Kugaaruk, NU
Wetland Treatment Area Assessment Report

Hamlet of Kugaaruk

December 10, 2009

Kugaaruk, NU – Wetland Treatment Area Assessment Report

Government of Nunavut – Department of Community and Government Services

Gary Strong - Project Manager

Submitted by

Dillon Consulting Limited

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(In reply, please refer to)
Our File: 05-4755

December 10, 2009

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Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU
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Attention: Phyllis Beaulieu, Manager of Licensing

Re: Wetland Treatment Area Assessment Report – Kugaaruk, NU

Dear Ms. Beaulieu:

Please find enclosed a copy of the Wetland Treatment Area Assessment Report as required by the water licence issued to the Hamlet of Kugaaruk (Licence Number: 3BM-PEL0712). This report has been re-issued in response to the letter issued by the Nunavut Water Board dated November 24, 2009. The letter requested the inclusion of the following items:

- A copy of the final as-built plans and drawings stamped by a Professional Engineer;
- Information regarding anticipated flow patterns through the wetland;
- A map marking the locations of the monitoring stations and final discharge point of the wetland;
- Further explanation of the ecological and vegetative assessment.

Should you require any further information please do not hesitate to contact me at (867) 920-4555 or by email at gstrong@dillon.ca.

Yours truly,

Dillon Consulting Limited

Gary Strong, P. Eng
Project Manager

GS/encl.

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TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

1.1 General

Dillon Consulting Limited (Dillon) has been retained by the Department of Community and Government Services (CGS), Government of Nunavut, to design waste facility alternatives for the Hamlet of Kugaaruk, formerly known as Pelly Bay. Construction of the sewage lagoon and wetland treatment facility was completed in August 2008.

1.2 Community Setting

The Hamlet of Kugaaruk is located 68.52° north latitude and 89.9° west longitude in central Nunavut. This places Kugaaruk along the east coast of Pelly Bay, which is roughly nine hundred and sixty kilometers (960 km) west of the capital of Iqaluit.

The annual snowfall in Kugaaruk is approximately 125 cm and the annual rainfall is approximately 11 cm. In January the daily mean temperature is approximately -33^{0}C while in July the daily mean temperature is approximately 6^{0}C. Freeze up usually occurs during the month of November but may happen as early as September or October while spring thaw usually happens between late May and June.

1.3 Scope of Work

The purpose of this report is to discuss the following aspects of the wetland treatment area:

- Design
- Site Ecology
- Monitoring Program
- Treatment Performance Expectations
- Potential Improvement Opportunities

2 BACKGROUND

2.1 Existing System

The community uses trucked services for both water delivery and sewage collection. The Hamlet continues to use a two cell sewage lagoon system that began operation about 14 years ago. The original lagoon was designed as a single cell. The second cell was only constructed later as an ad hoc addition to the system by hamlet crews and does not have much capacity. The system developed leaks and attempts were made to reinforce the berms surrounding the cells in the summer of 2004. Subsequent to the repairs, the leaking was reduced however the effluent continued to leak from the system at an elevated rate.

The lagoon is decanted throughout the summer and fall, starting at spring break-up and all effluent is discharged to the wetland leading to the ocean. Decant is to be maintained at a slow pace so that discharge is even throughout the season. The wetland had not been considered as part of the treatment process until

recently, when the water licence was renewed as part of the regulatory requirements for construction of a new lagoon facility. In order for the wetland to remain as part of the effluent treatment process, effluent discharged from the wetland must meet water quality standards as set out in the water licence.

The new lagoon cell has been designed to store and treat the Hamlet's sewage for the next 20 years. Construction of the lagoon and wetland treatment area was completed in August 2008.

2.2 Community Population and Sewage Production

In February 2007, Dillon Consulting Limited produced a report entitled *Sewage and Solid Waste Sites, Kugaaruk, NU – Detailed Design, Phase 2*. This report predicts that the population of Kugaaruk will be 1127 people in the year 2028. Using the formula **(*Water Usage (l/c/d) = 90 l/c/d x (1.0 + 0.00023 x population*)** as required by the Department of Municipal and Community Affairs (MACA), the annual sewage volume for 1127 people was calculated to be approximately 46,600m^3. The new lagoon cell was designed based upon this information.

3 WETLAND DESIGN CALCULATIONS

3.1 Water Quality Standards

The Hamlet of Kugaaruk wishes to use the natural wetland between the sewage lagoon and the ocean as a secondary means of sewage effluent treatment. The Nunavut Water Board has accepted this proposal, however effluent discharged from the wetland must meet certain water quality objectives. Based on the current water licence (Licence Number: 3BM-PEL0712) for the Hamlet of Kugaaruk, effluent quality discharged from both the sewage lagoon and the wetland are required to meet different standards. Table 3.1 and Table 3.2 below display the quality standards that must be met.

Table 3.1: Effluent Standards for Discharge from Sewage Lagoon

Parameter	Maximum Average Concentration
BOD_5	120 mg/L
Total Suspended Solids	180 mg/L
Fecal Coliforms	$1x10^4$ CFU/100mL
Oil and Grease	No visible sheen
pH	Between 6 and 9

Table 3.2: Effluent Standards for Discharge from Wetland Treatment Area

Parameter	Maximum Average Concentration
BOD_5	45 mg/L
Total Suspended Solids	45 mg/L
Fecal Coliforms	$1x10^4$ CFU/100mL
Oil and Grease	No visible sheen
pH	Between 6 and 9

3.2 Wetland Area Calculations

The most important characteristic that determines effluent treatment capability is the available area of the wetland. To determine the area required for effective removal of BOD_5 and TSS, the methodology outlined in *Guidelines for the Approval and Design of Natural and Constructed Treatment Wetlands for Water Quality Improvement* (Alberta Environment, 2000) was used. Employing current water use estimations and the Alberta model, an area of approximately 6400m^2 is needed in order to treat the annual sewage volume up to the year 2028 to the standards stated in the Hamlet's water licence. The width of the wetland is approximately 100m and the distance from the discharge point of the lagoon to the ocean edge is approximately 160m. Therefore an area of 16,000m^2 is available, much more than is required based on the Alberta Environment model. Please refer to Appendix A for detailed surface area calculations.

3.3 Hydraulic Loading Calculations

Hydraulic loading rates are used to determine the volume of effluent that can be discharged to the wetland on a daily basis. Guidelines for cold climate wetlands are to use loading rates from 100 to 200 m^3/ha*d (Heinke *et al.*, 1993). However further studies have shown that loading rates as high as 430 m^3/ha*d have been used in northern climates and that treatment performance of the wetland relies heavily on a variety of factors (physical characteristics, seasonal variations, etc.) rather than solely on loading rates (Dillon Consulting, 1997).

Hydraulic loading rates are calculated using the following formula:

$$HydraulicLoadingRate\left(\frac{m^3}{ha \cdot d}\right) = \frac{DesignFlow\left(m^3/d\right)}{Area\left(ha\right)}$$

Based on a 90 day discharge period and a wetland area of 1.6 ha, the estimated hydraulic loading rate for the 2009 treatment season is 196.6 m^3/ha*d. Using the same parameters, the estimated hydraulic loading rate for the 2028 treatment season is 323.6 m^3/ha*d. Please refer to Appendix A for detailed calculations.

3.4 Organic Loading Rates

Organic loading rates are not considered to be a critical design criterion when developing wetland treatment systems. They are, however, used as a check to ensure that adequate aerobic conditions exist within the wetland (Dillon Consulting, 1997). Heinke *et al.* (1993) proposes that organic loading rates should not exceed 8 kg BOD_5/ha*d.

Organic loading rates are calculated using the following formulas:

$$OrganicMatter\left(BOD_5\frac{kg}{m^3}\right)=\frac{BOD_5(mg/l)\times 1000l/m^3}{1{,}000{,}000mg/kg}$$

$$OrganicLoadingRate\left(\frac{kgBOD_5}{ha\cdot d}\right)=\frac{OrganicMatter\left(BOD_5kg/m^3\right)\times DesignFlow\left(m^3/d\right)}{Area(ha)}$$

Based on a BOD_5 value of 120 mg/l (the maximum concentration of BOD_5 to be discharged from the lagoon as set by the Nunavut Water Board), the organic loading rate for the 2009 treatment season is estimated to be 23.6 kg BOD_5/ha*d. Using the same BOD_5 concentration, the estimated organic loading rate for the 2028 treatment season is 38.8 kg BOD_5/ha*d.

3.5 Preliminary Sampling Results

In August 2007, construction of the new lagoon was underway and sewage was being deposited into the smaller temporary holding cell so as not to interfere with lagoon construction. Overflow from the holding cell was allowed to spill into the wetland area for further treatment. Two sewage effluent samples were obtained from the holding cell and two more were obtained from the wetland. The results of this analysis are listed in Table 3.3 below.

Table 3.3. Preliminary Sampling Results

Test Parameter	Units	Sewage Lagoon		Wetland	
		Sample 1 (AM)	Sample 2 (PM)	Sample 1 (AM)	Sample 2 (PM)
Ammonia as Nitrogen, NH_3-N	mg/L	91.8	93.8	56.4	57.4
Biological Oxygen Demand, BOD_5	mg/L	206	230	23	16
Total Suspended Solids, TSS	mg/L	1160	1020	33	27
Fecal Coliforms, FC	CFU/100 mL	3.5E+06	3.1E+06	21000	43000

As shown above, values for BOD_5, total suspended solids (TSS) and fecal coliforms from the holding cell exceeded the set maximum discharge values from the lagoon. Samples taken from the wetland for BOD_5 and TSS are well below the set discharge values for effluent discharged from the wetland. Fecal coliform levels were reduced in the wetland, however, they still exceeded the maximum discharge values.

4 SITE ECOLOGY AND PHYSICAL CHARACTERISTICS

4.1 Vegetation

The new lagoon cell was constructed in the same location as the old lagoon cell and as a result the discharge area for effluent from the lagoon has remained the same. Effluent from the lagoon is discharged onto the land below the lagoon and flows approximately 160m overland until it reaches the ocean. The final discharge point is the point at which effluent discharges from the wetland into the ocean. This point is marked on the surveillance monitoring program as location PEL-4. Please refer to Appendix B for a map and photograph of this location.

There are no known vegetative assessments prior to construction of the old lagoon cell that was commissioned approximately 20 years ago. Therefore it is difficult to determine what the effect of effluent discharge has been in this area over the past 20 years. No vegetative assessments were completed prior to, or after, the construction of the new lagoon cell. However it is expected that the vegetation in the area will not change dramatically as sewage effluent continues to be discharged into this area. Please refer to Figures 4-1 to 4-7 below for photos of the wetland vegetation.

Figure 4-1. Wetland Vegetation (photo taken August, 2007)

Figure 4-2. Wetland Vegetation (photo taken August, 2007)

Figure 4-3. Wetland Vegetation (photo taken August 2007)

Figure 4-4. Wetland Vegetation (photo taken August 2007)

Figure 4-5. Wetland Vegetation (photo taken August 2007)

Figure 4-6. Wetland Vegetation (photo taken August, 2007)

Figure 4-7. Wetland Vegetation (photo taken August 2007)

4.2 Site Characteristics

The wetland is located on the slope between the sewage lagoon and the ocean. During the spring, summer and fall months, sewage will be decanted from the lagoon into the smaller holding cell downstream of the lagoon. Once the holding cell is full, effluent will overflow the rip-rap berm wall of the cell and discharge into the wetland. As shown in Figures 4-1 to 4-7, the wetland has a relatively rough terrain and somewhat gentle slope. The many rocks and channels force the effluent to spread across the wetland thus increasing the contact and retention time of the effluent. Greater contact time increases the amount of treatment the effluent receives.

In order for the wetland to treat effluent to the acceptable standards as stated in the Hamlet's water licence, the wetland must be allowed time to establish its vegetation during each spring. Therefore effluent in the lagoon must not be discharged until there is sufficient vegetative growth in the wetland. Discharge of effluent from the lagoon will most likely be able to commence around the beginning to mid-July. At this point decant of the effluent must occur slowly, over a period of approximately 3 months. This will allow the effluent to remain in the wetland for a longer time period, thus increasing the amount of treatment it receives. It is difficult to determine exactly how much treatment will occur and by what time without extensive sampling and testing of the effluent. However, as long as vegetation has been established in the wetland and effluent is allowed to decant slowly, the effluent at the final discharge location (PEL-4) should meet the standards set out as per the Hamlet's water licence.

5 MONITORING PROGRAM

Sampling of effluent from the wetland will be performed three times during each discharge period; once during spring break-up, once during mid-summer and once before freeze-up. Four different locations pertaining to the wetland will be sampled during each sampling event. These stations are labeled PEL-3-1, PEL-3-2, PEL-4 and PEL-5. Station PEL-3-1 is located at the discharge point from the lagoon into the settlement pond. Station PEL-3-2 is located at the discharge point of effluent from the settlement pond into the wetland. Station PEL-4 is located at the discharge point of effluent from the wetland into the ocean and station PEL-5 is located in the ocean, 5m from PEL-4. Further details for the sampling program can be found in the Operation and Maintenance Manual for the Hamlet's sewage lagoon.

6 PERFORMANCE EXPECTATIONS

Based on preliminary sampling results during construction of the sewage lagoon, the wetland is expected to treat effluent to well below the set discharge values in the Hamlet's water licence. Effluent from the holding cell had BOD_5 and TSS concentrations well above the expected discharge concentrations from the sewage lagoon and the wetland was still able to reduce these concentrations to below acceptable levels. Fecal coliform concentrations are also expected to be lower in discharge from the sewage lagoon, however, based on the set discharge concentrations in the water licence fecal coliform values are not required to decrease after wetland treatment. Based on preliminary sampling results, wetland treatment will decrease fecal coliform values.

Using the Alberta Environment (2000) design guidelines, there is enough area in the current wetland to treat effluent in the 2009 treatment season continuing up to the 2028 treatment season. When considering the hydraulic loading rates, the calculated rate for the 2009 discharge period is within the guidelines. However, the calculated rate for the 2028 discharge period is somewhat higher. As previous studies have shown, hydraulic loading rates are directly dependent on the vegetative and physical characteristics of the wetland and can vary greatly in northern climates (Dillon Consulting, 1997). Therefore the appropriate hydraulic loading rate will have to be determined through use and sampling of the wetland.

Calculated organic loading rates for both the 2009 and 2028 discharge periods are much higher than the recommended value of 8 kg BOD_5/ha*d. This is not considered to be a critical design parameter, but is used mainly to check that enough oxygen is available to maintain aerobic treatment in the wetland. Due to the nature of the Kugaaruk wetland (the many streams, steady flowing water, minimal water depth of streams (<0.2m)), aerobic conditions should be well maintained. The calculated estimates were also based on the allowable maximum discharge concentration of BOD_5 from the sewage lagoon. It is expected that the BOD_5 concentration will be much lower than the maximum discharge limit and thus the calculated organic loading rate will be less.

7 CONCLUSIONS & RECOMMENDATIONS

The wetland is expected to treat effluent from the lagoon to the standards set out in the Hamlet's water licence. Preliminary sampling results indicate that the wetland is capable of treating high concentrations of BOD_5 and TSS to well below acceptable levels. The Alberta Environment model also predicts based on the available wetland area, that treatment of the effluent will be satisfactory.

The estimated hydraulic and organic loading rate calculations indicate that the wetland will not be able to treat effluent to acceptable levels. Hydraulic and organic loading rates are good guidelines to incorporate into wetland design, however, studies on northern climate wetlands have found that a wide range of hydraulic loading rates have been successful. They have also determined that the optimal loading rate depends heavily on the vegetation and physical characteristics of the wetland (Dillon Consulting, 1997). It is recommended that decant of the lagoon continue as planned in the spring and that monitoring of the lagoon and wetland begin at the same time. Unless there is something wrong with the treatment process (i.e. lagoon berm fails, wetland is failing to treat lagoon effluent), the decant and monitoring cycle should continue for 5 years until the water licence has expired. Treatment efficiencies of the lagoon and wetland should then be re-evaluated and improvements to the system may be implemented.

Improvements should be made when the system's deficiencies have been identified. The following is a list of potential improvements opportunities:

- Increase area of the wetland – There is room to increase the width of the wetland. The overflow berm may be made longer or diversion channels and culverts can be constructed to spread effluent over a greater area.

- Install a mechanical blower in the lagoon – This will aerate the lagoon increasing treatment within the lagoon prior to discharge into the wetland.

- Construct individual wetland cells – By constructing cells, effluent loading rates can be controlled more accurately and effluent will be treated through a filtration process.

8 REFERENCES

1. Alberta Environment. "Guidelines for the Approval and Design of Natural and Constructed Treatment Wetlands for Water Quality Improvement", Municipal Program Development Branch, Environmental Sciences Division, Environmental Service, March 2000.

2. Dillon Consulting Limited. "Sewage Treatment Using Tundra Wetlands", January 1997.

3. Heinke *et al.* "The Potential Use of Wetlands for Wastewater Treatment in the Northwest Territories", Prepared for Municipal and Community Affairs, Government of the Northwest Territories, 1993.

4. Nunavut Water Board. "Hamlet of Kugaaruk Water Licence, Licence Number: 3BM-PEL0712", September 2007.

APPENDIX A

WETLAND SURFACE AREA CALCULATIONS, HYDRAULIC & ORGANIC LOADING RATE CALCULATIONS

Required Wetland Area Calculation – Alberta Environment Model

Design Year: 2009

Surface Flow (SF) Treatment Wetland - Preliminary Feasibility Calculation Sheet

Location: Kugaaruk Sewage Lagoon

Design Flow (m^3/d) $Q =$ 314.6

Used average day calculation for 2009 ($28314 m^3/yr$)/(90d/yr discharge time) = $314.6 m^3/d$

		TSS	BOD	FC
Influent Concentration (mg/L)	$C_i =$	180	120	1000
Target Effluent Concentration (mg/L)	$C_e =$	45	45	1000
Wetland Background Limit (mg/L)	$C^* =$	19.14	9.86	100
for TSS, $C^* = 7.8 + 0.063Ci$ for BOD, $C^* = 3.5 + 0.053Ci$				
Areal rate constant @ 20°C (m/yr)	$k =$	1000	34	77
Required Wetland Area (ha)	$A =$	0.02	0.39	0
Required Wetland Area (m^2)	$A =$	209.89	3858.30	0

$A = [0.0365 \times Q/k] \times \ln[(C_i - C^*)/(Ce - C^*)]$

maximum calculated area from above boxes (A_{max}) = 3858.3 **m^2**

Design Year: 2028

Surface Flow (SF) Treatment Wetland - Preliminary Feasibility Calculation Sheet

Location: Kugaaruk Sewage Lagoon

Design Flow (m^3/d) $Q =$ 517.7

Used average day calculation for 2028 (46597m3/yr)/(90d/yr discharge time) = 517.7m3/d

		TSS	BOD	FC
Influent Concentration (mg/L)	$C_i =$	180	120	1000
Target Effluent Concentration (mg/L)	$C_e =$	45	45	1000
Wetland Background Limit (mg/L)	$C^* =$	19.14	9.86	100
for TSS, $C^* = 7.8 + 0.063Ci$ for BOD, $C^* = 3.5 + 0.053Ci$				
Areal rate constant @ 20°C (m/yr)	k =	1000	34	77
Required Wetland Area (ha)	A =	0.03	0.63	0
Required Wetland Area (m^2)	A =	345.39	6349.14	0

$A = [0.0365 \times Q/k] \times \ln[(C_i - C^*)/(Ce - C^*)]$

maximum calculated area from above boxes (A_{max}) = 6349.1 **m^2**

Hydraulic & Organic Loading Rate Calculations

Design Year: 2009

Wetland Treatment Area

Hydraulic Loading Rate			Organic Loading Rate (BOD_5)		
90 day Discharge Period					
HLR = Design Flow (m^3/d)/Area (ha)			Organic Matter (BOD) = BOD (mg/l)*1000 (l/m^3)/1000000mg/kg		
Design Flow	314.6	m^3/d	BOD	120	mg/l
Area	16000	m^2			
	1.6	ha	Organic Matter	0.12	kg/m^3
HLR	196.6	m^3/ha*d	OLR = Organic Matter (kg/m^3) *Design Flow (m^3/d)/Area (ha)		
			OLR	23.6	kg/ha*d

*BOD values based on Water Licence Requirements for Hamlet of Kugaaruk for discharge of effluent from lagoon to surrounding wetland.

*HLR values should range from 100m^3/ha*d to 200m^3/ha*d

*OLR values should not exceed 8kg/ha*d

(Source: The Potential Use of Wetlands for Wastewater Treatment in the Northwest Territories, Heinke et al., 1993)

Design Year: 2028

Wetland Treatment Area

Hydraulic Loading Rate			Organic Loading Rate (BOD_5)		
90 day Discharge Period					
HLR = Design Flow (m^3/d)/Area (ha)			Organic Matter (BOD) = BOD (mg/l)*1000 (l/m^3)/1000000mg/kg		
Design Flow	517.7	m^3/d	BOD	120	mg/l
Area	16000	m^2			
	1.6	ha	Organic Matter	0.12	kg/m^3
HLR	323.6	m^3/ha*d	OLR = Organic Matter (kg/m^3) *Design Flow (m^3/d)/Area (ha)		
			OLR	38.8	kg/ha*d

*BOD values based on Water Licence Requirements for Hamlet of Kugaaruk for discharge of effluent from lagoon to surrounding wetland.

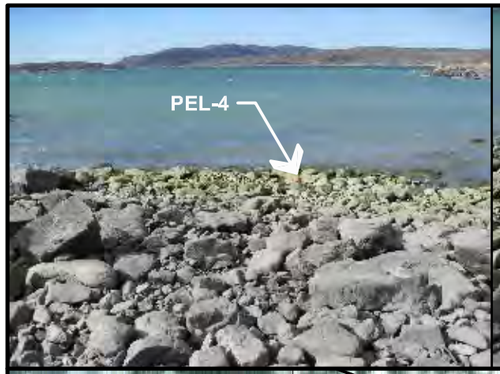
*HLR values should range from 100m^3/ha*d to 200m^3/ha*d

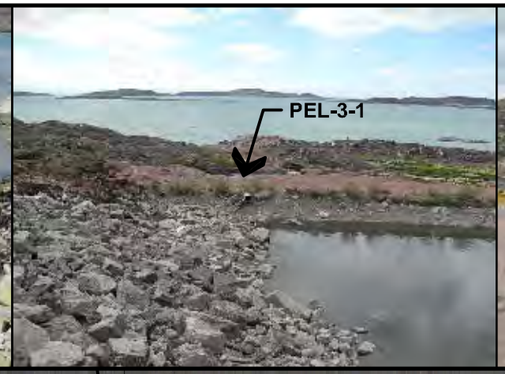
*OLR values should not exceed 8kg/ha*d

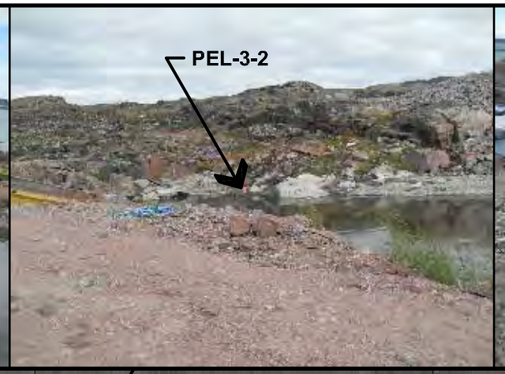
(Source: The Potential Use of Wetlands for Wastewater Treatment in the Northwest Territories, Heinke et al., 1993)

APPENDIX B

MAP OF MONITORING STATIONS AND FINAL DISCHARGE POINT







7,603,800mN

7,603,700mN

7,603,600mN

384,000mE

384,100mE

384,200mE

384,300mE

384,400mE

PEL-4

PEL-5

PEL-3-2

PEL-3-1

PEL-2

EXISTING LAGOON

25m 20 15 10 5 0 10 20 30 40 50m

SCALE 1:1,500

Nunavut

PROJECT

KUGARUUK SEWAGE AND SOLID WASTE DESIGN
SNP MONITORING

TITLE

SNP LOCATIONS AT LAGOON

DILLON CONSULTING

SCALE	AS SHOWN
DILLON PROJECT NUMBER	05-4755-6000
CLIENT PROJECT NUMBER	NA
DRAWING NUMBER	200

ACAD FILE: 41\pw_g\cad\05475516000\snp locations.dwg

PLOT DATE: 31.07.2008

EDIT DATE: 31.07.2008

APPENDIX C

RECORD DRAWINGS

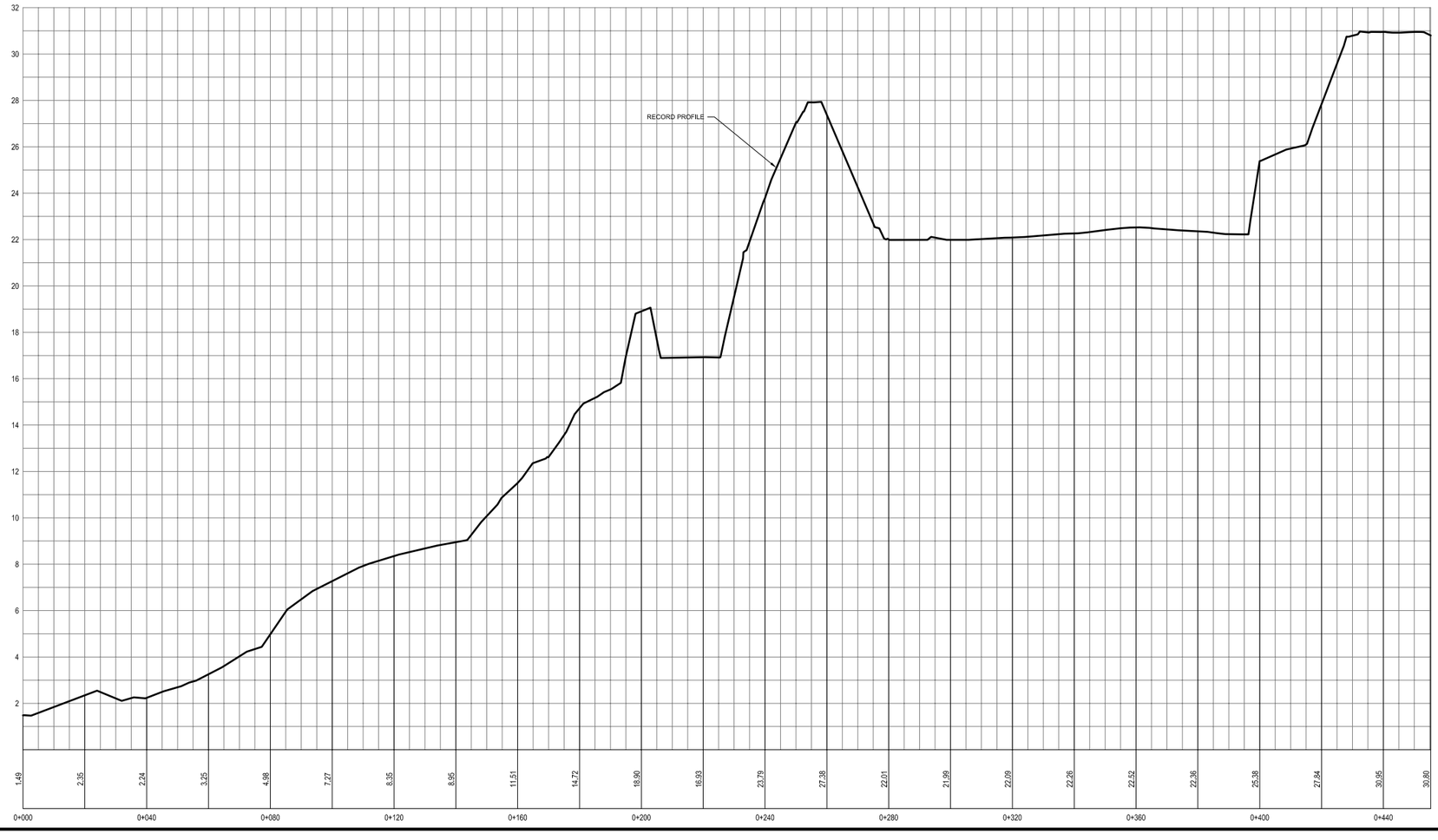
THE GOVERNMENT OF NUNAVUT
COMMUNITY AND GOVERNMENT SERVICES

SEWAGE & SOLID WASTE SITES - RECORD DRAWINGS
LOCATION: KUGAARUK, NUNAVUT
PROJECT NO: 05-4755-3000
DATE: DECEMBER 2009

LOCATION PLAN

LIST OF DRAWINGS	
Sheet Number	Sheet Title
000	Cover
100	Lagoon Site
101	Design Lagoon Site Plan View
102	Lagoon Sections
103	Wetland Sections
200	Discharge and Overflow Flume and Landfill Fence Details
201	Berm Sections and Details
202	Manhole Details

DILLON CONSULTING



EDIT DATE: 11.12.2009 PLOT DATE: 41tpw 11.12.2009 ACAD File#tpw g:\cad\054755\record\pond.dwg

LEGEND

PLAN:

DESIGN:
MINOR CONTOUR (0.2m)
MAJOR CONTOUR (1.0m)

BERM WALLS
BERM TOP
TOE OF SLOPE
LAGOON CONTAINMENT
DRAINAGE DIRECTION

NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE

1 (100/101) — DETAIL NUMBER; DRAWING SHEET WHERE DETAIL IS SHOWN; DETAIL REFERENCED (THIS DRAWING SHEET)

RECORD DRAWING

APPROVED BY — DATE 07/09

DRAWING REDUCED NOT TO SCALE

CHANGE	DATE	DESCRIPTION	CHECK
6	01/07/09	RECORD DRAWINGS	GS
5	07/10/07	REVISED FOR NWB APLLICATION	GS
4	01/31/07	REVISED FOR NWB COMMENTS	GS
3	05/05/06	ISSUED FOR TENDER	GS
2	08/29/05	ISSUED FOR 95% REVIEW	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	TPW	GS	JAN 2009

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 010
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER — G. STRONG — NWT.

Nunavut

PROJECT
SEWAGE & SOLID WASTE FACILITY
KUGAARUK, NUNAVUT

TITLE
LAGOON SITE

DILLON CONSULTING

SCALE 1:500
DILLON PROJECT NUMBER 05-4755-3000
CLIENT PROJECT NUMBER NA
DRAWING NUMBER 100

25 20 15 10 5 0 25m

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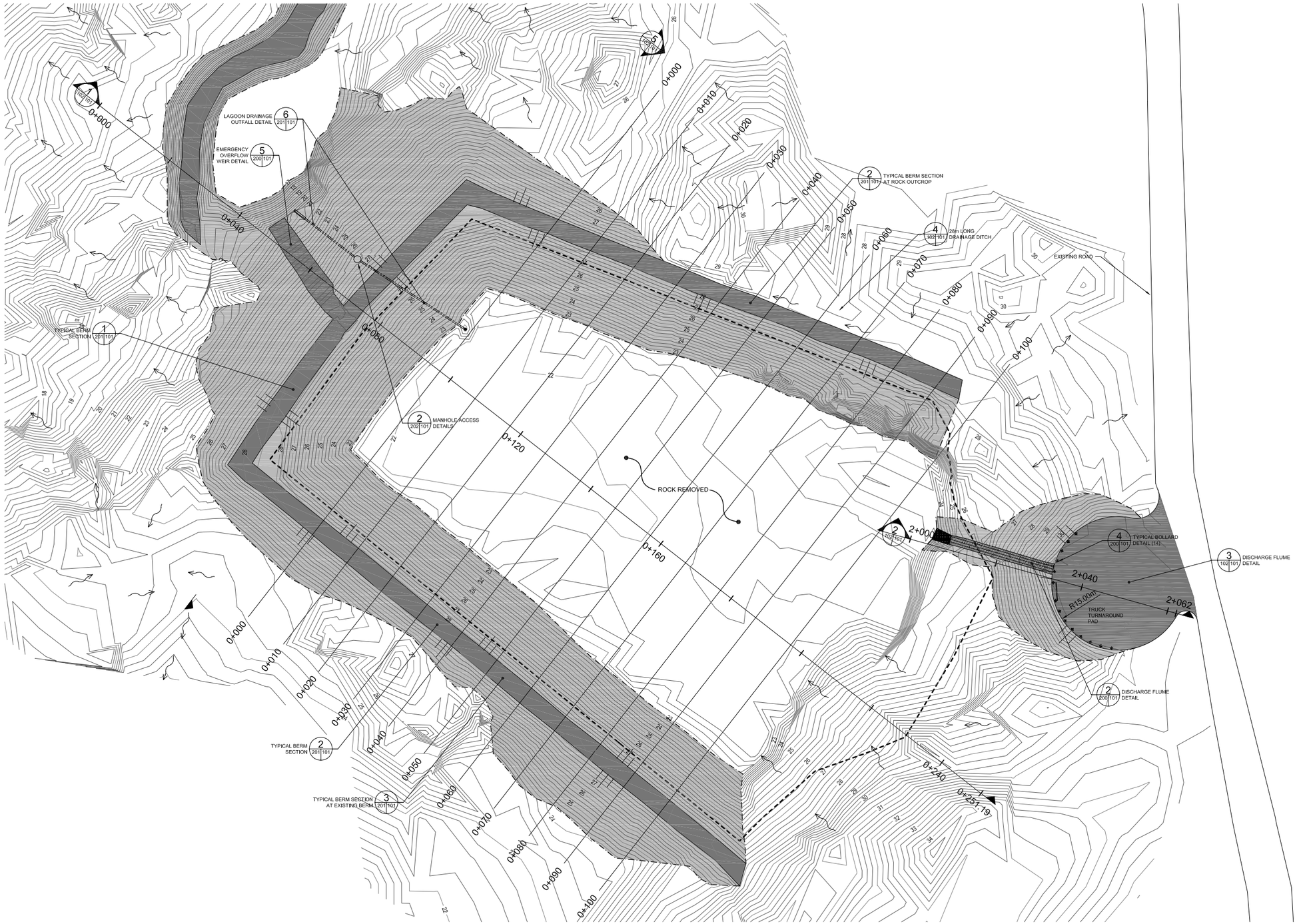

1 101 101 LAGOON DESIGN
SCALE 1:500

LEGEND

PLAN:

DESIGN:
MINOR CONTOUR (0.2m)
MAJOR CONTOUR (1.0m)

BERM WALLS
BERM TOP
TOE OF SLOPE
LAGOON CONTAINMENT
DRAINAGE DIRECTION

NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE

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APPROVED BY GS DATE Jan 07/09

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5	07/10/07	REVISED FOR NWB APLLICATION	GS
4	01/31/07	REVISED FOR NWB COMMENTS	GS
3	05/05/06	ISSUED FOR TENDER	GS
2	08/29/05	ISSUED FOR 95% REVIEW	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	TPW	GS	JAN 2009

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS AND GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 010
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER G. STRONG NWT

Nunavut

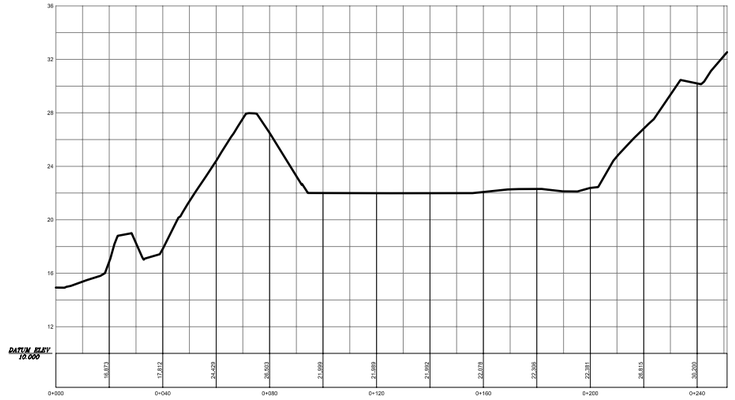
PROJECT
SEWAGE & SOLID WASTE FACILITY
KUGAARUK, NUNAVUT

TITLE
DESIGN LAGOON SITE PLAN VIEW

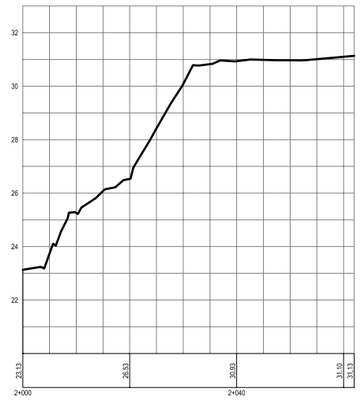
DILLON CONSULTING

SCALE	1:500
DILLON PROJECT NUMBER	05-4755-3000
CLIENT PROJECT NUMBER	NA
DRAWING NUMBER	101

EDIT DATE: 11.12.2009 PLOT DATE: 41tpw 11.12.2009 ACAD File: tpw c:\cad\05-4755\recordpond.dwg



1 101 102 LAGOON SECTION
SCALE 1:1000hor 1:200ver



2 101 102 TURNAROUND PAD SECTION
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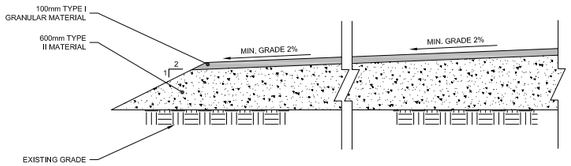

3 101 102 TURNAROUND PAD DETAIL
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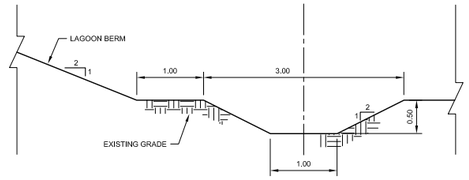

4 101 102 TOE DRAINAGE DITCH DETAIL
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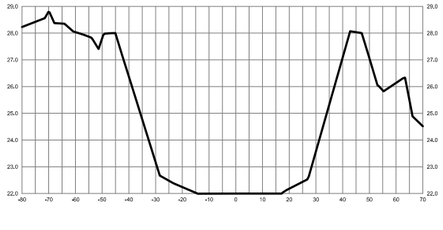

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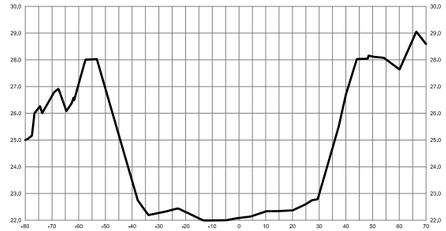

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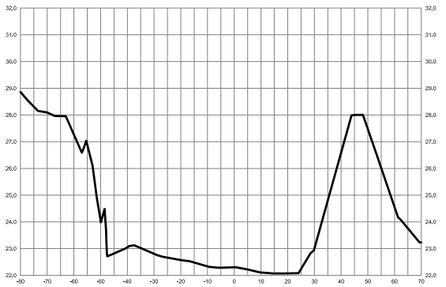

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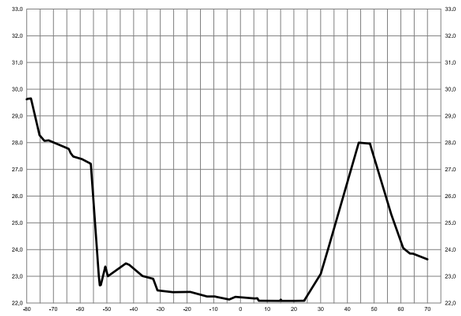

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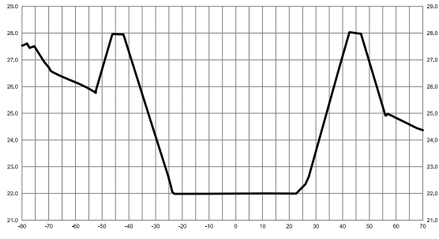

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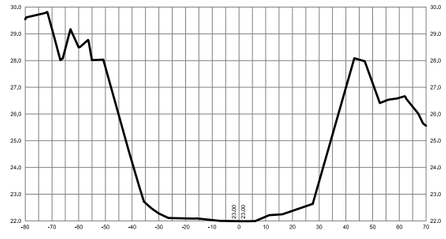

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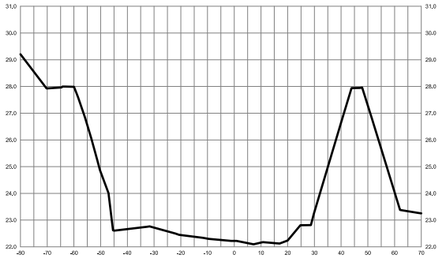

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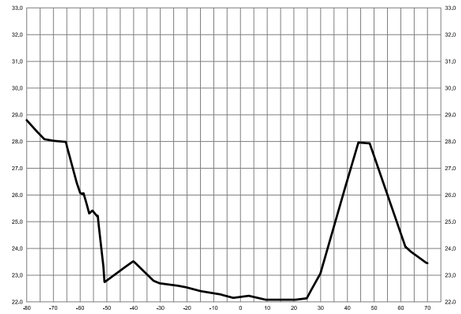

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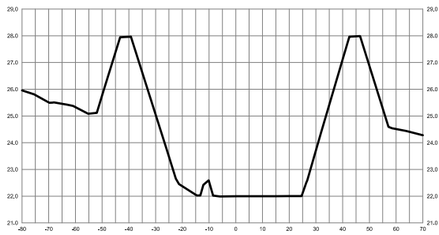

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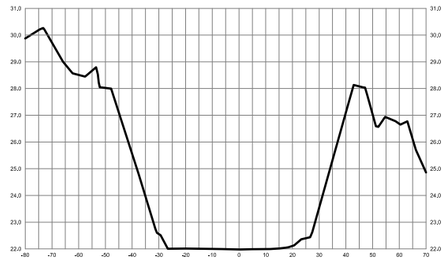

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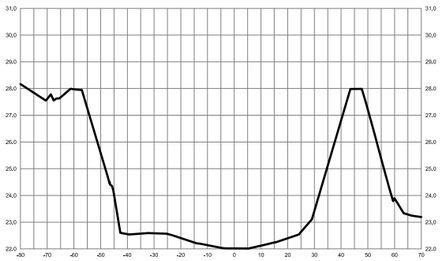


5 101 102 LAGOON CROSS SECTIONS
SCALE 1:1000hor 1:100ver

NOTE:

SEE DWG. 201 SECTION 1 AND SECTION 2 FOR BERM CONSTRUCTION DETAILS.

RECORD PROFILE: _____

RECORD DRAWING

APPROVED BY _____ DATE Jan 07/09

DRAWING REDUCED NOT TO SCALE

CHANGE	DATE	DESCRIPTION	CHECK
6	01/07/09	RECORD DRAWINGS	GS
5	07/10/07	REVISED FOR NWB APLLICATION	GS
4	01/31/07	REVISED FOR NWB COMMENTS	GS
3	05/05/06	ISSUED FOR TENDER	GS
2	08/29/05	ISSUED FOR 95% REVIEW	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	TPW	GS	JAN 2009

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 010
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER G. STRONG NWT

Nunavut

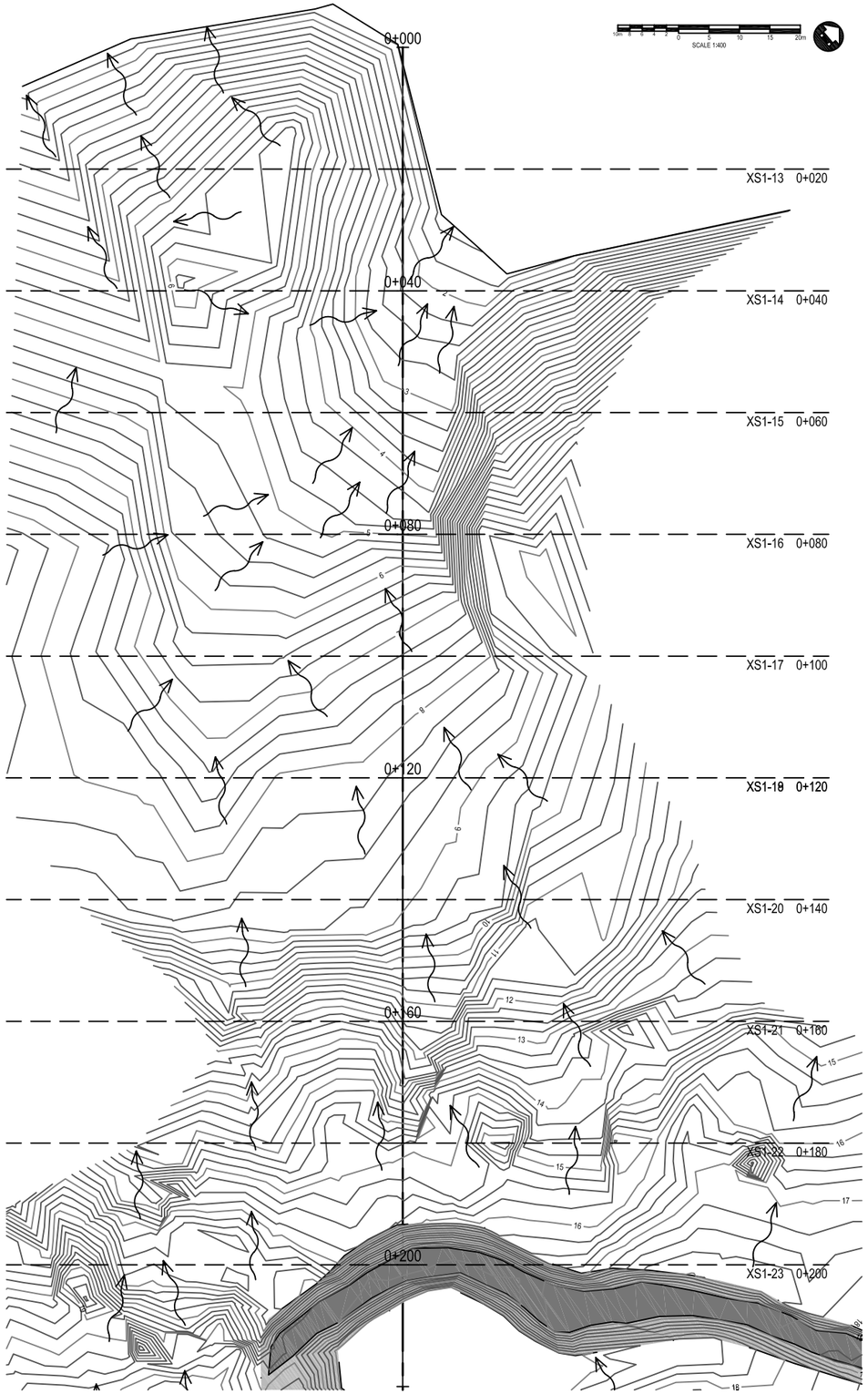
PROJECT
SEWAGE & SOLID WASTE FACILITY
KUGAARUK, NUNAVUT

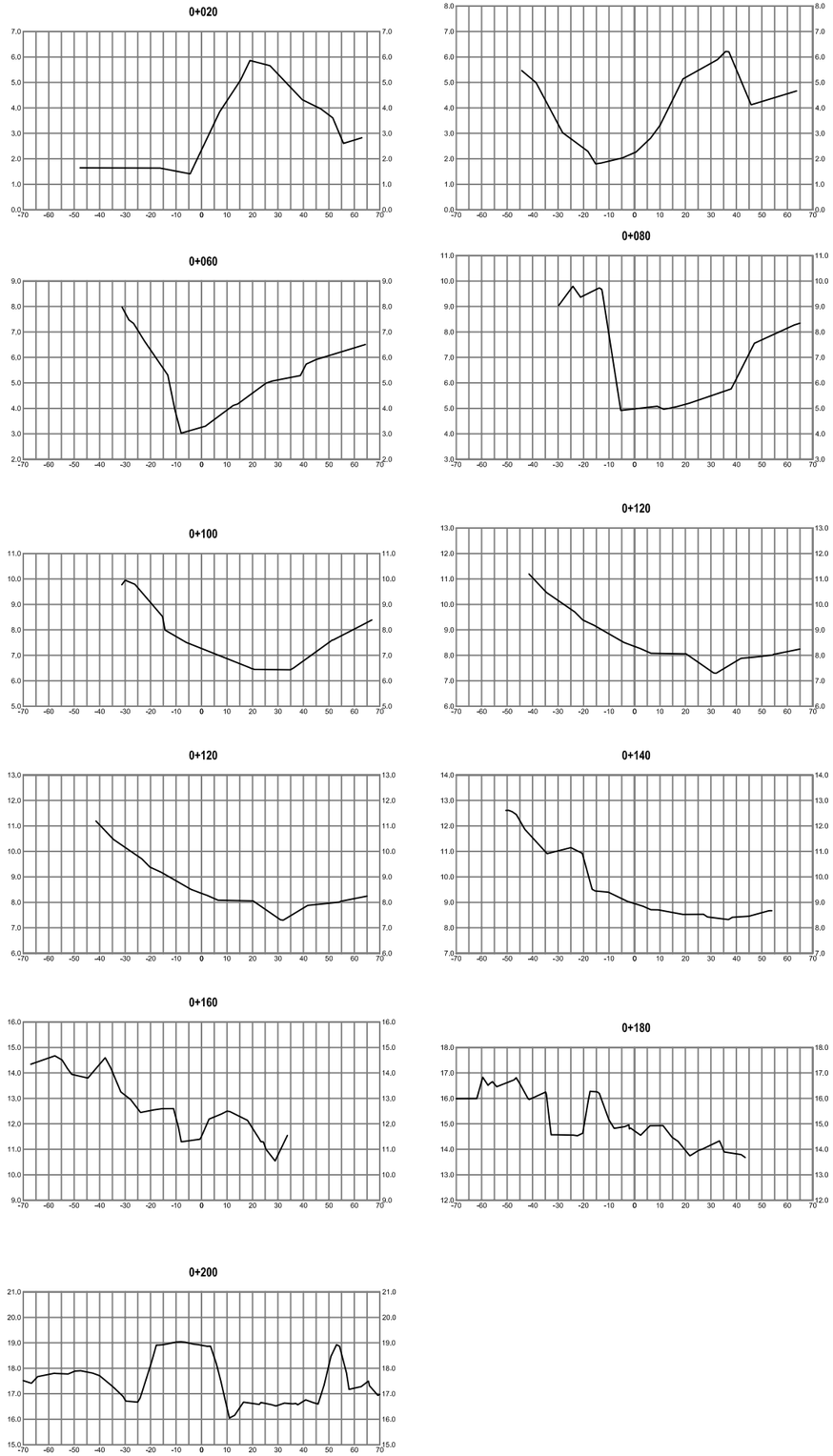
TITLE
LAGOON SECTIONS

DILLON CONSULTING

SCALE AS SHOWN
DILLON PROJECT NUMBER 05-4755-3000
CLIENT PROJECT NUMBER NA
DRAWING NUMBER 102

EDIT DATE: 11:12.2009 PLOT DATE: 4:19pm 11:12.2009 ACAD File: P:\cad\05\4755\recordpond.dwg





LEGEND

PLAN:

DESIGN:
MINOR CONTOUR (0,2m)
MAJOR CONTOUR (1,0m)

BERM WALLS
BERM TOP
TOE OF SLOPE
LAGOON CONTAINMENT
DRAINAGE DIRECTION

NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE

1 / 101 / 101 — DETAIL NUMBER; DRAWING SHEET WHERE DETAIL IS SHOWN; DETAIL REFERENCED (THIS DRAWING SHEET)

RECORD DRAWING

APPROVED BY — DATE 07/09

DRAWING REDUCED NOT TO SCALE

CHANGE	DATE	DESCRIPTION	CHECK
1	12/11/09	ISSUED FOR NWB APLLICATION	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	TPW	GS	JAN 2009

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 010
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER — G. STRONG — NWT.

Nunavut

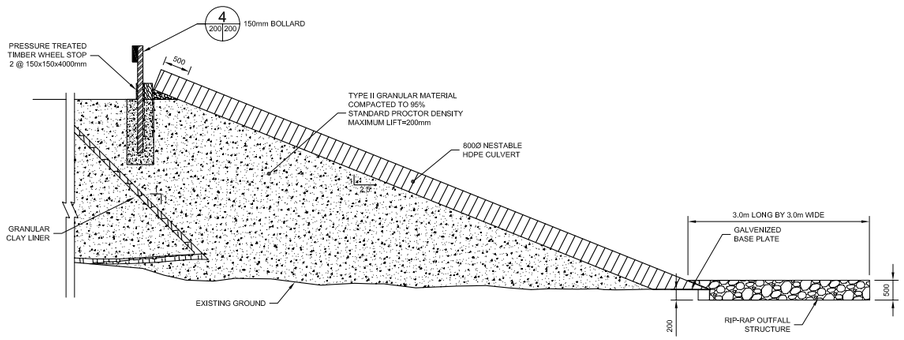
PROJECT
SEWAGE & SOLID WASTE FACILITY
KUGAARUK, NUNAVUT

TITLE
WETLAND SECTIONS

DILLON CONSULTING

SCALE	1:500
DILLON PROJECT NUMBER	05-4755-3000
CLIENT PROJECT NUMBER	NA
DRAWING NUMBER	103

EDIT DATE: 11.12.2009 PLOT DATE: 41pw 11.12.2009 ACAD File: G:\cad\05\4755\record\pond c3d sections.dwg



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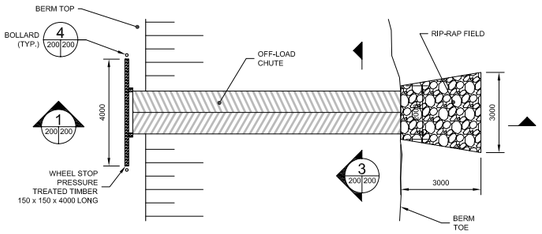
SCALE N.T.S.



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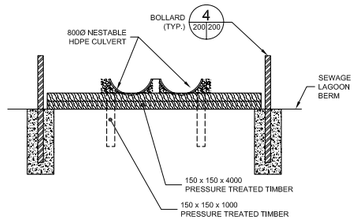

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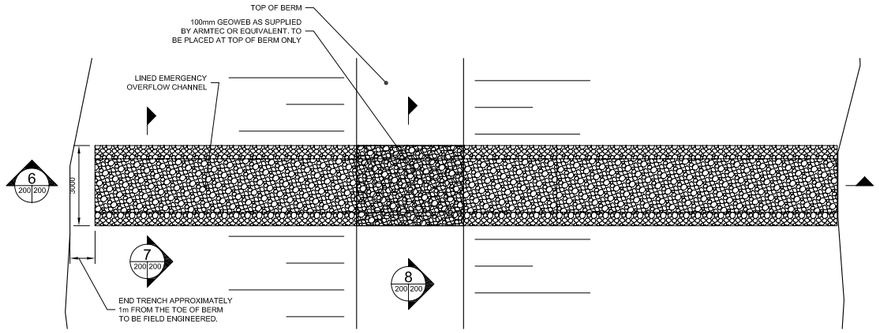

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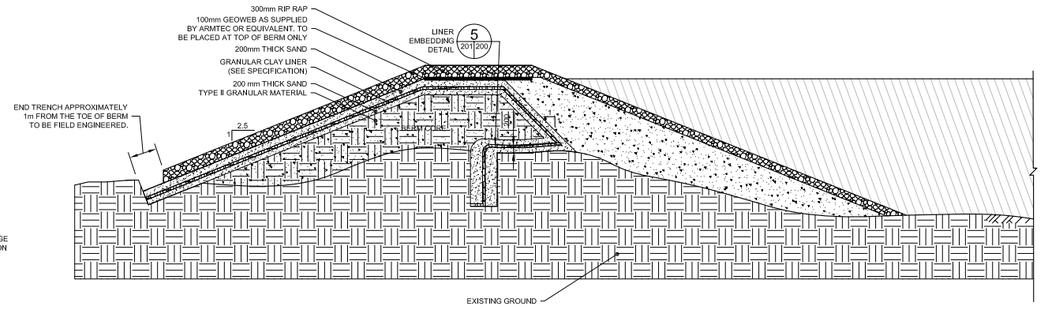
SCALE 1:100



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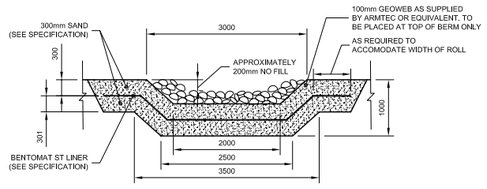

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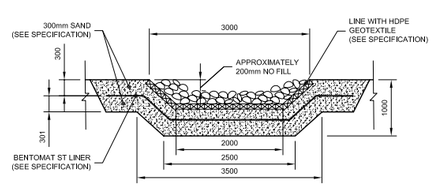

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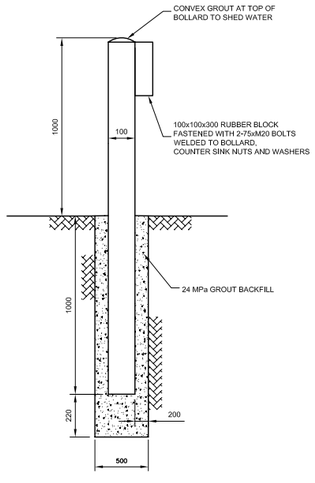

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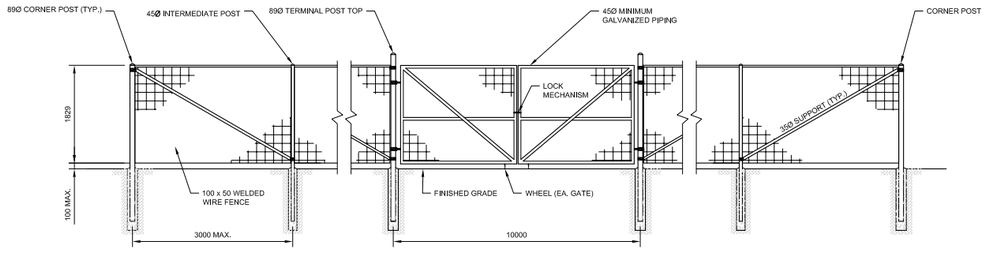

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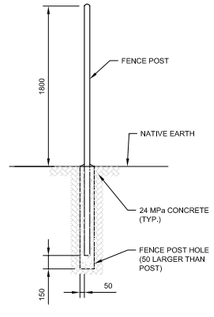

10 200 200 LANDFILL FENCE POST DETAIL
SCALE 1:30

NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE

1 100 101 — DETAIL NUMBER; DRAWING SHEET WHERE DETAIL IS SHOWN; DETAIL REFERENCED (THIS DRAWING SHEET)

RECORD DRAWING
APPROVED BY — DATE 07/09

DRAWING REDUCED NOT TO SCALE

CHANGE	DATE	DESCRIPTION	CHECK
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5	07/10/07	REVISED FOR NWB APLLICATION	GS
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2	08/29/05	ISSUED FOR 95% REVIEW	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	41TPW	GS	JAN 2009

Nunavut

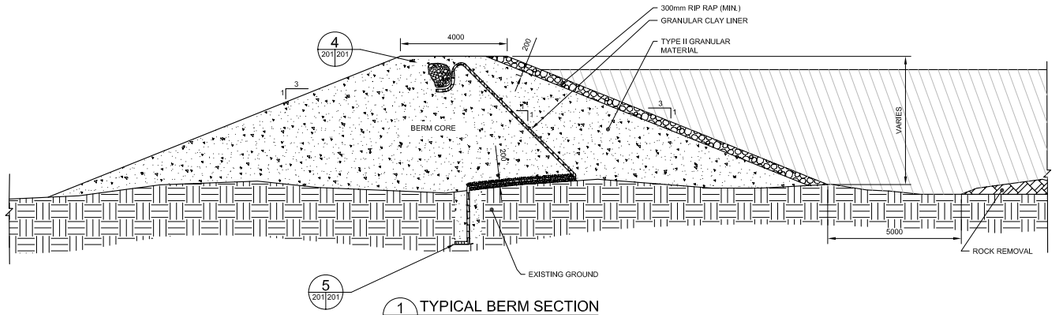
PROJECT
SEWAGE & SOLID WASTE FACILITY
KUGAARUK, NUNAVUT

TITLE
DISCHARGE AND OVERFLOW FLUME AND LANDFILL FENCE DETAILS

DILLON CONSULTING

SCALE: AS SHOWN
DILLON PROJECT NUMBER: 05-4755-3000
CLIENT PROJECT NUMBER: NA
DRAWING NUMBER: 200

EDIT DATE: 11.12.2009 PLOT DATE: 11.12.2009 ACAD FILE:41tpw g:\cad\05475\0recorddetails.dwg



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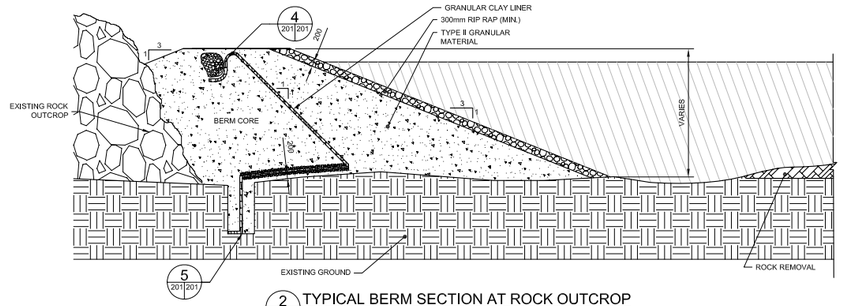
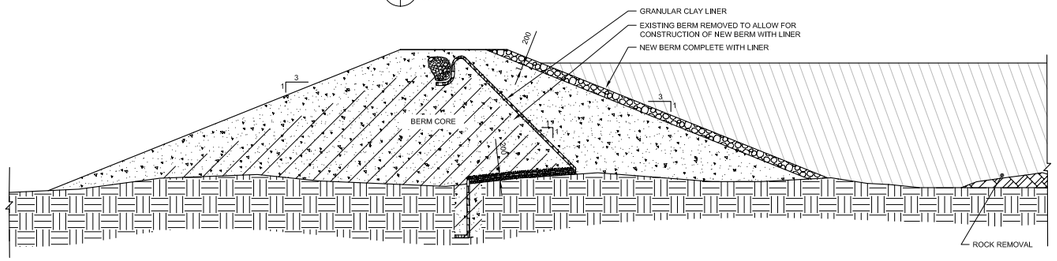
SCALE 1:100



2 101 201 TYPICAL BERM SECTION AT ROCK OUTCROP
SCALE 1:100



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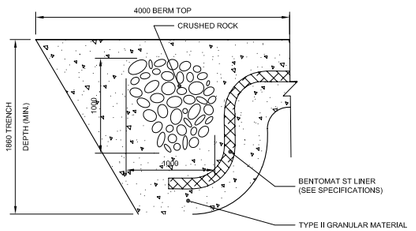

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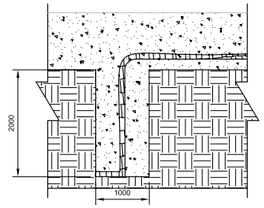

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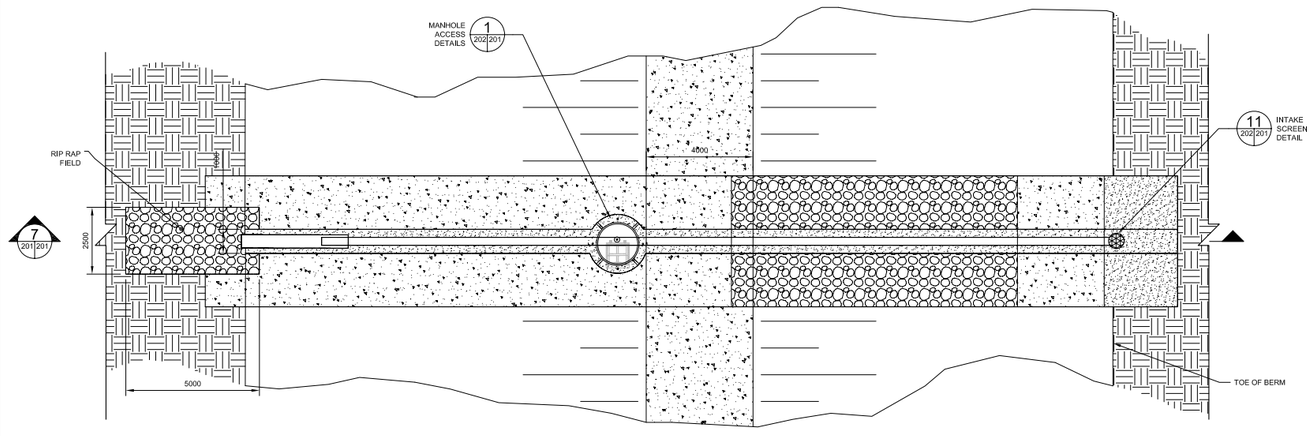
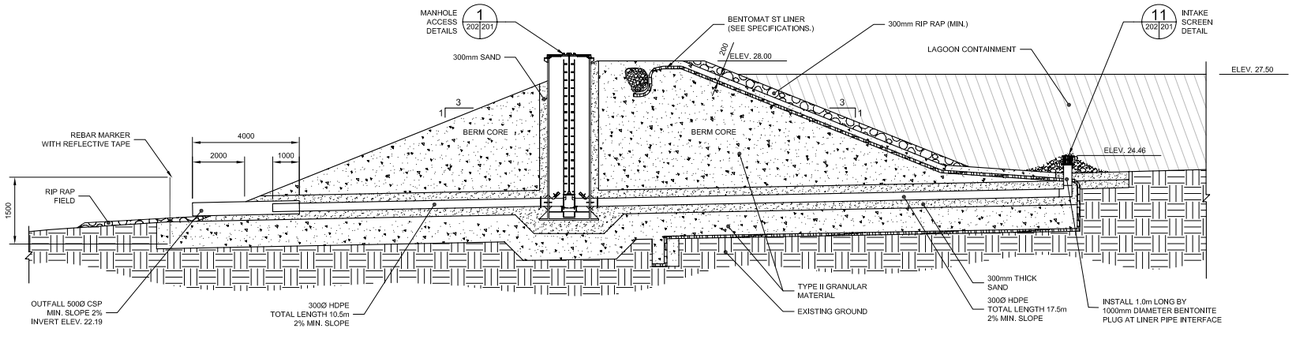


6 101 201 LAGOON DRAINAGE OUTFALL PLAN
SCALE 1:100



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SCALE 1:100

EDIT DATE: 11.12.2009 PLOT DATE: wotherspoon, trevor 11:12 AM File:tow g:\cad\05475\record\details.dwg

NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE

1 100 101 — 1: DETAIL NUMBER; 100: DRAWING SHEET WHERE DETAIL IS SHOWN; 101: DETAIL REFERENCED (THIS DRAWING SHEET)

RECORD DRAWING
APPROVED BY: GS DATE: Jan 07/09

DRAWING REDUCED NOT TO SCALE

CHANGE	DATE	DESCRIPTION	CHECK
6	01/07/09	RECORD DRAWINGS	GS
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REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	41TPW	GS	JAN 2009

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 010
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER — G. STRONG — NWT.

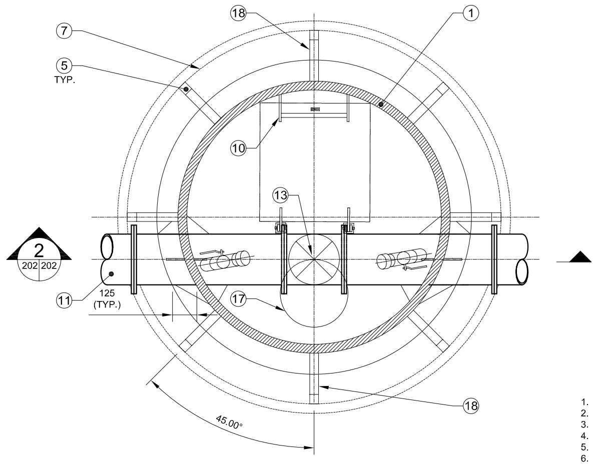
Nunavut

PROJECT
SEWAGE & SOLID WASTE FACILITY
SEWAGE & SOLID WASTE

TITLE
BERM SECTIONS AND DETAILS

DILLON CONSULTING

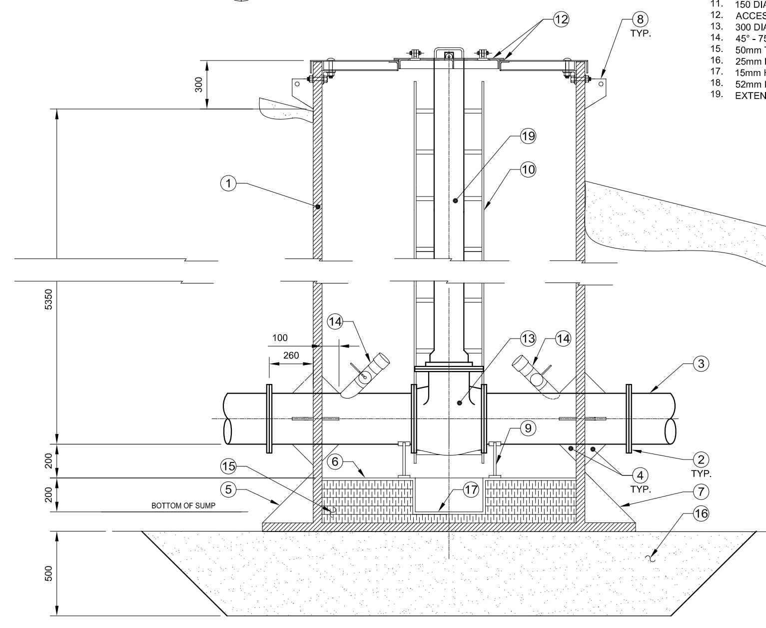
SCALE: AS SHOWN
DILLON PROJECT NUMBER: 05-4755-3000
CLIENT PROJECT NUMBER: NA
DRAWING NUMBER: 201



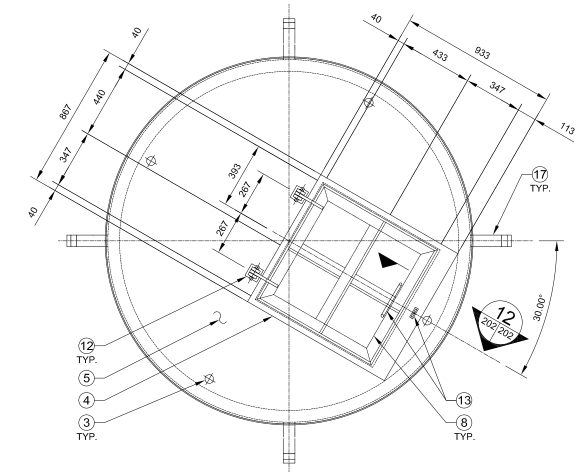
1 WATER SUPPLY LINE MANHOLE PLAN
201 202 SCALE 1:20

KEYNOTES:

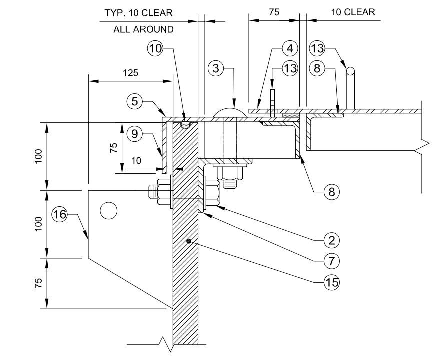
1. 1600mm DIA. HDPE PIPE DR 32.5
2. FLANGE TO FLANGE CONNECTION
3. 300 DIA. HDPE DR 17 PIPE FLANGED TO MANHOLE
4. 15mm HDPE STIFFENER (TYP. OF 4)
5. 52mm HDPE STIFFENER (TYP. OF 6)
6. 15mm HDPE FLOOR (SLOPE FLOOR TO SUMP), WELD TO MANHOLE
7. 52mm HDPE BASE, WELD TO MANHOLE
8. 52mm HDPE LIFTING HOOK (TYP. OF 4)
9. HUNT PIPE SUPPORT
10. BUILT UP HDPE LADDER 400mm WIDE C/W RUNGS @ 300 O.C. FIX TO HDPE MANHOLE
11. 150 DIA. HDPE DR 17 PIPE WELD TO MANHOLE
12. ACCESS VAULT LID C/W ACCESS HATCH
13. 300 DIA RESILENT SEAT GATE VALVE
14. 45° - 75mm DIA. HDPE ACCESS PORT C/W 75mm BALL VALVE AND CAP. INSTALL @ 10° SKEW FROM C
15. 50mm THK. BUILT UP BOARD INSULATION
16. 25mm MINUS GRANULAR BASE COURSE @ 97% S.P.D.
17. 15mm HDPE x 400mm DIA. SUMP
18. 52mm HDPE STIFFENER AND SEEPAGE CUT OFF 300mm X 1000mm HIGH (TYP. OF 6)
19. EXTENSION SPINDLE



2 WATER SUPPLY LINE MANHOLE SECTION
202 202 SCALE 1:20



7 MANHOLE ACCESS HATCH FRAMING DETAIL
202 202 SCALE 1:20



12 MANHOLE ACCESS SECTION
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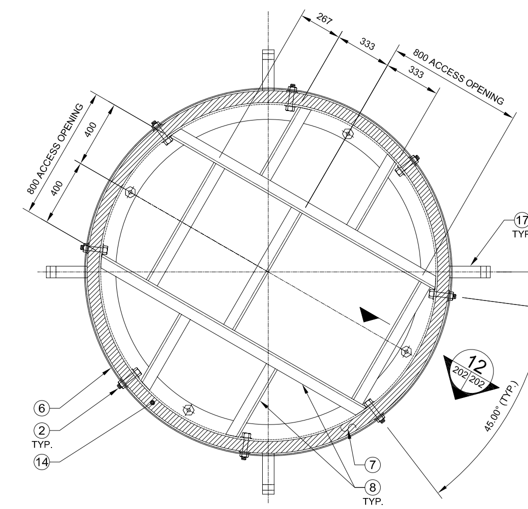


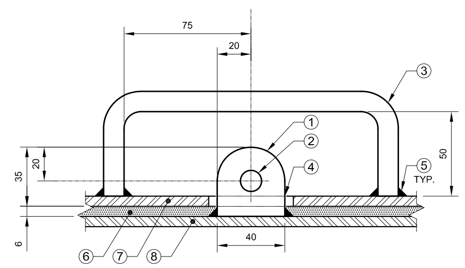
8 MANHOLE LID FRAMING DETAIL
202 202 SCALE 1:20

NOTES:

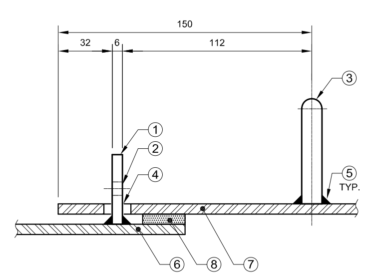
1. FOR ACCESS MANHOLE LID FRAMING PLANS 6mm THK. GALV. STEEL PLATE LID NOT SHOWN FOR CLARITY.
2. ALL WELDS AND ABRASIONS TO BE REPAIRED WITH TWO COATES OF GALVCON.

KEYNOTES:

1. 1220mm DIA. HDPE DR 32.5 MANHOLE WALL
2. 19mm DIA. GALV. NUT, BOLT & WASHER (8 REQ'D) SEE ACCESS MANHOLE LID FRAMING PLAN FOR ARRANGEMENT
3. 19mm DIA. GALV. NUT, CARRIAGE BOLT & WASHER (4 REQ'D) SEE ACCESS HATCH FRAMING PLAN FOR ARRANGEMENT
4. 6mm THK. GALV. STEEL PLATE ACCESS HATCH COVER
5. 6mm THK. GALV. STEEL PLATE MANHOLE LID
6. 6mm THK. x 75mm DEEP GALV. STEEL BAND, WELD TO LID
7. 75x75x8 GALV. ROLLED ANGLE CONTINUOUS ALL AROUND AND BOLTED TO HDPE MANHOLE
8. 55x55x6 GALV. ANGLE SEE LID FRAMING **DETAIL 4**
9. 55x55x6 GALV. ANGLE SEE ACCESS HATCH FRAMING **DETAIL 3**
10. 12.5mm DIA. RUBBER GASKET IN ROUTERED SLOT CONTINUOUS ALL AROUND WEATHER TIGHT
11. 25mm WIDE x 6mm THK. RUBBER GASKET, MASTIC TO UNDERSIDE OF HATCH COVER (TYP. 4 SIDES)
12. ACCESS HATCH COVER HINGE (TYP. OF 2/PER) SEE **DETAIL 8** THIS DWG.
13. ACCESS HATCH COVER HASP & LIFTING HANDLE SEE **DETAIL 6** THIS DWG.
14. 1600mm DIA. HDPE DR 32.5 MANHOLE WALL
15. HDPE MANHOLE WALL
16. HDPE LIFTING HOOK SEE FRAMING DETAIL FOR ARRANGEMENT
17. 52mm HDPE LIFTING HOOK C/W 25mm DIA. HOLE (4 REQ'D)



3 HASP AND LIFTING HANDLE DETAIL
202 202 SCALE 1:2



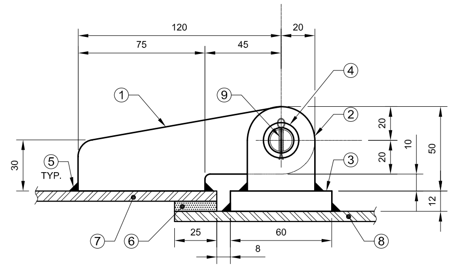
4 HASP AND LIFTING HANDLE SECTION
202 202 SCALE 1:2

NOTES:

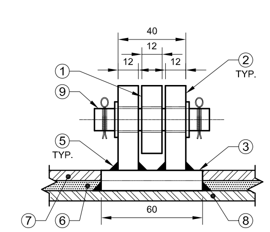
1. ACCESS MANHOLE LID & HATCH ANGLE FRAMING ARE NOT SHOWN FOR CLARITY. FOR DETAIL REFER TO FRAMING PLAN AS PER DETAIL
2. ALL WELDS AND ABRASIONS TO BE REPAIRED WITH TWO COATES OF GALVCON.

KEYNOTES:

1. 6mm THK. GALV. STEEL STAPLE
2. 12.5mm DIA. DRILLED HOLE FOR PADLOCK
3. 12.5mm DIA. GAVL. STEEL BAR LIFTING HANDLE
4. 50mmx15mm SLOT HOLE
5. 6mm FILLET WELD ALL AROUND (TYP.)
6. 25mm WIDE x 6mm THK. RUBBER GASKET MASTIC TO UNDERSIDE OF HATCH COVER (TYPICAL 4 SIDES)
7. 6mm THK. GALV. STEEL PLATE ACCESS HATCH COVER
8. 6mm THK. GALV. STEEL PLATE MANHOLE LID



5 MANHOLE ACCESS HATCH HINGE DETAIL
202 202 SCALE 1:2



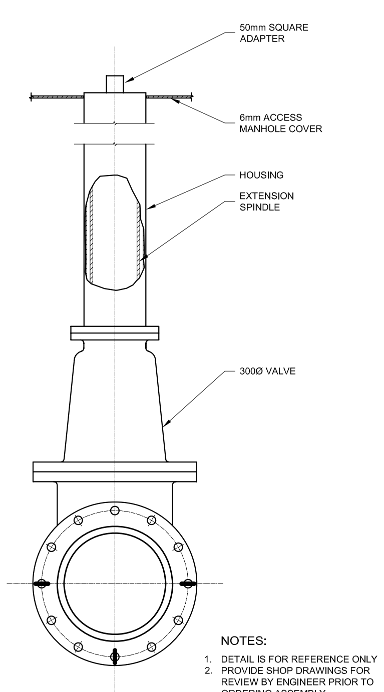
6 MANHOLE ACCESS HATCH HINGE SECTION
202 202 SCALE 1:2

NOTES:

1. ACCESS MANHOLE LID & HATCH ANGLE FRAMING ARE NOT SHOWN FOR CLARITY. FOR DETAIL REFER TO FRAMING PLAN AS PER DETAIL.
2. ALL WELDS AND ABRASIONS TO BE REPAIRED WITH TWO COATES OF GALVCON.

KEYNOTES:

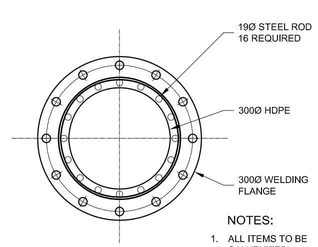
1. 12mm THK. GALV. STEEL HINGE ARM C/W HOLE FOR 13mm DIA. PIN
2. 12mm THK. GALV. STEEL HINGE ARM SUPPORT C/W HOLE FOR 13mm DIA. PIN (TYPICAL OF 2)
3. 60mm x 60mm x 12mm THK. GALV. STEEL BASE PLATE
4. GAVL. STEEL WASHER (TYP.)
5. 6mm FILLET WELD ALL AROUND
6. 25mm WIDE x 6mm THK. RUBBER GASKET MASTIC TO UNDERSIDE OF HATCH COVER (TYPICAL 4 SIDES)
7. 6mm THK. GALV. STEEL PLATE ACCESS HATCH COVER
8. 6mm THK. GALV. STEEL PLATE MANHOLE LID
9. 13mm DIA. GALV. STEEL PIN C/W 2 COTTER PIN



NOTES:

1. DETAIL IS FOR REFERENCE ONLY
2. PROVIDE SHOP DRAWINGS FOR REVIEW BY ENGINEER PRIOR TO ORDERING ASSEMBLY

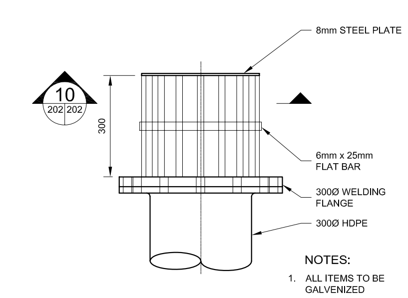
9 EXTENSION SPINDLE DETAIL
202 202 SCALE 1:10



NOTES:

1. ALL ITEMS TO BE GALVENIZED

10 INTAKE SCREEN SECTION
202 202 SCALE 1:10



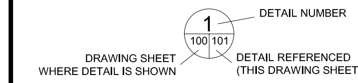
NOTES:

1. ALL ITEMS TO BE GALVENIZED

11 INTAKE SCREEN DETAIL
202 202 SCALE 1:10

NOTES

DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED OTHERWISE



RECORD DRAWING

APPROVED BY — DATE: Jan 07/09

DRAWING REDUCED
NOT TO SCALE

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CHANGE	DATE	DESCRIPTION	CHECK
6	01/07/09	RECORD DRAWINGS	GS
5	07/10/07	REVISED FOR NWB APLLICATION	GS
4	01/31/07	REVISED FOR NWB COMMENTS	GS
3	05/05/06	ISSUED FOR TENDER	GS
2	08/29/05	ISSUED FOR 95% REVIEW	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	41TPW	GS	JAN 2009

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER
P 010
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER
G. STRONG
N.W.T.

Nunavut

PROJECT
SEWAGE & SOLID WASTE FACILITY
KUGAARUK, NUNAVUT

TITLE
MANHOLE DETAILS

DILLON CONSULTING

SCALE	AS SHOWN
DILLON PROJECT NUMBER	05-4755-3000
CLIENT PROJECT NUMBER	NA
DRAWING NUMBER	202

EDIT DATE: 11.12.2009 PLOT DATE: wotherspoon, trevor 11.12.2009 FILE: ...recorddetails.dwg