OPERATION AND MAINTENANCE MANUAL

SEWAGE TREATMENT FACILITY INUVIK, N.W.T.

2010 UPDATE

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Acknowledgment:
Associated Engineering Services Ltd, designer of the Sewage Treatment Facility, prepared the first edition of this Manual (1982).
Reid Crowther and Partners Ltd prepared the second edition (1994).
The 2010 Update incorporates minor changes made since 1994.

OPERATION AND MAINTENANCE MANUAL

SEWAGE TREATMENT FACILITY INUVIK, N.W.T.

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1.0 DESCRIPTION OF FACILITY

1.1 General

Inuvik treats municipal sewage in a three-cell lagoon system, located immediately northwest of the developed townsite area. The receiving water is the East Channel of the Mackenzie River (Figure 1).

1.2 History of Development

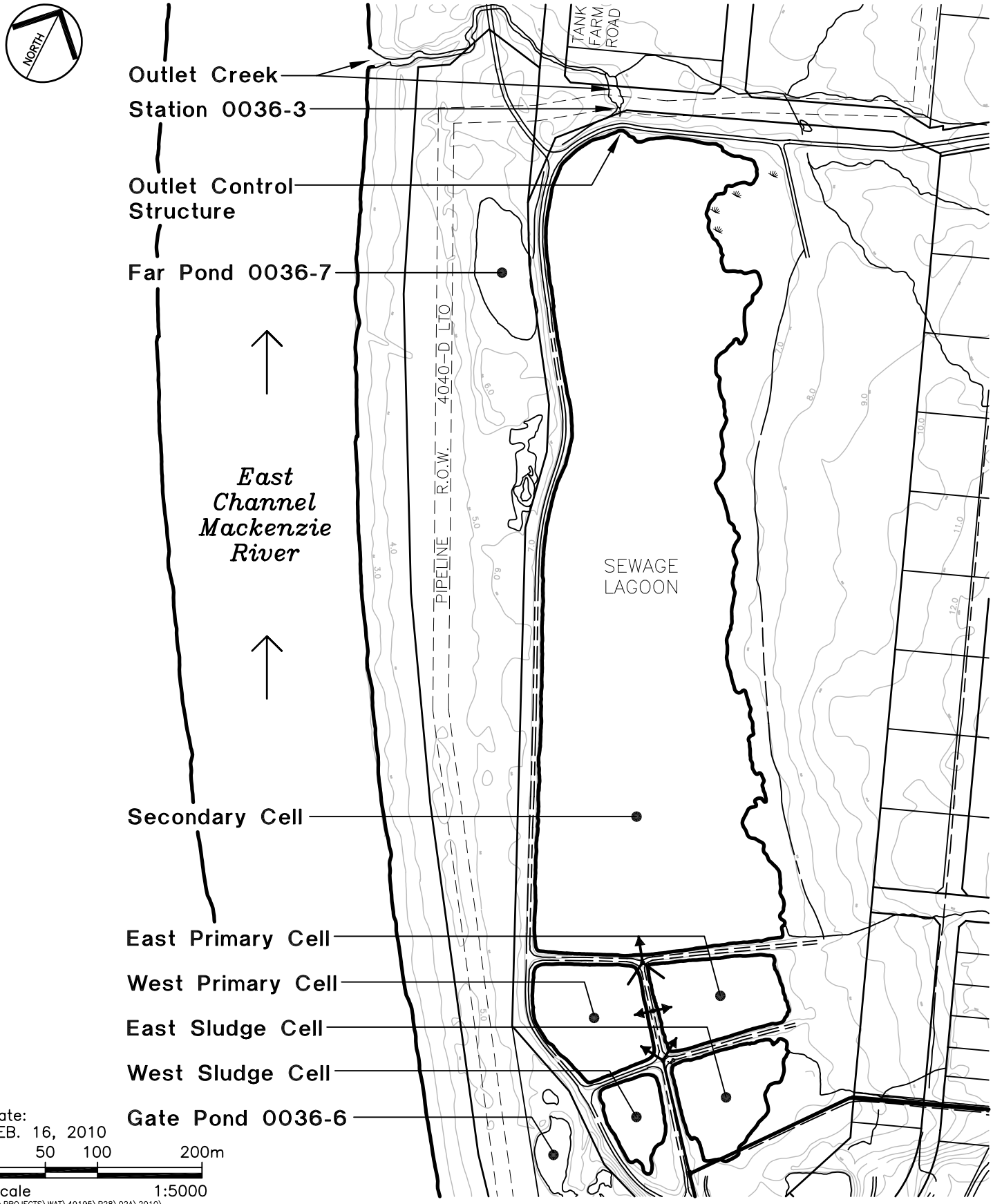
The sewage treatment facility was first constructed as a one-cell system in 1957. A pre-existing brush-filled slough was enclosed on three sides by dikes, to form a single large, shallow cell, 1,000 m long by about 200 to 250 m wide. Inuvik's trunk sewer discharged into the lagoon's south end. The lagoon's level was controlled by a stoplogged outlet built into its north dike. The outlet discharged into a small creek, which runs 370 m westerly to East Channel.

The lagoon system's two primary cells were built in 1982, by partitioning the southern portion of the existing lagoon with a number of dikes. In total, the 1982 project included building new dikes within the original lagoon's southern end to form two new sludge holding cells and two new primary cells; extending the trunk sewer pipe along the new sludge cells' median dike to reach the new primary cells; installing structures within the new primary cells' median dike to control flow into and through the new cells; raising and widening the entire lagoon system's north and west dikes; replacing the outlet weir structure at the original lagoon's north end; and addition of a sewage truck discharge station at its south end. Associated Engineering Services Ltd (AESL) of Edmonton, Alberta provided engineering services including construction oversight; Goodbrand Construction Ltd. of Whitehorse was the builder, under a contract with Water and Sanitation Section, Town Planning and Lands Division, Department of Local Government, Government of the Northwest Territories.

Figure 2 shows the lagoon system's longitudinal cross section and hydraulic profile.

1.3 Treatment Process

Treatment processes and treatment performance are described briefly in Appendix I. In outline:



Town of Inuvik, N.W.T.
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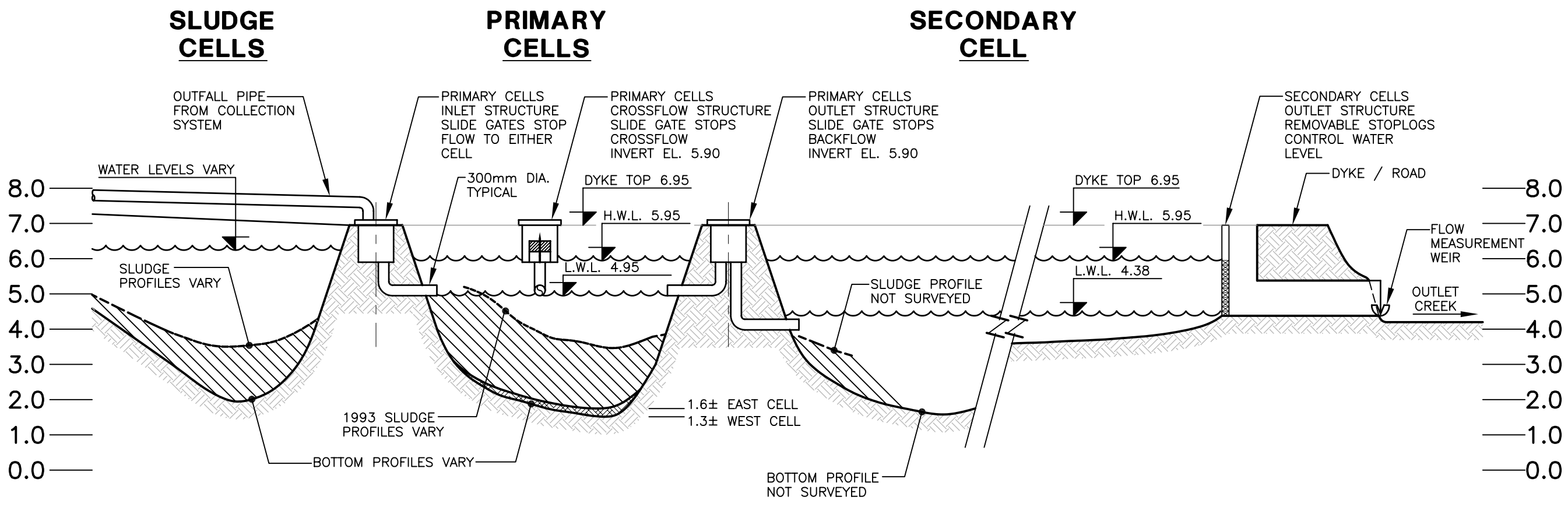
LAYOUT PLAN

AECOM

Figure 1



Note:

SYSTEM NORMALLY IS OPERATED AT H.W.L.
L.W.L. APPLIES IF LEVEL IS DRAWN DOWN FOR MAINTENANCE WORK. COMPLETE RE-FILLING AFTER TOTAL DRAW DOWN MAY TAKE SEVERAL SEASONS.

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Town of Inuvik, N.W.T.
Sewage Treatment O & M Manual
LAGOON HYDRAULIC PROFILE DIAGRAM

AECOM

Figure 2

1. The primary cells retain settleable solids and floatables (oil, grease, plastics, etc.). Settled material accumulates in a dedicated storage volume in the lower part of each cell. Because "digestion" of sludge proceeds quite slowly in cold climates, sludge accumulations need to be removed (transferred to the sludge cells) at intervals of five to ten years.

2. The secondary cell provides an environment where biological processes break down and stabilize dissolved organic matter, and where natural ultra-violet light and natural predation can eliminate pathogenic (disease-causing) micro-organisms. Since these processes are dependent on warm temperatures and sunlight, the secondary cell's efficiency is good in summer but poor in winter. Under ice cover it achieves only minor additional settlement of solid material.

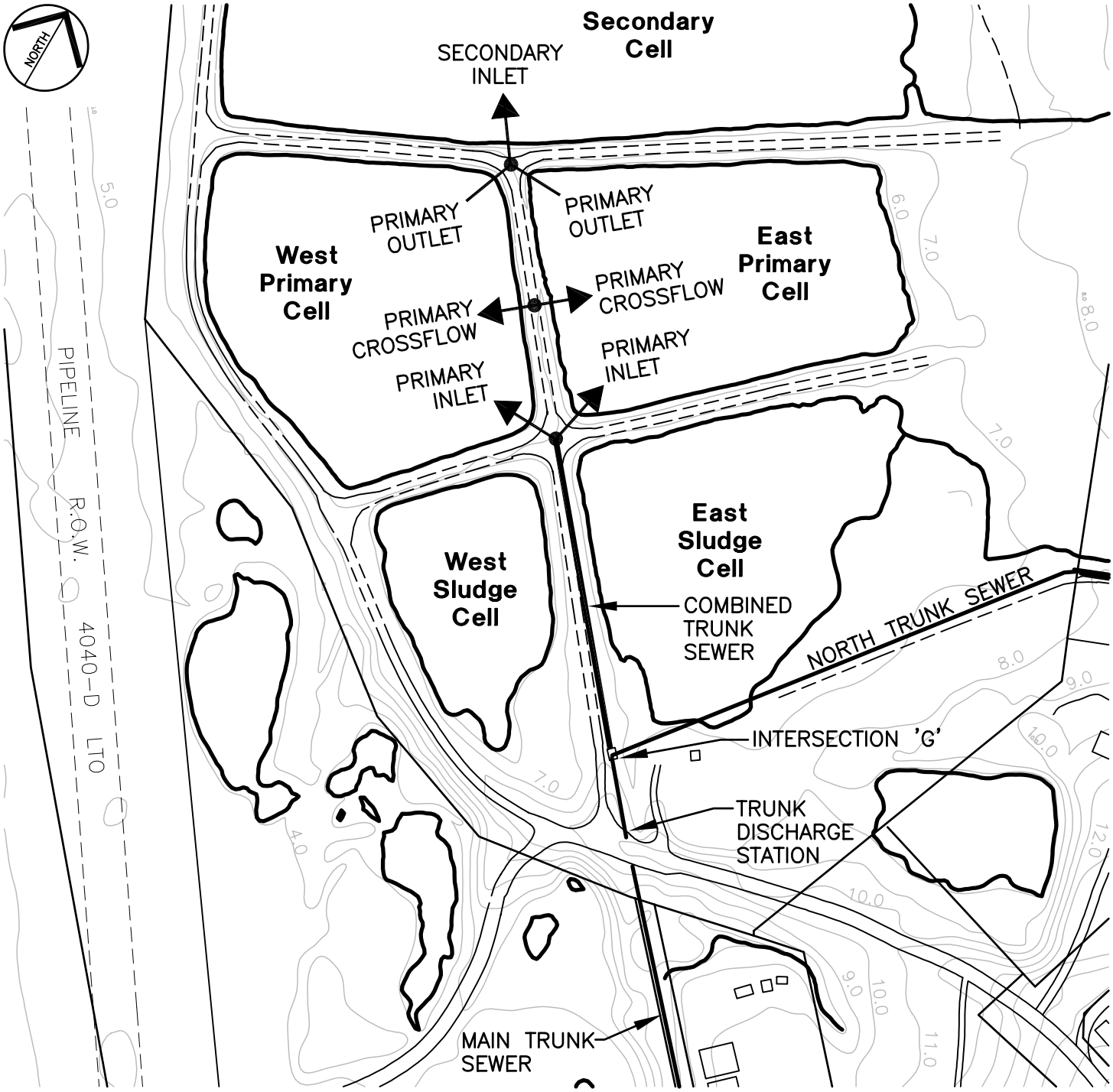
1.4 Basins

As indicated above the system has five basins: the east and west sludge cells; the east and west primary cells, and the secondary cell. In the 1982 construction program all basin dikes were constructed or raised to a crest elevation of 6.95 m (Geodetic). Planned freeboard in the lagoon cells is 1.0 m, yielding a planned high water level (HWL) of 5.95 m. The sludge cells can be operated with a freeboard as little as 0.5 m, and possibly less, yielding a HWL of 6.5 m or higher.

1.4.1 Sludge Cells

The layout of the sludge cells is shown in Figure 3.

The sludge cells were surveyed by Reid Crowther and Partners Ltd (RCPL) in October 1992 to determine available capacity, in preparation for a transfer of sludge from the primary cells to the sludge cells which took place in the summer of 1993. Capacity data are reported in Table 6, relative to a high water level in the sludge cells of 6.00.



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LAGOON SMALL BASINS

AECOM

Figure 3

TABLE 1

SLUDGE CELL VOLUMES AND SLUDGE VOLUMES

Fraction bottom to top	From m	To m	East m^3	West m^3	Total m^3
Freeboard	6.00	7.00	11,118	4,906	16,024
Empty	Var.	6.00	9,005	5,197	14,202
Water & Ice	Var.	Var.	2,542	761	3,303
Sludge	Var.	Var.	3,564	1,758	5,322
Total	Floor	7.00	26,229	12,622	38,851
Available to HWL	Sludge	6.00	11,547	5,958	17,505
Freeboard	6.00	7.00	11,118	4,906	16,024
Total Capacity	Var.	7.00	22,665	10,864	33,529

At the time of the survey, water levels were 4.75 m in the east cell and 4.30 m in the west cell. Water levels rise to top-of-dike height in the east cell, and sometimes in the west cell, during spring runoff.

The volume of sludge transferred in 1993 totalled about 13,500 m^3. Over time this volume will be reduced by freeze-thaw de-watering, consolidation, and biological digestion.

1.4.2 Primary Cells

The layout of the primary cells is shown in Figure 3.

The original Operations and maintenance manual for the lagoon system ("O & M" Manual) (AESL, 1982) indicates that the primary cells are designed to provide a minimum of five days retention [using combined capacity] at design flow. This is a normal design objective for primary cells.

The following key elevations are from AESL's construction drawings. [Elevations have been converted from IAND datum to geodetic.]

- Top of dike 6.95 m.
- High water level (HWL) 5.95 m, controlled by the maximum height of stoplogs in the secondary cell's outlet structure.
- Low water level (LWL) 4.95 m, controlled by the invert level of the outlets from the primary cells to the secondary cell. (Obviously, level in the primary cells is controlled by level in the secondary cell whenever the secondary cell is above LWL.)
- Cell bottom level 3.95 m approximately. (Bottom levels were measured by RCPL in October 1992 and July 1994, to average about 2.5 m in the east cell and about 1.7 m in the west one. Therefore, the actual volumes and retention capacities of both cells are somewhat greater than designed.
- Maximum sludge level 1.0 m above an assumed bottom elevation of 3.95 m; therefore, 4.95 m.

RCPL's surveys (1992 and 1994) indicate that the primary cells total volumes below HWL are: east, 21,250 m^3; west, 29,340 m^3; total, 50,590 m^3.

The allocation of available primary cell volume between ice allowance, fluid fraction and sludge storage was reviewed by RCPL in 1992. The design conditions adopted were:

- Five day retention at current peak day flow, 3.2 ML/d, with 25 percent allowance for growth; total 20 ML.
- Lagoon level at HWL.
- Ice cover 0.8 m (average).

The ice cover allowance may seem small, in light of the thickness of 2 m or more common to northern lakes. However, it is noted that maximum wastewater flow, which occurs in January or February, does not coincide with maximum ice thickness, which in natural lakes around Inuvik occurs in April. More importantly, sewage carries a lot of heat into the primary cells, and loss of heat to atmosphere is resisted by ice and snow cover. Actual thickness could be confirmed through field measurements taken in late winter.

The allocation of primary cell volumes recommended by RCPL is shown in Table 2.

TABLE 2

RECOMMENDED ALLOCATION OF PRIMARY CELL VOLUMES

Fraction bottom to top	From m	To m	East m^3	West m^3	Total m^3
Floor to HWL	Var.	5.95	21,249	29,338	50,587
Ice	5.15	5.95	6,996	8,020	15,016
Fluid	Var.	5.15	8,014	11,986	20,000
Sludge, max.	Var.	Var.	6,239	9,332	15,571

1.4.3 Secondary Cell

The secondary cell is about 770 m long by 180 m wide, on average. At HWL 5.95 it has a surface area of 14.0 ha, and a total volume of 225,000 m^3. Maximum ice thickness is estimated to be 1.5 m and maximum ice volume is estimated to be about 155,000 m^3; leaving a minimum effective volume at HWL of 70,000 m^3.

1.5 Physical Components

Physical components are described briefly below.

1.5.1 Dikes

All dikes have a minimum top width of 4 meters, side slopes of 3 to 1, and are construction to elevation 6.95 m Geodetic Datum. Surfacing gravel was placed on selected portions of the dikes to allow all-weather vehicular access.

1.5.2 Truck Discharge

The tank truck discharge facility provides a 100 mm diameter flanged outlet for disposal of sewage from tank trucks.

1.5.3 Valve House

The "valve house" predated the 1982 project and although redundant was not modified. It does not contain valves. Rather, it is the point at which two trunk sewers converge. The combined flow is discharged through the trunk sewer line, to the primary cells.

1.5.4 Trunk Sewer Line

The trunk sewer line extends from the valve house to the inlet structure. It consists of 400 mm diameter steel pipe with flanged joints, covered with 50 mm of insulation and banded-on sheets steel jacketing. The insulated, jacketed pipe rests on timber sleepers.

1.5.5 Primary Cells Inlet Structure

The primary cells inlet structure contains slide gates which allow the operator to direct sewage into the east primary cell, the west primary cell, or into both primary cells at the same time. Under usual operation both gates are open.

1.5.6 Primary Cells Crossflow Structure

The primary cells crossflow structure connects the two primary cells mid-way between the primary cells inlet structure and the primary cells outlet structure. The crossflow structure contains a slide gate which allows the operator to stop crossflow.

The crossflow structure has never been used and has no foreseen use. It was not re-built to design elevation along with restoration of the lagoon interior dikes in 2006, but could be restored if in future a need for it should arise.

1.5.7 Primary Cells Outlet Structure

The primary cells outlet structure contains slide gates which allow the operator to direct flow from either or both primary cells to the large secondary cell.

In operational experience the slide gates in the outlet structure have never been used and there is no foreseen need for them. The outlet structure was not re-built to design elevation along with restoration of the lagoon interior dikes in 2006, but it could be restored if in future a use for it should arise.

1.5.8 Lagoon Outlet Weir Structure

The lagoon outlet weir structure includes a stoplogged weir which allows the operator to control the liquid level in the large secondary cell (and also in the two primary cells if the level is above 4.95 m).

1.5.9 Fencing

Fencing and "No Trespassing" signs are provided at normal access points to discourage public access to the facility. "Danger - Thin Ice" signs are provided by Inuvik at appropriate locations.

2.0 OPERATION OF FACILITY

2.1 Introduction

In sharp contrast to the operation of mechanical sewage treatment works, the operation of a lagoon system is straightforward. Flow runs by gravity from headworks to outlet. Treatment occurs through natural processes along the way, without need for operator control.

2.2 Main Controls

As indicated earlier, the primary controls are:

1. Slide gates in primary cell flow control structures, which allow the operator to run the primary cells in parallel or in series, or to take one cell out of service for maintenance.

2. Stoplogs in the secondary cell outlet structure, which allow the operator to regulate the level in the secondary cell (and in the primary cells between the range 4.35 and 5.95 m); and which also provide the means of emptying the secondary cell.

2.3 Recommended Operating Regime

The primary cells are designed to be operated in parallel; that is, with the slide gates in the inlet, crossflow and outlet structures all fully open.

Under Inuvik's current (1993-1996) Water Licence, the system is to be operated as a flow through, continuous discharge facility throughout the year. Seasonal drawdowns are not part of the planned operating regime.

It is intended that all cells be operated at the planned HWL of 5.95 m throughout the year.

In this operating mode, the average rate of outflow from the outlet control structure will, in general, be about equal to the average rate of water consumption and sewage generation within Inuvik. (Uses of water which are independent of sewers, such as lawn care, are minor in Inuvik. Also, minor inflow of runoff to the lagoon, and evaporation losses from the lagoon, are neglected.)

The tops of the piles in the outlet structure are at elevation 6.95, 1.00 m above planned HWL.

2.4 Commentary on Past Operating Regime

Up to 1993 it was standard operating practice to discharge most of the contents of the lagoon system in fall, after a full summer's treatment. Following the fall discharge, part of the inflow was retained while part was discharged. Throughout the fall and part of the winter, the operating level gradually rose, until it again reached its normal maximum.

The fall drawdown was dropped in order to increase retention time, and to increase submergence of the outlet stoplogs in winter, and reduce the tendency for them to become blocked by ice.

Since 1993 the lagoon has operated on a continuous discharge basis year-round.

2.5 Drawdown

If it is necessary to draw down the level in the system, then the stoplogs in the outlet structures should be removed one at a time to maintain a moderate flow. Rapid discharge is likely to wash away the bedding around the outlet culverts.

2.6 Truck Discharge

The tank truck discharge facility should only be used by authorized tank truck operators. Care should be exercised in using the facility to ensure no spillage occurs.

The lagoon is designed to receive domestic sewage only. Absolutely no oil or petroleum products or toxic chemicals should be discharged into the lagoon at any time.

2.7 Enzyme Treatment

The primary cells are dosed with "Acti-zyme"[1] according to the following schedule:

- The three weeks immediately following melt of ice cover: one 50 lb bucket per cell per week.

[1] Acti-zyme Productions Ltd., Vancouver, B.C.

- Remainder of open water season: 25 lb (one half bucket) per cell per week.

Acti-zyme is supplied in 5 lb soluble bags. Bags are thrown from cell dikes, spread out to achieve good distribution.

2.8 Fencing

The gates in the fence should be kept locked at all times to discourage and limit public access.

3.0 MAINTENANCE OF FACILITY

3.1 General

A sewage treatment facility of this type has low daily maintenance requirements. Frequent routine inspection of the facility is, however, of prime importance.

3.2 Routine Inspection

It is recommended that the system be inspected twice weekly (or daily) during the summer and daily during the winter. Obviously, any problems discovered on an inspection trip should be rectified as soon as possible.

Routine inspection should cover:

- conditions at and around the sewage truck discharge station; spills.
- signs of unauthorized entry or willful damage at gates; and around structures.
- dike settlement or erosion.
- condition of control structures.
- flow problems; differences in levels between lagoon cells; possible blockages of flow structures; possible freezing.
- floating sludge "islands" (which need to be removed from primary cells from time to time).
- position of stoplogs in outlet structure; operating level.
- proper flow through outlet structure and channel (needed to prevent freezing in winter).
- outlet channel and culverts to East Channel clear of blockages and flowing freely (especially during winter).
- all other matters of interest.

3.3 Other Maintenance Requirements

3.3.1 Surface Drainage

The sludge cells tend to trap runoff water. During spring run-off, a large amount of water will enter the east sludge area in particular. Water should be pumped into the primary cells for disposal to prevent it from overtopping the dikes and causing erosion of the dikes.

3.3.2 Dikes

Some settlement can be anticipated in the dikes; however, the magnitude of settlement is not predictable from available information. Until the dikes and foundation soils adjust to a fully stable configuration, they should be built up periodically to original elevation in order to prevent overtopping during spring run-off or normal operation.

Surfacing gravel should be added to the dike crests as and where required to maintain all-weather vehicular access. Regrading should be carried out as required.

Dikes should be inspected annually by a qualified civil or geotechnical engineer to confirm general condition and stability. (This is also a Water License requirement: Condition D9, 2006 Water Licence.)

3.3.3 Trunk Sewer Line: Maintenance of Grade

Some settlement and movement is to be expected in the timber supports of the trunk sewer line. Supports should be inspected annually in the summer and wedges or other means should be used to raise the supports so that full support of the pipe is maintained.

3.3.4 Trunk Sewer Line: Maintenance of Flow

In recent years there has been a tendency for gravel to accumulate in the section of the trunk sewer downstream from the truck discharge, the suspected source being hydro-vac trucks used alternately for sewage trucking and ground excavation. Gravel needs to be flushed out each summer or more often, to avoid blockages.

3.3.5 Primary Cell Control Structures

Gravel washed or flushed down from the truck discharge station needs to be removed from the primary cells' inlet structure and the pipes leading to the primary cells. Check monthly during the summer.

Build-up of sludge around the ends of the pipes leading to the primary cells needs to be removed each summer, using a backhoe. This is also a good opportunity to remove any sludge mats floating within the primary cells. Material removed is deposited in the sludge holding cells. While this is routine annual maintenance it does involve transfer of a small amount of sludge transfer; hence it is prudent to advise the Water Board in advance.

Prior to freeze-up, it is essential to ensure that there are no blockages in the flow channels in the primary cells' inlet and outlet structures. Clean the pipes using a hydro-vac, if not already done earlier in the summer. The frost covers should be properly positioned to protect the structures.

The heat in the incoming sewage should be sufficient to keep the flow channels in these structures open through the winter. However, if freezing is discovered during the daily winter inspections, some appropriate action can be taken. It should not be necessary to remove the frost covers to see if there are problems as flow restrictions make themselves apparent in other ways. For example, the liquid level in the primary cells will increase if there is no flow into the secondary cell.

3.3.6 Secondary Cell Outlet

The outlet structure depends on frozen-in-place steel piles for stability, structural integrity and watertightness. Thurber Consultants Ltd. (Appendix B) recommends that piles be monitored by annual survey for signs of settlement or heaving of piles.

3.3.7 Outlet Creek to East Channel

Ensure that the creek bed and culvert are free flowing and clear of blockages in the fall. The creek froze off in the winter of 1991-92, backing up and resulting in a freeze-up in the outlet structure. Snow insulation over the flow channel probably helps to prevent freezing.

3.3.8 Infrequent Transfer of Accumulated Sludge from Primary Cells

When the accumulation of sludge in the primary cells approaches the design volume reported earlier, it should be removed from the primary cells and disposed of.

In 1993, 13,500 m^3 of sludge was transferred from the primary cells to the sludge cells; the first such operation since the primary cells were commissioned. The work was done by Marathon Waterworks Ltd. of Hay River, N.W.T., using a "Watermaster" equipped with a cutter suction dredge. The operation took about ten days to complete, and caused surprisingly little in the way of odours or other noticeable effects.

Since the 1993 sludge transfer operation, the rate of sludge accumulation has been much less. The change is attributed to enzyme addition, commenced not long after. Possible increase in primary cells' winter temperatures since Inuvik's 1998 change to residual heat for raw water tempering may also be a factor. Nevertheless, sludge accumulation needs to be monitored, by survey every two or three years.

3.3.9 Fencing

To discourage and limit public access, the fence should be kept in good repair and the no trespassing signs should be highly visible at all times.

4.0 WATER LICENCE REQUIREMENTS

4.1 Introduction

Inuvik's lagoon is operated under a Water License issued by the Gwich'in Land and Water Board (GLWB). Water license requirements relevant to normal lagoon O&M not covered elsewhere in this Manual are summarized here. Consult the actual license for precise wording. Also, consult the actual license for topics not included here, such as conditions pursuant to modifications of the facility; detailed requirements for routine reports; among others.

Inuvik's current water licence (2010) runs from July 1, 2006 to June 30, 2016. It is important to note that standards and requirements set out in the license are subject to change by the Water Board, upon issuance of a new licence or at any other time.

Indian and Northern Affairs Canada carries out inspections to ensure that the Water Board's requirements are being met. At this time, the Inspector is Mr. Jan Davies, INAC, Inuvik, 979-3361.

4.2 Water License Lagoon Operating Standards

Dike freeboard is to be maintained at 1.0 m.

Inuvik is to advise the Inspector 10 days before initiating a "batch decant" (lowering of lagoon water level).

4.3 Mandatory Routine Lagoon Performance Monitoring

Inuvik's water license sets monitoring requirements for effluent quality and dike integrity (the "Surveillance Network Program", or SNP). Samples are taken from designated sampling stations at stated intervals. Samples are analyzed for specified parameters, and results are reported to the water board in routine quarterly and annual reports.

Sampling stations related to the lagoon sysem are listed below:

- Station SNP 0036-3. Lagoon (secondary cell) outlet. Used to monitor effluent quality.

- Station SNP 0036-6. Pond just outside the lagoon system's west dike, near the entry gate adjacent to the truck discharge station ("Gate Pond"). Used to monitor pond for possible sewage contaminants, as a warning of possible leakage through the dike.

- Station SNP 0036-7. Pond just outside the lagoon system's west dike, 800 m northwest of Gate Pond ("Far Pond"). Used to monitor pond for possible sewage contaminants, as a warning of possible leakage through the dike.

- Station SNP 0036-8. Twin Lakes, west basin. Used as a background reference against which to compare results from Gate Pond and Far Pond.

Station locations are to be marked by signs, so that sampling locations remain consistent.

Specific instructions covering many aspects of sampling are provided in the "QA QC Program". The current edition (Revision "g") is in Appendix V.

4.4 Routine Effluent Monitoring and Performance Standards

Effluent (Station 0036-3) is sampled monthly. Parameters monitored and quality limits according to the current water licence are:

Biochemical oxygen demand (5-day) "BOD")	150 mg/L
Suspended solids (SS)	70 mg/L
Fecal coliforms (FC)	10^6 CFU/dL
pH	between 6 and 9
Oil and grease	not visible sheen
Ammonia nitrogen	no stated limit

Limits (except for pH) apply to average concentration of four consecutive SNP results. Means for BOD and SS are arithmetic, and for FC geometric. pH is not averaged. An additional limit of 150 mg/L also applies to any BOD grab sample.

In addition, the total mass of BOD discharged to East Channel is not to exceed 80 tonnes per year.

4.5 Batch Decant

In the event of a batch decant (lowering of water level in the secondary cell or all cells) effluent is to be sampled and tested for the usual parameters 10 days before the start, at the start, in the middle, and at the end.

4.6 Pond Surveillance

Ponds (Stations 0036-6, 7 and 8) are sampled annually, in September. The parameters tested for are the same as for Station 0036-3. The water board may order additional tests.

4.7 Spills, Unauthorized Discharges

It is a requirement of the water license (and legislation) that any spill be reported to the 24-hour spill report line, 867-920-8130.

4.8 Other Requirements

The water license requires an annual review and updating of the O&M manual for the lagoon and the SNP QA QC Program. Updating can be done by issue of errata where issue of an entirely new edition is not warranted.

Inuvik is required to advise the water board at least 60 days in advance of any planned modifications to the sewage treatment facility.

The water license requires submission of quarterly reports and an annual report covering many aspects of lagoon (and water use and solid waste site) operations, etc. Specific requirements are detailed in the water license (SNP, Section D). An engineer's certification of lagoon dyke stability is required annually (License, D9).

A special report is required following completion of a batch decant.

REFERENCES

Associated Engineering Services Ltd. Predesign Study of Sewage Treatment and Disposal, Inuvik, N.W.T. Report to Town of Inuvik, 1980.

Associated Engineering Services Ltd. Design Brief: Sewage Treatment Facility, Inuvik, N.W.T. Report Town of Inuvik, 1982 (a).

Associated Engineering Services Ltd. Operation and Maintenance Manual: Sewage Treatment Facility, Inuvik, N.W.T. Prepared for Town of Inuvik, 1982 (b).

Dawson, R.N. Report re Conventional Long Retention Sewage Lagoon Treatment at Inuvik, N.W.T. Public Health Engineering, Department of National Health and Welfare, Canada, 1966.

Heinke, G.W., D.W. Smith and G.R. Finch. Guidelines for the Design, Operation and Maintenance of Wastewater Lagoon Systems in the Northwest Territories, Vol. 1, Planning and Design. Department of Municipal and Community Affairs, Government of the Northwest Territories, 1988.

Heinke, G.W. and D.W. Smith. Guidelines for the Design, Operation and Maintenance of Wastewater Lagoon Systems in the Northwest Territories, Vol. 2, Operation. Department of Municipal and Community Affairs, Government of the Northwest Territories, 1988.

Jacobsen, N.A. Evaluation of a Sewage Lagoon at Inuvik, N.W.T. M.A.Sc. thesis, Department of Civil Engineering, University of Toronto, 1972.

Lambourne Enterprises Ltd. Alternative Methods of Sludge Removal from Sewage Lagoons at Inuvik, N.W.T. Report to Northwest Territories Power Corporation, 1991.

Magditch, A. and Heinke, G.W. Performance Study of the Lagoon at Inuvik, N.W.T. M.A.Sc. thesis, Department of Civil Engineering, University of Toronto, 1985.

Northwest Territories Water Board. Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories, 1992.

Reid Crowther & Partners Ltd. Primary Lagoon Sludge Management, Inuvik N.W.T. Report to the Inuvik Utilities Planning Committee, 1993.

Reid Crowther & Partners Ltd. Submission to the Northwest Territories Water Board In Support of the Town of Inuvik's Application for Renewal of Water Licence N3L4-0036. Report to Northwest Territories Water Board, 1993.

Reid Crowther & Partners Ltd. Operation and Maintenance Manual, Sewage Treatment Facility, Inuvik, N.W.T. Update of Associated Engineering Services Ltd 1982b for Town of Inuvik, 1994.

Schneiter, R.W., E.J. Middlebrooks and R.S. Sletten. "Cold Regions Wastewater Lagoon Sludge Accumulation". Water Research, 17:1201-1206, 1983.

Schneiter, R.W., E.J. Middlebrooks and R.S. Sletten. "Cold Regions Wastewater Lagoon Sludge Characteristics". Water Research, 18:861-864, 1984.

Smith, D.W. and G.R. Finch. A Critical Evaluation of the Operation and Performance of Lagoons in Cold Climates. Environmental Engineering Technical Report 85-2. Department of Civil Engineering, University of Alberta, Edmonton, Alberta, 1985.

APPENDIX I

TREATMENT PROCESS AND PERFORMANCE

CONTENTS:

APPENDIX I
TREATMENT PROCESS AND PERFORMANCE

(Section 1.1 is taken directly from the original O & M Manual; AESL, 1982.)

1.1 Treatment Process

When sewage is discharged into a natural lake or river, its load of organic wastes is assimilated and stabilized by bacteria and other small organisms. Pathogenic (disease-causing) microbes also carried in the sewage gradually die off in the outside environment, and are reduced as well by predators.

A sewage lagoon system is a confined, controlled space in which sewage is retained, while these natural processes occur. Lagoons also trap and hold most of the manufactured items that are discarded through the sewer, many of which resist degradation by natural environmental systems.

Inuvik's lagoon system has two stages. In the first, sewage passes through one of a pair of small "primary" cells, designed to retain and store heavier, "settleable" solids. In the second, the partially-clarified sewage is held for a period of months, to give bacteria and algae an opportunity to break down organic constituents.

The primary cells are designed for a minimum of five days retention at design flow. It is estimated that about 75 percent of the suspended solids carried in the sewage will settle here. Sludge retention is therefore estimated as shown in Table I.1.

TABLE I.1

EXPECTED RETENTION OF SOLIDS IN PRIMARY CELLS

	POPULATION	
Solids Component	3000	7000
Total solids, 450 mg/L	890 Kg/d	2080 Kg/d
Suspended solids	250 Kg/d	580 Kg/d
Settleable solids, retained	190 Kg/d	440 Kg/d
Sludge volume, 5.5% solids	3.4 m^3/d	7.9 m^3/d
Sludge volume	1250 m^3/yr	2900 m^3/yr

Some stabilization of retained sludge will occur in the primary cells, by anaerobic decomposition. Anaerobic processes produce gases, some of which are odourous; odours from the primary ponds may be particularly noticeable in the time around break-up. On the whole, however, odours should be very much reduced below the levels resulting from the exposed sludge banks of former years, once those banks have been covered.

The secondary cell volume remaining after construction of the primary cells will provide about two months retention at design average flow. The degree of treatment expected in the lagoon system is estimated very roughly to be as shown in Table I.2.

TABLE I.2

APPROXIMATE FORECAST OF EFFLUENT QUALITY

		POPULATION 3000		POPULATION 7000	
	Influent	Summer	Winter	Summer	Winter
BOD5, mg/l	250	40	55	60	75
*SS, mg/L	125	25	25	30	30
E. Coli/100 mL	10^7	10^4-10^5	10^4-10^5	10^4-10^5	10^4-10^5

*SS = Suspended Solids

1.2 Treatment System Performance

If the lagoon system is operated at normal high water level throughout the winter, then with maximum anticipated ice formation in all cells, and maximum anticipated sludge accumulation in the primary cells, the two primary cells currently (1994) provide a minimum of about 8 days retention, and the large secondary cell about 27 days retention. The comparable figures for summer operation, when there is no loss of volume to ice, are 18 days and 112 days respectively.

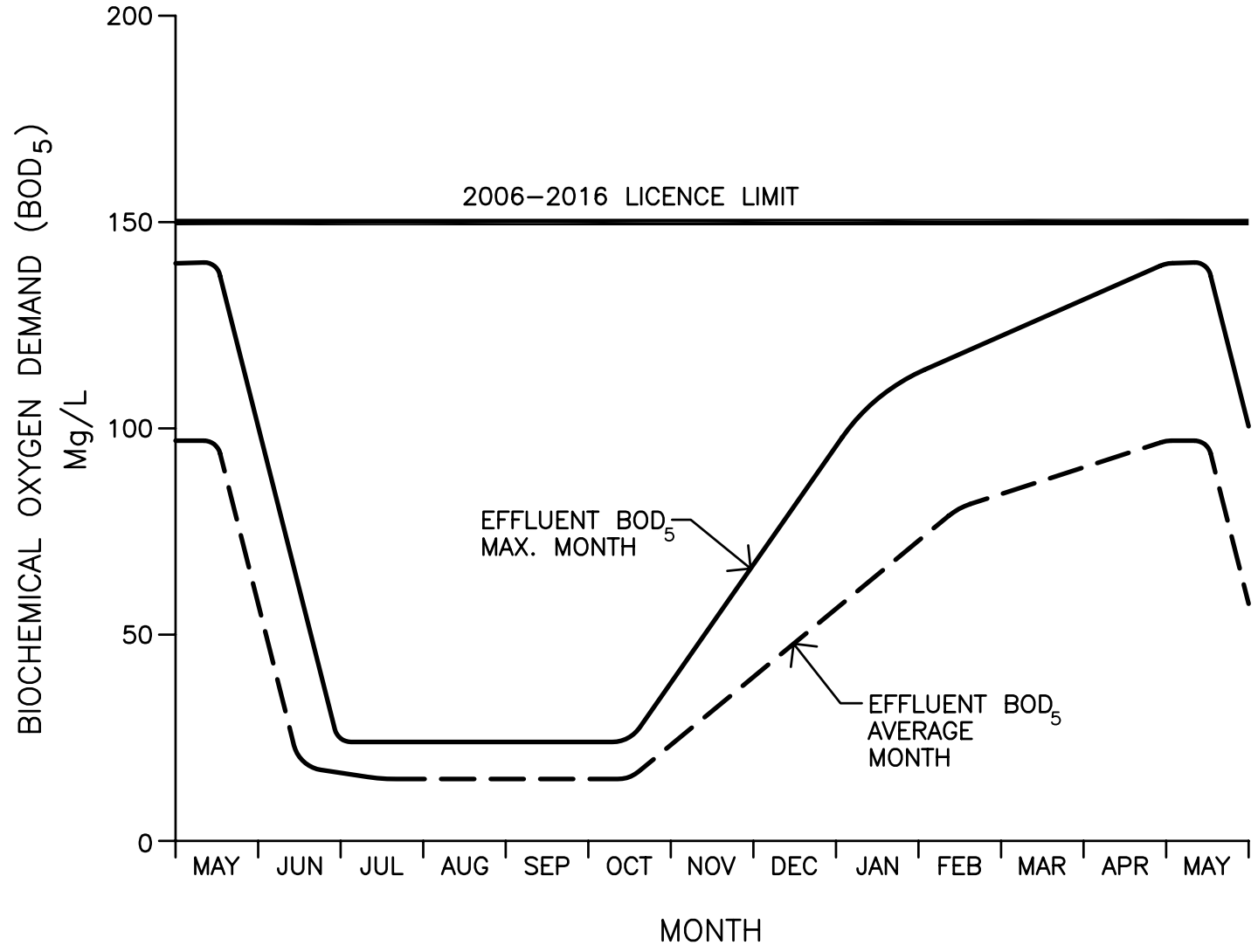
The performance of the wastewater treatment system, through its typical annual cycle, is shown in Figure I.1, I.2, and I.3. The three figures refer to BOD, SS and Fecal Coliforms, respectively, and as well show relevant limits. The performance

figures are based on data available from effluent quality monitoring records, and data reported by Magditch and Heinke (1985).

It is not expected that an increase in population, and in effluent quantity, in the order of, say, 20 percent, would change the system's performance significantly. The small reduction in retention time, and the small increase in loading, would have essentially no effect on wintertime effluent quality, and little, if any, effect on summertime effluent quality. At most, average BOD and TC in summer might rise slightly, but the effect, if any, would be small.

Figure I.1 and I.3 show very clearly the cyclic seasonal pattern of microbial activity, including disinfection activity, in the secondary lagoon.

SEASONAL PERFORMANCE
BIOCHEMICAL OXYGEN DEMAND (BOD_5)
Typical Effluent Ranges
During 2006–2016 Water Licence Period



Date: FEB. 16, 2010

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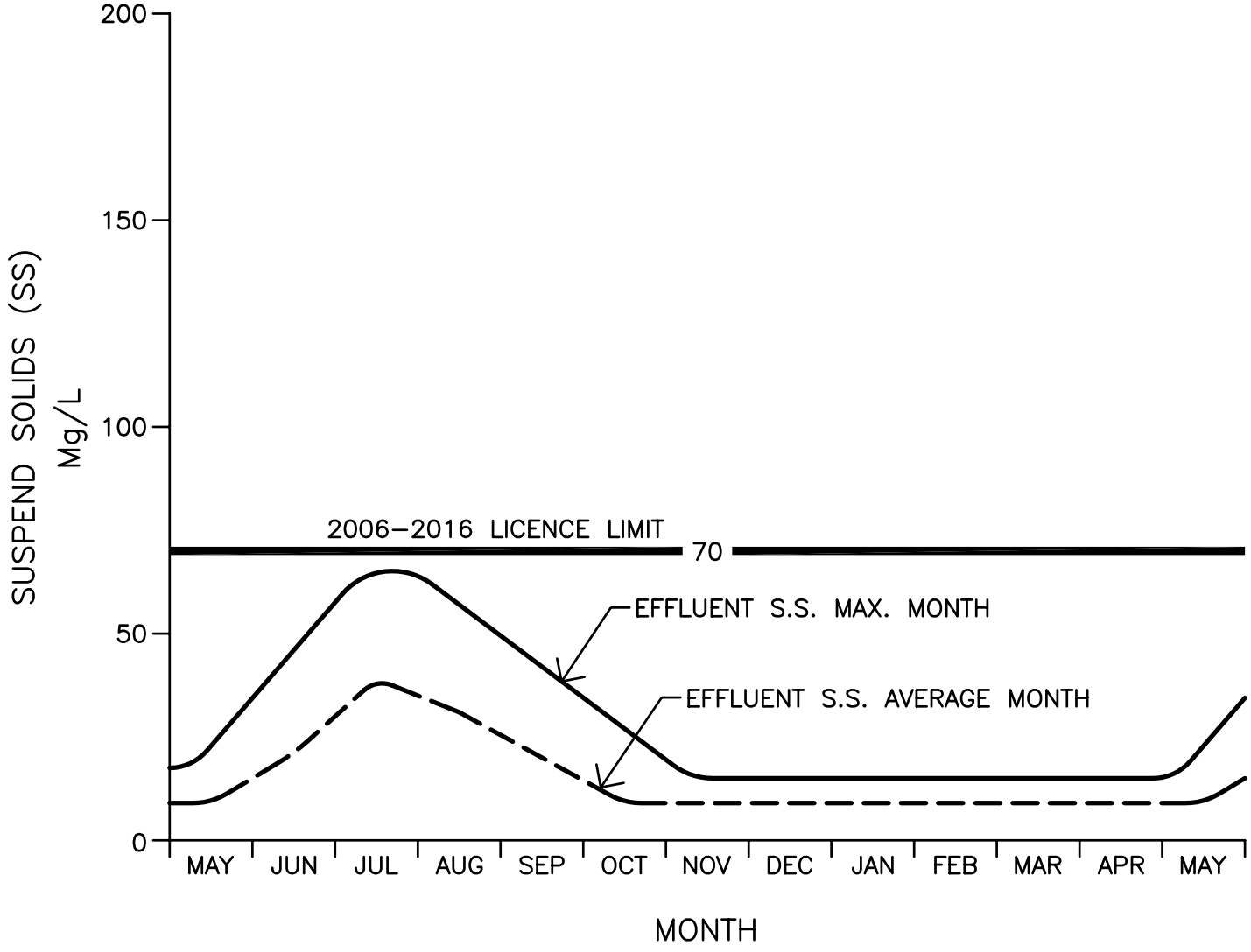
Cadd File:49195_FIG_01.1.dwg
Last Edit:2010-02-16 (15:00)
Plot Scale: 1:1 (A4)

Town of Inuvik, N.W.T.
Sewage Treatment O & M Manual
PERFORMANCE, BOD_5

AECOM

Figure 1-1

SEASONAL PERFORMANCE
SUSPENDED SOLIDS (SS)
Typical Effluent Ranges
During 2006–2016 Water Licence Period



Date: FEB. 16, 2010

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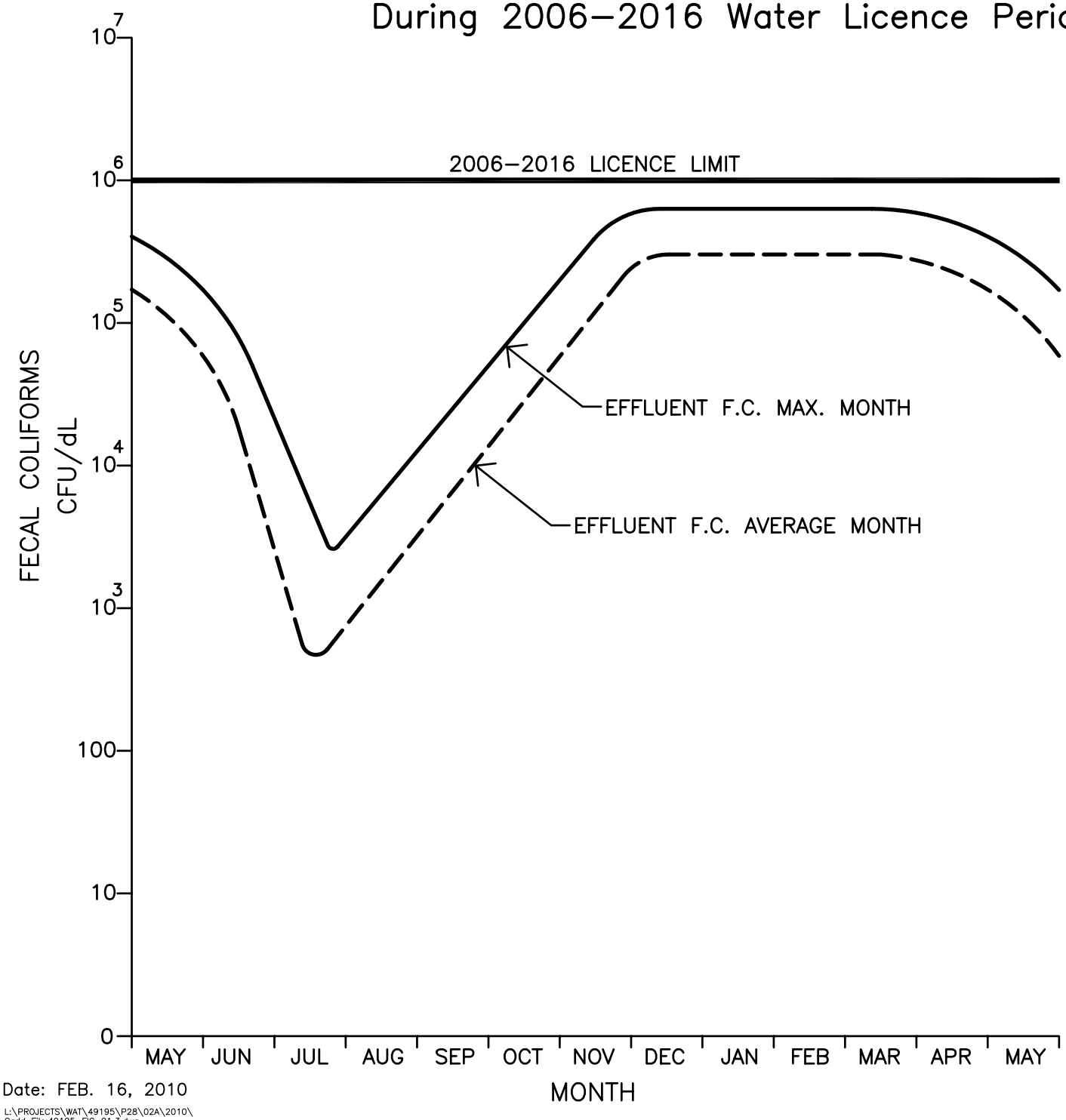
Last Edit:2010–02–12 (15:00)
Plot Scale: 1:1 (A4)

Town of Inuvik, N.W.T.
Sewage Treatment O & M Manual
PERFORMANCE, SUSPENDED SOLIDS

AECOM

Figure 1-2

SEASONAL PERFORMANCE
FECAL COLIFORMS (FC)
Typical Effluent Ranges
During 2006–2016 Water Licence Period



Date: FEB. 16, 2010

L:\PROJECTS\WAT\49195\P28\02A\2010\
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Plot Scale: 1:1 (A4)

Town of Inuvik, N.W.T.
Sewage Treatment O & M Manual
PERFORMANCE, FECAL COLIFORMS

AECOM

Figure 1-3

APPENDIX II

CELL VOLUME ESTIMATES

CONTENTS:

INUVIK LAGOON SYSTEM -- ESTIMATED VOLUMES OF ALL CELLS

Normal operating level = HL = 5.95 m

	East Primary Cell			West Primary Cell			Secondary Cell			Totals		
Elev	Area	DVol	CumVol	Area	DVol	CumVol	Area	DVol	CumVol	Area	DVol	CumVol
m	ha	m3	m3	ha	m3	m3	ha	m3	m3	ha	m3	m3
5.95	0.94	467	21941	1.06	526	30172	14.00	6937	224812	15.99	7930	276926
5.90	0.93	463	21475	1.05	523	29646	13.75	6813	217875	15.73	7798	268995
5.85	0.92	459	21012	1.04	519	29123	13.50	6687	211062	15.46	7666	261197
5.80	0.91	455	20553	1.04	516	28604	13.25	6562	204375	15.20	7533	253532
5.75	0.91	451	20099	1.03	513	28087	13.00	6437	197812	14.93	7401	245999
5.70	0.90	447	19648	1.02	509	27575	12.75	6312	191375	14.67	7269	238598
5.65	0.89	443	19201	1.02	506	27065	12.50	6188	185063	14.41	7136	231329
5.60	0.88	439	18758	1.01	503	26559	12.25	6062	178875	14.14	7004	224193
5.55	0.87	435	18319	1.00	499	26057	12.00	5937	172812	13.88	6872	217188
5.50	0.87	431	17884	1.00	496	25557	11.75	5812	166875	13.61	6740	210316
5.45	0.86	427	17453	0.99	493	25061	11.50	5687	161063	13.35	6608	203577
5.40	0.85	424	17025	0.98	489	24569	11.25	5563	155375	13.08	6476	196969
5.35	0.84	420	16602	0.98	486	24079	11.00	5437	149812	12.82	6344	190493
5.30	0.84	416	16182	0.97	483	23593	10.75	5312	144375	12.55	6211	184150
5.25	0.83	412	15766	0.96	480	23110	10.50	5187	139063	12.29	6079	177938
5.20	0.82	409	15354	0.96	476	22630	10.25	5062	133875	12.03	5947	171859
5.15	0.81	405	14945	0.95	473	22154	10.00	4938	128813	11.76	5815	165911
5.10	0.81	401	14540	0.94	470	21681	9.75	4812	123875	11.50	5684	160096
5.05	0.80	397	14139	0.94	467	21211	9.50	4687	119062	11.24	5551	154412
5.00	0.79	393	13742	0.93	463	20744	9.25	4578	114375	10.97	5434	148861
4.95	0.78	388	13349	0.92	458	20281	9.06	4484	109797	10.76	5331	143427
4.90	0.77	383	12961	0.91	453	19823	8.88	4391	105313	10.56	5227	138096
4.85	0.76	378	12578	0.90	449	19369	8.69	4297	100922	10.35	5124	132869
4.80	0.75	373	12199	0.89	444	18921	8.50	4203	96625	10.14	5021	127745
4.75	0.74	369	11826	0.88	440	18476	8.31	4109	92422	9.94	4918	122724
4.70	0.73	364	11457	0.87	435	18037	8.13	4016	88313	9.73	4815	117807
4.65	0.72	359	11093	0.87	430	17602	7.94	3922	84297	9.53	4712	112992
4.60	0.71	354	10734	0.86	426	17171	7.75	3828	80375	9.32	4609	108281
4.55	0.70	350	10380	0.85	421	16745	7.56	3734	76547	9.11	4506	103672
4.50	0.69	345	10030	0.84	417	16324	7.38	3641	72813	8.91	4403	99167
4.45	0.69	340	9685	0.83	413	15907	7.19	3547	69172	8.70	4300	94764
4.40	0.48	135	9344	0.58	164	15495	7.00	3453	65625	8.05	3752	90464
4.35	0.00	0	0	0.00	0	0	6.81	3359	62172	6.81	3359	62172
4.30							6.62	3266	58813	6.62	3266	58813
4.25							6.44	3172	55547	6.44	3172	55547
4.20							6.25	3078	52375	6.25	3078	52375
4.15							6.06	2984	49297	6.06	2984	49297
4.10							5.87	2891	46312	5.87	2891	46312
4.05							5.69	2797	43422	5.69	2797	43422
4.00							5.50	5313	40625	5.50	5313	40625
3.90							5.13	4938	35313	5.13	4938	35313
3.80							4.75	4562	30375	4.75	4562	30375
3.70							4.38	4188	25813	4.38	4188	25813
3.60							4.00	3813	21625	4.00	3813	21625
3.50							3.63	3438	17813	3.63	3438	17813
3.40							3.25	3063	14375	3.25	3063	14375
3.30							2.87	2687	11312	2.87	2687	11312
3.20							2.50	2313	8625	2.50	2313	8625
3.10							2.13	1938	6313	2.13	1938	6313
3.00							1.75	1575	4375	1.75	1575	4375
2.90							1.40	1225	2800	1.40	1225	2800
2.80							1.05	875	1575	1.05	875	1575
2.70							0.70	525	700	0.70	525	700
2.60							0.35	175	175	0.35	175	175
2.50							0.00	0	0	0.00	0	0

APPENDIX III

CONSTRUCTION REPORT, 1982 PROJECT

CONTENTS:

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1. Included by permission of Thurber Consultants Ltd.

PROJECT: Sewage Treatment Facility
for The Town of Inuvik
Northwest Territories

CLIENT: Water and Sanitation Section
Town Planning and Lands Division
Department of Local Government
Government of the Northwest Territories
Yellowknife, N.W.T.

CONTRACTOR: Goodbrand Construction Ltd.
202 - 107 Main Street
Whitehorse, Yukon

ENGINEER: Associated Engineering Services Ltd.
13140 St. Albert Trail
Edmonton, Alberta

AESL Job No. E75D

In 1982, Inuvik's sewage treatment facility was upgraded by Goodbrand Construction Ltd. under a contract with the Government of the Northwest Territories. Resident engineering services during construction were provided by Associated Engineering Services Ltd. In general, the project consisted of raising and widening the lagoon's north and west berms, building a new lagoon outlet weir structure, confining the sludge banks with new berms, creating two new primary cells complete with structures to control flow into and out of them, an extension to the outfall pipe, and means for disposal of sewage discharged from tank trucks.

Significant Dates:

June 23, 1982 - Contractor arrived on site
June 24, 1982 - Construction of lagoon outlet weir structure started
July 13, 1982 - Upgrading of existing berms started
July 15, 1982 - Construction of new berms started
July 22, 1982 - Upgrading of existing berms completed
August 26, 1982 - Construction of lagoon outlet weir structure completed
August 29, 1982 - Construction of new berms completed
August 31, 1982 - Construction of control structures for primary cells started
September 4, 1982 - Surfacing gravel placed on berms
September 5, 1982 - Construction of control structures for primary cells completed
September 7, 1982 - All construction activities completed by Contractor
September 8, 1982 - Final inspection of the facility carried out and no deficiencies noted

No serious problems were encountered during this construction project.

Drilling piles to a seven metre depth for the lagoon outlet weir structure made it difficult to control the hole and maintain plumbness. Plates welded to the bottom of the piles to prevent frost heaving caused the piles to slide if the hole was sloped on the bottom. In the future, such plates should be a short distance above the bottom of the piles to allow dropping the pile to seat it. Insulating the exposed portions of the piles to prevent heat transfer into the permafrost was carried out using sprayed-on foam insulation. A better end product (appearance wise) would have been accomplished by using rigid foam insulation glued to the piles and coating it with waterproof paint.

The new berms were constructed by end dumping fill material and pushing it down and out to displace the sludge and unsuitable native material. This procedure produced a coffer dam out of the displaced material and allowed compaction of the material by the construction equipment. This construction procedure proved very effective as there were no signs of instability during construction.

E75D

SEP 0 7 1982

THURBER CONSULTANTS LTD.
TWENTY-FIVE YEARS OF QUALITY GEOTECHNICAL ENGINEERING
CALGARY/EDMONTON/VANCOUVER/VICTORIA

August 30, 1982

File: 17-123-24

Associated Engineering Services Ltd.
13140 St. Albert Trail
Edmonton, Alberta
T5L 4R8

Attention: Mr. G.W. Stalker, P.Eng.

RE: INUVIK SEWAGE LAGOON

Dear Sir:

The purpose of this letter is to summarize the results of a site visit made to the Inuvik Sewage Lagoon by L.B. Smith, P.Eng. of Thurber Consultants. The site visit was made on August 18, 1982, in the company of Mr. B. Hunter of your firm.

1.0 Outlet Control Structure

At the time of the site visit, the Outlet Control Structure was essentially complete, and no major difficulties had been encountered during its construction. It is understood from Mr. Hunter that frozen ground was encountered in all pile holes drilled for this structure. The depth of thaw was found to be about 1 metre below the base of excavation. All piles (including corner angle piles) were placed at a minimum depth of 7 metres below the base of excavation. Horizontal plates were welded onto the base of each pile in order to provide additional resistance against frost heaving forces.

It is recommended that the elevation of the tops of all piles for this structure be determined to an accuracy of plus or minus 1 mm. The elevation of the tops of the piles should be determined each spring and fall for the next few years. This data will provide a positive indication of the stability of the structure.

2.0 Lagoon Dykes

The Lagoon Dykes were about 80 percent complete at the time of the site visit. No work was in progress at the time of inspection since it had rained on the previous day.

The berms were constructed using a gravelly clay taken from a pit located on the east side of Navy Road. The material in the pit consisted dominantly of gravelly clay with some gravel, sand and silt lenses present at random locations. The material in the pit appeared to contain significantly more clay than the sample received from Mr. Hunter in July, 1982. The pit was found to contain only minor ground ice. The pit was worked by bulldozing thawed material from the surface into a stockpile. The fill was then loaded into dump trucks for transport to the site.

It is understood that the fill for the dykes was end dumped and pushed down and out into the lagoon along the dyke centre-line. This method of placement was very satisfactory in that it caused the sludge in the lagoon to be displaced ahead of the fill. The fill was also pushed down the sides of the dykes, displacing the sludge and forming a finished sideslope of 3 horizontal to 1 vertical. The dykes were compacted by the bulldozer and dump trucks since there was no other practical means of compaction. It is understood that the dyke sideslopes remained stable throughout the period of construction.

Field observations indicate that the fill material and the method of construction used for the dykes has proven to be very satisfactory, and no major difficulties have been encountered. The fill material appears to compact well and the resulting dykes should be stable and relatively impervious.

Closure

In summary, no significant geotechnical concerns became apparent during the site visit and the upgrading of the sewage lagoon has proceeded extremely well. Please do no hestitate to call should you wish to discuss any aspect of the project in more detail.

Yours very truly
Thurber Consultants Ltd.

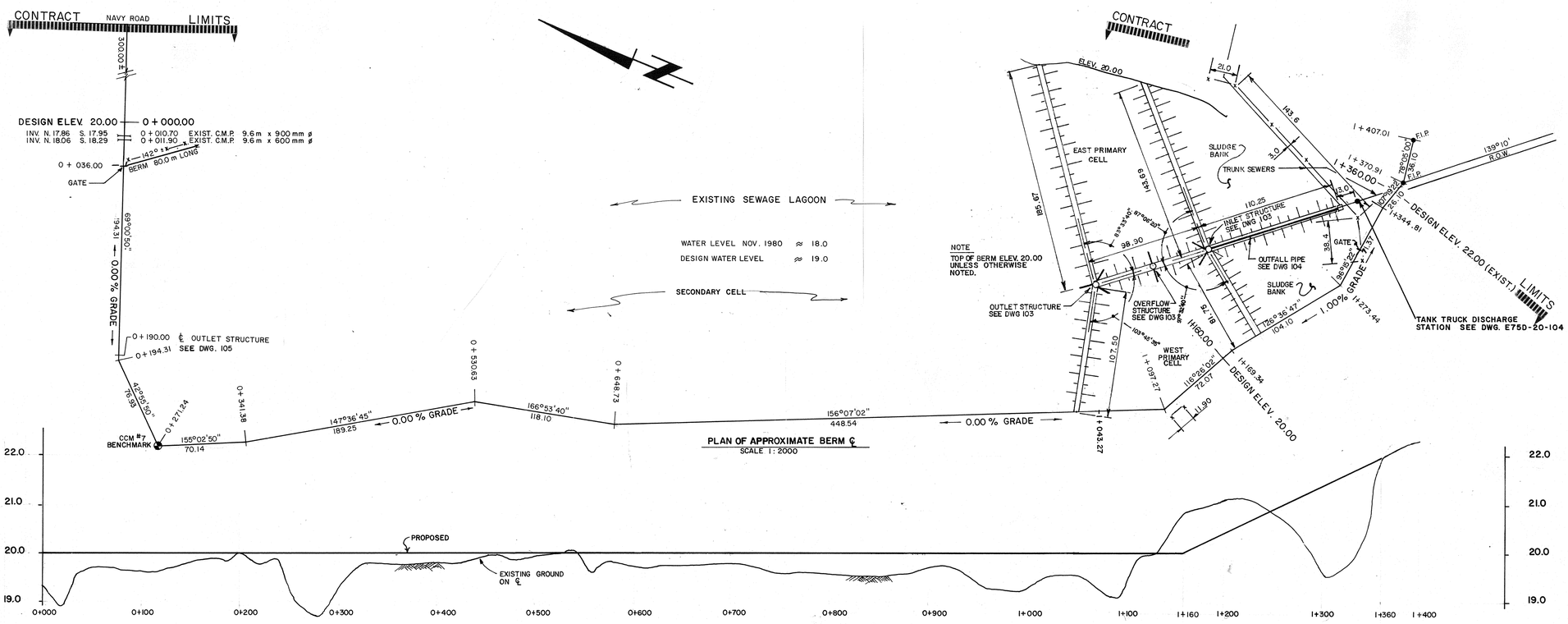
L.B. Smith, P.Eng.
Review Engineer

LBS/cb

APPENDIX IV

DRAWINGS

Drawing No.		Title
E75D-20-101	(AESL)	Location Plan [Not included here]
E75D-20-102	(AESL)	Lagoon Plan and Details
E75D-20-103	(AESL)	Lagoon Details
E75D-20-104	(AESL)	Outfall Pipe and Details
E75D-20-201	(AESL)	Sewage Lagoon Outlet Structure
E75D-20-202	(AESL)	Sewage Lagoon Outlet Structure Details
49328-201	(RCPL)	Outlet Structure Repair Details



AS – BUILT

Approved By M L Wills Date Oct. 13/82

ASSOCIATED ENGINEERING SERVICES LTD.

AESL

DRAWING REFERENCE

NOTES :

DIMENSIONS ON PLAN OF APPROXIMATE BERM ℄ ARE IN METRES UNLESS OTHERWISE SPECIFIED

DIMENSIONS ON SECTIONS ARE IN MILLIMETRES

ALL ELEVATIONS ARE RELATIVE TO GEODETIC DATUM IN METRES : BENCHMARK ON CCM#7 ELEV. 019.62

x——x FENCING

NO	DATE	BY	ENG	SUBJECT
2	82-10-82	R.V.G.	N.G.W.	AS BUILT
1	82-05-17	M.S.	G. S.	ISSUED FOR CONSTRUCTION
0	82-03-22	M.S.	G. S.	ISSUED FOR TENDER
A	81-08-11	A.J.	E.C.	PRELIMINARY

REVISIONS

JOB NUMBER	E75D
SCALE	AS SHOWN
DRAWN	A Lamp
DESIGNED	E. Collins
CHECKED	NGW
APPROVED	NGW
APPROVED	
DATE	AUG. 1981

PROFESSIONAL ENGINEER YUKON TERRITORY N.G. WILLS Mar. 8/82

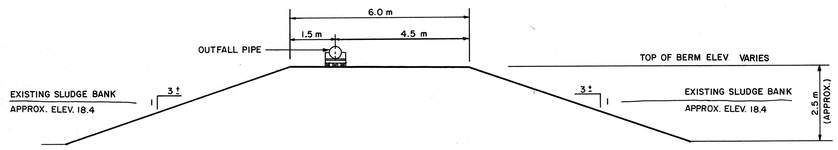
GOVERNMENT OF THE NORTHWEST TERRITORIES

INUVIK , N.W.T.

SEWAGE TREATMENT FACILITY

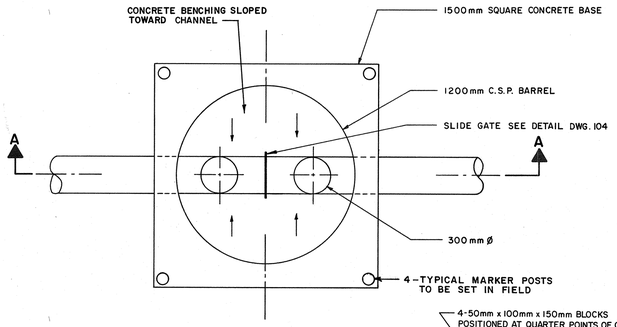
LAGOON PLAN AND DETAILS

DRAWING NUMBER	REV.	SHEET
E75D-20-102	2	2/6



CROSS-SECTION OUTFALL PIPE BERM

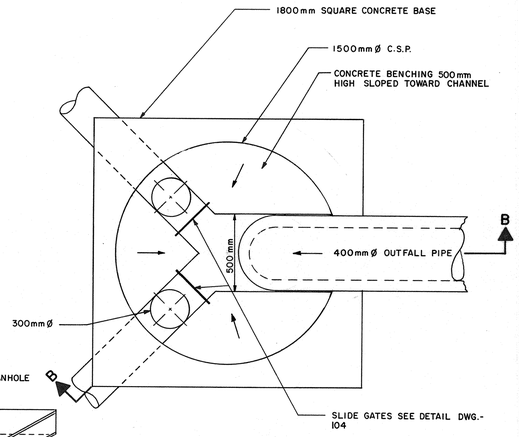
N.T.S.



OVERFLOW STRUCTURE

PLAN

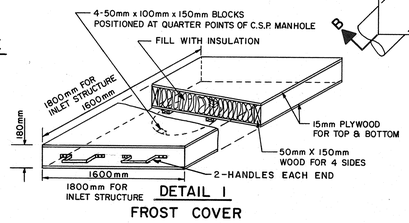
N.T.S.



INLET STRUCTURE

PLAN

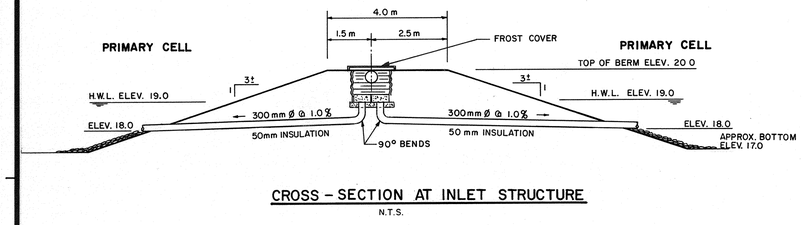
N.T.S.



DETAIL 1

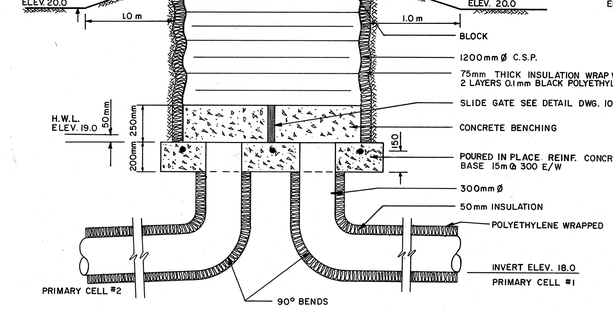
FROST COVER

N.T.S.



CROSS-SECTION AT INLET STRUCTURE

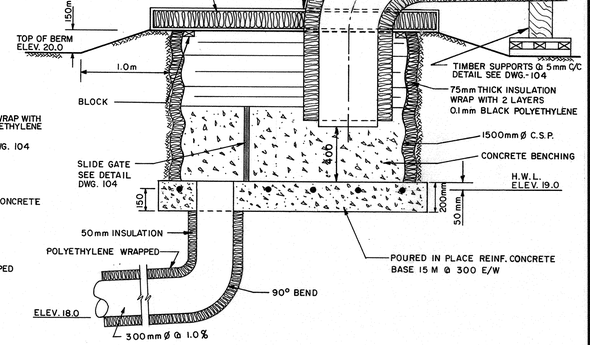
N.T.S.



OVERFLOW STRUCTURE

SECTION A-A

N.T.S.



INLET STRUCTURE

SECTION B-B

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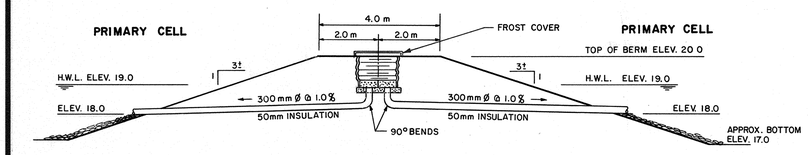
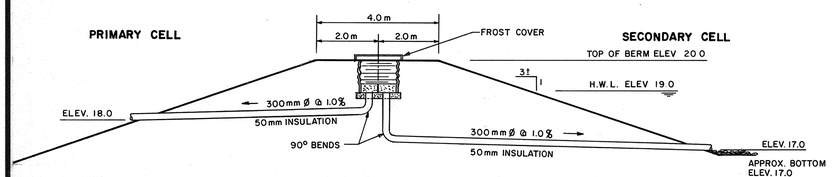


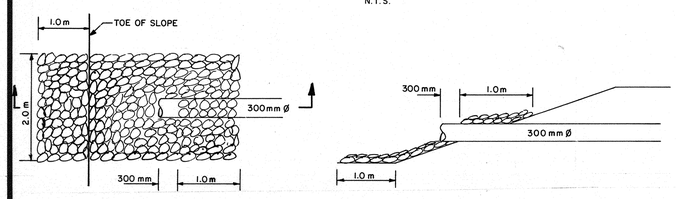
CROSS-SECTION AT OVERFLOW STRUCTURE

N.T.S.



CROSS-SECTION AT OUTLET STRUCTURE

N.T.S.

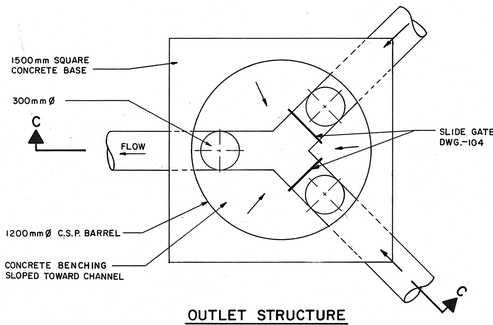


PLAN

CROSS SECTION

TYPICAL RIP-RAP DETAIL

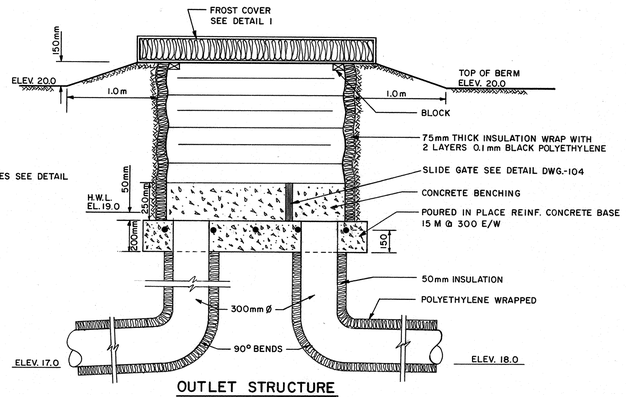
N.T.S.



OUTLET STRUCTURE

PLAN

N.T.S.



OUTLET STRUCTURE

SECTION C-C

N.T.S.

AS-BUILT

Approved By N.G. Wills Date Oct. 13/82

NO.	DATE	BY	ENG.	SUBJECT
2	82-10-12	R.V.G.	N.G.W.	AS BUILT
1	82-05-17	M.S.	G.S.	ISSUED FOR CONSTRUCTION
0	82-03-22	M.S.	G.S.	ISSUED FOR TENDER
A	82 03 04	P.C.	G.S.	PRELIMINARY ISSUE

REVISIONS

ASSOCIATED ENGINEERING SERVICES LTD.

AESL

DRAWING REFERENCE

JOB NUMBER	E75D
SCALE	AS SHOWN
DRAWN	P. CHEUNG
DESIGNED	G. STALKER
CHECKED	NGW
APPROVED	NGW
APPROVED	
DATE	1982-03-04

STAMP: PROFESSIONAL ENGINEER N.G. WILLS TERRITORY Mar. 8/82

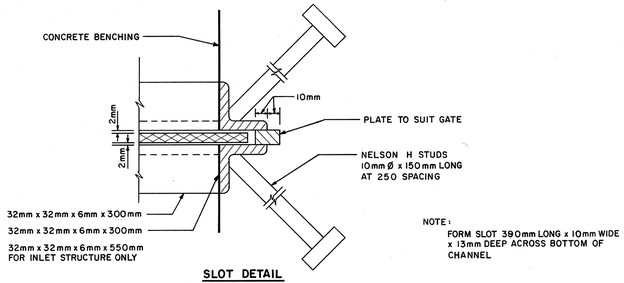
CLIENT: GOVERNMENT OF THE NORTHWEST TERRITORIES

LOCATION: INUVIK, N.W.T.

PROJECT: SEWAGE TREATMENT FACILITY

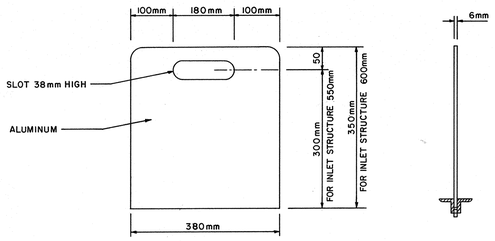
SUBJECT: LAGOON DETAILS

DRAWING NUMBER	REV.	SHEET
E75D-20-103	2	3/6



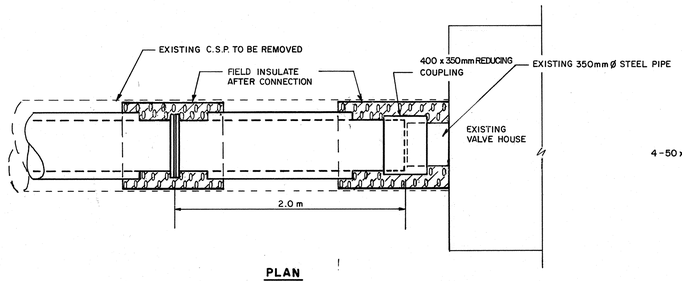
SLOT DETAIL

NOTE:
FORM SLOT 390mm LONG x 10mm WIDE
x 13mm DEEP ACROSS BOTTOM OF
CHANNEL

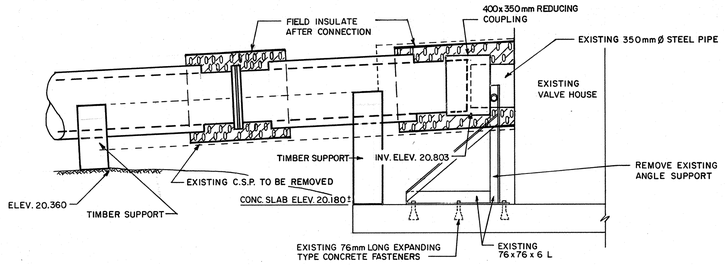


GATE DETAIL

SLIDE GATE DETAIL
N.T.S.

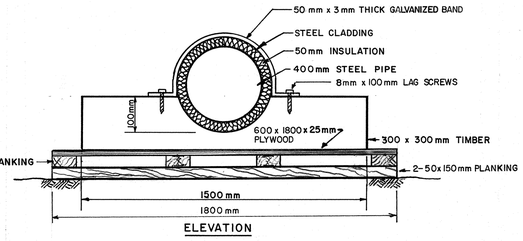


PLAN

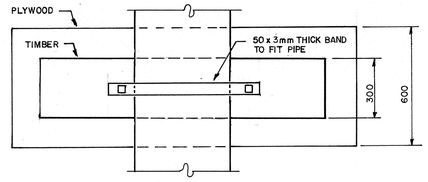


ELEVATION

OUTFALL CONNECTION DETAIL
N.T.S.

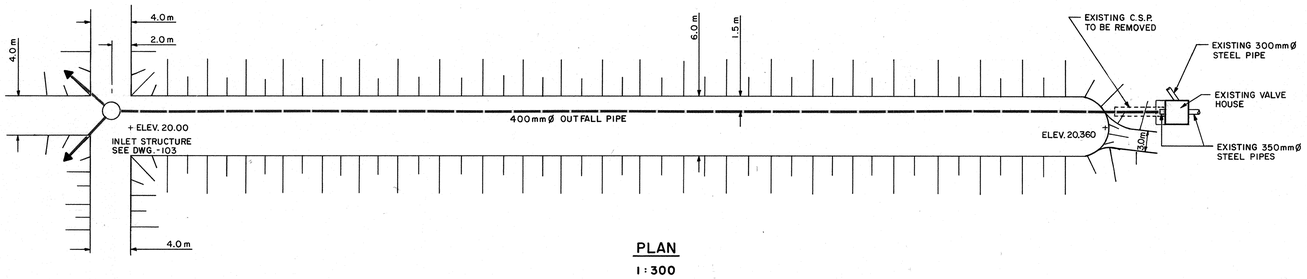


ELEVATION

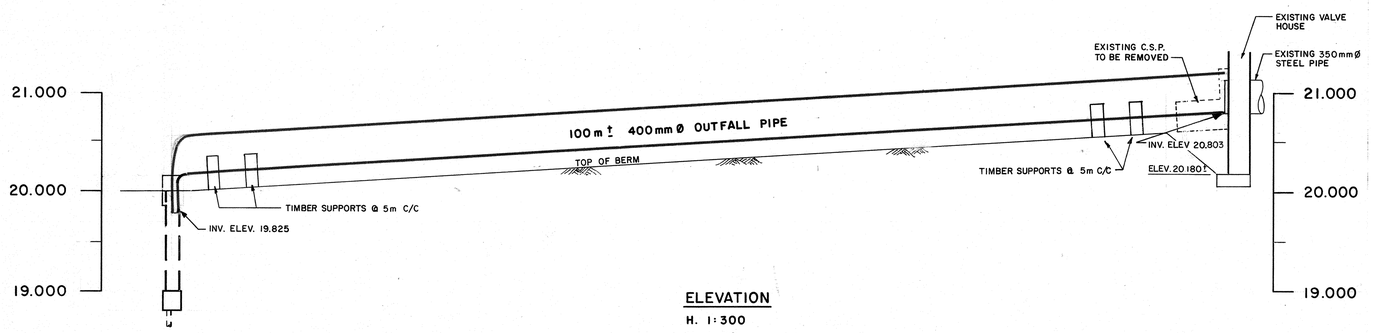


PLAN

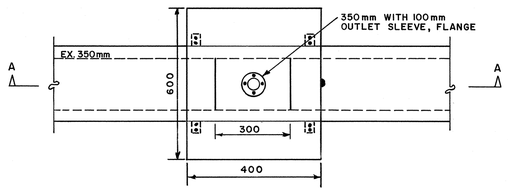
TIMBER SUPPORT DETAIL
N.T.S.



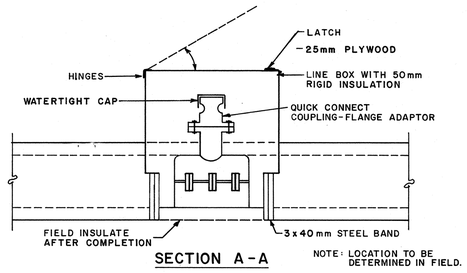
PLAN
1:300



ELEVATION
H. 1:300
V. 1:30



PLAN



SECTION A-A

NOTE: LOCATION TO BE DETERMINED IN FIELD.

TANK TRUCK DISCHARGE FACILITY

AS-BUILT
Approved By N.G. Wills Date Oct. 13/82

ASSOCIATED ENGINEERING SERVICES LTD.

AESL

DRAWING REFERENCE

NO.	DATE	BY	ENG	SUBJECT
2	82-10-12	R.V.G.	N. G. W.	AS BUILT
1	82-05-17	M.S.	G. S.	ISSUED FOR CONSTRUCTION
0	82-03-22	M.S.	G. S.	ISSUED FOR TENDER
A	82 03 04	P.C.	G.S.	PRELIMINARY ISSUE

REVISIONS

JOB NUMBER	E 75 D
SCALE	AS SHOWN
DRAWN	P. CHEUNG
DESIGNED	G. STALKER
CHECKED	NGW
APPROVED	NGW
APPROVED	
DATE	1982-03-04

PROFESSIONAL ENGINEER
N.G. WILLS
TERRITORY
Mar. 8/82

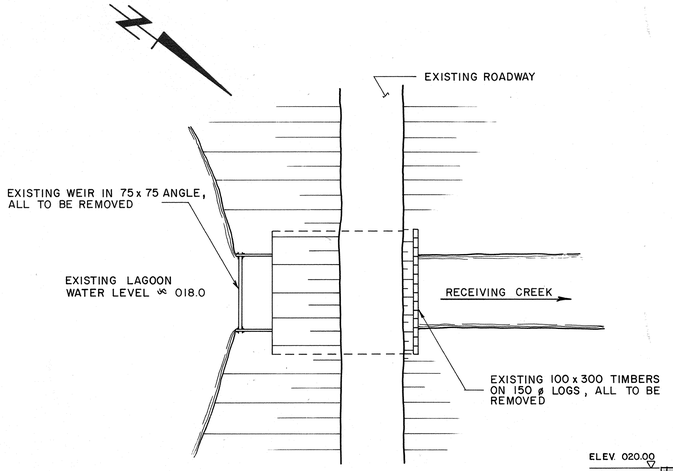
GOVERNMENT OF THE NORTHWEST TERRITORIES

INUVIK, N.W.T.

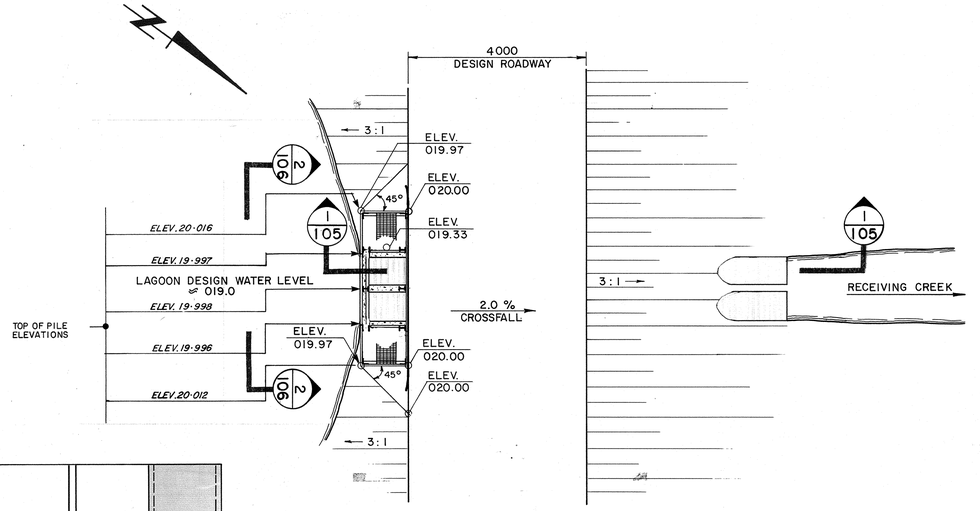
SEWAGE TREATMENT FACILITY

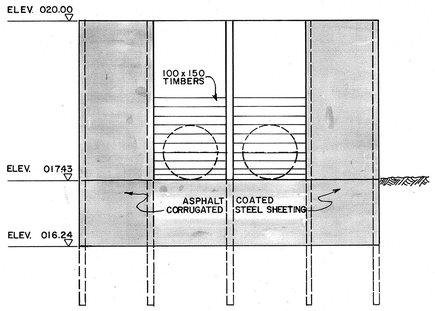
OUTFALL PIPE AND DETAILS

DRAWING NUMBER	REV.	SHEET
E 75 D-20-104	2	4/6



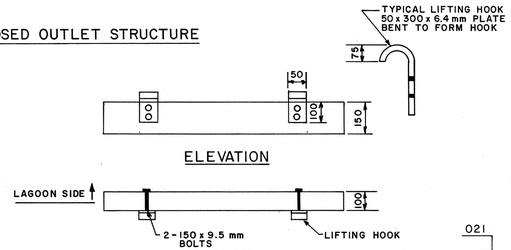
PLAN OF EXISTING OUTLET STRUCTURE
N.T.S.





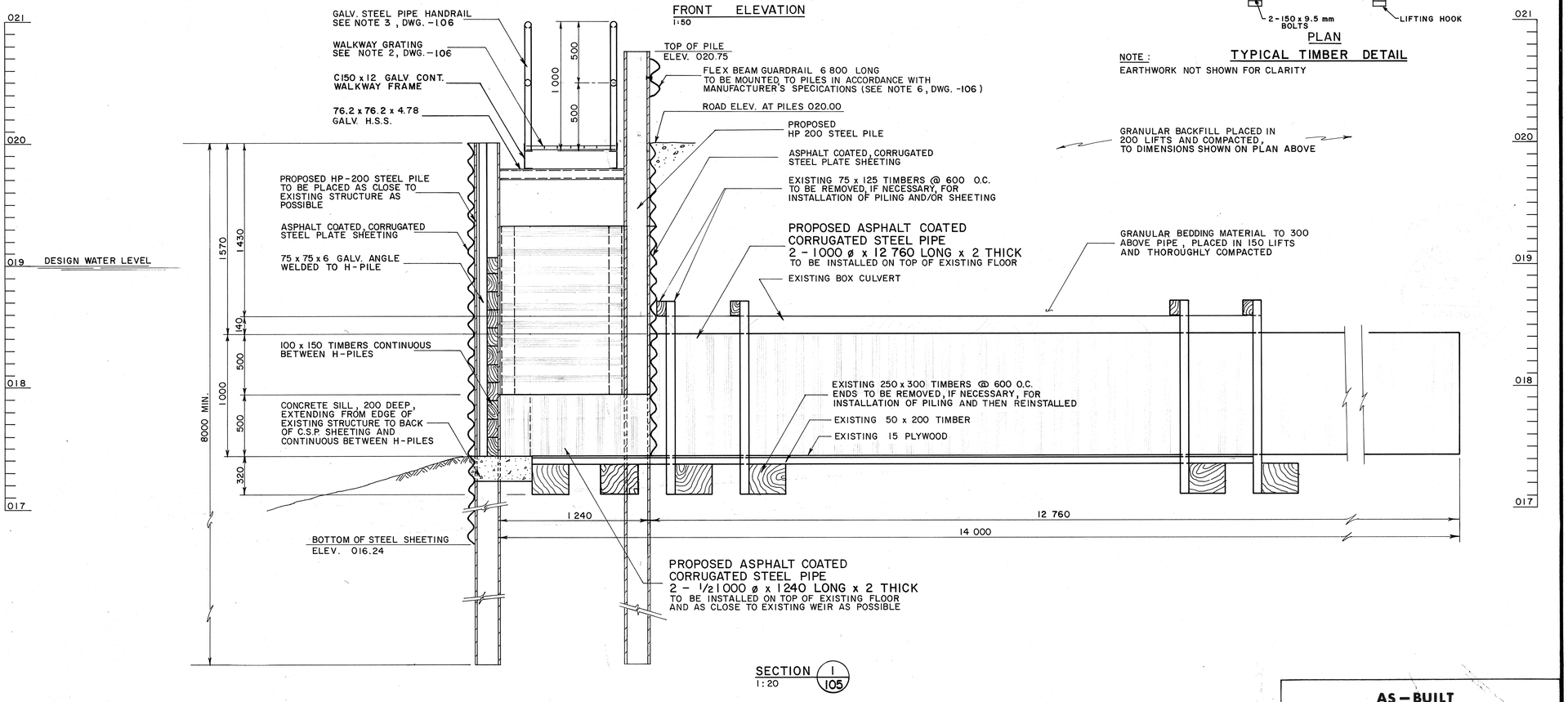
FRONT ELEVATION
1:50

PLAN OF PROPOSED OUTLET STRUCTURE
N.T.S.



TYPICAL TIMBER DETAIL

NOTE :
EARTHWORK NOT SHOWN FOR CLARITY



SECTION 1/105
1:20

AS – BUILT
Approved By N.G. Wills Date Oct. 13/82

ASSOCIATED ENGINEERING SERVICES LTD.

AESL

DRAWING REFERENCE

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. ALL ELEVATIONS ARE RELATIVE TO GEODETIC DATUM IN METRES: BENCHMARK ON CCM#7 ELEV. 019.62
3. ALL PILES TO EXTEND 4000 BELOW PERMAFROST LEVEL WHERE POSSIBLE.
4. ALL LOCATIONS AND DIMENSIONS OF THE EXISTING STRUCTURE ARE APPROXIMATE.

ABBREVIATIONS

CCM	CONCRETE SURVEY MONUMENT
℄	CENTRELINE
C.S.P.	CORRUGATED STEEL PIPE
ELEV.	ELEVATION
F.I.P.	IRON SURVEY MONUMENT
INV.	INVERT
MIN.	MINIMUM
N.T.S.	NOT TO SCALE
R.O.W.	RIGHT OF WAY

NO	DATE	BY	ENG	SUBJECT
2	82-10-12	R.V.G.	N.G.W.	AS BUILT
1	82-05-17	M.S.	G.S.	ISSUED FOR CONSTRUCTION
0	82-03-22	M.S.	G.S.	ISSUED FOR TENDER
A	81-09-01	A.J.	E.C.	PRELIMINARY

REVISIONS

JOB NUMBER	E75D
SCALE	AS SHOWN
DRAWN	
DESIGNED	E. Collins
CHECKED	NGW
APPROVED	NGW
APPROVED	
DATE	

PROFESSIONAL ENGINEER N.G. WILLS TERRITORY Mar. 8/82

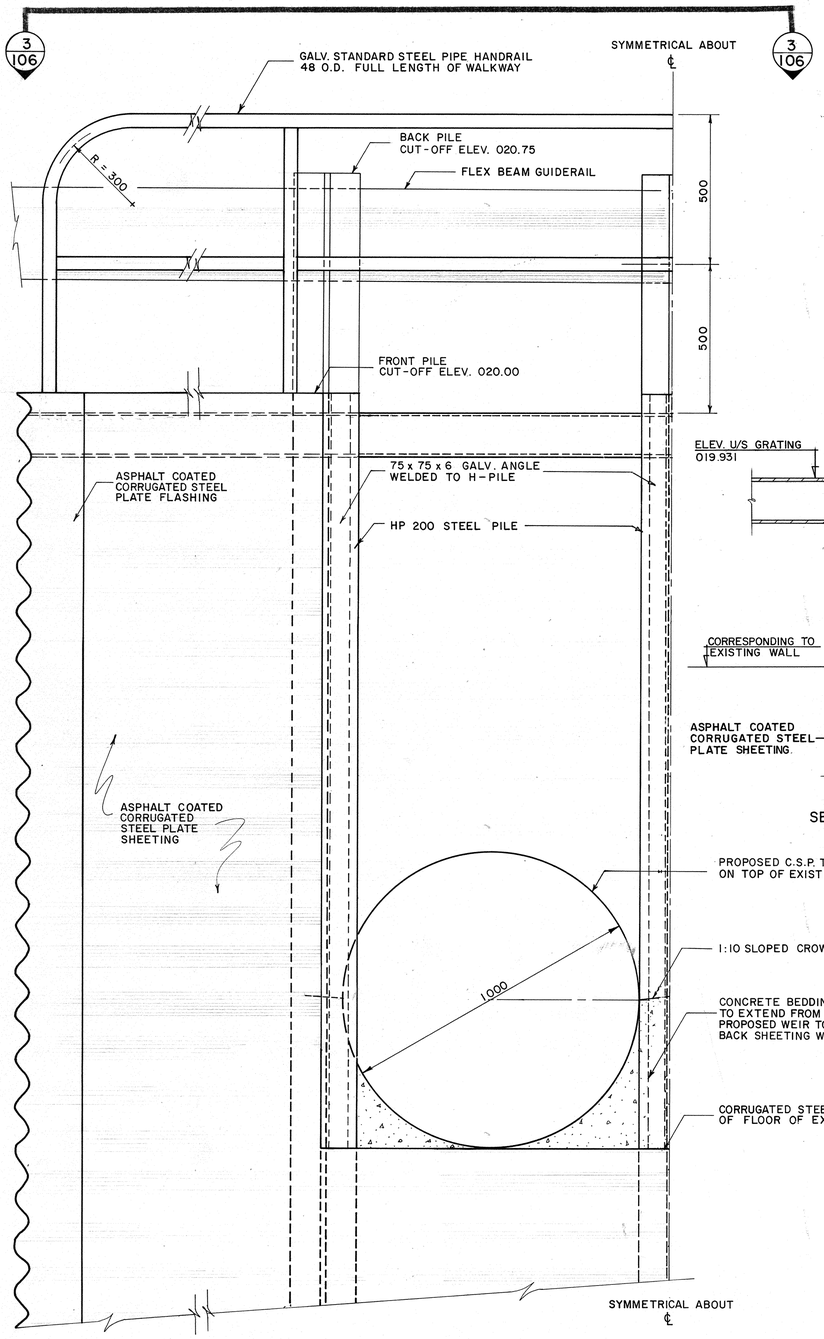
GOVERNMENT OF THE NORTHWEST TERRITORIES

INUVIK, N.W.T.

SEWAGE TREATMENT FACILITY

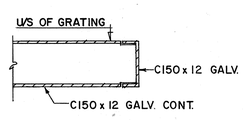
SEWAGE LAGOON OUTLET STRUCTURE

DRAWING NUMBER	REV.	SHEET
E75D-20-105	2	5/6

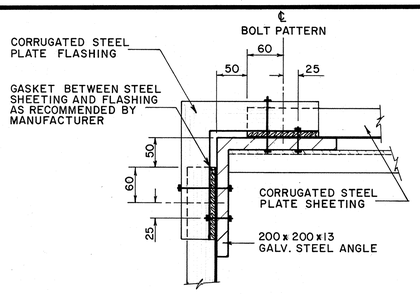


NOTE:
EXISTING WEIR STRUCTURE AND PROPOSED WEIR TIMBERS NOT SHOWN FOR CLARITY.

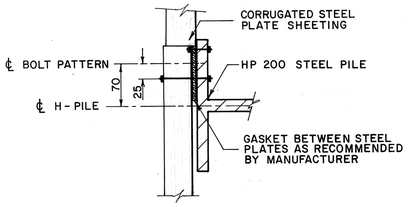
ELEVATION 2/105
1:10



SECTION B

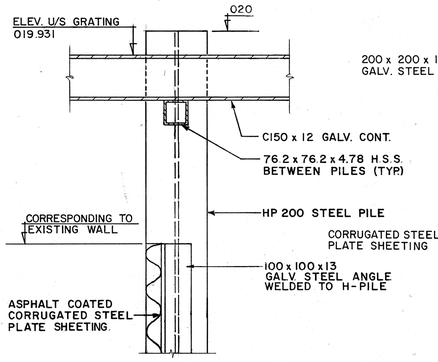


DETAIL B
Not to Scale



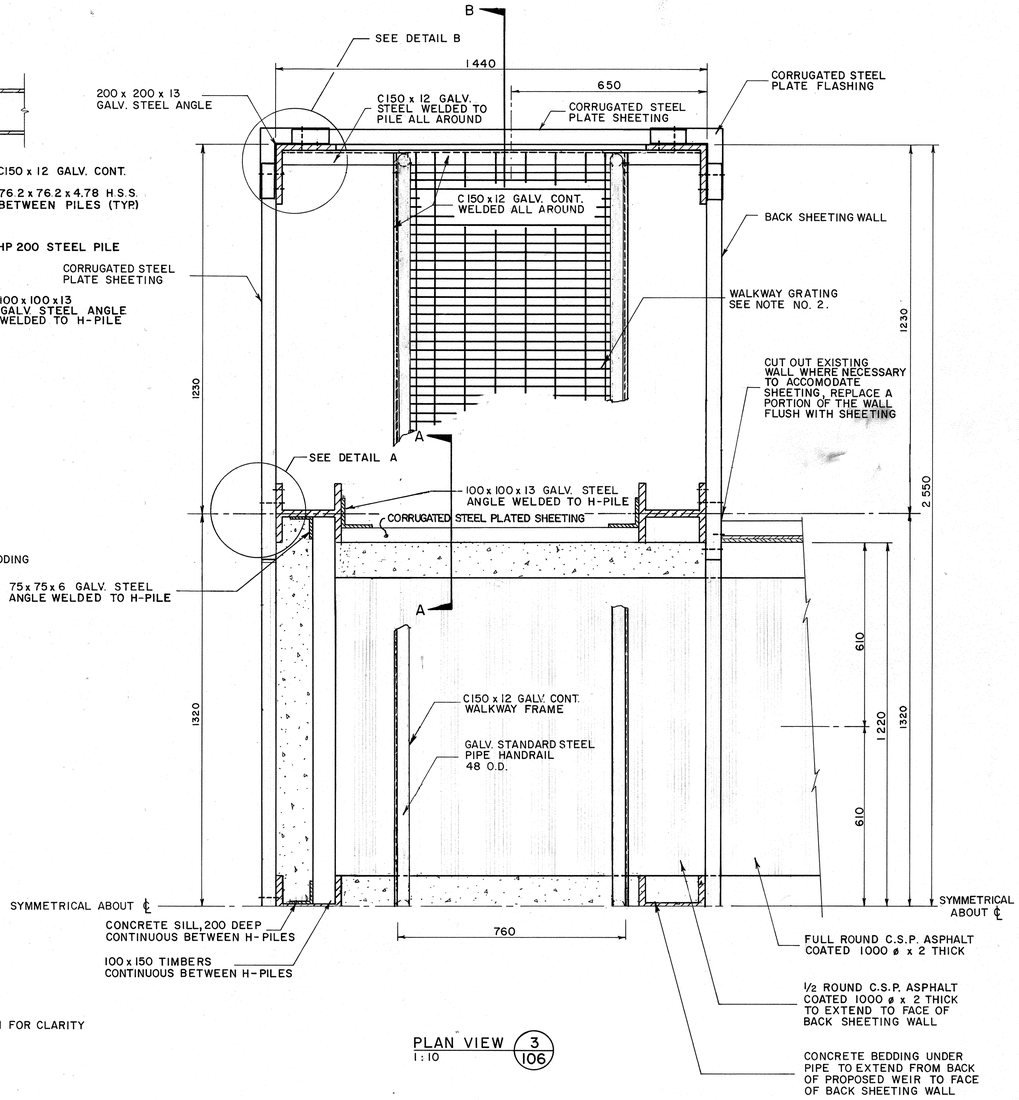
DETAIL A
Not to Scale

NOTE: ALTERNATE CONNECTION DETAILS CAN BE AS PER MFG. STANDARDS.



SECTION A-A

NOTE:
EARTHWORK NOT SHOWN FOR CLARITY



PLAN VIEW 3/106
1:10

AS-BUILT
Approved By N.G. Wills Date Oct. 13/82

ASSOCIATED ENGINEERING SERVICES LTD.

AESL

DRAWING REFERENCE

NOTES:

1. CORRUGATED STEEL PLATE TO BE : ASPHALT COATED 7 THICK WITH 150 x 50 CORRUGATIONS NOMINAL SHEET SIZE 1220 x 3660 OVERALL SHEET SIZE 1340 x 3760 2 BOLTS PER CORRUGATION
2. WALKWAY FLOORING TO BE : ARMCO TYPE 'AA' GALV. STEEL PRESSURE GRATING (OR APPROVED ALTERNATE) BEARING BARS 25 x 5 @ 30 O.C. CROSS BARS 16 x 3 @ 102 O.C. WIDTH 760 LENGTHS TO SUIT FRAME
3. PIPE FOR HANDRAILS TO BE GALV. STANDARD STEEL PIPE WITH O.D. OF 48
4. ALL DIMENSIONS ARE IN MILLIMETRES
5. ALL ELEVATIONS ARE RELATIVE TO GEODETIC DATUM IN METRES : BENCHMARK ON CCM#7 ELEV. 019.62
6. GUIDE RAIL TO BE 2.8 THICK GALV. STEEL FLEX BEAM, 1 1/2 STANDARD LENGTHS PLUS 2 STANDARD TERMINAL SECTIONS, CENTRED ABOUT STRUCTURE.

NO	DATE	BY	ENG	SUBJECT
2	82-10-12	R.V.G.	N.G.W.	AS BUILT
1	82-05-17	M.S.	G.S.	ISSUED FOR CONSTRUCTION
0	82-03-22	M.S.	G.S.	ISSUED FOR TENDER
A	81-08-30	A.J.	E.C.	PRELIMINARY

REVISIONS

JOB NUMBER	E75D
SCALE	AS SHOWN
DRAWN	[signature]
DESIGNED	E. Collin
CHECKED	NGW
APPROVED	NGW
APPROVED	
DATE	24 AUG. 1981

PROFESSIONAL ENGINEER — YUKON TERRITORY — N.G. WILLS — Mar. 7/82

GOVERNMENT OF THE NORTHWEST TERRITORIES

INUVIK, N.W.T.

SEWAGE TREATMENT FACILITY

SEWAGE LAGOON OUTLET STRUCTURE DETAILS

DRAWING NUMBER	REV.	SHEET
E75D-20-106	2	6/6

APPENDIX V

SURVEILLANCE NETWORK PROGRAM
QUALITY ASSURANCE / QUALITY CONTROL PROGRAM
Revision "g", dated February 26, 2009

CONTENTS:

AECOM

17203 - 103 Avenue
Edmonton, Alberta T5S 1J4
Phone: (780) 488-6800
Fax: (780) 488-2121

MEMO

To:	**Town of Inuvik**	Date:	**2007 10 01**
Attention:	**Mr. Rick Campbell**		
From:	**Richard Feilden**	Our File:	**49195-all-04b**
Subject:	**QA QC Program: Water Licence Clause B12**		

Introduction

In general, Inuvik's public works team has been diligent in collecting the samples required under the Surveillance Network Program ("SNP") attached to the Town's water licence. In general, there is a consistency in the seasonal patterns of test results that implies that samples are being taken, handled and analyzed using correct procedures. There has, infrequently, been a missed sample, or an outlying analysis result: in nearly anything there is room for improvement. This QA/QC protocol seeks to further reduce the likelihood of omissions or errors. It has been written in fulfillment of Condition B12 of Inuvik's Water Licence No G06L3-001 (Gwich'in Land and Water Board, 1 July 2006).

Scope

This protocol addresses the taking and shipping of SNP samples, and the reviewing of results.

Surveillance Network Program Stations and Sampling

The following is a summary. For precise wording and for exact locations of SNP stations refer to the formal SNP description attached to the Water Licence.

Stn 0036-1, East Channel Pumphouse. Meter and report volumes pumped per month.

Stn 0036-2, Hidden Lake Pumphouse. Meter and report volumes pumped per month.

Stn 0036-3, Lagoon Outlet. Sample monthly; sampler also to inspect for oil sheen. Report pH, BOD_5, SS[1], Fecal Coliform, Ammonia Nitrogen. If oil sheen is seen, sample and test for oil and grease.

Stn 0036-4, Mt. Baldy Runoff West. Sample monthly if flow; sampler also to inspect for oil sheen. Report pH, BOD_5, SS, Conductivity, total Phenols, Sulphate, total Phosphate, total Cadmium, total Chromium, total Copper, total Iron, total Lead, total Mercury, total Nickel, total Zinc, Calcium, Magnesium, Potassium, and Sodium. If oil sheen is seen, sample and test for oil and grease.

Stn 0036-5, Mt. Baldy Runoff East. Sampling identical to 0036-4.

Stn 0036-6, "Gate Pond". Sample annually, in September. Report pH, BOD_5, SS, Fecal Coliform, Ammonia Nitrogen. (Tests identical to SNP-3, but no check for oil/grease required.)

Stn 0036-7, "Far Pond". Sampling identical to 0036-6.

Stn 0036-8, Twin Lakes. Sampling identical to 0036-6.

Sampling Responsibility

Inuvik's utilidor maintenance supervisor is responsible for the taking of samples. Sampling is done members of the utilidor crew having training.

Sampling Schedule Management

As described below, recording of data for SNP 1 and 2 is done as a matter of daily routine, while sampling at other SNP stations is triggered by the "MMOS" system.

[1] Suspended solids.

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MMOS is a scheduling database, provided to municipalities by GNWT, that generates timely work orders throughout the year for all of the routine, scheduled operations and maintenance tasks entered into it. When an MMOS order is received in the utilidor shop, it is attached to a large wall-sized calendar-board that covers the whole month, one large square for each day, at the appropriate day. An MMOS order that has been partly fulfilled but needs future action is re-attached to the calendar board, at the next day where action is required.

Samples for laboratory testing are taken early on Tuesdays, so that samples can travel and be analyzed all within the week.

SNP 1 and 2 (water plant meter log: monthly total of water used). There is a designated water plant operator on duty every day of the year. The duty operator makes morning rounds of main facilities, starting with the active water plant. It is a standard, basic action to update each facility log as rounds proceed. Reading the water meter and recording the value is a standard action at the water plant, prompted by a labeled column in the logbook. The fixed-daily-routine nature of plant rounds makes it extremely rare for a reading to be missed: most years' records have 365 (or 366) entries.

SNP 3 (lagoon effluent: monthly sample). The sample group is taken second Tuesday of the month, in order to leave time to re-sample if necessary. MMOS generates a work order as the sample date approaches. The work order instructs the crew to (1) Second Tuesday: take and ship the SNP sample set; (2) Third Tuesday: check to ensure that an e-mail confirmation of sample receipt has been received from NWLabs; if not, take and ship a second sample set; recheck on the Fourth Tuesday.

SNP 4 and 5 (solid waste site runoff: monthly when there is flow). As with SNP3, a work order is generated by MMOS. The task is also listed on the utilidor shop scheduling board.

SNP 6, 7 and 8 (ponds near lagoon: one sample annually, in September). A work order is generated by MMOS. The work order prompts additions of the task the utilidor shop scheduling board, for September.

Sampling Supplies and Related Instructions

Sample bottle kits are provided by the Laboratory. Included are sample chain-of-custody sheets, with pre-printed sample identification information as described farther on.

All sampling supplies are kept in a cupboard in the utilidor shop. Instructions as to types of samples to be taken, and as to filling out of the custody form, are posted on the cabinet doors.

Within the supplies cupboard are labeled shelf sections for each type of sample bottle, e.g., BOD, Metals, etc, and for corresponding vials of preservative (if any). Incoming shipments of clean bottles and preservatives are sorted into their shelf sections, ready for later use. Note that some types of samples have a matching preservative that may be pre-loaded into the bottle by the lab or may need to be added in the field; and that other types of samples (BOD, for instance) do not have preservative.

Quarterly, the MMOS system issues a work order requiring a check of inventories of sample bottles and forms, against limits posted on the sampling supplies cupboard.

Types of Samples Needed

At SNP 3 (lagoon) and at SNP's 6, 7 and 8 (ponds) the samples to be taken are BOD, Microbiology, Nutrients, and Routine (4 samples).

At SNP's 4 and 5 (Mt. Baldy landfill) the samples to be taken are BOD, Microbiology, Nutrients, Phenols, Metals, and Oil and Grease and Routine (7 samples).

Taking of Samples

Members of the utilidor crew receive training in proper methods of taking and handling samples at MACA-sponsored operator courses (generally held in Yellowknife). Samples are only taken by

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MEMO

qualified members of the utilidor crew. Standard instructions in sample-taking technique are appended to this protocol: see Appendix I.

Samples are taken using a long pole with a bottle clamp on the end.

Identification of Samples; Ambient Conditions

The laboratory (currently NorWest Labs) generates a year's supply of triplicate "Chain of Custody" sample identification forms (with some spares), in advance, for Inuvik's SNP program. These are kept in the utilidor shop. The "Special Instructions / Comments" field of the COC form contains the following instructions:

> Sampler: circle project ID below and note weather:
> SNP3 Lagoon - SNP4 Mt.B W - SNP5 Mt.B E
> SNP6 GatePond - SNP7 FarPond - SNP8 TwinL
> Raw Water
>
> temp ____ °C, precip ____, wind dir ____ vel ____km/h

Shipping of Samples

Samples are packaged well-padded, and sent directly to the laboratory as guaranteed air freight.

Confirmation of Receipt of Samples, and Assurance

When the laboratory (NorWest Labs) receives a sample in good order, it e-mails a "Confirmation of Analysis" form to the utilidor shop (and other recipients of analysis results). As described above, the "take sample" work order remains open and prompts further sampling until closed by matching a sample receipt confirmation to it.

In addition, the MMOS system generates a work order at the beginning of the third week of the month that lists the samples due (or probably due) in the particular month. The work order prompts Town Office Public Services staff to check off the sample receipt confirmations from the lab against its list, and to pursue any that may be missing.

Review of Sample Results

Sample results are distributed electronically by the labor oratory when ready, to Inuvik's utilidor shop, Inuvik's Director of Public Works, and to Inuvik's consulting engineer. All recipients review results for general conformity to established patterns and for excursions beyond licence limits.

Infrequently, a test result reported by the laboratory is clearly an anomaly, and does not represent conditions in the water body sampled. An anomalous result triggers re-sampling. Discussion of possible need to repeat sampling is initiated by any reviewer who considers results to seem erratic.

Reporting

SNP results are reported to the Gwich'in Land and Water Board, quarterly. Currently, reports are prepared and submitted on behalf of Inuvik by Inuvik's consulting engineer.

Any observations of an unusual nature are noted in the report. Thus, any anomalous test result received, and action taken, is reported.

Annual Review

The effectiveness of sampling program procedures will be reviewed annually in December or January. Procedures will be updated, and this QA/QC program will be amended, as experience indicates.

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Edmonton, Alberta T5S 1J4
Phone: (780) 488-6800
Fax: (780) 488-2121

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APPENDIX 1 – SAMPLE TAKING PROCEDURES

The procedures below are summarized from instructions provided by Norwest Labs.

All Samples: General

1. Sample Tuesday and air express same day, to avoid a weekend's delay in lab work.
2. Review samples to be taken, and process. Assemble the correct bottles. For each bottle determine if a preservative is needed, and if so if it has been pre-loaded by the lab or is in a separate vial. Rubber band any preservative vials needed to the corresponding sample bottles.
3. Assemble the rest of the field kit: shipping cooler to carry bottles and preservative, custody form, sampling pole, eye protection and bug repellant. Also, if sampling at Mt. Baldy, arrange to be accompanied by the By-law Enforcement Officer, armed. The landfill is frequented by black bears and grizzlies. Do not sample there alone.
4. Protect samples from freezing.
5. Complete the sample Custody form. Clearly identify sample source. Note weather conditions.
6. Pack well in shipping cooler to prevent damage by usual rough handling en route.
7. Include cold pack(s) chosen to maintain sample temperature near 4 °C.
8. Once the preservatives have been added to the samples, the shipment is no longer considered dangerous goods. Remove stickers, labels pertaining to dangerous goods from the cooler.

Field Sampling Technique

1. Samples from the lagoon, ponds etc are taken using a sampling pole having a bottle clamp.
2. Sample an undisturbed location. Avoid the shore, where waves may have stirred up sediment. Avoid anything floating, or visibly suspended in the water column. Aim for typical conditions.
3. Clamp the bottle to the pole. Dip and fill.
4. If a preservative is to be added, leave enough head space. Add the preservative. Cap, and invert the bottle a few times to mix.
5. Cap bottles firmly, but not over tight as that causes the lid to pop off.

Information on preservatives and other information particular to certain types of samples is given below.

BOD (Biological Oxygen Demand)

1. BOD bottles do not have preservative.

Microbiology (Coliform Bacteria)

1. BacT bottles are supplied sterile. **Do not** open or break seal until sampling. Be extremely careful not to touch or contaminate the inside cap or top of the sample bottle.
2. If from faucet, clean faucet with bleach, then run water for 5 minutes before sampling.
3. The preservative is sodium thiosulphate (white powder), pre-loaded. **Do not** rinse out.
4. Fill to within 2 cm of top; cap.

Nutrients

1. Nutrient preservative is 2.5ml 25% sulfuric acid. Nutrient bottles may be supplied with preservative pre-loaded. If preservative is separate it is in a white-capped vial.

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Phenols

1. Phenol preservative is 1ml 50% sulfuric acid. Phenol bottles may be supplied with preservative pre-loaded. If preservative is separate it is in a green-capped vial.

Oil & Grease

1. Oil and Grease preservative is 5ml 50% sulfuric acid. Oil and grease bottles may be supplied with preservative pre-loaded. If preservative is separate it is in a yellow-capped vial.

Metals

1. Metals preservative is 5ml 20% nitric acid. Metals bottles may be supplied with preservative pre-loaded. If preservative is separate it is in a blue-capped vial.

Routine (Routine Water)

1. Routine water bottles do not have preservative.