Table 6.5: Predicted Sewage Generation Beyond Year 2026

Year	Population	MACA Predicted Sewage Production (L)	MACA Predicted Sewage Production (m^3)
2027	2072	100520230	100520
2028	2110	102924133	102924
2029	2148	105392901	105393
2030	2186	107928488	107928
2031	2226	110532909	110533
2032	2266	113208245	113208
2033	2306	115956647	115957
2034	2348	118780333	118780
2035	2390	121681597	121682
2036	2433	124662807	124663
2037	2477	127726409	127726
2038	2522	130874930	130875
2039	2567	134110979	134111
2040	2613	137437253	137437
2041	2660	140856538	140857
2042	2708	144371710	144372
2043	2757	147985745	147986
2044	2806	151701714	151702
2045	2857	155522791	155523
2046	2908	159452257	159452

In order to treat sewage up to year 2046 (year 40 of system operation) the P Lake lagoon must be built up to accommodate 63 900 m^3 of sewage (160 000m^3 generated in 2046 – 96 100 m^3 capacity of primary lagoon). This may be accomplished by building up berms surrounding P Lake similar to those described in **Section 5.1**.

After this expansion, the system would operate in a slightly different manner. The primary lagoon would no longer act as an annual retention lagoon since it would no longer accommodate a year's volume of sewage. Once full, the primary lagoon would be discharged to the newly expanded P Lake lagoon. The P Lake lagoon would then act as an additional long retention plug flow lagoon. After making its way to the plug flow lagoon, effluent would flow by gravity to the wetlands area before final discharge to Telik Inlet.

7 SAMPLING PROGRAM

A key component to the operations and maintenance of the proposed sewage treatment system is a sampling program. Dillon has developed the following sampling program to:

- Monitor treatment and verify compliance to regulations; and
- Model and understand the treatment process to aid with future expansions of the system.

The proposed sampling program will address the water quality on a temporal basis, the cumulative impacts to the plants and soil, and allow for trending of the data to see if we reach a stasis point after several years of treatment. The sampling program should be undertaken by the community as part of the annual operations.

7.1 Sampling Protocol

It is estimated that 8 sample locations will be required to document conditions along the effluent path:

- Control;
- Primary Lagoon inflow;
- Primary Lagoon effluent;
- P Lake (Secondary) Lagoon effluent;
- Wetlands effluent; and
- 3 taken along wetlands (between P Lake discharge and outlet).

Water samples would be taken weekly, during periods of open water. With these sample locations, each stage of the treatment process would be noted, with emphasis on the wetlands area. This sampling protocol would need to be conducted over several years, to obtain data for trend analysis. It could be scaled down after the first year, to remove sample locations that are not considered essential (i.e. lagoon inflow, along wetlands flow path).

As recommended in Dillon's "Sewage Treatment Using Tundra Wetlands" report (1997), a site specific ecological study of the wetland system should be undertaken, to identify and characterize the plant species in the wetland system. If this is conducted before discharging sewage to the wetland and for a few subsequent years, it could be used to monitor changes in the plant species with time. A minimum of two plots is recommended, located along the wetlands channel, and one control plot. Data would be collected twice during the growing season, late June (early stages of growth) and early-August (peak growth). This should be conducted by trained biologists, made up of the same team each season, to ensure consistency. No sample analysis is required, as data collection and logging is done in the field, by trained personnel. Costs would include the time and disbursements to send biologist(s) to site to conduct survey, twice/year.

Cumulative impacts to the soil have not been addressed in the above program. Sediment sampling could occur, if desired, at various locations along the wetlands. Deposition rate could be measured, or sediment samples could be analyzed themselves, for various parameters. These options could be explored further, if desired.

Table 7.1: Analytical Parameters and Costs for Water Sampling

Parameter	Analytical Cost*
BOD_5	$21.60
Fecal coliforms	$11.20
Total suspended solids	$8.80
Ammonia nitrogen	$12.80
Total phosphorus	$14.40
Total (per sample)	$68.80

*Based on prices from Accutest Laboratories in Ottawa

For 8 samples, the total cost would be: $550.40 + GST

For weekly samples, over 10 weeks, the total cost would be: $5504.00 + GST

7.2 Sample Shipment

If samples are taken early Tuesday or Thursday mornings, they can be shipped on the 11 am First Air flight to Iqaluit. There is a 6 pm freighter from Iqaluit to Ottawa on Tues/Thurs. Coolers can be delivered/picked-up first thing Wednesday or Friday morning to/by Accutest.

According to Accutest, FC samples need to be analyzed within 48 hours, and BOD_5 samples need to be analyzed within 7 days of sampling. For both parameters, 24 hours is preferred between sampling and analysis, but not required.

Shipping costs are approximately $140 (general) and $180 (priority). Regular shipping should be sufficient to make the Iqaluit connection, but it could be sent priority just in case.

7.3 Sampling Equipment

Sample bottles and coolers will be sent to the community by Accutest. Latex gloves will be required for each sample. If a boat was available, samples could be taken from the middle of the wetlands.

Cost of latex gloves for the summer: $80

8 CONSTRUCTION STRATEGY

The GN's intent is to complete this project over the fiscal years 2005/06 and 2006/07. The work is to proceed with the supply of as much of the materials on the 2005 sea lift. Some earth works may proceed in 2005. The majority of the works will be completed in 2006. The tender of the major works will occur in 2005. The entire project is to be commissioned in September/October 2006.

A schedule outlining this construction strategy is shown in **Table 8.1**.

Table 8.1: Project Schedule

Task	**Milestone Date**
Acceptance of the Pre-Design Document	October, 2005
Site Survey, geotechnical investigation & Community Consultation	August 2005
Fisheries study Field Work	August 2005
50% submission Detailed Design	August 2005
Application for Water License	**July 6th, 2005**
Completion of Fisheries Study	August 2005
100% Submission of Detailed Design	October 2005
Comments Received From DFO & EC	November 2005
Comments Received From Water Board	December 2005
Comments Received From Client	September 2005
Authorization From Water Board received	December 2005
Tender Period	January 2005
Construction FY 2006	
Contract Award	January, 2006
Quarrying	January to March, 2006
Construction FY 2007	
Quarrying and material mobilization	April to June 2006
Road Construction	July 2006
Lagoon works	July to September 2006
Sea lift of materials	September 2006
Commissioning	October 2006

9 APPROVALS

9.1 Regulatory Agencies

To complete this project there are several approval agencies that need to be made aware of the intended works. Not all of the agencies provide authorization, however, they all can be involved through the required licensing and authorization processes required of the project owner. **Table 9.1** outlines the agencies that need to be involved in the approval process.

Table 9.1: Approval Agencies

Agency	Regulations
Indian and Northern Affairs Canada (INAC)	Inland Waters Act Marine Waters Act Monitoring of Water Licenses
Department of Health	Health Act General Sanitation Act
Department of Fisheries and Oceans (DFO)	Fisheries Act (Section 35) related to fish habitat
Environment Canada (EC)	Fisheries Act (Section 36) related to the discharge of deleterious substances
Nunavut Water Board	Nunavut Land Claims agreement

Each of the above agencies has been contacted to discuss their requirements for the proposed works. While the project proposal must meet the requirements of all the agencies of particular note are the Nunavut Water Board, the Department of Fisheries and Oceans, and Environment Canada. The project can not proceed without specific authorization from each of these three bodies.

The Water Board issues a Water License to the community for the withdrawal of water (over 50,000 L) and the subsequent deposit of the waste water. There is a formalized licensing process and application form to be completed and submitted to the Water Board for review and approval. This can only proceed once the detailed design is at the point to show sufficient information for the Board's review.

9.2 DFO Approvals

In September 2005 Dillon Consulting Limited (Dillon), on behalf of the Government of Nunavut (GN) submitted a report to the Department of Fisheries and Oceans (DFO) concerning the fisheries at P Lake. A description of the work plan and results is described in Section 4.0 of this report.

9.2.1 Access to "P" Lake, and Impacts to Fish or Fish Habitat

A new road has been planned to access "P" Lake. Based on the information we have, there is no indication that the road will have any impact on fish or fish habitat. The current road design does not include any stream crossings, nor does the route encroach on any permanent water bodies. All construction work will likely be carried out in isolation of flow or in the dry. The culvert being installed is intended to handle natural runoff that intersects the road at the point indicated on figure 2.

Additional sediment resulting from the construction works will not enter any fish habitat. During construction, sediment controls will be in place to ensure sediment-laden water is not released to areas downstream of the work site. All disturbed areas will be isolated from fisheries habitat, and there will be no permanent disruption of native plants or grasses.

9.3 Water License Application Requirements

As part of the regulatory review process completed by Dillon, the technical advisor for the Nunavut Water Board was contacted to discuss the requirements for the Water License application. With the license application, or shortly after the application, the Water Board will likely require the submission of the following documents;

- Operations and Maintenance Plan for the Proposed System
- Abandonment and restoration plan for the Existing 3 Cell Sewage Lagoon System
- Abandonment and Restoration Plan for the new P Lake lagoon system
- An Emergency or Contingency Plan to address the potential for sewage discharge in the event that the new system (P Lake Lagoon) is not accessible. An example would be in blizzard conditions when the access road maybe blocked with snow.

The GN has identified the use of the existing Cell 1 of the 3 cell system as a potential resolution to the contingency plan at times that the proposed access road is inaccessible. This will be carried forward through the design.

10 SUMMARY AND CONCLUSIONS

The new sewage treatment system will be designed for a 20-year life span (2006-2026). Predicted population values until the year 2020 were provided by Nunavut Bureau of Statistics (**Appendix D**). The population for 2026 was predicted to be 2002 persons. Based on this information, the lagoon will be designed to treat 96 100 m^3, the annual sewage volume for a population of 2002 persons.

Cape Dorset trucked sewage is assumed to have the following characteristics:

- Average raw Biochemical Oxygen Demand (BOD_5) concentration of 625 mg/L
- Average raw suspended solids (SS) concentration of 900 mg/L

The lagoon treatment system will be designed to meet the following effluent criteria:

- 45 mg/L BOD_5
- 45 mg/L SS
- 10^4 Fecal Coliform / 100mL

Dillon has taken several measures to predict treatment quality and ensure that the lagoon treatment systems effluent discharged to Telik Inlet will meet the above criteria. Each method indicates that the use of an annual storage lagoon will meet the discharge criteria.

The annual retention lagoon will be constructed with (near) rectilinear dimensions to promote plug flow conditions. Plug flow conditions are important during the time of annual discharge in order to prevent short circuiting, or raw sewage by-passing treatment and directly discharging to P Lake. The lagoon will be constructed to facilitate anaerobic sewage treatment (at full capacity) using the following characteristics:

- 3.5 m liquid operating depth
- 0.5 m of allowance on the lagoon bottom for sludge accumulation

The size of the lagoon was determined to accommodate the above design parameters and the predicted volume of sewage generated in 2026 (96 100 m^3). The parameters of the lagoon are:

- 185 m x 132 x to the lagoon liquid surface at full capacity in year 2026 (3.1 ha)
- 179 m x 129 m to the inside toe of the berms (2.4 ha)

The above dimensions can be accommodated by the proposed area preceding P Lake.

Drawings 100-112 show the proposed detail to be carried forward to the detailed design phase. This includes;

- Approximately 950 meters of new road construction. The road will have a maximum grade of 6%. Guardrails will be installed on all down gradient edges. The road width will be 8.0 meters.
- A truck turn around pad.
- A gravity truck discharge flume.
- A gravity discharge pipe complete with an access vault and valve to control the lagoon discharge
- Ditching and culverts to direct runoff away from the lagoon.
- The lagoon walls will be constructed partially from fill, and partially from cut into the rock. The rock removed will be use for fill sections. The inside of the lagoon walls will be riprap protected in the fill sections.

The estimated cost of construction for the proposed system is shown in **Table 10.1**. Life cycle costing is shown in **Table 10.2.**

Table 10.1 Cost Estimates

Item	Units	Quantity	Unit Cost	Total Cost
Access Road & Truck Pad				
Cut (rock blasting)	M3	3,921	$100	$392,100
Fill (borrow)	M3	22,405	$35	$784,175
Granular 19 mm Minus	M3	901	$50	$45,050
Culvert (1,200 mm)	LM	78	$50	$3,900
Guard Rail	LM	276	$200	$55,200
Road Delineators	each	160	$50	$8,000
Lagoon Construction				
Cut (rock blasting)	M3	0	$100	$0
Fill (borrow)	M3	21,942	$35	$767,970
Rip Rap	M2	686	$35	$24,010
Discharge Flume	Each	1	$10,000	$10,000
Effluent Discharge Structure	Each	1	$80,000	$80,000
Bollard	Each	30	$500	$15,000
Ditching	LM	350	$10	$3,500
Liner	M2	3,200	$40	$128,000
Subtotal				2,316,900
Engineering	10%			230,000
Contingency	20%			460,000
GST	7%			210,000
Total				**$3,217,000**

The above costs include the cost of mobilization for equipment, manpower and material (other than granular) to the community. It has been assumed that part of the equipment and labour will be provided from the local contractors and labour forces in accordance with the Inuit Content requirements for the contract.

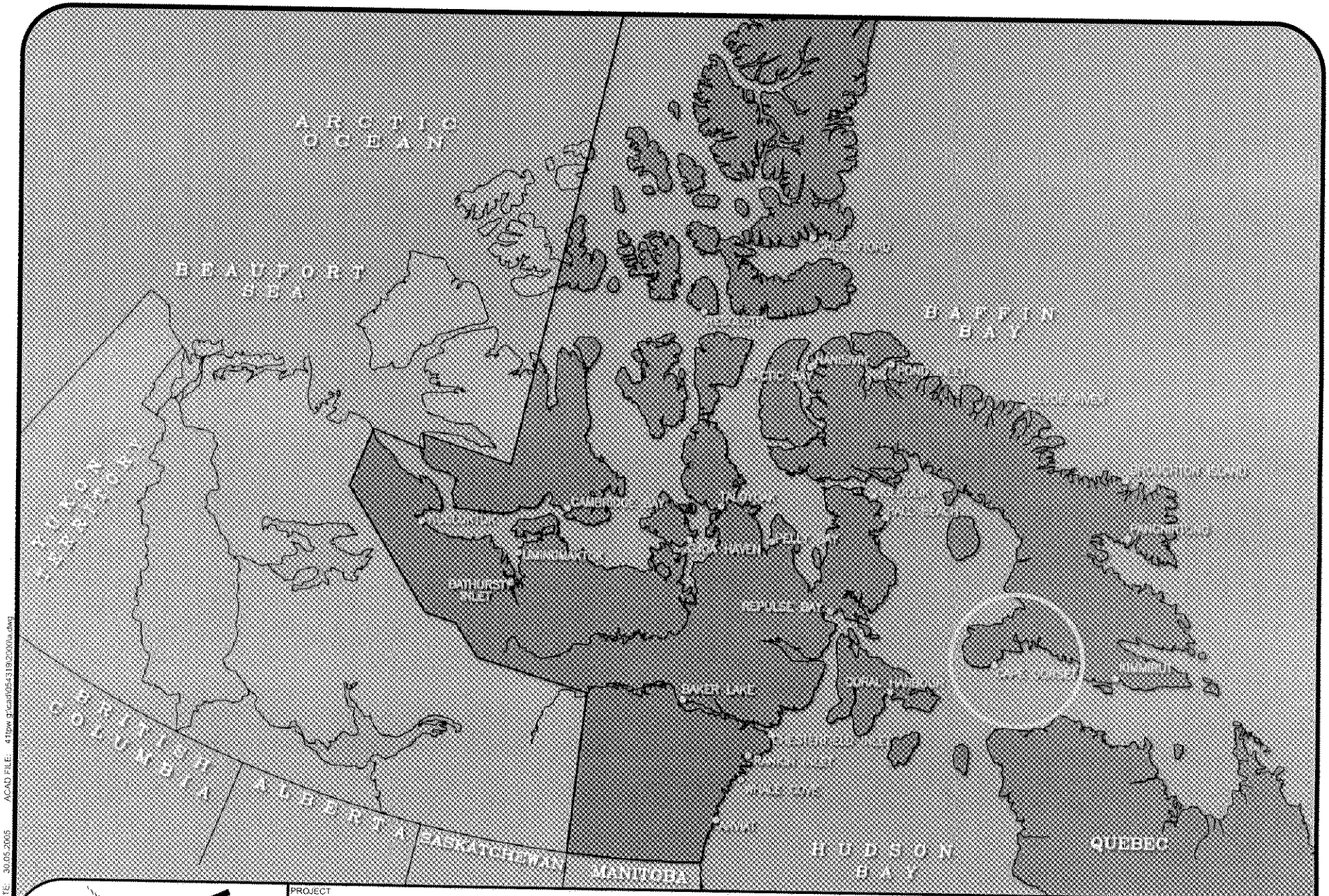
Table 10.2 Life Cycle Costing

Item	Total Cost
Total Lagoon Capital	**$3,047,000**
Total Sewage Hauling Life Cycle Costing[1, 2]	**$14,827,000**
Total Life Cycle Costing[1]	**$17,874,000**

[1]Life Cycle Costing is determined for a 20 year life, using an 8% discount rate. [2] Sewage hauling Life Cycle Costing is determined from a template provided by the Department of Municipal and Community Affairs, Government of the Northwest Territories.

APPENDIX A

FIGURES



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DILLON CONSULTING

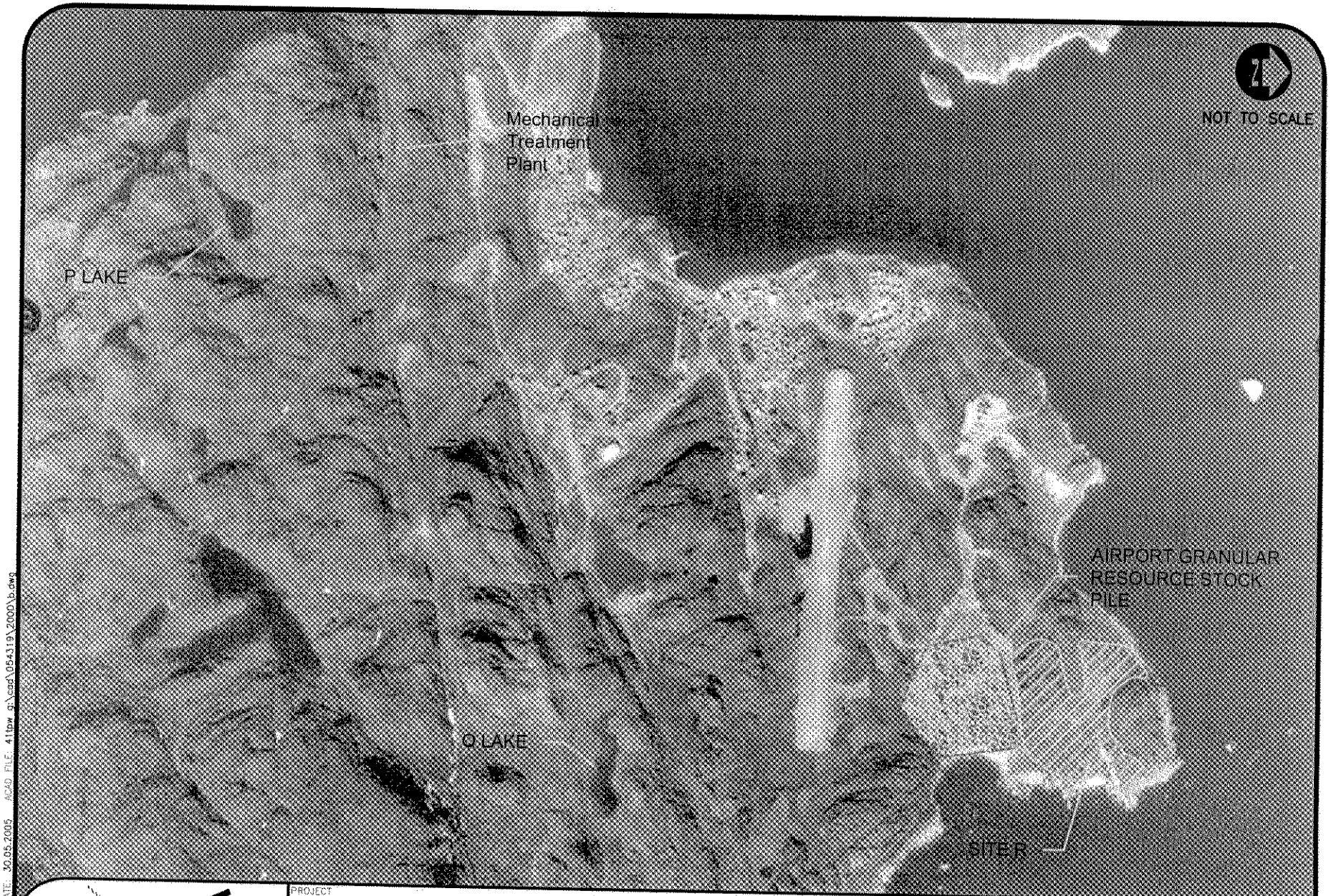
PROJECT
Cape Dorset
Sewage Treatment System

TITLE
Cape Doset Location Plan

PROJECT NUMBER
05-4319-2000

DATE
May 05

FIGURE NUMBER
A



DILLON CONSULTING

PROJECT
Cape Dorset
Sewage Treatment System

TITLE
Community Layout and Alternative Sites

PROJECT NUMBER
05-4319-2000

DATE
May 05

FIGURE NUMBER
8

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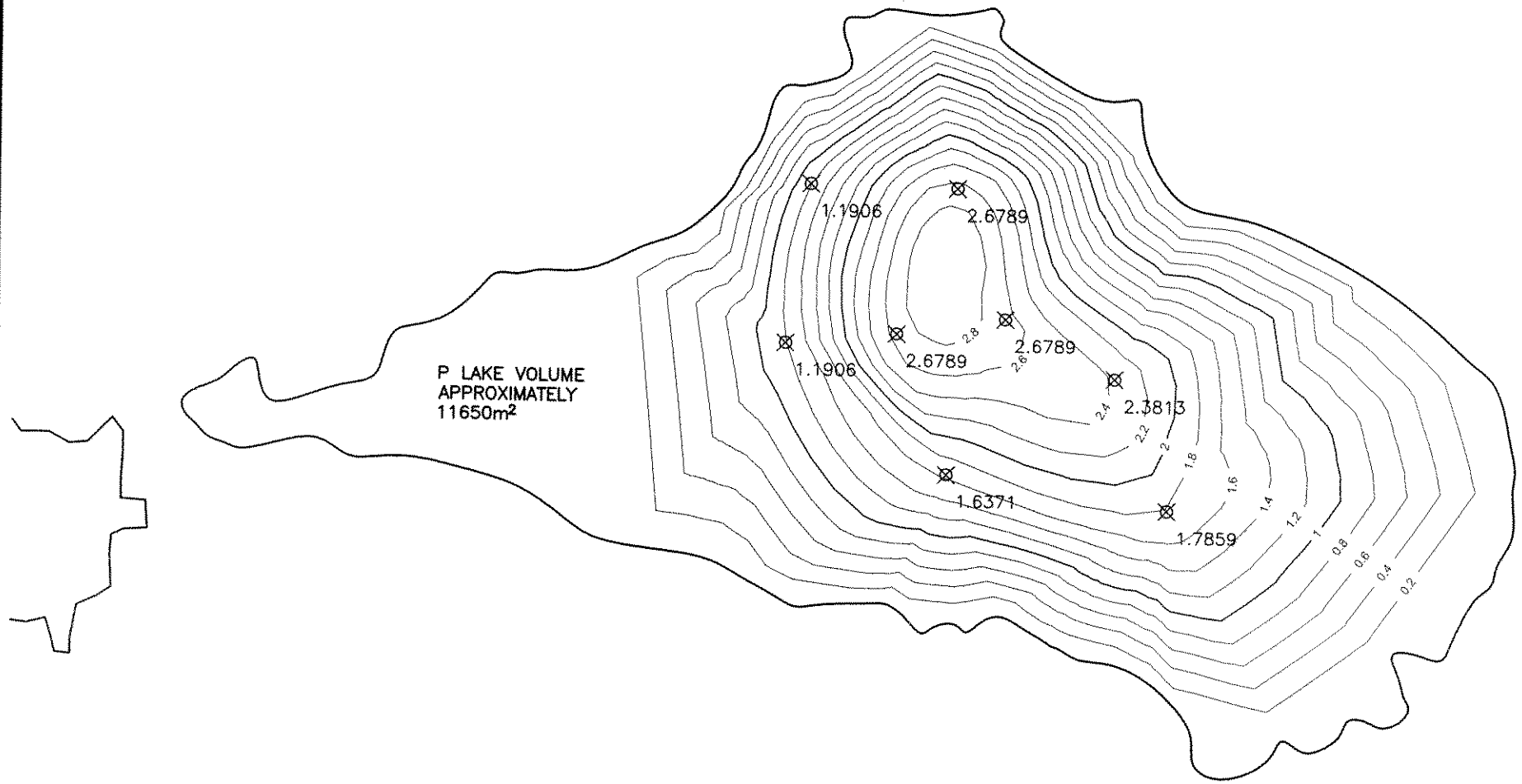

NOTE: ALL DIMENSIONS ARE IN METERS UNLESS NOTED OTHERWISE.

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DILLON CONSULTING

PROJECT
Cape Dorset
Sewage Treatment System

TITLE
Bathymetry of Lake – P

PROJECT NUMBER
05-4319-2000

DATE
June 05

FIGURE NUMBER
C