PEACE RIVER
REGIONAL DISTRICT

KELLY LAKE SEWER SYSTEM
CONDITION ASSESSMENT

SIMO

KELLY LAKE SEWER SYSTEM CONDITION ASSESSMENT

NOVEMBER 2021 FINAL REPORT

RECORD OF ISSUES AND REVISIONS					
R	DATE	DESCRIPTION	PREPARED	VERIFIED	APPROVED
0B	2021-11-10		R. Flannery	A.Hernandez	G.Boutron, P.Eng.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 SCOPE OF WORK

Simo Management Inc. (Simo) was selected by Peace River Regional District (PRRD) to undertake a non-destructive and non-invasive field condition assessment and an overall operational structural evaluation of the Kelly Lake Sewer System to determine the remaining service life, and repair/replacement costs of any identified deficiencies.

This report summarizes the results found from the condition assessment of the Kelly Lake Sewer System. Assets reviewed include the collection system, lift stations, lagoons, engineered wetland and the outflow pipe as described in table 1.

1.2 DESCRIPTION OF FACILITIES

The Kelly Lake sewer system consists of a wastewater collection system within the Kelly Lake subdivision, a lift station, 5 stages settling lagoons, a wetland, and an outflow pipe to Steeprock Creek.

The Kelly Lake sewer system was initially constructed in 1995-1996. The wastewater collection system within the scope of this report includes:

Table 1. Kelly Lake Sewer System Facilities

INFRASTRUCTURE	DESCRIPTION
FORCEMAINS	2.4 km long 100mm or 150mm
SEWER LAGOON	5 settling lagoons
WETLAND	6th stage engineered
LIFT STATION	Lift station housing 2 alternating pumps

1.3 REPORT LIMITATIONS

The objective of this report is to supply a common sign of the current physical state of the sewer collection system. The following assumptions were considered:

- Estimated Useful Life is based on a sensible degree of continuous maintenance.
- Timeframes given for undertaking work represent our opinion on when to budget for the work. Variations of our estimate could happen in the case failure of the item, or the optimum repair/replacement process.
- Costs of replacement is based on our knowledge and experience but is

subject to change depending on labor market, resources availability and projects peculiar constraints.

- We focused our recommendations on short to medium term action plans (1 to 5 years). We recommend re-assessments for longer term issues.
- Where measures where not used for assessing the condition of the assets, a knowledge-based evaluation was conducted using the available data from the district and interview with its operator.
- We used a condition-based similarity model to estimate remaining lifetime and not a statistical degradation model.

2.0 ASSESSMENT RESULTS

Our team conducted the assessments of the designated Kelly Lake sanitary system between the August 24th and August 28th, and October 12th to 13th with the assistance of Peace River Regional District operator.

Our crew employed a high-resolution Zoom Camera to check the pipes, valves, shut offs, and cleanouts for wall structural integrity and sewage leaks. T

Following the inspection of the pipes and manholes, PACP/MACP certified viewers reviewed and graded the inspection videos. This report includes listings of defects encountered during inspections, according to PACP/MACP terminology. The following information is provided:

Figure 1: Zoom Inspection of Lift Station

- Observed manhole defects categorized according to physical condition and operation and maintenance (O&M) grades from MACP v 7.
- Pipe defects categorized according to internal structural condition and O&M grades from PACP v 7.
- Infiltration/inflow sources observed at each manhole and pipe by type of defect
- Manholes and pipes requiring hydraulic and/or special cleaning (grease, roots, incrustations, debris, etc.)
- Manholes and sections requiring repairs
- Printed photos of major defects observed during the inspection of pipes

This report also includes color-coded maps illustrating:

- Manholes and pipes inspected
- Manholes and pipes O&M Condition
- Manholes and pipes structural Condition
- Pipes required hydraulic and/or special cleaning

The condition assessment is designed to provide prioritized lists of defects intended to assist the district in the development of a proactive operations and maintenance program, and to define where capital improvement spending may be required. Compared to classical CCTV

inspection, this allows to narrowing the scope of flushing activities by identifying the pipes and manholes in excellent condition (not requiring cleaning) and those that have a very poor physical condition and requires repairs instead of cleaning.

All our camera inspections of pipes and manholes were carried out at ground level. The information contained in this report such as diameters, type of pipe, section lengths, etc. was taken directly from the files furnished by the District and were complemented by measurements performed by our field crews.

Table 2: Kelly Lake Summary inspections

Site	Kelly Lake
Type of the collection system:	Sanitary
Total number of sections inspected:	22
Number of manholes inspected:	29
Number of Lagoons	5 + 1 Engineered wetland
Date of Survey:	August 26th and 28th, November 12th and 13th

The zoom inspection was carried out in the Disctrict in order to assess the sanitary sewer condition. Therefore, 29 manholes and 22 pipe sections were inspected. The inspected manholes and pipes inventories are presented respectively in Appendix 1 and Appendix 2.
The attached report summarizes our findings of the O&M and structural condition, as well as infiltration/inflow (I/I) found in the Kelly Lake Sanitary Sewer System. We have also summarized our recommendations for cleaning, repairs and manhole intervention. The following paragraphs contain the details of all these items.

The lagoons and surroundings were also assessed to identify any issues that may be affecting treatment performance or that could require repairs, maintenance, or changes in day-to-day operations.

Finally, an environmental expert assessed the Constructed Wetland (CW) with in order to:

- Determine whether the as-built condition of the CW is consistent with the original design drawings (L&M Engineering Ltd. 1996; no. 200A and no. 202A), and document any significant differences.
- Assess the condition and function of the main elements of the CW including the inlet, outlet, operating depth, substrate, and wetland plant cover and species distribution.

- Review the normal operating procedures of the CW;
- Identify any issues that may be affecting treatment performance or that could require repair, maintenance, or changes in day-to-day operations.
- Assess the biophysical condition of the immediate receiving environment (i.e. area <200 m from discharge point);
- Assess compliance with the conditions specified in Permit #14420 that apply to the CW; and
- Comment on potential environmental issues related to the discharge of treated municipal effluent from the Kelly Lake WWTF.

2.1 SITE CONDTIONS

2.1.1 ACCESS ROAD AND SITE SECURITY

Access to the lagoons is through Kelly Lake Transfer Station (PRRD). The shared gravel access road is in good condition. Two gates closed with padlocks need to be opened to access the cells area. All gates, fencing and access road are in acceptable condition except for a few potholes.

Numerous muskrats' burrows have been seen on the edges of the various lagoons and along the access roads. This is not causing any functional or structural problems at this time but should be monitored as the accumulation of these could cause the edges to become brittle and lead to the collapse of the roads especially between the cells 3 and 4 where the berm is already unstable and cannot allow heavy rolling equipment to access. Furthermore, this passage is not level and should be reconditioned.

Figure 2: Muskrats Burrows between cell 4 & 5

Figure 3: Unlevelled Access between Cell 3 & 4

Repeated overflowing of lagoon 3 has created crevasses as well as a slight subsidence of the road. It is advisable to proceed to a sludge measurement on cells 1, 2 and 3 to evaluate if the design capacity is still maintained and prevent further overflow. In addition, the level of pond 3 should be lowered regularly in anticipation of the high rainfall seasons.

Figure 4: Crevasses between Cell 3 & 5

There is very little human activities in the vicinity of the lagoons. There are potential accesses to the site through the section north of the Constructed wetland and east of the lagoons through the forest. Human intrusions are unlikely, but animals could venture into the lagoons.

A break in the fence, probably caused by an animal, was seen on the south side fence surrounding lagoons 1 and 2.

Table 3. Kelly Lake Access Road Repair Recommendations

Recommendations				
Item	Repairs	Priority	Estimated Cost	Remaining Useful Life
Access Between Cell 3 and 4	Leveling of the road Approx. 50mx5m	5-10 years	$50,000	35
Fence Cell 1 and 2	New Fencing Approx. 50m	1-3 years	$1,500	15

2.2 LAGOONS

The 5 stage lagoons were designed 1995 and commissioned in 1996. According to the study of the CAD drawings, the main technical characteristics built in 1995 still seem to be present. The lagoons are designed to discharge sequentially into each other through the sanitary manholes B, D, E, F and H. Bypass valves (A, B and C) exist to level the water tables and prevent the overflow of certain cells by isolating them. In particular, by using the overflow C between cell 1 and 3 and G between cell 3 and 5. Since the exercise of the valves (submerged at this time of the year) would not have given us any indication as to their tightness and degree of closure, we relied on the operational history of the valves to judge their condition. The valves are in working condition and exercised at least once a year.

The levels of the lagoons observed are within acceptable ranges. Nevertheless, it seems that cell 3 is regularly overflowing. A sludge measurement by sludge judge is recommended for cells 1, 2 and 3.

Figure 5 : Cell 1 and Cell 2

Figure 6 : Cell 3 and Cell 4

The berms of the different cells are in average to poor condition. In addition to muskrat burrows and uncontrolled vegetation, there is a strong degradation of the berm slope, especially on the eastern side of lagoon 5. The clay layer is uneven and may result in infiltration and increase risk of collapsing from the surrounding roads.

Figure 7 : Cell 5 berm

Table 4. Kelly Lake Lagoon Repair Recommendations

Recommendations				
Item	Repairs	1-3 years	3-5 years	Estimated Replacement Cost
East Berm of Cell 5	Re-sloping or repacking. Could be part of a larger rehabilitation of the lagoon in the next 15-20 years.		$50,000 - $100,000	N/A
Sludge	Sludge Judge	$3,500		N/A

2.3 WETLAND

The detailed report of the environmental expert is available in Appendix 3. The main conclusions are as follows

- The current structure and condition of the CW is consistent with the original design drawing from 1995. In general, the wetland appears to be functioning as intended with adequate depth and vegetation cover and operational features to minimize short-circuiting of the flow.
- The discharge of treated effluent from Lagoon 5 to the CW is reportedly stopped on September 15 each year); and
- The treated effluent released from the CW is discharged to ground after travelling about 160 m through a ditch, rather than being discharged to Steeprock Creek. The District confirmed the ENV was aware and approve that water will discharge to Steeprock Creek after running off and infiltration through the woods soil.
- The treated effluent flowing through the ditch downstream from the CW was clear and there was no evidence during the site visit of excessive nutrient enrichment or other adverse environmental effects. At the end of the ditch, the water was infiltrating to ground.
- Given the high level of treatment measured in 2021 (n=3), the final effluent likely presents negligible risk to the environment or to human health, regardless of the point of discharge. Before contacting ENV to clarify the Permit requirements, PRRD may wish to analyze additional recent monitoring data (e.g. from 2019 and 2020) to demonstrate treatment performance. Moving forward, PRRD should sample the Lagoon 5 and CW discharges at least monthly and forward the data to ENV, as required.

2.4 MANHOLES

To determine a maintenance and repairs priority list, the manholes were graded according to their O&M, Structural and Physical defects. To do so, a grade from 1 to 5 was assigned (according to MACP v 7) to each identified defect.

Manhole A, B and F could not be inspected because they were full at the period of the year due to level equalizing operations. Though, no signs of heavy infiltration or leak were notice from above-ground visual inspection.

2.4.1 Operation and Maintenance (O&M)

From an operation and maintenance standpoint, the inspection results confirmed that the inspected manholes are in fair condition. Only 10 manholes (35%) have grades 4 and 5 O&M deficiencies.

A breakdown of the percentage of the manholes falling under each of the five (5) O&M defects is provided in the following tables.

Table 5. Kelly Lake Sewer Manholes O&M Grade

Manholes						
O&M grade	5	4	3	2	1	Total
Number of manholes	6	4	2	11	6	29
%	20.5%	14%	7%	38%	20.5%	100%

2.4.2 Structural and Physical Condition

In order to determine intervention priorities, the manholes inspected by Simo's camera were graded in accordance with MACP coding procedures. Grade from 1 to 5 are allocated to each defect.

From a structural standpoint, the inspection confirmed that 17% (5) of the manholes are not in good condition (physical condition grade of 4 or 5). Nevertheless, the vast majority of the manholes inspected are in excellent condition, 82% (24 Mh) of them was found with no significant deficiencies.

A breakdown of the percentage of manholes falling under each of the five (5) structural and physical condition categories is provided in the following tables:

Table 6. Kelly Lake Sewer Manholes Physical Grade

Manholes						
Physical condition grade	5	4	3	2	1	Total
Number of manholes	5	0	1	2	21	29
%	17%	0	3.5%	7%	72.5%	100%

2.4.3 Manhole Repairs Recommendations

As blocked collection systems can have serious repercussions, manholes and sections with O&M grades of 4 and 5 justify immediate maintenance to eliminate further consequences. In addition, all manholes and sections graded 3 should be scheduled for maintenance in a near future to avoid the amplification of blockage risks.

Manholes with physical condition grade 5-4 require a special attention and we recommend repairing any defects found and to reassess their physical condition in a near future to monitor the manholes' deterioration. Most of them have defect located near the surface. These manholes must be repaired in the near future to eliminate the risk of surface settlement or mining of the soil and further structural deterioration.

All manholes grade 3 require a second inspection in medium-term (5 to 10 years).

Additionally, all lids from the lagoons were originally sealed with concrete lips, which had failed over. This leads to rain fall infiltration, but do not cause serious functional problems, we do not recommend any actions.

Table 7. Kelly Lake Manhole Repair Recommendations

Recommendations						
Item	Repairs	Next Year	1-3 years	5- 10 years	Estimated Replacement Cost	Estimate Remaining Service Life
SMH-02	Inspection			$800	$15,000.00	14
SMH-03					$15,000.00	28
SMH-04					$15,000.00	28
SMH-05					$15,000.00	28
SMH-16					$15,000.00	28
SMH-19					$15,000.00	28

SMH-21					$15,000.00	28
SMH-22	Hydraulic Cleaning	$500			$15,000.00	28
SMH-23	Hydraulic Cleaning	$500			$15,000.00	28
SMH-24					$15,000.00	28
SMH-25					$15,000.00	28
SMH-26					$15,000.00	28
SMH-27					$15,000.00	28
SMH-A					$15,000.00	28
SMH-B					$15,000.00	28
SMH-D	Hydraulic Cleaning	$500			$15,000.00	28
SMH-E	Hydraulic Cleaning	$500			$15,000.00	28
SMH-F					$15,000.00	28
SMH-G					$15,000.00	28
SMH-H					$15,000.00	28
SMH-J					$15,000.00	28
SMH-K					$15,000.00	28
SMH-L	Frame seal installation.		$1,500		$15,000.00	15
SMH-M					$15,000.00	28
SMH-N (RipRap)	Frame adjustment and seal installation		$1,500			
SMH-17					$15,000.00	21
SMH-C	Hydraulic Cleaning	$500			$15,000.00	21
SMH-06	Hydraulic Cleaning Precast concrete chimney components adjustment.	$500	$3,500		$15,000.00	15
SMH-07	Frame adjustment and extending the height of the frame by manhole cover adjustment ring.		$3,500		$15,000.00	15
SMH-18	Precast concrete chimney components adjustment and extending the height of the frame by manhole cover adjustment ring.		$3,500		$15,000.00	15
TOTAL		$3,000.00	$13,500.00	$800.00	$450,000.00	

2.5 PIPELINES

To determine a maintenance and repair priority list, pipes were graded according to their defects. To do so, a grade from 1 to 5 was assigned (according to PACP v 7) to each identified defect.

Normally, two (2) views of the pipes are taken; one from the upstream manhole and the other from downstream manhole. In some cases, sections were accessible only from one end. In these cases, only one (1) view of the pipe was captured. 15 sections were inspected with 2 view and 6 with only one.

2.5.1 Operation and Maintenance (O&M)

Regarding operation and maintenance condition of pipes sections, the inspected part of the network is in fair condition, 6 pipes (29%) present deficiencies (Grade 4 and 5).

Table 8. Kelly Lake Sewer Pipes O&M Grade

Pipes						
O&M grade	5	4	3	2	1	Total
Number of pipes	1	5	6	6	3	21
%	5%	24%	28%	28%	15	100%

Table 9. Summary of main defects

Class of Defect	Section Number	Details
Significant O&M	SP-24	O&M Defects->Deposits->Attached->Encrustation
	SP-18	O&M Defects->Deposits->Settled->Fine
	SP-22	O&M Defects->Deposits->Settled->Fine
	SP-I	O&M Defects->Deposits->Settled->Gravel
	SP-J	O&M Defects->Obstacles/Obstructions->Construction Debris

2.5.2 Structural and Physical Condition

All pipes inspected were in great condition and do not require any intervention or repair except where leaks were located, see 2.2.3 Infiltration.

Table 10. Kelly Lake Sewer Pipes O&M Grade

Pipes						
O&M grade	5	4	3	2	1	Total
Number of pipes	0	0	0	9	12	21
%	0%	0%	0%	43%	57%	100%

2.5.3 Infiltration

One of the main goals of this inspection program was to assess the water tightness of the sanitary sewer system. For this reason, special attention was required to help in locating high risks of any water ingress. Information related to cover condition, frame condition, pipe seal condition, potential for runoff and rim to grade heights were collected during the inspection by our field crews. All data collected is available in the PACP/MACP database provided with this report. Given the size of the leaks we do not recommend any repairs at this stage. An inspection should be carried out in the 3 to 5 years to monitor the evolution of these leaks.

Table 11. Summary of main defects

Class of Defect	Section Number	Details
Infiltration	SP-24	O&M Defects->Infiltration->Dripper
	SP-04	O&M Defects->Infiltration->Dripper

2.5.4 Surcharges

Surcharges indicate a higher-than-expected level of water within the pipes. In these cases, all these surcharges correlate with obstructed manholes upstream and/or downstream. The corrective action is cleaning of the manholes as indicated per their OM grades in the manholes section of the present report.

Table 12. Summary of main defects

Class of Defect	Section Number	Details
Surcharges	SP-23	Surcharged/Debris
	SP-22	Surcharged/Debris
	SP-J	Surcharged/Debris

2.5.5 Pipes Corrective actions Recommendations

As blocked collection systems can have serious repercussions, sections with O&M grades of 4 and 5 justify immediate maintenance to eliminate further consequence.

In general, hydraulic cleaning is recommended for pipes with silt and gravel debris and special cleaning should be performed in pipes with encrustation, roots, hard debris, grease, intruding connections, joint gasket visible and penetration of foreign objects. A CCTV camera should always work in conjunction with specialized pipe cleaning equipment to supervise and guide all these operations.

Pipes with physical condition grade 5-4 require a special attention and we recommend repairing any defects found.

All pipes grade 3 require a second inspection in medium-term (5 to 10 years).

Pipes Repair Recommendations

Table 13. Kelly Lake Repair Recommendations

	Recommendations					
Item	Remediation Description	Next Year	3-5 years	5-10 years	Estimated Cost Of replacement	Estimate Remaining Service Life
SP-02					$122,624.00	60
SP-03	Inspection			$850	$124,736.00	60
SP-04	Hydraulic Cleaning and Inspection monitoring leaks	$750	$750		$122,048.00	60

SP-05					$147,584.00	80
SP-06					$144,632.00	80
SP-07					$144,128.00	60
SP-16	Inspection			$850	$144,056.00	60
SP-17					$131,504.00	60
SP-18	Special Cleaning	$750			$86,456.00	80
SP-19	Inspection			$850	$127,040.00	60
SP-20					$145,220.00	80
SP-21	Inspection			$850	$146,072.00	80
SP-22	Hydraulic Cleaning	$500			$102,872.00	80
SP-23					$112,280.00	60
SP-24	Inspection monitoring leaks	$750	$750		$103,892.00	80
SP-25					$138,608.00	60
SP-26	Inspection			$750	$93,932.00	80
SP-27					$71,984.00	80
SP-I	Special Cleaning	$750			$143,348.00	80
SP-J	Hydraulic Cleaning	$500			$145,772.00	80
SP-K	Special Cleaning	$500			$48,740.00	80
TOTAL		$4,500	$1,500	$4,150	$2,547,528	

2.6 LIFT STATION

2.6.1 Operation and Maintenance (O&M)

The lift station was in good condition with a MACP grade of 2. It does not require any cleaning in the short term

2.6.2 Structural and Physical Condition

The lift station was in very good physical condition with a MACP grade of 1. It does not require actions at the moment.

2.6.3 Pumps

Although no data was available with the exact installation date or preventive/corrective records, it has been understood from discussions with the operator that the pumps meet their intended purpose without specific sign of failure or premature aging. The yearly routine maintenance is followed. Their design capacity is not exceeded by the average daily flows.

2.6.4 Panels and controls

Panels were recent (about 10-15 years). Although no data was available about the exact installation date or preventive/corrective data it has been understood from discussions with the operator that the panel meet their intended purpose without specific sign of failure or premature aging.

2.6.5 Access Ladder, Lids and safety features

Although rust was present, the Access ladder did not show safety concerns.

A bolt-in protective fence is available to visually inspect the pit without the need for fall protection equipment. The anchorages are in good condition.

Ventilation of the well seem satisfying, although no measurements of the air was performed.

The guiding rails to extract the pumps are in good working condition. The absence of a built-in jib-crane support forces the use of mobile crane. Long term savings could be generated by upgrading this station with the addition of such equipment.

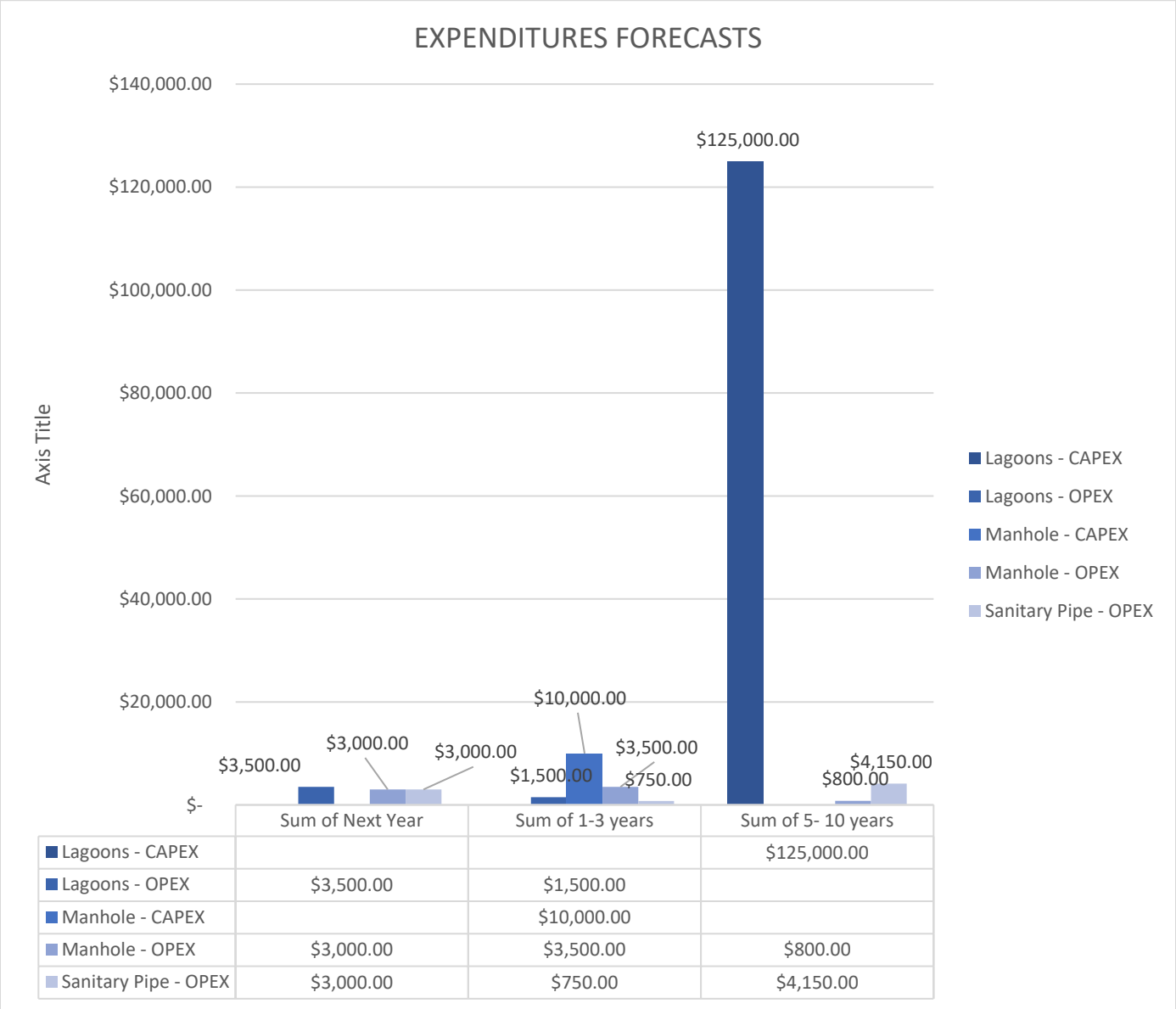
3.0 RECOMMANDATIONS SUMMARY

The costs estimated include study, permits, excavation, road work and material. This is based on the best of our knowledge and subject to changes based on geographic availability of resources. These costs should be used as guideline to provision and prioritize and accurate estimates, request for quote should be launched at the time of the repairs.

Table 14. Kelly Lake Summary of Recommendations

Recommendations						
Item	Repairs	Next Year	1-3 years	5- 10 years	Estimated Replacement Cost	Estimate Remaining Service Life
SMH-02	Inspection			$800	$15,000.00	28
SMH-22	Hydraulic Cleaning	$500			$15,000.00	28
SMH-23	Hydraulic Cleaning	$500			$15,000.00	28
SMH-D	Hydraulic Cleaning	$500			$15,000.00	28
SMH-E	Hydraulic Cleaning	$500			$15,000.00	28
SMH-L	Frame seal installation		$1,500		$15,000.00	15
SMH-N (RipRap)	Frame adjustment and seal installation		$1,500			
SMH-C	Hydraulic Cleaning	$500			$15,000.00	21
SMH-02					$15,000.00	14
SMH-06	Hydraulic Cleaning Precast concrete chimney components adjustment.	$500	$3,500		$15,000.00	15
SMH-07	Frame adjustment and extending the height of the frame by manhole cover adjustment ring.		$3,500		$15,000.00	15
SMH-18	Precast concrete chimney components adjustment and extending the height of the frame by manhole cover adjustment ring.		$3,500		$15,000.00	15
East Berm of Cell 5	Re-sloping or repacking. Could be part of a larger rehabilitation of the lagoon in the next 15-20 years.			$50,000-$100,000		
Sludge	Sludge Judge	$3,500				
Access Between Cell 3 and 4	Leveling of the road Approx. 50mx5m			$50,000		
Fence Cell 1 and 2	New Fencing Approx. 50m		1,500			
SP-03	Inspection			$850	$124,736.00	60
SP-04	Hydraulic Cleaning and Inspection monitoring leaks	750$	$750		$122,048.00	60
SP-16	Inspection			$850	$144,056.00	60
SP-18	Special Cleaning	$750			$86,456.00	80
SP-19	Inspection			$850	$127,040.00	60
SP-21	Inspection			$850	$146,072.00	80

SP-22	Hydraulic Cleaning	$500			$102,872.00	80
SP-24	Inspection monitoring leaks	750$	750$		$103,892.00	80
SP-26	Inspection			$750	$93,932.00	80
SP-I	Special Cleaning	$750			$143,348.00	80
SP-J	Hydraulic Cleaning	$500			$145,772.00	80
SP-K	Special Cleaning	$500			$48,740.00	80
TOTAL		$9,500	$15,750	$129,950		



	Sum of Next Year	Sum of 1-3 years	Sum of 5- 10 years
Lagoons - CAPEX			$125,000.00
Lagoons - OPEX	$3,500.00	$1,500.00	
Manhole - CAPEX		$10,000.00	
Manhole - OPEX	$3,000.00	$3,500.00	$800.00
Sanitary Pipe - OPEX	$3,000.00	$750.00	$4,150.00

Figure 8 : Expenditures forecast

PEACE RIVER
REGIONAL DISTRICT

APPENDIX 1

PIPES LIST

Number	Start Date of inspection	Completion Date of inspection	Node Upstream	Node Downstream	Start Node	Street Name	SG	OMG	Network Type	Dimension 1 mm	Shape	Material	Length m	Hydraulic Cleaning	Special Cleaning	CCTV Inspection
SP-04	2021-08-24 17:09	2021-08-24 17:35	SMH-04	SMH-03	SMH-04 / SMH-03	Kelly Lake Road 11	2	3	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	100,042	-	S	-
SP-03	2021-08-24 17:32	2021-08-24 17:58	SMH-03	SMH-02	SMH-03 / SMH-02	Kelly Lake Road 11	2	3	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	102,284	H	-	-
SP-07	2021-08-24 15:44	2021-08-24 16:20	SMH-07	SMH-06	SMH-07 / SMH-06	Kelly Lake Road 11	2	1	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	118,442	-	-	-
SP-06	2021-08-24 16:17	2021-08-24 16:48	SMH-06	SMH-05	SMH-06 / SMH-05	Kelly Lake Road 11	1	2	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	118,856	-	-	-
SP-05	2021-08-24 16:45	2021-08-24 17:12	SMH-05	SMH-04	SMH-05 / SMH-04	Kelly Lake Road 11	1	2	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	121,322	-	-	-
SP-21	2021-08-24 13:24	-	SMH-21	SMH-20	SMH-21	Gauthier Road	1	3	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	120,060	H	-	-
SP-20	2021-08-24 14:01	-	SMH-20	SMH-19	SMH-19	Gauthier Road	1	1	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	119,347	-	-	-
SP-19	2021-08-24 13:58	2021-08-24 14:31	SMH-19	SMH-18	SMH-19 / SMH-18	Gauthier Road	2	3	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	104,201	H	-	-
SP-18	2021-08-24 14:26	2021-08-24 14:54	SMH-18	SMH-17	SMH-18 / SMH-17	Gauthier Road	1	5	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	70,381	H	S	-
SP-17	2021-08-24 14:50	2021-08-24 15:22	SMH-17	SMH-16	SMH-17 / SMH-16	Gauthier Road	2	2	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	107,924	-	-	-
SP-16	2021-08-24 15:16	2021-08-24 15:51	SMH-16	SMH-07	SMH-16 / SMH-07	Kelly Lake Road 11	2	3	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	118,381	H	-	-
SP-24	2021-08-25 12:50	2021-08-25 13:19	SMH-24	SMH-23	SMH-24 / SMH-23	Gauthier Road	1	4	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	84,907	-	S	-
SP-23	2021-08-25 13:17	-	SMH-23	SMH-22	SMH-23	Easement	2	1	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	91,897	-	-	-
SP-22	2021-08-24 17:11	-	SMH-22	SMH-04	SMH-04	Kelly Lake Road 11	1	4	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	84,059	H	-	-
SP-27	2021-08-25 11:33	2021-08-25 11:56	SMH-27	SMH-26	SMH-27 / SMH-26	Gauthier Road	1	2	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	58,317	-	-	-
SP-26	2021-08-25 11:54	2021-08-25 12:29	SMH-26	SMH-25	SMH-26 / SMH-25	Gauthier Road	1	3	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	76,610	-	S	-
SP-25	2021-08-25 12:17	2021-08-25 12:52	SMH-25	SMH-24	SMH-25 / SMH-24	Gauthier Road	2	2	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	113,843	-	-	-
SP-I	2021-08-25 17:21	-	SMH-I	SMH-J	SMH-J	Lagoons	1	4	Sanitary Sewage Pipe	150	Circular	Polyvinyl Chloride	117,794	H	S	-
SP-J	2021-08-25 16:59	-	SMH-J	SMH-K	SMH-K	Lagoons	1	4	Sanitary Sewage Pipe	150	Circular	Polyvinyl Chloride	119,806	H	-	-
SP-K	2021-08-25 16:40	2021-08-25 16:57	SMH-K	SMH-L	SMH-L / SMH-K	Lagoons	1	4	Sanitary Sewage Pipe	150	Circular	Polyvinyl Chloride	38,952	-	S	-
SP-02	2021-08-24 17:48	2021-08-24 18:39	SMH-02	Lift_St-01	SMH-02 / Lift_St-01	Kelly Lake Road 11	2	2	Sanitary Sewage Pipe	200	Circular	Polyvinyl Chloride	100,521	-	-	-

Number	30. Pipe Use	26. Street (Name & Number)	11. Intervention - Date	Node Upstream	Node Downstream	Start Node	Deficiency (Deficiency found)	Operation and maintenance grade	Order #
SP-24	Sanitary Sewage Pipe	Gauthier Road	2021-08-25	SMH-24	SMH-23	SMH-23	O&M Defects-	4	Zoom2021_Kelly Lake
SP-04	Sanitary Sewage Pipe	Kelly Lake Road 11	2021-08-24	SMH-04	SMH-03	SMH-03	O&M Defects-	3	Zoom2021_Kelly Lake

Number	30. Pipe Use	26. Street (Name & Number)	11. Intervention - Date	Node Upstream	Node Downstream	Start Node	Deficiency (Deficiency found)	Extent	Operation and maintenance grade	Order #
SP-24	Sanitary Sewage	Gauthier Road	2021-08-25	SMH-24	SMH-23	SMH-23	O&M Defects-	> 20% & <= 30%	4	Zoom2021_Ke
SP-18	Sanitary Sewage	Gauthier Road	2021-08-24	SMH-18	SMH-17	SMH-17	O&M Defects-	> 30%	5	Zoom2021_Ke
SP-22	Sanitary Sewage	Kelly Lake Road	2021-08-24	SMH-22	SMH-04	SMH-04	O&M Defects-	> 20% & <= 30%	4	Zoom2021_Ke
SP-I	Sanitary Sewage	Lagoons	2021-08-25	SMH-I	SMH-J	SMH-J	O&M Defects-	> 20% & <= 30%	4	Zoom2021_Ke
SP-J	Sanitary Sewage	Lagoons	2021-08-25	SMH-J	SMH-K	SMH-K	O&M Defects-	> 20% & <= 30%	4	Zoom2021_Ke

Number	30. Pipe Use	26. Street (Name & Number)	11. Intervention - Date	Node Upstream	Node Downstream	Start Node	21. Inspection Status	Order #
SP-23	Sanitary Sewage Pipe	Easement	2021-08-25	SMH-23	SMH-22	SMH-22	Surcharged/Debris	Zoom2021_Kelly Lake
SP-22	Sanitary Sewage Pipe	Kelly Lake Road 11	2021-08-25	SMH-22	SMH-04	SMH-22	Surcharged/Debris	Zoom2021_Kelly Lake
SP-J	Sanitary Sewage Pipe	Lagoons	2021-08-25	SMH-J	SMH-K	SMH-J	Surcharged/Debris	Zoom2021_Kelly Lake

PEACE RIVER
REGIONAL DISTRICT

APPENDIX 2

MANHOLES LIST

Number	Inspection Date	Street Name	PCG	OMG	Network Type	Hydraulic Cleaning	Special Cleaning
Lift_St-01	2021-08-24 18:23	Kelly Lake Road 11	1	2	Sanitary	-	-
Rip-Rap	2021-08-25 16:01	Lagoons	5	2	Sanitary	-	-
SMH-02	2021-08-24 17:16	Kelly Lake Road 11	3	2	Sanitary	-	-
SMH-03	2021-08-24 17:15	Kelly Lake Road 11	1	2	Sanitary	-	-
SMH-04	2021-08-24 15:55	Kelly Lake Road 11	1	2	Sanitary	-	-
SMH-05	2021-08-24 15:54	Kelly Lake Road 11	1	3	Sanitary	H	-
SMH-06	2021-08-24 15:53	Kelly Lake Road 11	5	2	Sanitary	-	-
SMH-07	2021-08-24 15:24	Kelly Lake Road 11	5	1	Sanitary	-	-
SMH-16	2021-08-24 15:03	Kelly Lake Road 11	1	4	Sanitary	-	-
SMH-17	2021-08-24 14:33	Gauthier Road	2	2	Sanitary	-	-
SMH-18	2021-08-24 13:33	Gauthier Road	5	2	Sanitary	-	-
SMH-19	2021-08-24 13:32	Gauthier Road	1	4	Sanitary	H	-
SMH-21	2021-08-24 12:58	Gauthier Road	1	2	Sanitary	-	-
SMH-22	2021-08-25 13:21	Easement	1	4	Sanitary	H	-
SMH-23	2021-08-25 12:56	Easement	1	4	Sanitary	H	-
SMH-24	2021-08-25 11:59	Gauthier Road	1	2	Sanitary	-	-
SMH-25	2021-08-25 11:58	Gauthier Road	1	3	Sanitary	-	S
SMH-26	2021-08-25 11:35	Gauthier Road	1	1	Sanitary	-	-
SMH-27	2021-08-25 11:18	Gauthier Road	1	1	Sanitary	-	-
SMH-C	2021-08-25 14:05	Lagoons	1	5	Sanitary	-	S
SMH-D	2021-08-25 14:19	Lagoons	1	5	Sanitary	-	S
SMH-E	2021-08-25 14:37	Lagoons	2	5	Sanitary	-	S
SMH-G	2021-08-25 15:18	Lagoons	1	5	Sanitary	-	S
SMH-H	2021-08-25 14:55	Lagoons	1	5	Sanitary	-	S
SMH-I	2021-08-25 15:26	Lagoons	1	2	Sanitary	-	-
SMH-J	2021-08-25 17:02	Lagoons	1	5	Sanitary	H	-
SMH-K	2021-08-25 16:51	Lagoons	1	1	Sanitary	-	-
SMH-L	2021-08-25 16:22	Lagoons	5	1	Sanitary	-	-
SMH-M	2021-08-25 16:15	Lagoons	1	1	Sanitary	-	-

PEACE RIVER
REGIONAL DISTRICT

APPENDIX 3
ENVIRONMENTAL ASSESMENT

SIMO

Associated Environmental

DRAFT

October 28, 2021
File: 2021-8015

Gregoire Boutron
Project Manager
Helios Group
4570 Henry-Julien Avenue
Montreal, Quebec H2T 2C8

Re: KELLY LAKE WASTEWATER TREATMENT FACILITY CONDITION ASSESSMENT - CONSTRUCTED WETLAND COMPONENT

Attn: Gregoire Boutron:

This draft letter provides the findings from the Condition Assessment of the constructed wetland component of the Kelly Lake Wastewater Treatment Facility (WWTF) in Kelly Lake, BC. The facility is owned and operated by Peace River Regional District (PRRD) and operates under a Permit (#14420) issued by the BC Ministry of Environment and Climate Change Strategy (ENV). The assessment was completed through a review of available background information (including the original design drawings) and a site visit on October 13, 2021 by Hugh Hamilton, P.Ag. of Associated Environmental Consultants Inc. and Gregoire Boutron, P.Eng. of Groupe Helios. We were accompanied on the site visit by Nathan Goudie from PRRD.

The goals of the constructed wetland (CW) condition assessment were to:

- Determine whether the as-built condition of the CW is consistent with the original design drawings (L&M Engineering Ltd. 1996; no. 200A and no. 202A), and document any significant differences;
- Assess the condition and function of the main elements of the CW including the inlet, outlet, operating depth, substrate, and wetland plant cover and species distribution;
- Review the normal operating procedures of the CW;
- Identify any issues that may be affecting treatment performance or that could require repair, maintenance, or changes in day-to-day operations;
- Assess the biophysical condition of the immediate receiving environment (i.e. area <200 m from discharge point);
- Assess compliance with the conditions specified in Permit #14420 that apply to the CW; and
- Comment on potential environmental issues related to the discharge of treated municipal effluent from the Kelly Lake WWTF.

1 DESCRIPTION OF THE CONSTRUCTED WETLAND

The CW is the sixth cell in a lagoon-based treatment system. Municipal wastewater from the Kelly Lake community flows to the WWTF, which is located 3.3 km west from the community centre. The

wastewater moves through five lagoon cells before being discharged to the CW for final polishing before it is released to the environment. The CW is a surface flow (SF) type of wetland, with emergent aquatic plants growing in water that is contained by berms on all four sides. The key features of the CW design and current status are as follows:

- The wetland surface area is approximately 8,160 m^2 (rectangle 102 m long by 80 m wide). Including the berms, the total footprint area is 9,290 m^2.
- The design water depth is 0.33 m. The wetland was ice-covered near the banks at the time of the site visit, but it appeared that the depth was close to this value. Mr. Goudie indicated that the water depth during summer operations would be about 0.45 m. The water level was being drawn down for the winter during the site visit, which is intended to prevent the inlet and outlet structures from freezing.
- The base of the wetland is compacted native soil. This material appears to be adequate to hold water in the CW.
- The most common wetland plant species is Common cattail (*Typha latifolia*). Other species noted to be present include Hardstem bulrush (*Scoenoplectus acutus*), Arctic rush (*Juncus arcticus*), and *Carex* spp. Duckweed *(Lemna* spp.), a free-floating plant, is also present in patches, notably at the inflow. Duckweed can be an indicator of available nitrogen in the water. Willow (*Salix* spp.) shrubs are common along the CW margins.
- The vegetation cover in the wetland is approximately 30%-40%, and the remainder of the wetland is open water. According to Mr. Goudie, the vegetation coverage was much less three years ago, but the plants have recolonized the wetland since then.
- The inflow to the CW from the lagoons is through a pipe that connects in a T-junction to a 150-mm slotted drainpipe that runs across the width of the CW. The ends are capped.
- The outflow is through a similar pipe running across the full width, with the slots facing downwards. A 150-mm pipe collects the water and directs it through a manhole that connects to a second 150-mm pipe that leads to a Palmer-Bowlus flume for flow measurement. Just below the flume, the water discharges to a ditch through a final 0.3-m long section of 150-mm pipe.
- Permit #14420 authorizes PRRD to discharge treated effluent from the lagoons to the CW discharge from the CW between May 15 and September 15 each year (~124 days).
- After it enters the ditch, the treated effluent flows through a linear ditch for a distance of about 160 m before dissipating to ground in the forest. This is discussed further in Section 3 Regulatory Compliance.

2 FUNCTIONAL ASSESSMENT OF THE CONSTRUCTED WETLAND

Based on the field observations, the CW appears to be fulfilling its intended function. The factors that support this conclusion are as follows.

- The configuration of the inflow, which distributes the flow across the width of the CW, is a good design for optimizing the hydraulic retention time (HRT) of the CW by minimizing "short-

circuiting." The estimated HRT, assuming the average authorized design flow, is between 7.5 days (with 0.33 m depth) and 10 days (with 0.45 m depth) [1].

- The operating water depth is adequate, as it provides for a sufficient HRT while providing favourable conditions for wetland plant growth.
- Plants appear healthy and vigorous. The amount of plant cover could be better, but the ongoing natural regeneration will likely increase the cover in several years (e.g. to >70%). Some open is desirable to enable UV radiation to act on the water column.
- The Inlet system was not being used at the time of the site visit, but Mr. Goudie reported that it works well if properly maintained. The outlet system appeared to be functioning as intended, with flow being steadily discharged through the pipe to the receiving ditch.
- The water in the wetland (where there was no ice cover) and flowing through the discharge pipe is clear with no visible turbidity or suspended algae.

3 REGULATORY COMPLIANCE

The requirements of the latest version of Permit #14420 (January 7, 2020) were reviewed, and the physical attributes and operational regime of the CW were compared against those requirements. The areas of potential non-compliance that were observed based on our review and site visit are as follows:

- **Authorized Discharge Period** (Permit Section 1.1.2). As noted above, water (treated effluent) was still being discharged at the time of the October 13 site visit to prepare for winter. According to the Permit, the discharge should cease on September 15.
- **Final Effluent Quality** (Permit Section 1.1.3). PRRD provided Associated with the monitoring data that are available from 2021. Sampling of the discharge from the CW took place on three dates: May 17, June 14, and July 12. On all three dates, the effluent quality met the Permit requirements of ≤10 mg/L biochemical oxygen demand (BOD), ≤10 mg/l total suspended solids (TSS), and ≤200 CFU/100 mL fecal coliforms. The average concentrations in the discharge in 2021 were 2.4 mg/L BOD, 4.4 mg/L TSS, and 8.3 CFU/100 mL fecal coliforms.
- **Point of Discharge** (Permit pg. 1 and Section 1.1.4). The Permit is unclear on the required point of discharge. Page 1 of the Permit states that PRRD is authorized to discharge effluent "into Steeprock Creek," while Site Plan A suggests it would discharge to the ditch (as indicated by a dashed line, with no specific termination in Steeprock Creek). Section 1.1.4 mentions an outfall, but the Site Plan A only labels the pipe connecting Lagoon 5 to the CW as an outfall. Also, Section 4.4 describes the sampling location as "Discharge from the wetland *to land* draining into Steeprock Creek." During the site visit, the water was confirmed to flow into and through a well maintained ditch for a distance of about 160 m (measured on Google Earth). The flow then dissipates into the soil in the forest and does not reach Steeprock Creek. The implication of this for regulatory compliance is discussed further below.

[1] HRT = (width x depth x *f*) ÷ Flow Rate. Where *f* is a factor accounting for volume occupied by plants in the CW (*f* is assumed to be 0.9).

- **Posting of Outfall** (Permit Section 3.4). There are no signs identifying the CW or the location of the outfall.
- **Surface Water Entering CW** (Permit Section 3.6.2). Mr. Goudie reported that spring runoff occasionally enters the CW on the south corner. There was no evidence that this is affecting the berm.
- **Effluent Quality Sampling** (Permit Sections 4.4 & 4.5). The Permit requires monthly sampling of the discharge from Lagoon 5 and from the CW (i.e. 4 samples each year). In 2021, PRRD sampled the Lagoon 5 water four times and the CW discharge three times. The additional Lagoon 5 sample was from April 19, prior to discharge. All of the required parameters were analyzed. Permit compliance would require an additional sampling date in late August/early September.

The point of discharge to the environment is potentially an issue. From the 1985 aerial photograph on Google Earth (attached), after the first 160 m, the ditch appears to have entered a cutline that runs north-south, and proceeds for another 140 m. Steeprock Creek was about 290 m further north at its closest point. At the time of the site visit, that cutline has filled in with trees and shrubs, and the ditch is no longer present. The aerial imagery indicates that the terrain shifts from mixed forest to wetland around the end of the original ditch. In its present condition, the treated effluent that is released from the CW is discharged to ground and not to Steeprock Creek. Based on Permit Site Plan A and Section 4.4, it is likely that this is what the Permit intended. However, PRRD may wish to confirm this with ENV.

The local topography suggests that the water enters the ground, and any portion not taken up by vegetation likely flows as shallow groundwater flow towards Steeprock Creek. To evaluate the potential implications of the ground discharge, we searched the BC groundwater well database[2]. There are no registered wells downgradient of the CW between the point of discharge and Steeprock Creek. Furthermore, there are no points of diversion on Steeprock Creek downgradient of the CW licensed for domestic use, based on a search of the BC Water Resource Atlas[3]. Therefore, there is negligible risk to human health from the existing discharge.

All of the other technical requirements of Permit #14420 that pertain to the CW are being met, based on the available information and what could be observed from a single site visit. Note that we did not check the administrative requirements of the Permit, such providing the monitoring data to ENV annually (Section 5.1).

[2] On-line at https://apps.nrs.gov.bc.ca/gwells/groundwater-information.
[3] On-line at https://maps.gov.bc.ca/ess/hm/wrbc/. We also searched for Steeprock Creek in the BC Water Licence Search Tool. The BC Ministry of Transportation & Infrastructure holds two licences to take water from the creek for dust control and road maintenance.

4 ENVIRONMENTAL PERFORMANCE AND POTENTIAL ISSUES

Based on our review of the monitoring data from 2021, the Kelly Lake WWTF is capable of meeting the treatment requirements that are specified in the Permit. The maximum concentrations of BOD, TSS, and fecal coliform bacteria were well within the specified limits.

The Permit does not set limits for total phosphorus (TP) or total ammonia-N. As a benchmark, we compared the 2021 data to the standards set by the BC *Municipal Wastewater Regulation* (MWR)[4]. For TP, all three samples met the MWR standard of ≤1 mg/L, averaging 0.042 mg/L. The MWR ammonia-N standard is based on a back-calculation after initial dilution. However, the ammonia-N concentrations in the discharge met the most restrictive BC water quality guideline of ≤1.22 mg/L on all three dates[5], averaging <0.153 mg/L. This indicates that the discharge comfortably met the MWR requirement for ammonia-N in 2021.

As noted, the treated effluent discharged from the CW is presently being discharged to ground rather than to Steeprock Creek. Given the high level of treatment measured in 2021 (n=3), the treated effluent likely presents negligible risk to the environment or to human health, regardless of the point of discharge.

5 SUMMARY AND CLOSURE

To summarize:

- The current structure and condition of the CW is consistent with the original design drawing from 1995. In general, the wetland appears to be functioning as intended with adequate depth and vegetation cover and operational features to minimize short-circuiting of the flow.
- There are two potential issues related to compliance with Permit #14420 that PRRD may wish to clarify with ENV:
    - Water (treated effluent) was being discharged from the CW after the cut-off date of September 15 (the discharge of treated effluent from Lagoon 5 to the CW is reportedly stopped on September 15 each year); and
    - The treated effluent released from the CW is discharged to ground after travelling about 160 m through a ditch, rather than being discharged to Steeprock Creek. The Permit is unclear on the authorized point of discharge, but it is likely that the current operation is what the Permit intended.

[4] *Municipal Wastewater Regulation*, B.C. Reg. 87/2012.
[5] The ammonia-N guideline varies with pH and water temperature. No data are available, so the guideline shown assumes pH = 7 and temperature = 20°C. It is the chronic (average) guideline for aquatic life protection.

- The treated effluent flowing through the ditch downstream from the CW was clear and there was no evidence during the site visit of excessive nutrient enrichment or other adverse environmental effects. At the end of the ditch, the water was infiltrating to ground.
- Given the high level of treatment measured in 2021 (n=3), the final effluent likely presents negligible risk to the environment or to human health, regardless of the point of discharge. Before contacting ENV to clarify the Permit requirements, PRRD may wish to analyze additional recent monitoring data (e.g. from 2019 and 2020) to demonstrate treatment performance. Moving forward, PRRD should sample the Lagoon 5 and CW discharges at least monthly and forward the data to ENV, as required.

We look forward to your comments on this draft report. Please contact Hugh Hamilton or Jacques Groenewald if you have any questions or require additional information.

Sincerely yours,

Prepared by:

(Signatures on final report)

Hugh Hamilton, Ph.D., P.Ag.
Senior Environmental Scientist

Reviewed by:

Jacques Groenewald, M.Sc., P.Geo.
Senior Hydrogeologist

Attachment: 1985 aerial photograph

Figure 1

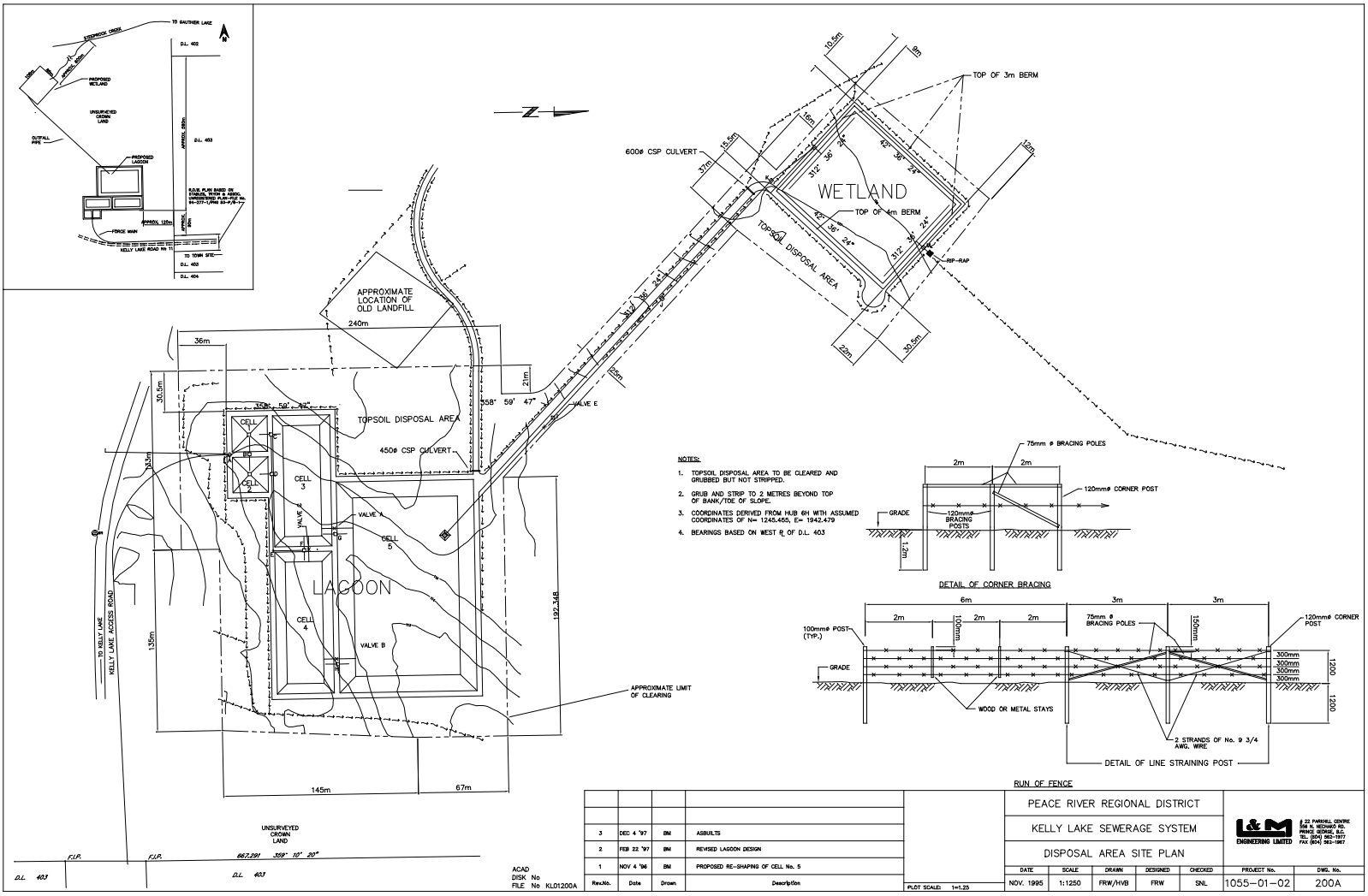
Kelly Lake WWTF and Constructed Wetland: Steeprock Creek is in north part of photo.

DRAFT

PEACE RIVER
REGIONAL DISTRICT

APPENDIX 4
DRAWINGS

USE 22 x 34 PAPER PLOT 1 = 0.5



NOTES:

1. TOPSOIL DISPOSAL AREA TO BE CLEARED AND GRUBBED BUT NOT STRIPPED.
2. GRUB AND STRIP TO 2 METRES BEYOND TOP OF BANK/TOE OF SLOPE.
3. COORDINATES DERIVED FROM HUB 6H WITH ASSUMED COORDINATES OF N= 1245.465, E= 1942.479
4. BEARINGS BASED ON WEST ℄ OF D.L. 403

DETAIL OF CORNER BRACING

DETAIL OF LINE STRAINING POST

RUN OF FENCE

Rev.No.	Date	Drawn	Description
3	DEC 4 '97	BM	ASBUILTS
2	FEB 22 '97	BM	REVISED LAGOON DESIGN
1	NOV 4 '96	BM	PROPOSED RE-SHAPING OF CELL No. 5

ACAD DISK No
FILE No KLD1200A

PLOT SCALE: 1=1.25

PEACE RIVER REGIONAL DISTRICT

KELLY LAKE SEWERAGE SYSTEM

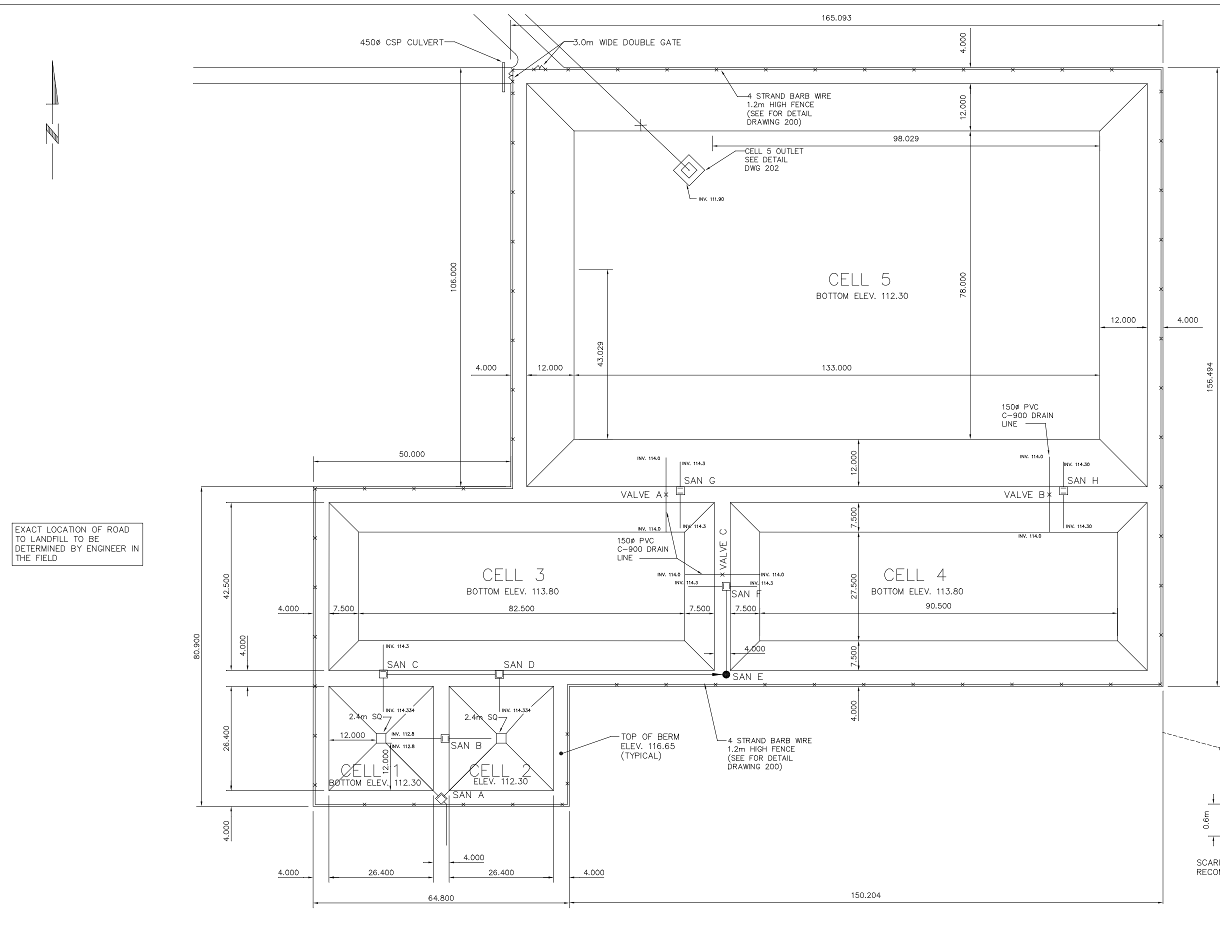
DISPOSAL AREA SITE PLAN

DATE	SCALE	DRAWN	DESIGNED	CHECKED	PROJECT No.	DWG. No.
NOV. 1995	1:1250	FRW/HVB	FRW	SNL	1055-01-02	200A

L&M ENGINEERING LIMITED

22 PARKNELL CENTRE 536 N. NECHAKO RD. PRINCE GEORGE, B.C. PH: (604) 563-1977 FAX: (604) 563-1967

USE 22 x 34 PAPER PLOT 1 = 0.5



DESIGN DATA

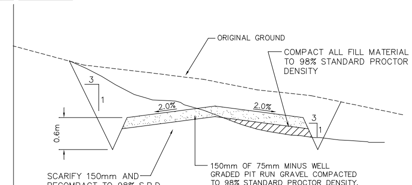
1. DESIGN FLOW: 136.4m³/DAY

2.

CELL	VOLUME
1	$470m^3$
2	$470m^3$
3	$4180m^3$
4	$5060m^3$
5	$32900m^3$

NOTE:

1. TOE OF SLOPE/TOP OF BANK NOT SHOWN FOR CLARITY. (SEE DWG 200)



LANDFILL ACCESS ROAD TYPICAL CROSS SECTION
N.T.S.

ACAD
DISK No 371
FILE No KL01201A

Rev.No.	Date	Drawn	Description
2	DEC 19 1997	BM	ASBUILT
1	FEB 22 1997	BM	REVISED LAGOON DESIGN

PLOT SCALE: 1=0.5

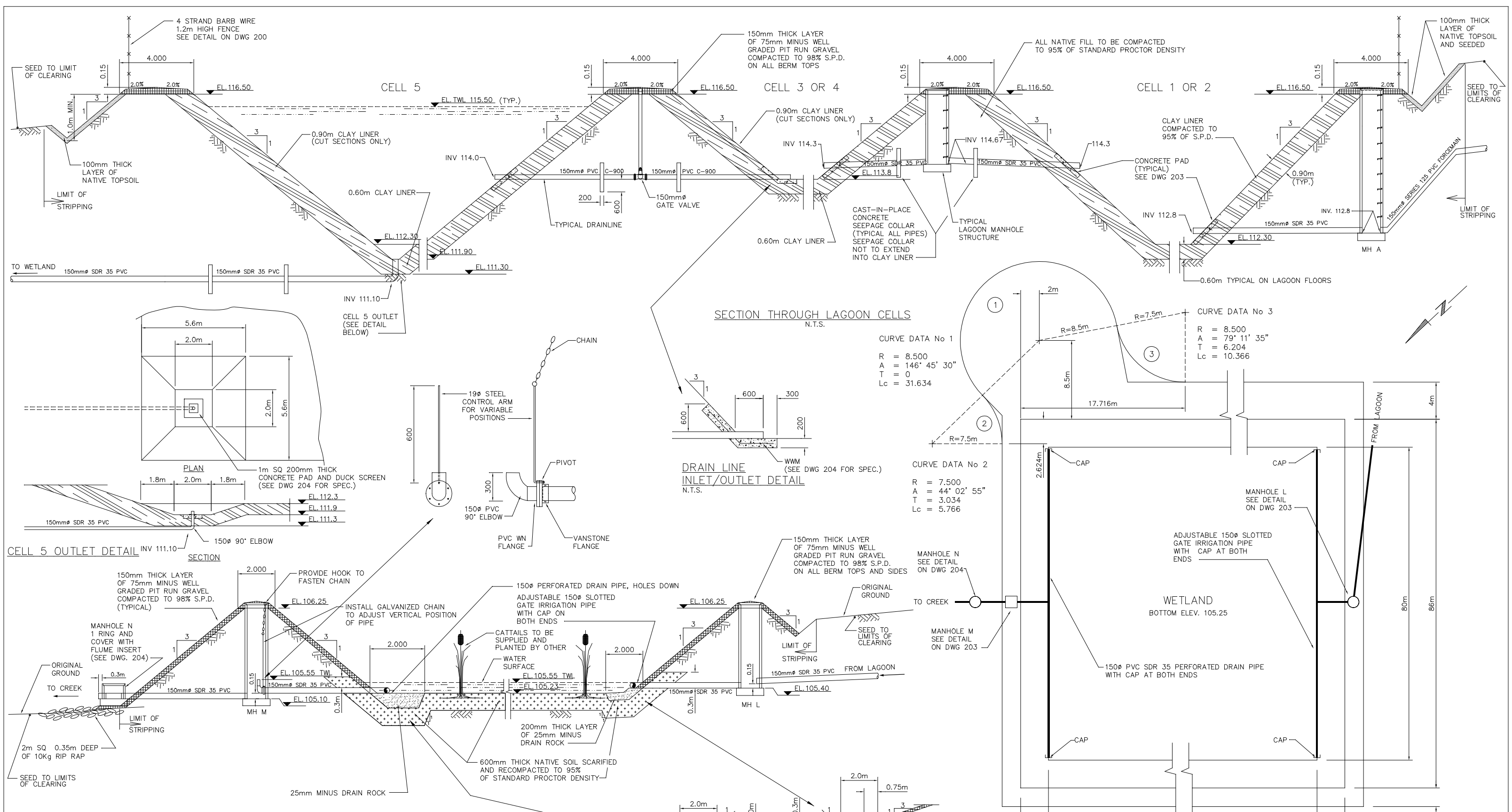
PEACE RIVER REGIONAL DISTRICT

KELLY LAKE SEWERAGE SYSTEM

LAGOON SITE PLAN

DATE	SCALE	DRAWN	DESIGNED	CHECKED	PROJECT No.	DWG. No.
JAN. 1996	1:500	H.V.B.	F.R.W.	S.N.L.	1055-01-02	201A

L&M ENGINEERING LIMITED
22 PARKHILL CENTRE
556 N. NECHAKO RD.
PRINCE GEORGE, B.C.
TEL. (604) 562-1977
FAX (604) 562-1967



NOTES

1. NATIVE SOIL BENEATH LAGOON AND WETLAND MUST BE SCARIFIED TO A DEPTH OF 600mm AND RECOMPACTED TO 95% STANDARD PROCTOR DENSITY.
2. AGGREGATE IN EXCESS OF 100mm DIAMETER MUST BE REMOVED PRIOR TO COMPACTION.
3. CLAY LINER CAN BE OBTAINED THROUGH THE FOLLOWING PREPARATION OF NATIVE SOILS.
   a) BASE AND CUT SLOPES MUST BE SCARIFIED, STRIPPED AND RECOMPACTED TO A DEPTH OF 200mm.
   b) LINER CLAY MUST BE THROUGHLY MIXED AND PLACED IN UNIFORM LIFTS NO GREATER THAN 150mm.
   c) COMPACT TO 95% OF STANDARD PROCTOR DENSITY
   d) LINER CLAY MUST BE 0.6m THICK ON LAGOON FLOORS AND 0.9m THICK ON SIDE SLOPES.
   e) LINER CLAY MUST BE PLACED AT A MOISTURE CONTENT WITHIN 4 PERCENT ABOVE OPTIMUM MOISTURE CONTENT.
4. SEE SOIL REPORTS PREPARED BY AGRA EARTH & ENVIRONMENTAL (AT THE BACK OF THE TENDER DOCUMENTS) FOR FURTHER INFORMATION ON LAGOON AND WETLANDS CONSTRUCTION.
5. SAND BEDDING TO BE OMITTED FROM PIPE BACKFILL WITHIN THE CLAY LINER.
6. ELEVATIONS TO BE CONFIRMED BY THE ENGINEER AFTER CLEARING, GRUBBING AND STRIPPING HAS BEEN COMPLETED.

ACAD
DISK No 371
FILE No KL01202A

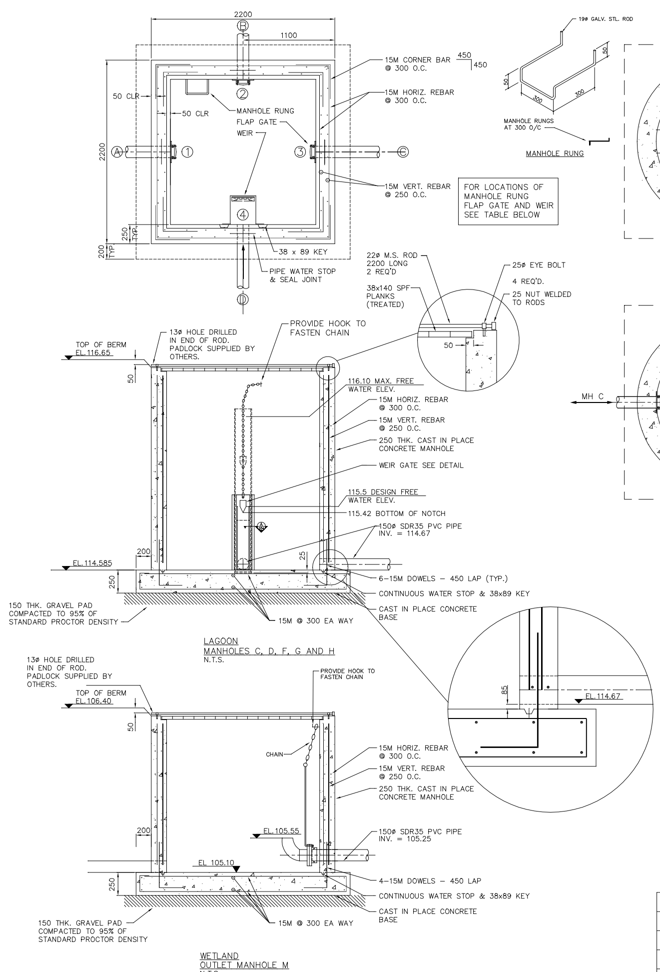
Rev.No.	Date	Drawn	Description
2	DEC 19 '97	BM	ASBUILT
1	FEB 22 '97	BM	REVISED LAGOON DESIGN

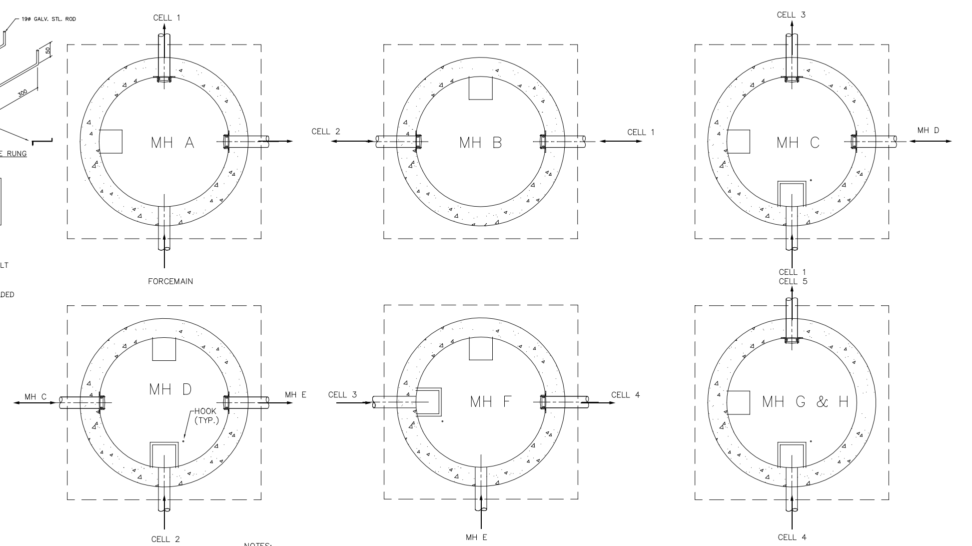
PLOT SCALE: 1=0.1

PEACE RIVER REGIONAL DISTRICT
KELLY LAKE SEWERAGE SYSTEM
LAGOON & WETLAND SECTIONS

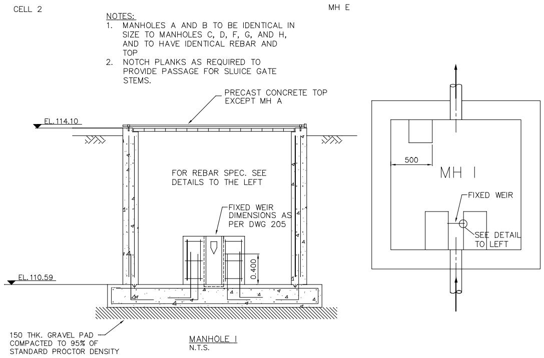
DATE	SCALE	DRAWN	DESIGNED	CHECKED	PROJECT No.	DRG. No.
MAR 1996	N.T.S.	H.V.B.	F.R.W.	S.N.L.	1055–01–02	202A

L&M ENGINEERING LIMITED
22 PARKHILL CENTRE
556 N. NECHAKO RD.
PRINCE GEORGE, B.C.
TEL. (604) 562-1977
FAX (604) 562-1967





NOTES:
1. MANHOLES A AND B TO BE IDENTICAL IN SIZE TO MANHOLES C, D, F, G, AND H, AND TO HAVE IDENTICAL REBAR AND TOP
2. NOTCH PLANKS AS REQUIRED TO PROVIDE PASSAGE FOR SLUICE GATE STEMS.



LAGOON AND WETLAND MANHOLES

MH	BASE ELEV	WEIR GATE No	FLAP GATE No	INLET	OUTLET
A	112.465	–	2–3	D	B–C
B	114.585	–	1–3		A–C
C	114.585	4	2–3	D	B–C
D	114.585	4	1–3	A–D	C
E	114.585	STANDARD MANHOLE –SEE DWG 114			
F	114.585	1	3	D	A–C
G	114.585	4	2	D	B
H	114.585	4	2	D	B
I	110.505	4–FIXED	–	D	B
J	106.216	STANDARD MANHOLE –SEE DWG 114			
K	105.706	STANDARD MANHOLE –SEE DWG 114			
L	105.400	STANDARD MANHOLE –SEE DWG 114			
M	104.850	SEE DETAIL AT LEFT			
N	104.850	SEE DETAIL ON DWG 204			

ACAD
DISK No 329
FILE No KL01203A

Rev.No.	Date	Drawn	Description
1	FEB 22 '97	BM	REVISED LAGOON DESIGN

PLOT SCALE: 1=0.5

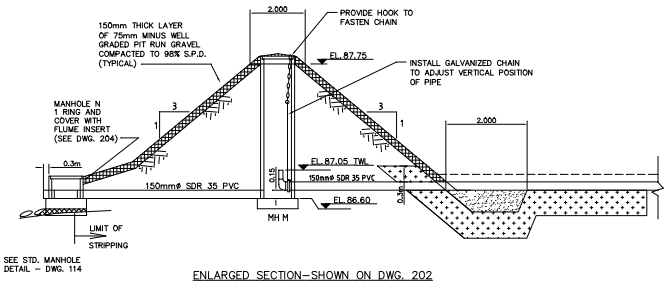
PEACE RIVER REGIONAL DISTRICT

KELLY LAKE SEWERAGE SYSTEM

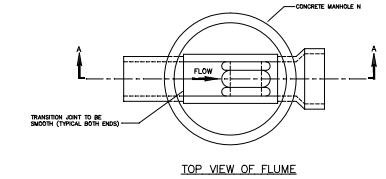
LAGOON MANHOLE DETAILS

DATE	SCALE	DRAWN	DESIGNED	CHECKED	PROJECT No.	DRG. No.
APR. 1996	AS SHOWN	H.V.B.	F.R.W.	S.N.L.	1055–01–02	203A

L&M ENGINEERING LIMITED
22 PARKHILL CENTRE
556 N. NECHAKO RD.
PRINCE GEORGE, B.C.
TEL. (604) 562-1977
FAX (604) 562-1967



ENLARGED SECTION–SHOWN ON DWG. 202

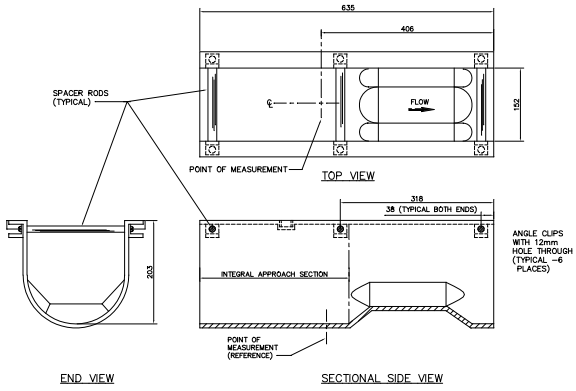


MANUFACTURER: FISCHER & PORTER
SERIES: 10F1980 PALMER–BOWLUS FLUME
TYPE: PERMANENT
SIZE: 6 INCH
MAXIMUM FLOW: 150 USGPM
MINIMUM FLOW: 17.4 USGPM

TOP VIEW OF FLUME

SECTION A–A ENLARGED

TYPICAL INSTALLATION PERMANENT TYPE – PALMER BOWLUS FLUME
SCALE : N.T.S.



TOP VIEW

END VIEW

SECTIONAL SIDE VIEW

PERMANENT TYPE FLUME
SCALE : N.T.S.

Rev.No.	Date	Drawn	Description
1	DEC 19 '97	BM	ASBUILT

ACAD DISK No 409
FILE No KL01204A

PLOT SCALE: 1=0.1

PEACE RIVER REGIONAL DISTRICT

KELLY LAKE SEWERAGE SYSTEM

Manhole N and Palmer–Bowlus Flume Details

DATE	SCALE	DRAWN	DESIGNED	CHECKED	PROJECT No.	DRG. No.
AUG 1996	N.T.S.	D.W.M.	F.R.W.	S.N.L.	1055–01–02	204A

L&M ENGINEERING LIMITED