the run-off is about 50 m away, with the closet house being about 75 m away from this intersection point.

On August 23, 2001, a sample was located at the pond closest to the lagoon on the community side. This sample was labelled as WC02 and was taken at the water's edge.

Sample WC01 was taken within the lagoon along the berm on the ocean-side. WC03 was collected in a stream-like area approximately 200 m from the lagoon. A final sample was taken at a pond that was about 75 m from the ocean. This sample, WC04 was taken at the lagoon side of the pond. The pond is located approximately 400m from the lagoon.

The area between the lagoon and the final sampling point was made up of lush vegetation. There were many tire tracks from off road vehicles traveling through this area. Between the pond and the ocean, the landscape consisted mainly of rocks and had little vegetation.

1.2.2 ACTIVE LANDFILL

The landfill was visited next. There is a large gravel source at the entrance to the landfill. This is good quality gravel. It is currently not in use by the community but may be at a later time if required.

There is a large amount of waste metal in the bulky waste area. This includes vehicles of all types, appliances, barrels, tanks, wood waste etc. Several barrels in this area were still full and have been left on their sides some leaking contents.

There is a honey bag pit that has a fence around three sides of it. There are many bags within it, but initially, it appeared to be a waste oil containment facility because there were also several overturned barrels within it.

Two trenches had been dug on the ocean side of the landfill. It appears that the trenches were dug to be filled with waste. Both trenches were less then 1 metre deep and were partially filled with contained water. Because of the close proximity to the ocean it is believed that the trenches had reached the water table. Both trenches had run-off that led towards the ocean.

The trench closest to the gravel pile was where new dumping was taking place and where a burn would take place. The refuse was vast in quantity and quality. The second trench also contained much waste, but it was mainly smaller, bagged garbage.

There were many gulls and marmots in the area. Within the dumping area there was a full walrus that was being picked apart by the gulls. Near the dumping area were caribou carcasses. Three of these had ribs showing and were almost picked clean. The fourth one still had the hide intact. There was plenty of food to keep these animals permanent residents of the landfill.

The shore also had waste on it. Barrels were checked that were not entirely empty and were not properly sealed. There was refuse that had most likely been carried by the wind from the dumping area as well as some bulky waste items.

The community has not discussed a possible site for a new landfill in any detail.

A sample was taken within the trench that is not currently the burning site. The sample was taken as close as possible to the ocean side of the trench. The runoff could not be sampled because the streams were too low to fill any of the sample bottles. This sampled was labelled WC1AC.

Sample WC3AC was taken of seepage from the trench that contained the recently dumped refuse. The sample was taken approximately 4 m from the end of the trench. Because of the quantity of refuse and animal bones in the stream it took some time to find an area deep enough to sample. Once the first sample was taken the water became turbid.

1.2.3 ABANDONED LANDFILL

The third location visited was the abandoned landfill. This was located in close proximity to town. It is very near a Public Works garage that snow removal equipment is stored in. There is very little evidence of trash at the site, but there is a large amount of waste metal. There is a large quantity of crushed barrels and construction equipment. Most of the waste metal is extremely rusty.

There is ponding in this area and run-off. Vegetation is abundant in the abandoned landfill and has grown around much of the waste.

After speaking with Guy Enaupik, sampling was undertaken on August 23rd, 2001. The first site sampled was the abandoned landfill. Sample WC2AB was collected in an area of actual water run-off. This run-off was a shallow stream of running water with a width of several inches. It was difficult to fill the glass bottles so another clean bottle was filled and then emptied into the larger bottles.

1.2.4 AREAS OF CONCERN

The community has only sacred area is the graveyard. The graveyard is well marked with crosses and easy to identify. Most of the area surrounding community of Whale Cove has cabins or tents scattered about. People live in these areas at different times of the year. This may pose a problem if relocation of the landfill becomes necessary.

All accessible side roads were traveled between the community of Whale Cove and the airport. There appears to gravel sources directly outside of town with most side roads leading to cabins or tents. The landforms appear to be static with rock outcrops and ponds or lakes in all traveled areas.

Kelly Henderson and Wade Lovell left Whale Cove later the afternoon of August 23rd, 2001 and returned to Rankin Inlet.

2. Community Information

2.1.1 GENERAL

Whale Cove is located at the tip of Term Point on the west coast of Hudson Bay at 62°10' N, 92°36' W. It is 80-air km south of Rankin Inlet and 1,139 km east of Yellowknife.

2.1.2 GEOLOGY AND TERRAIN

Whale Cove is a sheltered bay that faces southward. The Community is situated on a grassy, boulder-strewn area that gently slopes upward from the sea. The overburden of coarse gravel and sands reaches up to 1 m in depth. A ridge of Precambrian rock 15 to 20 m in height surrounds the community; rocky outcrops are common. The active layer of permafrost extends to about 1 m. Annual thaw in the summer is negligible.

2.1.3 VEGETATION

A thin layer of organic material supports mosses and lichens along the rocky coast and low hills.

2.1.4 CLIMATE

Whale Cove receives an average of 16.0 cm of rainfall and 118.1 cm of snowfall per year. Mean annual precipitation totals 27.8 cm. July mean high and low temperatures are 12.5° C and 4.2° C. January mean high and low temperatures are -28.0° C and -34.7° C. Winds are generally northwest and average 24 km/h annually.

2.1.5 COMMUNITY HISTORY AND ECONOMY

The first Europeans to explore the Whale Cove area were Captain Thomas Button in 1613 and Captain Luke Foxe in 1631. The Hudson Bay Company began trading with people of the area during the 18th century. At the same time, European interest in mineral exploration developed.

Whale Cove was officially established in 1959 by the Department of Northern Affairs. Starvation had stricken outlying camps the year before when the caribou herd failed to return. The Department of Northern Affairs believed that the Inuit could adapt their technologies to the use of coastal resources.

The Whale Cove area has abundant game resources. Hunting, fishing and trapping are the major economic activities of the Hamlet. Local businesses include meat product sales, cartage, general retail, food sales, hotels, outfitting, restaurants, amusement centers, and vehicle rentals.

Whale Cove gained Hamlet status on July 1, 1976. A traditional name for the Community is "Tikirarjuaq", meaning 'where many people arrive'.

2.1.6 TRANSPORTATION AND ACCESS

The GNWT and the Hamlet jointly operate a 1,219 m x 30 m certified Arctic 'C' gravel runway. Facilities and services include a terminal building, weather/communications equipment, and navigational aids. Scheduled flight service is available through Calm Air via Rankin Inlet/Churchill and by Skyward Aviation to Rankin Inlet. There is an unlicensed water aerodrome that provides floatplane access in the summer months.

Marine transportation is provided by the Northern Transportation Company Ltd.'s barge service from Churchill. Facilities include a beach landing and a gravel push out, which is rebuilt annually by the Department of Public Works and Services.

There is no direct road access to Whale Cove. Within the community there are approximately 12.4 km of gravel surface roads. Calcium chloride is applied annually to 5 km of road to act as a dust suppressant and surface-stabilizing agent.

2.1.7 HOUSING

The number of private occupied dwellings increased 43.9% between 1986 and 1991. As of 1994, the Housing Corporation owned 50 housing units. The Housing Assistance Program, the Alternative Housing Program, and Government Lease-to-Own units have accounted for 19 new homes in the community.

2.1.8 COMMERCIAL ACCOMODATION

The Issatik Co-op Hotel accommodates six guests.

2.1.9 RECREATION AND CULTURAL ACTIVITIES

Whale Cove's gymnasium was built in 1986. The Hamlet also has a playground, a playfield, and an outdoor rink. A new arena was opened in 1995.

2.1.10 EDUCATIONAL FACILITIES

The Inullak School teaches grades K-9. Six teachers and four language specialists are on staff.

2.1.11 HEALTH FACILITIES

The Whale Cove Health Centre was built in 1987. The facility is 866 m^2 in area and contains one medical bed, one bassinet and one crib. One nurse and one community health representative are on staff.

2.1.12 FIRE PROTECTION FACILITIES

Fire protection consists of an eight-person volunteer fire brigade. Equipment includes a 1987, 2363 L/min. triple combination pumper and a telephone alarm system. The community's Fire Hall is 149 m^2 in area.

2.1.13 OTHER SERVICES AND MUNICIPAL SERVICES

RCMP services are available from Rankin Inlet. Social services include one social services field officer.

Mail is delivered three times per week. NorthwesTel local and long telephone service and CBC Radio are available through the Anik satellite system. There is also a community FM radio station and CBC-TV east and west channels. NWTPC provides 620 kW capacity diesel-generated power to the Hamlet.

Other infrastructure funded by Community Government and Transportation programs includes staff housing, a 269 m^2 Hamlet office, a two-bay maintenance garage (180 m^2), and two two-bay parking garages (190 m^2 and 226 m^2). CG&T also funded the new 5 bay parking garage (433 m^2).

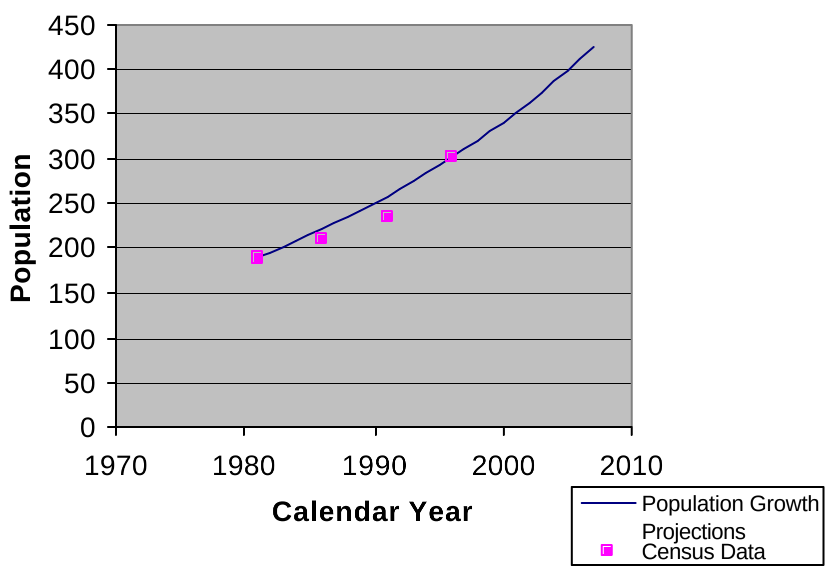
2.1.14 GENERAL DEMOGRAPHIC INFORMATION

The population of Whale Cove was recorded as 301 in the 1996 census. The per capita growth rate was estimated to be 3.18% determined through extrapolation from the community population growth between 1981 and 1996 census years. The projected estimate for the current population, in 2001, is 352. The ethnic distribution of the population is 94% Inuit and 6% non-aboriginal. The population by age and sex distribution is as follows: 0-4 (21%), 5-14 (22%), 15-64 (53%), 65+ (4%), 52% male and 48% female.

Table 2.1: Population projections for the Hamlet of Whale Cove

Calendar Year	Population
1996	301
1997	310
1998	320
1999	330
2001	352
2004	386
2007	424

Figure 2.1 - Population projection for the Hamlet of Whale Cove



3. BACKGROUND

3.1 WATER SUPPLY AND TREATMENT

The community currently obtains its potable water from Fish Lake, located approximately 3.5 km north of the community. This source has been used since about 1982. The former source was Water Lake, 1 km north of the community. A new access road and truck turnaround pad were constructed at Fish Lake in 1986, allowing improved year-round access to the lake.

Until completion of the new intake/truck fill in 1991, water was drawn directly from the lake by the water truck. In winter, an ice auger was used to obtain access. Adding chlorine bleach to the tank of the delivery truck disinfected the water.

During the planning for the new intake/truck fill facility, Fish Lake was retained by the GNWT and the community as the supply source due to its pristine condition and favourable recharge characteristics. The lake's proximity to the Hamlet allows convenient access but has sufficient separation to mitigate possible contamination.

Observations of the shoreline indicate that the water elevation is relatively stable. Lakeshore erosion characteristics and high water markings indicate that the water level fluctuates less than 0.5 m, ensuring a reliable supply of water.

Based on topographical and geotechnical constraints, access to the Lake is sited at the most advantageous location for the facility. Water depths to 7 m are found within 60 m of shore. Only 140 m of relocated access road and a new turnaround pad had to be constructed.

A single vertically-mounted drum screen intake and inclined shaft casing, which had been used successfully in other similar installations, was installed for the new intake system. The intake is located at a depth of 6 m. A submersible pump, located inside the casing about 15 m from the intake, is mounted on a skid and can be removed from the casing for servicing by means of a wire pull arrangement. The 100 mm diameter uninsulated, heat traced HDPE discharge line is carried inside the 300 mm diameter, 120 m long, HDPE insulated casing. The casing is ballasted and protected by a granular berm and riprap. The pump fills the trucks at a rate of 1000 L/min.

The pre-engineered, skid-mounted pump house, 3.5 m x 7 m, is divided into two rooms. One room contains hypochlorinator facilities and the steel discharge line from the intake casing to the truckfill arm. The other contains the emergency diesel electric generator. The pump house is normally powered by the NWTPC power plant in the community.

Water for the hypochlorite mixing tank is supplied from the discharge line. The hypochlorite feed pump is controlled by the rate of water supplied to the water trucks by means of a flow-sensing meter mounted on the discharge line. The chlorine is supplied to the main line by a tube and chlorine injector. The design flow rate of the injection system provides 0.5 mg /L residual chlorine. The dosage rate at the pump house allows for consumption and volatilization during delivery and residential storage. Estimated chlorine residual concentration at the point of domestic supply is 0.2 mg/L for a typical truck delivery system. Water is supplied to the water trucks by means of an overhead truckfill arm with flexible downspout, with thaw capability afforded by a manually activated heat trace. Provisions for future fluoridation were made by the installation of a supply fitting on the steel water discharge line and reserving space within the pump room for fluoridation equipment.

3.2 WATER STORAGE AND DISTRIBUTION

The recharge potential of Fish Lake includes 37.4 ha of adjacent watershed, the discharge from two lakes to the South, and additional discharge from the North.

Nearly 93,000 m^3 of water per year is available as recharge for the lake, compared with the present annual consumption of 9,000 m^3. Winter storage capacity of 97,000 m^3 was calculated based on an assumption that 50% of the total volume of the lake was occupied by ice cover.

A 4540 L 1976 water truck and a 4540 L 1993 water truck are used for water distribution. Water is pumped directly into the truck tank using a truck mounted pump. The water is trucked approximately 4.0 km from the source. All water deliveries are metered.

3.3 SOLID WASTE COLLECTION AND DISPOSAL

A two-person crew using a 1991 Ford F-350 compactor with a 9 m^3 capacity collects solid waste daily. Residents do not burn wastes in oil drums at home. Bulky waste disposal is the responsibility of the individual. An annual spring cleanup takes place in July.

Solid waste is deposited 1.1 km northwest of the community in a 40,000 m^2-modified landfill. A separate bulky waste disposal area has been set aside for disposal of used vehicles, large appliances and other large metal items. Used oil wastes are placed in 205 L oil drums.

Coarse gravel is readily available for covering the disposal site.

3.4 SOLID WASTE VOLUME PROJECTIONS

There is no published information on waste volumes in Whale Cove. Relying on data from other communities in this region, the following table of estimated solid waste volumes was prepared.

The following assumptions were made to prepare this table:

- Per capita volume described by Heinke and Wong (1990) has been increasing at a rate of 1 % per year
- The per capita population growth rate of the Hamlet of Whale Cove is 3.18% per year
- The waste density is 0.099 tonnes/m^3 (Bryant et al., 1996)

Table 3.1 Solid Waste Projection estimates for the Community of Whale Cove

Planning Year	Calendar Year	Total Population	Projected Daily Rate	Projected Daily Volume	Projected Daily Weight	Projected Annual Volume	Projected Annual Weight	Running Total
			m^3pcd	m^3/day	tonnes	m^3	tonnes	m^3
	1996	301	0.014	4.2	0.4	1538	152	
	1997	311	0.014	4.4	0.4	1603	159	
	1998	320	0.014	4.6	0.5	1670	165	
	1999	331	0.014	4.8	0.5	1741	172	
	2000	341	0.015	5.0	0.5	1814	180	
0	2001	352	0.015	5.2	0.5	1890	187	1890
	2002	363	0.015	5.4	0.5	1970	195	3861
	2003	375	0.015	5.6	0.6	2053	203	5914
	2004	387	0.015	5.9	0.6	2140	212	8053
	2005	399	0.015	6.1	0.6	2230	221	10283
5	2006	412	0.015	6.4	0.6	2324	230	12606
	2007	425	0.016	6.6	0.7	2421	240	15028
	2008	438	0.016	6.9	0.7	2523	250	17551
	2009	452	0.016	7.2	0.7	2630	260	20181
	2010	467	0.016	7.5	0.7	2740	271	22921
10	2011	481	0.016	7.8	0.8	2856	283	25777
	2012	497	0.016	8.2	0.8	2976	295	28754
	2013	512	0.017	8.5	0.8	3102	307	31855
	2014	529	0.017	8.9	0.9	3232	320	35087
	2015	546	0.017	9.2	0.9	3368	333	38455
15	2016	563	0.017	9.6	1.0	3510	348	41966
	2017	581	0.017	10.0	1.0	3658	362	45624
	2018	599	0.017	10.4	1.0	3812	377	49436
	2019	618	0.018	10.9	1.1	3973	393	53408
	2020	638	0.018	11.3	1.1	4140	410	57548
20	2021	658	0.018	11.8	1.2	4314	427	61863

3.5 SEWAGE COLLECTION AND TREATMENT SYSTEM

Sewage collection is provided by the Hamlet. A Ford model F-800 8172 L capacity sewage pump out truck services those buildings with sewage holding tanks.

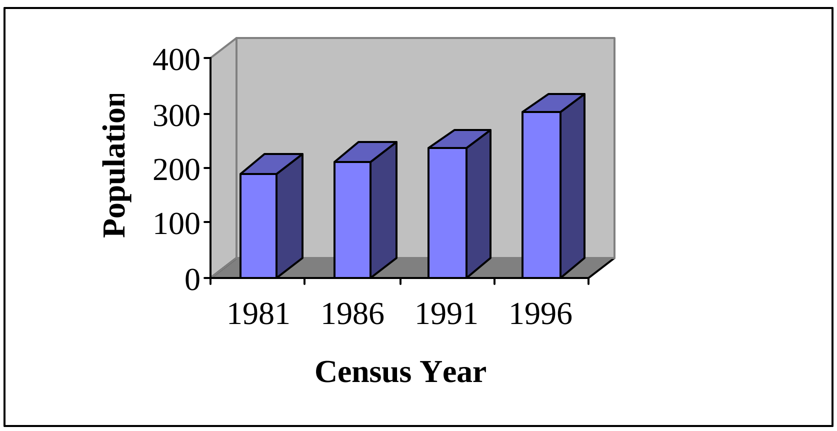
Pump-out sewage is treated at the community lagoon 0.7 km southwest of the community; this lagoon covers an area of 15,000 m². Effluent from the lagoon is further treated in a natural wetlands area, 640 m in length, before it flows into Hudson Bay.

Wetlands treatment is a web of complex physical and biological processes. Sedimentation, absorption of pollutants in the surface soils, nutrient uptake by plants, and the oxidation of compounds by microorganisms are some of the processes that effect the treatment

3.6 SEWAGE GENERATION PROJECTIONS

The 1996 Census Report demonstrates the increase in population of the Hamlet of Whale Cove between the years of 1981 to 1996. The following figure (Figure 2.1) illustrates this population increase. A per capita growth rate of 3.18% was determined between the census years of 1981 and 1996.

Figure 3.1 Population Increase in the Hamlet of Whale Cove



The Municipal and Community Affairs (MACA) planning guidelines suggest that the increase in the projected per capita water use in a community should be modelled through the following equation.

(1) RWU x (1.0 + (0.0023 x Population)) **Population <2000**

The RWU or residential water use is estimated to be 90 litres per capita (Lpcd) for populations lower than 2000 using a trucked delivery system.

Ln is the natural logarithm.

From this equation, the sewage generation of the community of Whale Cove was modelled within a 20-year span (Table 2.2). The current amount of sewage generation was estimated to be 12,499,402 L annually. This corresponds to a per capita water use of 97.29 Lpcd. In the year 2021, the per capita water use would be 103.63 Lpcd, corresponding to an annual sewage generation of 24,901,392 L.

Table 3.2 Sewage Generation Projections for the Hamlet of Whale Cove

Planning Year	Calendar Year	Total Population	Projected Water Use	Daily Projected Volume	Annual Projected Volume
		#	Lpcd	Litres	Litres
	1996	301	96.23	28,965	10,572,386
	1997	311	96.43	29,948	10,931,048
	1998	320	96.63	30,966	11,302,567
	1999	331	96.84	32,020	11,687,445
	2000	341	97.06	33,113	12,086,208
0	2001	352	97.29	34,245	12,499,402
	2002	363	97.52	35,418	12,927,599
	2003	375	97.76	36,634	13,371,398
	2004	387	98.00	37,894	13,831,423
	2005	399	98.26	39,201	14,308,326
5	2006	412	98.52	40,556	14,802,789
	2007	425	98.79	41,960	15,315,525
	2008	438	99.07	43,417	15,847,281
	2009	452	99.36	44,928	16,398,836
	2010	467	99.66	46,496	16,971,006
10	2011	481	99.96	48,122	17,564,647
	2012	497	100.28	49,810	18,180,652
	2013	512	100.61	51,562	18,819,958
	2014	529	100.95	53,380	19,483,545
	2015	546	101.29	55,267	20,172,442
15	2016	563	101.65	57,227	20,887,724
	2017	581	102.02	59,262	21,630,521
	2018	599	102.41	61,375	22,402,015
	2019	618	102.80	63,571	23,203,446
	2020	638	103.21	65,852	24,036,117
20	2021	658	103.63	68,223	24,901,392

4. SEWAGE LAGOON

An existing lake was used as the site of the current sewage lagoon. The lake did not appear to be drained before it became the lagoon and thus it seems that there may be some dilution happening to the sewage. Samples were taken at the lagoon and three other surrounding sites.

According to Whale Cove Solid Waste and Sewage Disposal, Design and Operations Report that was prepared by DPW&H in August 1988, "The natural drainage appears to be occurring at the east and west ends of the lake water appears to drain overland as well as underground through fractures in rock and between big boulders at the east end back to the community.

At the time of the visit, it appeared that there might still be a possibility of leakage toward the community.

A sample was collected at the pond closest to the lagoon on the community side. This sample was labelled as WC02 and was taken right at the water's edge.

Sample WC01 was taken within the lagoon directly along the berm on the ocean-side. WC03 was collected in a stream-like area approximately 200 m from the lagoon. A final sample was taken at a pond that was about 75 m from the ocean. This sample, WC04 was taken at the lagoon side of the pond. The sample results are listed in the following table.

Table 4.1 Sample Results

Parameters	Samples			
	WC01	WC02	WC03	WC04
Faecal Coliforms (CFU/100ml)	800	100	100	<100
Ammonia as N (mg/L)	<0.005	<0.005	2.62	0.018
Nitrate+Nitrite as N (mg/L)	<0.008	<0.008	0.349	<0.008
Total Phosphorous (mg/L)	4.66	0.045	0.503	0.028
Conductivity (uS/cm)	604	914	632	566
pH (pH units)	7.45	7.45	8.43	8.40
Total Suspended Solids (mg/L)	17	24	7	4

Table 4.2 Wastewater Effluent Quality Limits

Wastewater Flow (Lcpd) & Season	Parameter	Unit	Overland Flow to Marine Mixing Condition	
			Open Coastline	Bay or Fjord
<150 Lcpd Summer	BOD_5 TSS F. Coliform	mg/L mg/L CFU/dL	360 300 N/A	100 120 N/A

WC01 was taken directly from the lagoon. There appears to be very little contamination here. The suspended solids prove to well below the limits for both an open coastline and a bay or fjord. The lagoon's faecal coliform count is low and shows that the lagoon is treating the wastewater.

WC02, WC03 and *WC04* were taken in three separate areas that may be affected by the lagoon's exfiltration patterns. All of these have low levels of the tested parameters and thus do not appear to be a threat to the community or the environment.

It does not appear that having the lagoon made impervious would be a desirable option. At present, the lagoon's performance appears to be in accordance with the Nunavut Water Board Guidelines.

The cost of placing a liner in the lagoon to make it impervious is explained in Table 4.2. This table does not include the cost of cleaning out the lagoon or supplying a secondary lagoon during the time that it is inactive.

Table 4.3 Cost of Lining the Lagoon

Cost of Liner	$864,000
Screened Material for Fill	$432,000
General Fill	$100,800
Shipping	$21,600
Total	**$1,418,400**

Phillipe Lavallee, Water Resources Officer for INAC, Nunavut District stated in both the August 30, 2000 and August 29, 2001 Municipal Water Use Inspection Reports that the wetlands provided additional treatment to that of the lagoon itself. Also noted were the low analytical results for the samples done as well as a negative result on the Microtox test.

The surface area of the lagoon has been stated to be about 14,000 m^2, which gives a capacity of 21,000,000 L if we use the 1.5 metre active layer of the lagoon as the depth. This should last the community between 15 to 20 years.

There appears to be no reason to do any work on the lagoon at present.

5. SOLID WASTE DISPOSAL SITES

5.1 EXISTING SOLID WASTE DISPOSAL SITE

The landfill consists of three main areas. The bulky waste area is to the back of the site, followed by the honey bag pit and the garbage trenches.

There is a vast amount of waste metal in the bulky waste area. This includes such items as vehicles of all types, appliances, barrels, tanks, wood waste etc. Several barrels in this area were still full and had been left on their side and were leaking contents.

There was a honey bag pit that had a fence around three sides of it. There was a great quantity of bags within it, but at first sight, it appeared to be a waste oil containment facility because there were also a few barrels overturned within it.

Two trenches had been dug on the ocean side of the landfill. It appeared that these were dug to be filled in with waste. Both trenches were less than 1 m deep and contained water. Because of the close proximity to Hudson Bay it is believed that the trenches had reached the water table. Both trenches had run-off that led towards the bay.

New dumping is taking in the trench closest to the gravel pile. This was also where a burn would take place. The refuse was vast in quantity and quality. The second trench also contained much waste but it was mainly smaller bagged garbage.

Two samples were taken at the site of the existing solid waste disposal site. Both samples were taken from the water associated with the trenches near the shoreline.

A sample was taken within the trench that is not currently the burning site. The sample was taken as close as possible to the ocean side of the trench. The runoff could not be sampled because the streams were too low to fill any of the sample bottles. This sampled was labelled WC1AC.

Sample WC3AC was taken of seepage from the trench that contained the recently dumped refuse. The sample was taken approximately 4 m from the end of the trench. Because of the quantity of refuse and animal bones in the stream it took some time to find an area deep enough to sample. Once the first sample was taken the water became turbid.

Sample results are found in the following table.

Table 5.1 Sample Results

Parameters	Samples		CCME Water Guidelines		
				Aquatic Life	
	WC1AC	WC3AC	Community	Freshwater	Marine
Ammonia as N (mg/L)	0.077	1.1	N/A	1370-2200	N/A
Oil and Grease (mg/L)	<0.2	1.7	N/A	N/A	N/A
Conductivity (uS/cm)	977	1010	N/A	N/A	N/A
pH	7.96	7.55	6.5-8.5	6.5-9.0	7.0-8.7
Total Suspended Solids (mg/L)	14	48	N/A	N/A	N/A
Phenols (ug/L)	<0.5	<0.5	N/A	4	N/A
Arsenic (ug/L)	1.4	2	25	5	12.5
Cadmium (ug/L)	<0.3	0.3	5	5	N/A
Chromium (ug/L)	<3	4	50	0.0035	0.002
Cobalt (ug/L)	<1	<1	N/A	N/A	N/A
Copper (ug/L)	3	14	N/A	2-4	N/A
Iron (ug/L)	437	3320	N/A	300	N/A
Lead (ug/L)	<1	3	10	1-7	N/A
Manganese (ug/L)	109	113	N/A	N/A	N/A
Mercury (ug/L)	<0.01	<0.01	1	0.1	N/A
Nickel (ug/L)	4	4	N/A	25-150	N/A
Zinc (ug/L)	<10	122	N/A	N/A	N/A

Samples from each trench prove to have an excess of iron. The runoff from the garbage/burning trench shows to be high in chromium as well.

Because of the close proximity to the shoreline, it appears that these pits will always be a form of constant concern as well as the miscellaneous trash and waste metal that have been left in the area.

Further concern comes from the lack of proper handling of hazardous wastes within the solid waste site.

Philippe Lavallee, Water Resource Officer for INAC's Nunavut District performed two separate Municipal Water Use Inspection at the active waste management site. The dates of the inspections were August 29, 2000 and August 30, 2001. Reports regarding these inspections were sent to the current Senior Administrative Officer of Whale Cove.

The first report revealed several items of concern, which included:

- Scattered waste in the area
- Pooled water on site
- Improper storage of hazardous wastes and waste oil
- The usefulness of the honeybag pit

Sampling was done of the discharge from the solid waste disposal facility. The results showed that the levels of ammonia, arsenic, cadmium, copper, iron, phenols and zinc were above the Canadian Water Quality Guidelines for the Protection of Aquatic Life. A Microtox test was also done and came back with a negative result.

The later inspection proved that work had been done to correct the problems outlined in the previous years report. The combustible domestic garbage was moved further back from both the shoreline and the pooled water. Mr. Lavallee commented that waste metal was currently being compacted before infilling and capping.

At the time hydrocarbon contamination was noted on site and it was suggested for a sealift container to be used to house hazardous materials. Fencing would still be required to eliminate the spread of waste around the property.

Samples were taken again. The Microtox was again negative while the levels of copper and iron were minimally above the Canadian Water Quality Guidelines for the Protection of Aquatic Life.

5.2 ABANDONED SOLID WASTE DISPOSAL SITE

The abandoned solid waste site is located within the community of Whale Cove. It has not been used in years but still has a large amount of waste.

The majority of the site is covered with scrap metal that includes vehicles, crushed barrels and culvert material. There is some old garbage bags and refuse in the area as well.

A water sample was taken in an area of runoff from the site. The results are in the table that follows.

There is a concern that this site has chromium and iron contaminated runoff. The iron runoff is mainly associated with the waste metal that is within or beside ponding areas on site. This practice will cause the trace metals to be leached from the waste metal.

Table 5.2 Sample Results

Parameters	WC2AB	CCME Water Guidelines			NWB Guidelines	
			Aquatic Life			
		Community	Freshwater	Marine	Freshwater	Overland to Marine
Ammonia as N (mg/L)	<0.005	N/A	1370-2200	N/A	N/A	N/A
Oil and Grease (mg/L)	0.2	N/A	N/A	N/A	None Visible	None Visible
Conductivity (uS/cm)	345	N/A	N/A	N/A	N/A	N/A
pH (pH units)	8.09	6.5-8.5	6.5-9.0	7.0-8.7	N/A	N/A
Total Suspended Solids (mg/L)	3	N/A	N/A	N/A	N/A	N/A
Phenols (ug/L)	<0.5	N/A	4	N/A	N/A	N/A
Arsenic (ug/L)	<1.0	25	5	12.5	0.5	0.5
Cadmium (ug/L)	<0.3	5	5	N/A	0.00017	0.0012
Chromium (ug/L)	5	50	0.0035	0.002	0.89	5.6
Cobalt (ug/L)	<1	N/A	N/A	N/A	N/A	N/A
Copper (ug/L)	3	N/A	2-4	N/A	0.3	0.3
Iron (ug/L)	320	N/A	300	N/A	30	N/A
Lead (ug/L)	<1	10	1-7	N/A	0.2	0.2
Manganese (ug/L)	16	N/A	N/A	N/A	N/A	N/A
Mercury (ug/L)	<0.01	1	0.1	N/A	0.001	N/A
Nickel (ug/L)	3	N/A	25-150	N/A	0.5	0.5
Zinc (ug/L)	33	N/A	N/A	N/A	0.5	0.5

5.3 OPTIONS

There are currently three options for the abandoned solid waste site, two options for the active solid waste site and two options for the current gravel pit. The options will be compared in combination.

5.3.1 ABANDONED SOLID WASTE SITE

5.3.1.1 Option 1: Close out the abandoned solid waste site

All waste metal and all other refuse should be pushed back on the property to a dry area so nothing remains in the areas of pooled water. Once this is completed, a layer of gravel can be applied to the property and compacted over the waste. A "No Dumping" sign should be placed in the area to discourage any further dumping by residents. Detailed cost analysis is appended.

Table 5.3 Estimated Cost Analysis Summary for Option 1

Transfer of shallow dump materials to main landfill	$7,520.00
Supply and spread of fill cover for deposit area	$146,980.00
Sub-total	$154,500.00
Engineering and contingency @40%	$61,800.00
Total	**$216,300.00**

5.3.1.2 Option 2: Remove solid waste from abandoned site and move to active site

All waste metal and all other refuse that is on the surface should be removed. Once this is completed, a layer of gravel can be applied to the property. A "No Dumping" sign should be placed in the area to discourage any further dumping by residents. Detailed cost analysis is appended.

Table 5.4 Estimated Cost Analysis Summary for Option 2

Transfer of solid waste to active site	$9,520.00
Supply and spread of fill cover for deposit area	$146,980.00
Sub-total	$156,500.00
Engineering and contingency @40%	$62,600.00
Total	**$219,100.00**

5.3.1.3 Option 3: Use abandoned site for waste metal

This site may never be considered clean by the Department of Health and Social Services and /or Department of Sustainable Development without removing all waste, including that which has already been buried and performing many costly tests. It may be a good option to continue using this site as an area that stores waste metal.

If the waste metal is removed from the water that has pooled on site, it should provide little contamination to the outlying areas. Once the existing waste metal is removed from the pooled water, the pools should be filled to eliminate future contamination. Detailed cost analysis is appended.

Table 5.5 Estimated Cost Analysis Summary for Option 3

Transfer of shallow dump materials to main landfill and level ground	$13,420.00
Sub-total	$13,420.00
Engineering and contingency @40%	$5,368.00
Total	**$18,788.00**

5.3.2 ACTIVE SOLID WASTE SITE

Before implementing either of the two options for the active solid waste site several issues should be dealt with.

- Waste that is lining the shoreline. This should be cleaned up and moved into the dump and there should be no dumping allowed within 30 m of the waters edge.
- Since the current trenches are filled with water and have metal runoff, they should be covered when they become full. At this point, new trenches can be built on the surface after it has been built up with fill. See appended trench method.
- The trenches and any other items that should not have public access, such as the hazardous waste area, should be fenced with a locked gate. (Locked gates have been used in Iqaluit, Arviat, Gjoa Haven and Fort Good Hope.) Depending on whether or not polar bears are felt to be an issue in the area, the fencing may need to be electrified.
- Litter fences should also be installed to stop the spread of garbage throughout the site
- The honey bag pit can be eliminated
- Peizometers should be installed to monitor runoff from site

5.3.2.1 Option 4: Continue to use site for domestic waste, bulky waste and hazardous waste

The existing site will have to be cleaned up to the recommendations made above. Detailed cost analysis is appended.

Table 5.6 Estimated Cost Analysis Summary for Option 4

Clean up of waste lining shoreline	$2,240.00
Fence construction	$16,200.00
Litter fence construction	$400.00
Honey bag pit burial	$1,570.00
Peizometer	$5,000.00
Sub-total	$125,410.00
Engineering and contingency @40%	$50,164.00
Total	**$175,574.00**

5.3.2.2 Option 5: Remove all bulky wastes and metal

All the bulky waste and waste metal can be removed from the active site. Once the removal is completed gravel will have to cover the site even if it is going to be used as additional space for the municipal waste. Detailed cost analysis is appended.

Table 5.7 Estimated Cost Analysis Summary for Option 5

Transfer of bulky waste and waste metal from active site	$57,120.00
Supply and spread of fill cover for deposit area	$67,080.00
Sub-total	$124,200.00
Engineering and contingency @40%	$49,680.00
Total	**$173,880.00**

5.3.3 GRAVEL PIT

The existing gravel pit is the only source of granular material for the community. Material would be used from this gravel pit to complete any of the options where granular material is required.

5.3.3.1 Option 6: Open gravel pit to waste metal

The gravel pit would be used as a waste metal site once its resources have been depleted. For this to happen the slopes of the sides would have to be reduced to 4:1. Detailed cost analysis is appended.

Table 5.8 Estimated Cost Analysis Summary for Option 6

Slope Sides of Pit to 4:1	$13,420.00
Sub-total	$8,640.00
Engineering and contingency @40%	$3,456.00
Total	**$12,096.00**

5.3.3.2 Option 7: Close active site and move entire solid waste site to the gravel pit.

All of the bulky waste would be moved to the gravel pit. The domestic waste would be buried on its current site. The existing gravel pit would become the new solid waste site. This new waste site would be fenced (electrified if necessary). The existing road access should be sufficient for waste site access. The abandoned and active sites would then be to be closed by covering them in a layer of gravel and then graded. A "No Dumping" sign should be placed in the areas to discourage any further dumping by residents. Detailed cost analysis is appended.

The cost estimate does not include the entire cost of modifying the gravel pit into a landfill.

Table 5.9 Estimated Cost Analysis Summary for Option 7

Transfer of bulky waste and waste metal from active site	$57,120.00
Bury and compaction of domestic waste	$9,216.00
Peizometer installation	$5,000.00
Supply and spread of fill cover for deposit area	$132,020.00
Fence construction (400m fencing and gate)	$63,500.00
Sub-total	$266,856.00
Engineering and contingency @40%	$106,742.40
Total	**$373,598.40**

5.3.4 COMBINED OPTIONS

Table 5.10 Combination of options for Whale Cove

	OPTION 1	OPTION 2	OPTION3	OPTION 4	OPTION 5	OPTION 6	OPTION 7
OPTION A	●			●			
OPTION B		●		●			
OPTION C			●	●	●		
OPTION D			●	●			
OPTION E	●			●	●	●	
OPTION F	●						●

Table 5.11 Capital Costs of Final Options

	Cost
OPTION A	$391,874
OPTION B	$394,674
OPTION C	$368,242
OPTION D	$194,362
OPTION E	$361,550
OPTION F	$589,898

6. MODIFIED K-T ANALYSIS FOR SOLID WASTES

6.1 GENERAL

To evaluate potential alternatives objectively, a decision making tool called modified Kepner-Tregoe (K-T) analysis or a weighted factor analysis has been used. This tool/method involves two distinct steps, which are outlined as follows.

6.2 INITIAL SCREENING

The initial screening process involves the creation of constraints, which each option/alternative must meet. Only options/alternatives that meet each constraint will be included in the final analysis. These constraints have been provided by the client in the project scope of work. They are:

- Must meet the *Public Health Act*
- Must meet Nunavut Water Board Acts and Regulations

Table 6.1 – Results of Initial Screening

	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E	OPTION F
Public Health Act	Pass	Pass	Pass	Pass	Pass	Pass
Nunavut Water Board	Pass	Pass	Pass	Pass	Pass	Pass

6.3 OPTIONS ANALYSIS

If an option passes our initial screening process it will be included in our final evaluation process. The final process consists of evaluating each option on a set of objectives that has been deemed the "want" criteria.

The want criteria are a list of objectives that are weighted according to their importance to the decision to be made. Each option is then objectively ranked against these criteria and scores assigned based on the ranking multiplied by the weight of the criteria. The weighted scores for the various options are added to provide a total score for each option.

The total score for different options can be compared to provide an indication of which option best meets the stated objectives for a new solid waste disposal system.

The following "want" objectives have been established for this project:

1. Lowest Capital Cost
2. Fits within the present community plan
3. Does not create a new solid waste site
4. Provides 20-year storage requirement

6.4 SELECTING WEIGHTS

A binary choice decision model was used to generate preliminary weighting for each objective.

In this model, only two objectives are considered at a time, the more important objective receiving a "1" and the other a "0". When all objectives are considered the scores are summed and the results placed in descending order. The highest-ranking objective is then assigned a "10". Others receive a lesser weight.

The following table shows the decision process:

Table 6.2 - Binary Decision Model to Assign Weights to Objectives

Objective	Capital Cost	Community Plan	New Waste Site?	20 Years?	Total	Assigned Weight
Capital Cost	-	1	1	0	2	9
Community Plan	0	-	1	0	1	8
New Waste Site	0	0	-	0	0	7
Meets 20 Year Plan	1	1	1	-	3	10

6.5 SCORING

1. Lowest Capital Cost

The lowest capital cost will be scored "10". Others will be scored on percentage.

2. Meets Community Plan

No changes required – 10

Trivial changes are required – 8

Minor changes are required- 5

Major changes are required - 0

3. Creates a New Solid Waste Site

Creates a new solid waste site - 0

The new site only stores metal, bulky wastes, or other salvageable items – 5

Uses the existing site - 10

4. Meets 20 Year Requirements

Sites that meet 20-year requirements will be scored 10. Others will be scored on a percentage.

6.6 RESULTS

Table 6.3 - Results of the "Want" Analysis

	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E	OPTION F
Total	**244.6**	**236.3**	**281.5**	**316.0**	**246.4**	**183.4**
Rank	4	5	2	1	3	6

The want analysis calculations are appended.

6.7 SENSITIVITY ANALYSIS

In this analysis, non-monetary factors were reduced to determine how they impacted on the scoring. Such an analysis suggests the acceptability of a project.

Table 6.4 – Sensitivity Analysis Revised Weights

Objective	Assigned Weight
Capital Cost	9
Community Plan	4
Creates New Site	3
Meets 20 Year Plan	5

6.8 RESULTS OF SENSITIVITY ANALYSIS

Table 6.5 - Results of Sensitivity Analysis

	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E	OPTION F
Total	139.6	135.3	159.5	198.0	144.4	109.4
Revised Rank	4	5	2	1	3	6
Previous Rank	4	5	2	1	3	6

The sensitivity analysis calculations are appended.

7. CONCLUSIONS

Option D, scored the highest in our initial analysis, and did not change in the sensitivity analysis. Option D combines options 3 & 4 that involve the use of the abandoned site for waste metal, and the continued use of the active site for MSW, bulky wastes and hazardous wastes.

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Appendix A

Photos

Photo 1 Sewage Lagoon

Photo 2 Sewage Lagoon

Photo 3 Sewage Lagoon

Photo 4 Berm on the ocean side of the lagoon.

			
Photo 5	Sample location for WC01	Photo 6	Drainage from the ocean side berm
			
Photo 7	Sample location WC03	Photo 8	Wetlands that leads to the ocean

			
Photo 9	Sample location of WC04	Photo 10	Sample location of WC04
			
Photo 11	Pond that may be catching lagoon drainage	Photo 12	Pond that may be catching lagoon drainage

Photo 13	Sample location of WC02	Photo 14	Gravel pile at the active solid waste site

Photo 15	Gravel pile at the active solid waste site	Photo 16	Trenches and honey bag pit at the landfill

Photo 17	Burning area	Photo 18	Trench beside the honey bag pit

Photo 19	Honey bag pit	Photo 20	Bulky waste site

			
Photo 21	Bulky waste site	Photo 22	Bulky waste site
			
Photo 23	Bulky waste site	Photo 24	Bulky waste site

Photo 25 | Overturned barrels at the honey bag pit

Photo 26 | Trench beside the honey bag pit

Photo 27 | Trench near the honey bag pit

Photo 28 | Trench near the honey bag pit

			
Photo 29	Trench below the dumping area	Photo 30	Trench below the dumping area
			
Photo 31	Runoff from the trench below the dumping area	Photo 32	Sample location WC3AC

			
Photo 33	Barrels lined up the hill at the landfill	Photo 34	Waste on the beach below the landfill
			
Photo 35	Barrels on the beach below the landfill	Photo 36	Abandoned solid waste site

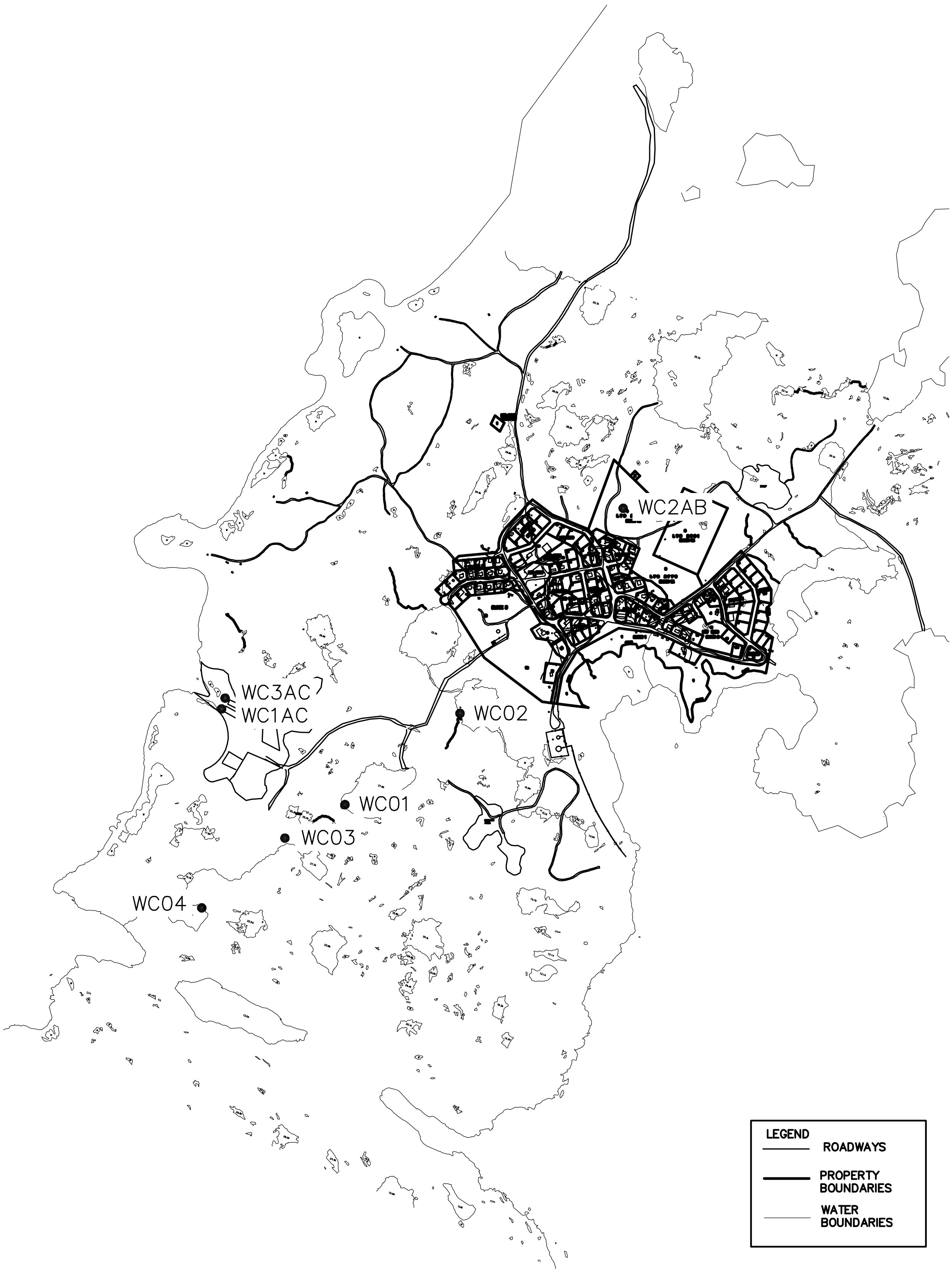
Photo 37	Abandoned solid waste site	Photo 38	Abandoned solid waste site

Photo 39	Abandoned solid waste site	Photo 40	Abandoned solid waste site

			
Photo 41	Abandoned solid waste site	Photo 42	Abandoned solid waste site
			
Photo 43	Sample location WC2AB	Photo 44	Runoff from abandoned land site

Appendix B

Sampling Locations



FSC GROUP
FERGUSON SIMEK CLARK
ENGINEERS AND ARCHITECTS

F.S.C. JOB NO. 2001–1050

JOB TITLE
WHALE COVE SEWAGE AND SOLID WASTE

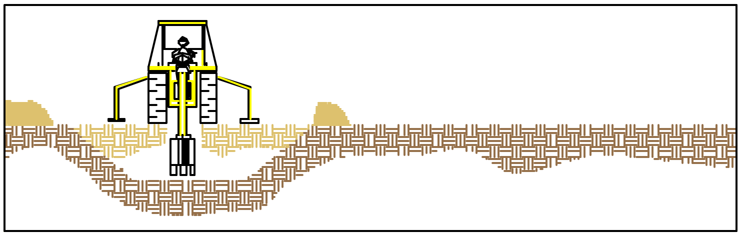
WHALE COVE, NU

DRAWING TITLE
WHALE COVE SAMPLE LOCATIONS

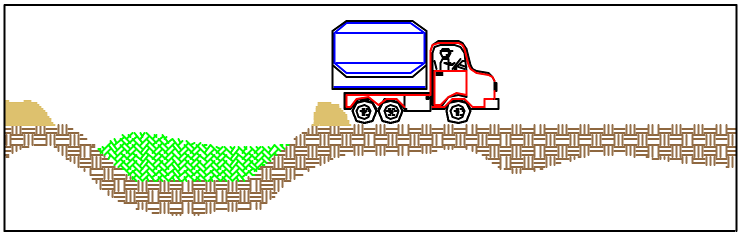
DESIGNED BY JP	SCALE 1:15000
DRAWN BY JP	DATE MAR 02
CHECKED BY RK	JOB NUMBER
SHEET 1 OF 1	DRAWING NO 1–C

Appendix C

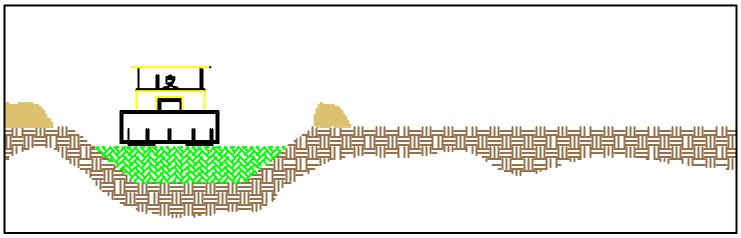
Trench Method



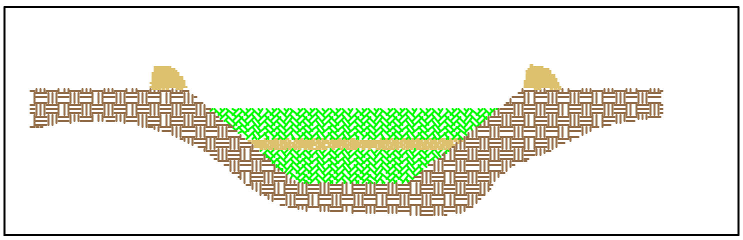
1. DIG TRENCH, 6 m (18 ft.) WIDE UP TO 2.5 m (8 ft) DEEP. SLOPE SIDES TO PREVENT CAVE-INS. BUILD WHEEL STOP BERM ON DUMPING SIDE 0.45 m (1.5 ft) HIGH.



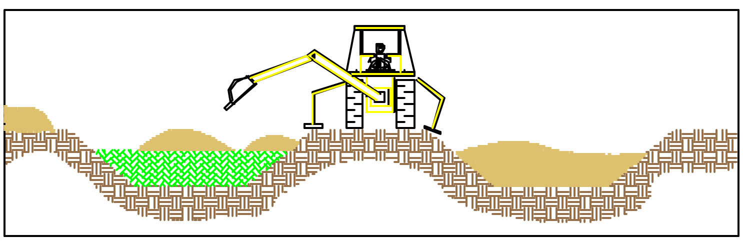
2. DUMP GARBAGE INTO TRENCH.



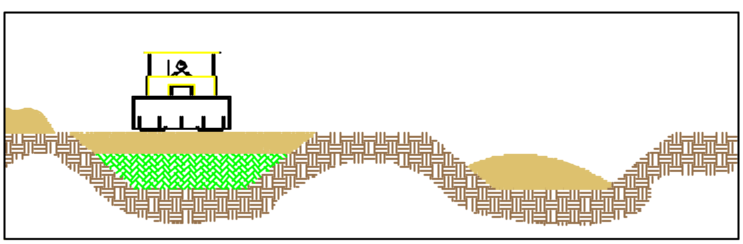
3. USE BULLDOZER ONCE PER WEEK TO PACK GARBAGE 3 TO 5 TIMES UNTIL PACKED GARBAGE IS 1 m (3 ft) THICK.



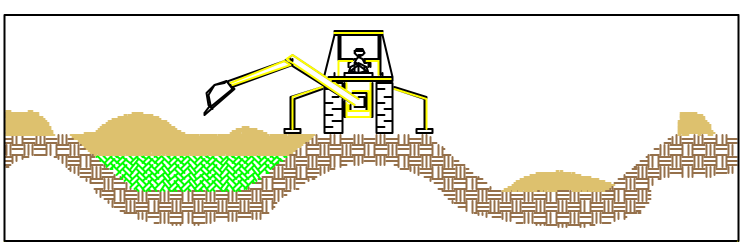
4. IF TRENCH IS DEEP ENOUGH TO DO MORE THAN ONE LAYER OF GARBAGE, PACK 0.3 m (1 ft) OF DIRT BETWEEN LAYERS OF GARBAGE.



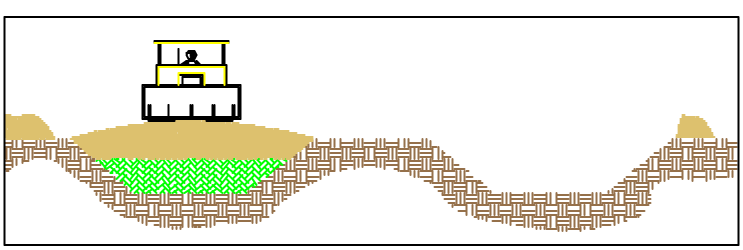
5. COVER GARBAGE WITH 0.3 m (1 ft) OF DIRT FROM NEW TRENCH WHEN CRUSHED GARBAGE IS 1 m (3 ft) THICK.



6. ADD AND PACK DIRT WITH BULLDOZER UNTIL EVEN WITH GROUND.



7. TO CLOSE OUT TRENCH, PACK DIRT WITH BULLDOZER UNTIL HARD SO THAT WATER RUNS OFF.



8. ADD MORE DIRT TO MAKE MOUND 0.3 m (1 ft) HIGH IN THE MIDDLE. MAKE SURE TO BUILD NEW 0.45 m (1.5 ft) WHEEL STOP BERM FOR NEXT TRENCH.

Appendix D

Cost Analysis

Whale Cove Option 1

Transfer of Shallow Dump Materials to Main Landfill	Estimated Values
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	4
Hours per work day	8
Number of Days	3
Truck /load	$80.00
Loader/hour	$150.00
Shovels	$80.00
Sub-total	**$7,520.00**
Supply and Spread of Fill Cover for Deposit Area	**Estimated Values**
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	2
Hours per work day	8
Number of Days	6
Loader/hour	$150.00
Truck /hour	$80.00
Number of trucks	2
Number of loaders	2
Fill material/m3	$35.00
Fill Supply	3,500
Sub-total	**$146,980.00**

Total	**$154,500.00**
Engineering and contingency @40%	**$61,800.00**
Total	**$216,300.00**

Transfer of Shallow Dump Materials to Main Landfill	$7,520.00
Supply and Spread of Fill Cover for Deposit Area	$146,980.00
Sub-total	$154,500.00
Engineering and contingency @40%	$61,800.00
Total	**$216,300.00**

Whale Cove Option 2

Transfer of Solid Waste to Active Site	**Estimated Values**
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	4
Hours per work day	8
Number of Days	0.5
Loader/hour	$150.00
Gravel truck /load	$1,000.00
Number of trucks	2
Number of loaders	2
Number of loads	10
Sub-total	**$9,520.00**
Supply and Spread of Fill Cover for Deposit Area	**Estimated Values**
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	2
Hours per work day	8
Number of Days	6
Loader/hour	$150.00
Truck /load	$80.00
Number of trucks	2
Number of loaders	2
Fill material/m3	$35.00
Fill Supply	3,500
Sub-total	**$146,980.00**

Total	**$156,500.00**
Engineering and contingency @40%	**$62,600.00**
Total	**$219,100.00**

Transfer of Solid Waste to Active Site	$9,520.00
Supply and Spread of Fill Cover for Deposit Area	$146,980.00
Sub-total	$156,500.00
Engineering and contingency @40%	$62,600.00
Total	**$219,100.00**

Whale Cove Option 3

Transfer of Shallow Dump Materials to Main Landfill and fill puddles	**Estimated Values**
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	4
Hours per work day	8
Number of Days	4
Truck /load	$80.00
Loader/hour	$150.00
Fill material/m3	$35.00
Fill Supply	100
Sub-total	**$13,420.00**

Total	**$13,420.00**
Engineering and contingency @40%	**$5,368.00**
Total	**$18,788.00**

Transfer of Shallow Dump Materials to Main Landfill and Fill Puddles	$13,420.00
Sub-total	$13,420.00
Engineering and contingency @40%	$5,368.00
Total	**$18,788.00**

Whale Cove Option 4

Waste Lining Shoreline	Estimated Values
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	2
Hours per work day	8
Number of Days	1
Truck /load	$80.00
Loader/hour	$150.00
Sub-total	**$2,240.00**
Fence	
Frost Fence /m installed	$150.00
1 Gate 1220 mm wide	$1,700.00
1 Gate 6000 mm wide	$3,500.00
Length of fence (m)	740
Sub-total	**$116,200.00**
Litter Fences	
Welder/hour	$50.00
Hours per work day	8
Number of Days	1
Scrap metal	$0.00
Sub-total	**$400.00**
Honey Bag Pit Burial	
Labourer/hour	$15.00
Loader/hour	$150.00
Hours per work day	8
Number of Days	1
Bag of lime	$250.00
Sub-total	**$1,570.00**
Peizometer Installation	
/peizometer with installation	$1,250.00
Number of pedometers	4
Sub-total	**$5,000.00**
Total	**$125,410.00**
Engineering and contingency @40%	**$50,164.00**
Total	**$175,574.00**
Clean up of Waste Lining Shoreline	$2,240.00
Fence Construction	$116,200.00
Litter Fence Construction	$400.00
Honey Bag Pit Burial	$1,570.00
Pedometer	$5,000.00
Sub-total	$125,410.00
Engineering and contingency @40%	$50,164.00
Total	**$175,574.00**

Whale Cove Option 5

Transfer of Bulky Wastes from Active Site	Estimated Values
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	4
Hours per work day	8
Number of Days	3
Loader/hour	$150.00
Gravel truck /load	$1,000.00
Number of trucks	2
Number of loaders	2
Number of loads	50
Sub-total	**$57,120.00**
Supply and Spread of Fill Cover for Deposit Area	**Estimated Values**
Forman/hour	$20.00
Hours per work day	8
Number of Days	3
Loader/hour	$150.00
Fill material/m3	$35.00
Fill Supply	1,800
Sub-total	**$67,080.00**

Total	**$124,200.00**
Engineering and contingency @40%	**$49,680.00**
Total	**$173,880.00**

Transfer of Solid Waste from Active Site	$57,120.00
Supply and Spread of Fill Cover for Deposit Area	$67,080.00
Sub-total	$124,200.00
Engineering and contingency @40%	$49,680.00
Total	**$173,880.00**

Whale Cove Option 6

Slopes sides of pit to 4:1	Estimated Values
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	4
Hours per work day	8
Number of Days	2
Dozer/hour	$150.00
Truck /load	$80.00
Number of dozer	2
Number of trucks	2
Sub-total	**$8,640.00**
Engineering and contingency @40%	**$3,456.00**
Total	**$12,096.00**

Slope Sides of Pit to 4:1	$13,420.00
Sub-total	$8,640.00
Engineering and contingency @40%	$3,456.00
Total	**$12,096.00**

Whale Cove Option 7

Transfer of Wastes from Active Site	**Estimated Values**
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	4
Hours per work day	8
Number of Days	3
Loader/hour	$150.00
Gravel truck /load	$1,000.00
Number of trucks	2
Number of loaders	2
Number of loads	50
Sub-total	**$57,120.00**
Bury and compaction of domestic waste	
Forman/hour	$20.00
Labourer/hour	$15.00
Number of Labourers	4
Hours per work day	8
Number of Days	3
Loader/hour	$150.00
Number of loaders	2
Sub-total	**$9,216.00**
Pedometer Installation	
/peizometer with installation	$1,250.00
Number of peizometers	4
Sub-total	**$5,000.00**
Supply and Spread of Fill Cover for Deposit Area	**Estimated Values**
Forman/hour	$20.00
Hours per work day	8
Number of Days	7
Loader/hour	$150.00
Fill material/m3	$35.00
Fill Supply	5,000
Sub-total	**$132,020.00**
Total	**$198,356.00**
Engineering and contingency @40%	**$79,342.40**
Total	**$277,698.40**
Transfer Bulky wastes from Active Site	$57,120.00
Bury and compaction of domestic waste	$9,216.00
Peizometer Installation	$5,000.00
Fill Cover for Deposit Area	$132,020.00
Sub-total	$198,356.00
Engineering and contingency @40%	$79,342.40
Total	**$277,698.40**

Option Combinations

	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
OPTION A	·			·			
OPTION B		·		·			
OPTION C			·	·	·		
OPTION D			·	·			
OPTION E	·			·	·	·	
OPTION F	·						·

	Cost
OPTION A	$391,874
OPTION B	$394,674
OPTION C	$368,242
OPTION D	$194,362
OPTION E	$361,550
OPTION F	$493,998