REGIONAL WASTEWATER STUDY

HENDERSON CATCHMENT AREA
RURAL MUNICIPALITY OF ST CLEMENTS
FINAL REPORT

REGIONAL WASTEWATER STUDY

HENDERSON CATCHMENT AREA RURAL MUNICIPALITY OF ST. CLEMENTS

FINAL REPORT

PROJECT NO.: 171-11066-00.
DATE: DECEMBER 2017

WSP
1600 BUFFALO PLACE
WINNIPEG, MB, CANADA R3T 6B8

TEL.: +1 204 477-6650
FAX: +1 204 474-2864
WSP.COM

December 6, 2017

Project No. 171-11066-00

D J Sigmundson, CAO
RM of St Clements
1043 Kittson Road
Box 2, Group 35, RR#1
East Selkirk, MB
R0E 0M0

Dear DJ:

Re: St Clements Regional Wastewater Study

Attached is our finalised report summarising our work on the above study. We were pleased to present the results of the study to Council on December 5. We look forward to the opportunity of working with St Clements on the implementation of the project.

Yours sincerely,

Bill Brant

W H (Bill) Brant, P.Eng., FEC
Senior Water Specialist & Project Manager

WHB/lr

Encl.

cc. Dick Menon

cc. Greg Elson

1600 Buffalo Place
Winnipeg, MB, Canada R3T 6B8

Tel.: +1 204 477-6650
Fax: +1 204 474-2864
wsp.com

SIGNATURES

PREPARED BY

W H (Bill) Brant, P.Eng., FEC
Senior Water Specialist & Project Manager

PROVINCE OF MANITOBA
W. H.
BRANT
2017 12 06
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
WSP Canada Inc.
No. 5750 Date: 2017 12 06

Dana Bredin, P.Eng.
Wastewater Specialist & Project Engineer

REVIEWED BY

Ian M McKinnon, P.Eng.
Senior Director, Municipal Infrastructure

This report was prepared by WSP Canada Inc for the account of the Rural Municipality of St Clements, in accordance with the professional services agreement. The disclosure of any information contained in this report is the sole responsibility of the intended recipient. The material in it reflects WSP Canada Inc's best judgement in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. WSP Canada Inc accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This limitations statement is considered part of this report.

The original of the technology-based document sent herewith has been authenticated and will be retained by WSP for a minimum of ten years. Since the file transmitted is now out of WSP's control and its integrity can no longer be ensured, no guarantee may be given with regards to any modifications made to this document.

PRODUCTION TEAM

CLIENT

Project Manager	R (Dick) Menon, P.Eng., FEC
Public Works Manager	Greg Elson, CET.
Project Technician	Kevin Grabowski, CET
Project Sponsor	D J Sigmundson, CMMA, CAO

WSP

Project Manager	W H (Bill) Brant, P.Eng., FEC
Project Engineer	D T G (Dana) Bredin, P.Eng.

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY 1
1.1 WASTEWATER CONVEYANCE 1
1.2 WASTEWATER TREATMENT 2

2 PROJECT BACKGROUND 2
2.1 BACKGROUND SUMMARY 3
2.2 PROJECT CONTEXT 3
2.3 PROJECT SCOPE 4

3 NEEDS ASSESSMENT 5
3.1 EXISTING HYDRAULIC LOADING ON LS/FM SYSTEMS 5
3.1.1 LOCKPORT CATCHMENT AREA 5
3.1.2 DONALD CATCHMENT AREA 5
3.2 FUTURE HYDRAULIC LOADING ON LS/FM SYSTEMS 6
3.2.1 EXISTING HOMES 6
3.2.2 NEW HOMES 6
3.2.3 LOCKPORT CATCHMENT AREA 6
3.2.4 DONALD CATCHMENT AREA 7
3.3 CURRENT LOADING ON EAST SELKIRK WWTL 7
3.3.1 ORGANIC LOADING 7
3.3.2 HYDRAULIC LOADING 8
3.4 LOADING FROM HCA - EXISTING HOMES 9
3.4.1 ORGANIC LOADING 9
3.4.2 HYDRAULIC LOADING 9
3.5 CAPACITY OF EAST SELKIRK WWTL WITH HCA 10
3.5.1 ORGANIC LOADING WITH HCA 10
3.5.2 HYDRAULIC LOADING WITH HCA 10
3.6 FUTURE EAST SELKIRK WWTL LOADINGS 10
3.6.1 FUTURE ORGANIC LOADING 11
3.6.2 FUTURE HYDRAULIC LOADING 11

4 EXISTING INFRASTRUCTURE 12

4.1 LOCKPORT SEWER SYSTEM 12

4.1.1 COLLECTION SYSTEM 12

4.1.2 LIFT STATION & FORCEMAIN 12

4.2 DONALD ROAD SUB CATCHMENT SEWER SYSTEM 12

4.2.1 COLLECTION SYSTEM 12

4.2.2 LIFT STATION & FORCEMAINS 13

4.3 CONCLUSIONS RESPECTING THE LIFT STATIONS..............13

4.3.1 LOCKPORT LS 13

4.3.2 DONALD ROAD LOCKPORT LS 13

4.4 MEDIUM—TO-LONG TERM PUMPING STRATEGY 13

4.4.1 REGIONAL PUMPING STATION 14

4.4.2 REGIONAL (LOCKPORT TO EAST SELKIRK) FORCEMAIN SYSTEM 14

4.5 INTERIM SHORT-TERM STRATEGY 14

4.5.1 LOCKPORT LS SHORT-TERM STRATEGY 14

4.5.2 DONALD ROAD LS SHORT-TERM STRATEGY 14

5 WASTEWATER CONVEYANCE SCHEMES 15

5.1 LONG-TERM SCENARIO 15

5.1.1 NEW REGIONAL LIFT STATION 15

5.1.2 NEW REGIONAL FORCEMAIN 15

5.2 MEDIUM-TERM SCENARIO 16

5.2.1 FORCEMAIN SCENARIOS 16

5.3 SHORT-TERM SCENARIO #1 16

5.3.1 DONALD ROAD LS OPERATING ALONE 16

5.3.2 UPGRADED LOCKPORT LS OPERATING WITH DONALD ROAD LS............. 16

5.3.3 UPGRADED LOCKPORT LS OPERATING ALONE 17

5.3.4 CAPACITY LIMITS OF SHORT-TERM SCENARIO 17

5.3.5 VALUE LIMITATIONS OF SHORT-TERM SCENARIO 17

5.4 SHORT TERM SCENARIO #2 17

5.4.1 RETAIN LOCKPORT WWTP & CONVEY DONALD WW TO EAST SELKIRK17

5.5 SHORT TERM SCENARIO #3 18

5.5.1 TWIN FORCEMAINS DEDICATED TO EACH SUBCATCHMENT LS 18

5.6 SHORT-TERM IMPLEMENTATION STRATEGY 18

5.7 OPINION OF PROBABLE COSTS OF CONVEYANCE SCHEMES 19

5.7.1 FORCEMAIN – SHORT-TERM, SINGLE 300Ø LINE 19

5.7.2 FORCEMAIN – TWIN 300Ø LINES 20

5.7.3 LOCKPORT LS – SHORT-TERM UPGRADING 21

5.7.4 REGIONAL LS – MEDIUM-TO-LONG TERM 22

5.8 SUMMARY OF SHORT- AND LONG-TERM SCENARIOS FOR CONVEYANCE SCHEMES 23

5.8.1 MEDIUM–TO-LONG TERM SCENARIO 23

5.8.2 RECOMMENDED INTERIM SCENARIO #1: SHORT-TERM 23

5.8.3 ALTERNATIVE INTERIM SCENARIO #2: SHORT-TERM 23

5.8.4 ALTERNATIVE INTERIM SCENARIO #3: SHORT-TERM 24

6 WASTEWATER TREATMENT SCHEMES 25

6.1 SHORT TO MEDIUM TERM SCENARIO 25

6.1.1 ORGANIC CAPACITY 25

6.1.2 STORAGE CAPACITY 25

6.1.3 PHOSPHORUS TREATMENT 25

6.2 LONG TERM SCENARIOS 26

6.2.1 ADDITIONAL AERATED AND STORAGE CELLS 26

6.2.2 CONTINUOUS DISCHARGE WITH SAGR 26

6.3 OPINION OF PROBABLE COSTS WASTEWATER TREATMENT SCHEMES 27

6.3.1 SHORT TO MEDIUM TERM SCENARIO 27

6.3.2 LONG TERM SCENARIO #1 – ADDITIONAL AERATION AND STORAGE CELLS 27

6.3.3 LONG TERM SCENARIO #2 – CONTINUOUS DISCHARGE WITH SAGR 28

7 CONCLUSIONS 29

7.1 WASTEWATER CONVEYANCE SUMMARY AND RECOMMENDATIONS 29

7.2 WASTEWATER TREATMENT SUMMARY AND RECOMMENDATIONS 29

7.2.1 SUMMARY OF WASTEWATER TREATMENT CAPACITY ASSESSMENT 29

7.2.2 SUMMARY OF WASTEWATER TREATMENT SCHEMES AND COSTING .. 30

7.2.3 LONG TERM PLANNING AND RECOMMENDATIONS 30

8 LIMITATIONS 32

9 BIBLIOGRAPHY 33

APPENDICES

A CONCEPTUAL PLANS

A-1 LOCATION PLAN SHOWING CONCEPTUAL FORCEMAIN ROUTE

A-2 NEXOM PROPOSALS FOR LONG TERM WASTEWATER TREATMENT SCENARIOS

1 EXECUTIVE SUMMARY

The Rural Municipality of St Clements is expanding sewer service in the Henderson Catchment Area (HCA) which extends south from Lockport to the Old River Road (ORR) district. There are about 900 existing homes in the HCA, with potential for another 1100, therefore projecting a total of 2000 in the foreseeable future. This study focuses on using the East Selkirk Wastewater Treatment Lagoon (WWTL) system to accommodate wastewater from the HCA.

1.1 WASTEWATER CONVEYANCE

There are two lift (pumping) stations which serve the HCA. The estimated peak wastewater flow for the station serving the existing Lockport service area was determined to be 13.7 L/s, plus 8.8 L/s for the proposed expanded service area, for a total of 22.5 L/s which will be the criterion used to design the lift station/forcemain (LS/FM) system for the Lockport service area. The estimated future peak wastewater flow for the existing Donald Road lift station service area was estimated to be 30.4 L/s, plus 50.8 L/s for the expanded service area, for a total of 82.5 L/s. The combined total is 105 L/s but the design capacity for the new regional LS/FM system is recommended to be 125 L/s, because the actual pumping capacity of the Donald Road LS exceeds 100 L/s. Provision will be made in the new regional LS design to allow an increase to 150 L/s in the longer term.

The existing Lockport lift station cannot be used in the long term to convey large quantities of low pressure sewer (LPS) effluent as it was not designed to be compatible with the aggressive, corrosive, odourous nature of LPS wastewater. If both stations would discharge into a common 300 mm forcemain to the East Selkirk WWTL, the existing Lockport pumps would not generate enough head to overcome the significant pressures generated by the Donald Road LS pumps. However, if twin 300 mm forcemains are constructed initially, the existing Lockport pumps will have sufficient capability to convey the design target of 22.5 L/s to the lagoon. The existing Donald Road LS cannot be upgraded with higher pressure pumps needed to convey the medium-to-long term peak wastewater volumes through a significantly longer forcemain to the lagoon. However, for the short term, the existing pumps have capacity to convey wastewater from the existing 20 connected dwellings and 300 additional dwellings in the Donald catchment area directly to the lagoon through a dedicated 300 mm forcemain.

The new regional forcemain system will consist of two 300 mm HDPE pipelines. Initially, one forcemain will be connected to the existing Lockport LS and the other will be connected to the 200 mm Donald Road forcemain. In the longer term, both 300 mm forcemains would be connected to the proposed new regional lift station. The length of each forcemain will be about 7,500 m, depending upon the exact route and alignment which is ultimately selected. It is assumed that the forcemain route will follow PTH #44 east from Lockport across the Floodway to the CEMR right-of-way, then northward within an easement on the CEMR right-of-way, then west on PR #212 to the East Selkirk wastewater treatment facility. The forcemains would be primarily installed by directional drilling and will extend into the existing aerated primary cell. The short-term scenario of constructing two forcemains to East Selkirk has an anticipated budget of $3,213,000 including construction, engineering and other soft costs.

The medium-to-long term solution involves constructing a new regional pumping facility, designed to handle septic tank effluent as well as “fresh” sewage from Lockport, specifically when more than 320 dwellings are connected to the Donald Road LS. It will need to convey the design target of 125 L/s through both 300 mm HDPE forcemains, with the ability to upgrade to 150 L/s in the longer-term future if needed. The station location will be along PTH #44 east of Lockport, on the west side of the Floodway. The existing Lockport station will then be decommissioned. The preliminary opinion of the probable cost of constructing a new regional lift station at Lockport is $1,362,000 including construction, engineering and other soft costs.

The recommended short-term implementation scenario involves constructing two 300 mm forcemains, one being connected to each of the existing lift stations, that should allow for 20 L/s flow rates from the Donald Road LS and 25 L/s from the Lockport LS, using existing pumps. This provides for a modest amount of short-to-medium term growth without having to invest in the regional lift station which will be needed for the medium-to-longer term. It also allows for the immediate abandonment of the Lockport WWTP, and conveyance of existing Lockport and HCA wastewaters to the East Selkirk WWTL.

1.2 WASTEWATER TREATMENT

The East Selkirk WWTL is presently underutilized in terms of organic treatment capacity and storage capacity. The lagoon, as per its Environment Act Licence (EAL), has an organic loading limit of 216.3 kg-BOD_5/day, and based on the as-constructed drawings has a 227-day storage capacity of approximately 211,500 m^3. Currently, the RM is using 55% of the lagoon's organic capacity and only 26% of its storage capacity. The RM is using more of the lagoon's organic capacity as it accepts a significant amount of outside truck-hauled septage and wastewater.

The 227-day storage capacity of 211,500 m^3 will allow approximately 850 additional dwelling connections beyond what is currently being treated. The organic loading limit of 216.3 kg-BOD_5/day will only allow approximately 750 additional dwelling connections, 100 less than what the storage capacity can accept. However, the actual system organic treatment capacity is 250 kg-BOD_5/day, potentially adequate for about 865 additional dwelling units. As a result, additional organic treatment can be achieved with a submission to MB Sustainable Development for a minor alteration of the EAL increasing the organic loading limit from 216.3 kg-BOD_5/day to 250 kg-BOD_5/day. It is also important to note that it is expected that the BOD_5 loading from truck-hauling is to be reduced by up to 75% of its current level as the RM of St. Andrews and the HCA stop contributing their truck-hauled wastewater to East Selkirk. Thus, the storage capacity will be the limiting factor to determine when an expansion of the lagoon is needed.

Once the East Selkirk WWTL reaches its current storage capacity, there will be a need to expand to accommodate the projected total of 2,000 dwellings in the HCA as well as any additional growth in East Selkirk. There are a couple long-term options for the expansion of the wastewater treatment system, a conventional expansion or a conversion of the lagoon to a continuous discharge facility.

The conventional option would be to expand the lagoon with additional aeration and storage cells. This will also require expanding the existing blower building and upsizing the chemical dosing system for phosphorus removal. The new storage cell(s) will have a larger footprint than the existing two storage cells, thus available land may become an issue. The RM will most likely need to acquire land to the south or east of the existing lagoon property to allow for the construction of the new storage cell(s). Also, the existing southeastern portion of the lagoon property is known to have contaminated soils that may need remediation prior to any construction. The preliminary opinion of the probable cost of constructing a conventional lagoon expansion is $3,616,270 including construction, engineering and other soft costs, but excluding land, which will likely be in the order of at least $250,000.

An alternative to the conventional expansion of the existing East Selkirk WWTL would be to convert to a continuous discharge operation with SAGRs (Submerged Attached Growth Reactors). A continuous discharge system is preferable from a land availability standpoint, as well as, the proximity of the lagoon to the Red River (800 m from the site) which will allow for a year-round discharging of effluent. The SAGR system has been implemented for use in continuously discharging lagoons in Manitoba, effectively meeting effluent requirements. Chemical dosing will still be necessary to reduce the total phosphorus levels. Alternatively, a chemical filtration system similar to what was installed for the Lorette WWTL in 2017 may also be considered for phosphorus treatment.

The continuous discharge alternative would include some modifications and upgrading to existing cells and aeration systems such as: constructing a dual-cell aerated SAGR for nitrification, BOD_5, and total dissolved solids polishing; UV disinfection after the SAGR units; expanding the existing blower building; constructing a pipeline (and possible lift station) from the lagoon to the Red River for continuous discharge; and upgrading the chemical dosing system for continued phosphorus removal. The preliminary opinion of the probable cost of constructing a continuous discharge lagoon with a SAGR system is $3,983,350 including construction, engineering and other soft costs.

2 PROJECT BACKGROUND

2.1 BACKGROUND SUMMARY

The Rural Municipality of St Clements encompasses a large area in the Capital Region north-east of Winnipeg. Its communities of Lockport and East Selkirk are served by sewer systems with wastewater treatment facilities. Stringent provincial regulations recently required installation of low pressure sewers (LPS) in the Old River Road (ORR) district in the south-west corner of the RM. The RM is now moving toward expanding sewer service in the Henderson Catchment Area (HCA) which extends south from Lockport to the ORR district. In total, there are about 900 existing homes in the HCA, with a potential for a total of 2000 in the foreseeable future. After several studies on sewer servicing alternatives, the RM has initiated a study to provide greater detail on the implementation of the selected alternative, which is expansion of the East Selkirk aerated lagoon system to accommodate wastewater from the HCA.

A brief summary of key tasks includes:

— Review of the relevant existing wastewater infrastructure in the HCA, in Lockport and East Selkirk

— Confirming future needs as identified in previous studies and developing design criteria for the proposed regional system

— Developing design concepts for conveyance pumping and piping, for wastewater treatment facility upgrades at East Selkirk and for repurposing or decommissioning existing facilities

— Analysing the design alternatives, developing opinions of probable cost to a Class "C" level and preparing a summary report outlining the foregoing

2.2 PROJECT CONTEXT

The Rural Municipality of St Clements encompasses a large area stretching from the Manitoba Capital Region (with several communities and many rural residential districts), through farmland, northward along the east side of Lake Winnipeg where there are numerous seasonal and recreational developments. There are two discrete communities at the south end of the Municipality, namely Lockport and East Selkirk, both of which are served by sewer systems with wastewater treatment facilities. Lockport has a gravity sewer system with a mechanical treatment plant incorporating sequencing batch reactor technology, while East Selkirk is served by septic tank effluent pumpout-type low pressure sewers with an aerated stabilisation pond ("lagoon") system to treat the wastewater.

Stringent provincial regulations have been implemented to reduce nutrient contributions to Lake Winnipeg. Septic fields have been the disposal method most commonly used for rural residential wastewater effluent, and these have been identified as a significant point source of nutrients entering the watershed. This led to a prohibition of septic disposal fields in the Old River Road (ORR) district in the south-west corner of the RM. A low pressure sewer (LPS) system was constructed, with service lines from septic tank pumping systems to the LPS mains which convey the tank effluent to a central sewage pumping ("lift") station located on the northeast corner of the municipal fire hall property near the intersection of Henderson Highway and Donald Road. There are two 200mm diameter forcemains which run north along the CEMR railway track to the Lockport treatment plant. Only one is currently in service while the other is ready for use whenever demand warrants it. The ultimate intention of the design of the existing system is that wastewater effluent from all homes south of Lockport will no longer be disposed in septic fields, but rather that they will be conveyed to a suitable wastewater treatment facility. The effluent from homes south of Church Road will be directed to the Donald Road lift station, whereas wastewater from all homes north of Church Road will be conveyed by LPS directly north to Lockport.

As noted, the long term intention is to provide LPS service to all residents in the Henderson Catchment Area (HCA). A map included in this report depicts the extent of the HCA. It extends from the municipal boundary in the south to PTH #44 in the north, and from the Red River in the west to the Red River Floodway in the east. To take advantage of low piping installation costs and to facilitate system extensions, additional LPS piping was constructed several years ago along the east-west roads in the HCA when the LPS mains were installed for the ORR district. There are currently no service connections to the LPS mains outside the ORR district.

In total, there are about 900 homes in the HCA, with a potential for a total of 2000 in the foreseeable future, as more subdivisions are developed. In anticipation of having to provide treatment for far more wastewater than the Lockport plant could handle, the RM commissioned studies to consider alternatives which concluded that the best scheme involves the expansion of the East Selkirk lagoon system. The current study is intended to provide greater detail on the implementation of the selected alternative.

2.3 PROJECT SCOPE

A summary of proposed project scope follows:

— Extend the existing HCA forcemain system across the floodway and northwards along CEMR to the East Selkirk lagoon
— Upgrade or replace the Lockport lift station and connect to a forcemain system connected to the East Selkirk lagoon
— Confirm capacity of the Donald Road station and upgrade as needed
— Upgrade the capacity of the East Selkirk lagoon system and add engineered wetlands for nutrient reduction

The specific tasks include:

— Reviewing defined project scope and previous documentation including Dillon phase 1 sewer predesign study reports, Trek geotechnical report for previous phase, as-constructed plans of phase 1 works constructed in 2014-16
— Meeting with RM staff and officials at project initiation and milestone dates
— Reviewing and analysing existing wastewater flow and treatment plant loading
— Estimating future population growth and wastewater flow rates/volumes for the HCA (including Lockport and ORR district)
— Developing design criteria for each element of the proposed infrastructure (piping, pumping, treatment, SCADA)
— Confirming capability of Donald Road lift station and determining upgrading as may be needed
— Identifying repurposing and/or decommissioning plans for existing Lockport pumping and treatment facilities
— Conceptualising forcemain route alternatives and prepare preliminary plan of optimum route
— Preparing Class “C” budget for pumping, piping and treatment infrastructure, plus engineering and contingencies
— Submitting four hard copies and one electronic copy of a draft report for review
— Incorporating comments from the RM and finalise the report
— Submitting four hard copies and two electronic copies (CD or USB stick) of a final report
— Attending three meetings during the course of the study (initiation, status review and presentation of report)

The following services were specifically excluded from this study:

— Detailed topographic surveys of the forcemain route
— Detailed soils investigation
— Consultation with regulatory agencies
— Detailed budget for a wetland facility
— An Environment Act Proposal

3 NEEDS ASSESSMENT

3.1 EXISTING HYDRAULIC LOADING ON LS/FM SYSTEMS

Much of the data on the existing HCA and Lockport sewer systems was extracted from the Dillon predesign study, subsequent design plans and lift station and wastewater treatment data provided by the Municipality. In the course of reviewing reports and data, some discrepancies were noted. Where data appeared to be anomalous, it was disregarded.

3.1.1 LOCKPORT CATCHMENT AREA

The RM has provided daily flow data recorded at the Lockport wastewater treatment plant (WWTP) for the period 2015-17. The data is summarised as follows (all data in m^3, cubic metres; $1m^3$ = 1000 litres):

	2013 (Dillon)	2015	2016	2017 (first 6 months)
Average daily volume	110.0 m^3	101.3 m^3	112.0 m^3	128.6 m^3
Peak day volume	450.0 m^3	310.0 m^3	281.0 m^3	250.0 m^3
Peak hour rate	900.0 m^3 *			

**Note: This peak hour rate was an estimate by Dillon based upon a 2:1 peak hour to peak day ratio; the other data are hard numbers recorded at the sewage treatment plant*

The increased average daily wastewater volumes over the period reflects the impact of the LPS connections in the ORR district. It appears anomalous that peak flows were higher in 2014-2016 than in 2017. This may reflect the relatively drier conditions in the past year, reducing the inflow/infiltration (i/i) into the gravity sewers in Lockport.

The sizing of lift station/forcemain systems must be based upon peak hour flows, in order that sewers do not back up during those peak events. Normally, a rule of thumb is that peak hour flow rates are at least two times the peak day rate. The same "rule of thumb" approach suggests that peak day flows are about two times average flow rates. As can be seen from the data, peak day rates range from 2.0 to 4.5 times the average daily rate. There is no known data on peak hour rates, although Dillon did suggest a rate which is eight times average, which is rather extreme compared to what is experienced elsewhere, unless weeping tiles are connected to increase the i/i flows.

The most prudent approach is to go back to basics, and use available hard data as a starting point. The first fundamental parameter to be considered is the number of dwelling units and population to be serviced. It is known that in 2013, there were 182 dwelling units (DU) in the Lockport catchment area, with 130 additional units expected over the next 20 years, for a total design target of 312.

3.1.2 DONALD CATCHMENT AREA

There are very limited data for wastewater volumes and flow rates from existing dwellings connected to the ORR subcatchment. It has been reported by RM staff that only 20 of 65 homes have connected to the sewer constructed in 2015-16. This has resulted in the Donald lift station pumps operating an average of eight minutes per day. This provides a limited basis for analysis. However, since the lift station pumps are rated at 55 L/s, it can be calculated that the average discharged per dwelling is 1300 L/d. Statistics Canada reports that in the 2016 census, there were 2.5 residents per dwelling. That suggests that the average per capita wastewater volume is 520 L/d. This appears high in the context of water consumption, which is normally in the range of 250-300 L/d for older homes (i.e., limited use of low-flow/low-flush plumbing fixtures) where there is no metering or payment for water use, which is the case due to water being supplied by private wells, not by a public water system. The balance of the wastewater volumes is contributed by extraneous i/i (inflow and infiltration) flows which primarily emanate from seepage of groundwaters into septic tank manholes. When low pressure sewers were first designed for Manitoba communities around 40 years ago, there was no allowance made for this. The RM of Macdonald documented their experiences with their four LPS systems, and this forms the basis of design criteria which we now use.

3.2 FUTURE HYDRAULIC LOADING ON LS/FM SYSTEMS

The following criteria have been used to estimate the anticipated peak wastewater volumes for which lift station/forcemain systems must be designed.

3.2.1 EXISTING HOMES

— Average per capita wastewater volume 300 L/c.d
— Average 2.5 persons per dwelling as per StatsCan data
— Average domestic wastewater water volume per dwelling: 300 x 2.5 = 750 L/d
— Wet weather i/i: 0.04 L/s per connection

3.2.2 NEW HOMES

— Average per capita wastewater volume 200 L/c.d (reflecting water-efficient plumbing systems)
— Average 3.0 persons per dwelling, as per typical new developments in Capital Region
— Average domestic wastewater water volume per dwelling: 200 x 3.0 = 600 L/d
— Wet weather i/i: 0.04 L/s per connection

For both old and new, peak domestic flows will be based upon the Harmon Peaking Factor, which is statistically-based upon population.

3.2.3 LOCKPORT CATCHMENT AREA

The anticipated peak wastewater flows for existing dwellings in this area were determined as follows:

— Average domestic flow: existing dwellings 182, population (@ 2.5/DU =) 455 @ 300 L/d = 136,500L (= 1.6 L/s)
— Peaking factor @ population 455 = 4.0; peak hour domestic flow = 1.6 L/s x 4.0 = 6.4 L/s
— i/i = 182 DU x 0.04 L/s = 7.3 L/s
— Total = 6.4 + 7.3 = 13.7 L/s

The anticipated peak wastewater flows for new dwellings in this area were determined as follows:

— Average domestic flow: future dwellings 130, population (@ 3.0/DU =) 390 @ 200 L/d = 78,000L (= 0.9 L/s)
— Peaking factor @ population 390 = 4.0; peak hour domestic flow = 0.9 L/s x 4.0 = 3.6 L/s
— i/i = 130 DU x 0.04 L/s = 5.2 L/s
— Total = 3.6 + 5.2 = 8.8 L/s

The total of (13.7 + 8.8 =) 22.5 L/s will be used to design the lift station/forcemain system for the Lockport service area.

It may be noted that the capacity of the existing lift station is about 25 L/s. However, this is through a very short forcemain, running only 200m to the nearby sewage treatment plant.

3.2.4 DONALD CATCHMENT AREA

The anticipated peak wastewater flows for existing dwellings in this area were determined as follows:

— Average domestic flow: existing dwellings 418, population (@ 2.5/DU =) 1045 @ 300 L/d = 313,500L (= 3.6 L/s)
— Peaking factor @ population 1045 = 3.8; peak hour domestic flow = 3.6 L/s x 3.8 = 13.7 L/s
— i/i = 418 DU x 0.04 L/s = 16.7 L/s
— Total = 13.7 + 16.7 = 30.4 L/s

The original Dillon design report was based upon a total of just over 1000 DU for the whole HCA but the current target is 2000 DU. The difference is made up by the addition of the lands between the CEMR and the Floodway, which are expected to include 980 DU, which would be served via the Donald LS/FM system. The anticipated peak wastewater flows for new dwellings in this area were determined as follows:

— Average domestic flow: future additional dwellings 1270 (290 west of CEMR, 980 east of CEMR), population (@ 3.0/DU =) 3810 @ 200 L/d = 762,000L (= 8.8 L/s)
— Peaking factor @ population 3810 = 3.35; peak hour domestic flow = 8.8 L/s x 3.35 = 31.7 L/s
— i/i = 1270 DU x 0.04 L/s = 50.8 L/s
— Total = 31.7 + 5.2 = 50.8 L/s

The total of (31.7 + 50.8 =) 82.5 L/s will be the design target for the lift station/forcemain system for the Donald service area. It may be noted that with one pump running, the Donald LS currently has 55 L/s capacity. When a third pump is added to restore redundancy, there will be 110 L/s firm capacity, since each of two operating pumps will have its own forcemain. This facility is therefore expected to have adequate capacity for the projected population which it will have to serve in the longer term.

3.3 CURRENT LOADING ON EAST SELKIRK WWTL

The existing East Selkirk Wastewater Treatment Lagoon (WWTL) consists of two primary aerated cells and two secondary cells. The lagoon was designed by WSP and was commissioned in 2016. Currently, the majority of the wastewater collected and treated by the lagoon comes from the LPS system recently installed within the community of East Selkirk. The lagoon also accepts truck-hauled wastewater and septage from the southern half of the Municipality of St. Clements, as well as the Municipality of St. Andrews. A minor amount of truck-hauled wastewater and septage is also accepted from the Municipality of East Saint Paul, the Municipality of Springfield and the City of Selkirk.

The data to determine the existing organic and hydraulic loadings for the lagoon was provided by the Municipality of St. Clements including the truck hauling records from January 2016 to October 2016 as well as just over one year (July 2016 – Sept 2017) of pump hour data from the East Selkirk lift station.

3.3.1 ORGANIC LOADING

The ability of a lagoon to treat the incoming wastewater is measured by organic loading capacity. Organic loading refers to the quantity of organic material present in the incoming wastewater and is measured as the five day Biochemical Oxygen Demand (BOD_5). The organic loading becomes the total mass of BOD_5 in kilograms per day (kg/d) in the wastewater received at the lagoon.

Organic loading from piped service areas is consistent on a year-round basis and does not have a seasonal variation. On the basis of accepted practice, the daily BOD_5 production from domestic wastewater collected via the piped system is 0.077 kg per person. For a LPS system, the liquid portion of the wastewater is pumped to the lagoon while the solid portion is contained within a septic tank. These solids are generally emptied from septic tanks every one to two years. For the purpose of this report, it is assumed that the organic loading will not fluctuate from the daily BOD_5 value of 0.077 kg per person, even though the liquid and solid portions of the wastewater reach the lagoon at different intervals.

There are approximately 260 dwellings that were connected to the LPS in the Community of East Selkirk. From the 2016 Census, there are approximately 2.5 persons per dwelling, which gives us an estimated population of 650. The Environment Act Proposal (EAP) submitted by WSP in May 2012 for the East Selkirk WWTL indicated that there is an additional 30 equivalent people that are serviced by the LPS system, which includes employees in the RM of St. Clements Office as well as the staff and visitors to the Recreation Centre. Thus, the current estimated equivalent population that is serviced by the LPS is 680. Using this population, the organic loading collected by the LPS system is 52.4 kg-BOD_5/d.

The truck-hauled wastewater and septage rely on certain assumptions to determine their loading effects. The Environment Act Licence (EAL #3058) for the East Selkirk WWTL states that the Municipality may only accept septage from June 1 to October 15, with the peak septic tank emptying generally occurring within a 45-day period from September 1 to October 15. There is also a significant amount of truck-hauled wastewater from holding tanks in the region. These tanks are emptied throughout the year and contribute only a fraction of the amount of BOD_5 when compared to septage.

The truck-hauled data provided from the Municipality was broken down by date, location, size and type of tank (holding or septic). A breakdown of the truck-hauled wastewater and septage by location is as follows:

- 48% from the Municipality of St. Clements (southern half)
  - 52% of this comes from the HCA
- 48% from the Municipality of St. Andrews
- 4% from the Municipality of East St. Paul, the Municipality of Springfield and the City of Selkirk.

From the data, the two months with the highest amount of truck-hauled wastewater and septage were found to be September and October. The average strength of septage is estimated to be 5,000 mg/L BOD_5 and the average strength of holding tank wastewater is estimated to be 500 mg/L BOD_5. Utilizing these average strengths and applying this to the size and type of tank data from the months of September and October, it was determined that the peak organic loading for the truck-hauled wastewater is 67.5 kg-BOD_5/d.

Therefore, the total daily organic loading for the East Selkirk WWTL is 119.9 kg-BOD_5/d.

The existing Licence allows a maximum daily organic loading of 216.3 kg-BOD_5/d, thus the Municipality is currently utilizing 55% of the facility's allowable daily organic loading.

3.3.2 HYDRAULIC LOADING

The ability of a lagoon to store the incoming wastewater is measured by its hydraulic loading capacity. The hydraulic loading refers to the volume of wastewater that flows to the lagoon. The East Selkirk WWTL is presently designed for a 227-day storage period beginning on November 1st and ending on June 15th of the following year. Hydraulic loading of the 227-day storage period is used to calculate the volume of storage required for the lagoon.

WSP had previously completed a pump test of the lift station in July 2016 and has determined the pumping rate to be approximately 15.0 L/s. A review of the lift station pump hour records indicated that from July 2016 to September 2017, the average per capita wastewater flow rate per day is 170 L/c.d, which includes infiltration. This is lower than what is typically used for per capita wastewater flow, though not unreasonably low, as the population generally commutes elsewhere during working hours and the community has metered water which contributes to lower water usage (and therefore lower wastewater generation). Also, the period July 2016 to September 2017 was drier than normal, thus less infiltration is to be expected during this time period. More pump hour data will be necessary to further evaluate the wastewater flow rate for East Selkirk, though for this report an average per capita wastewater flow rate of 250 L/c.d is assumed.

For the purposes of this report, the following criteria were used to calculate the wastewater generated by the residents of East Selkirk connected to the LPS system:

- Average per capita wastewater volumetric flow rate of 250 L/c.d
- Average infiltration rate of 100 L/d per dwelling
- Number of dwellings connected to the LPS system is 260
- Average 2.5 persons per dwelling as per StatsCan data

- An additional 30 equivalent people connected to the LPS system (RM Office and Recreation Centre)
- Population = (2.5 x 260) + 30 = 680

The wastewater generated per day was determined as follows:

- (250 L/c.d x 680 persons) + (100 L/d x 260 dwellings) = 196,000 L

Therefore the wastewater generated by the East Selkirk residents connected to the LPS system during the 227 day winter storage period is estimated to be 44,492,000 L or 44,500 m^3.

From the truck-hauling data, the total volume of truck-hauled wastewater and septage from January 1, 2016 to June 15, 2016, was calculated to be 6,930,860 L, which is approximately 41,752 L/day. Over the 227-day winter storage period, this equates to a volume of approximately 9,500,000 L or 9,500 m^3.

The current hydraulic loading on the East Selkirk WWTL for the 227 day winter storage period is approximately 54,000 m^3.

The existing capacity of the East Selkirk WWTL is 211,500 m^3, thus the Municipality is currently utilizing 26% of the facility's allowable hydraulic loading capacity.

3.4 LOADING FROM HCA - EXISTING HOMES

Presently, the HCA has a limited wastewater collection system. The majority of the wastewater is generated and collected via privately owned holding tanks, septic tanks and field systems. These holding tanks and septic tanks are disposed periodically via septic truck at the East Selkirk WWTL. The Lockport Wastewater Treatment Plant (LWWTP) also treats a portion of the HCA's wastewater. There is approximately 100 homes connected to the LWWTP via a forcemain and lift station. The wastewater flows to the Lockport lift station via gravity sewer and LPS.

There are approximately 900 dwellings in the HCA, including the homes connected to the LWWTP. All these dwellings are to be connected to the East Selkirk WWTL, with the treatment system at the LWWTP being decommissioned, unless an alternative use can be justified.

3.4.1 ORGANIC LOADING

The following criteria was used to calculate the organic loading of the wastewater generated by the residents of the HCA:

- Average daily BOD_5 value of 0.077 kg per person
- Number of dwellings is 900
- Average 2.5 persons per dwelling as per StatsCan data
- Population = (2.5 x 900) = 2250

The organic loading was determined as follows:

- (2250 persons x 0.077 kg-BOD_5/d/person) = 173.3 kg-BOD_5/day

3.4.2 HYDRAULIC LOADING

The following criteria was used to calculate the wastewater generated by the residents of the HCA:

- Average per capita wastewater flow rate of 300 L/c.d
- Average infiltration rate of 100 L/d per dwelling
- Number of dwellings is 900
- Average 2.5 persons per dwelling as per StatsCan data
- Population = (2.5 x 900) = 2250

The wastewater generated by day was determined as follows:

— (300 L/c.d x 2250 persons) + (100 L/d x 900 dwellings) = 765,000 L/d

Therefore the wastewater generated by the HCA resident during the 227 day winter storage period is approximately 173,655,000 L or 173,700 m^3.

3.5 CAPACITY OF EAST SELKIRK WWTL WITH HCA

The East Selkirk WWTL has a storage capacity of 211,500 m^3 within its two secondary cells based on the 2016 East Selkirk WWTL as-constructed drawings. This capacity can be increased only by the construction of an additional new secondary cell(s). The organic loading capacity of the lagoon is based on the existing EAL which allows a maximum daily organic loading of 216.3 kg-BOD_5/d. This capacity can be increased by the construction of an additional aerated primary cell or the construction of new SAGR units, among other potential options as discussed in Section 5.0.

3.5.1 ORGANIC LOADING WITH HCA

From section 2.3.1, the current organic loading on the East Selkirk WWTL is 119.9 kg-BOD_5/d, 52.4 kg-BOD_5/d from the LPS and 67.5 kg-BOD_5/d from the truck-hauled wastewater and septage. Presently, approximately 25% of all truck-hauled wastewater and septage comes from the HCA. Furthermore, St. Clements has indicated that the RM of St. Andrews will be transitioning to a LPS system so the truck-hauled wastewater from the RM St. Andrews will be considerably reduced in the near future. The RM of St. Andrews currently contributes approximately 50% of the organic loading from the truck-hauled wastewater. Thus, it is assumed that the current organic loading from the truck-hauled wastewater and septage will be reduced by approximately 75% once all 900 dwellings within the HCA are connected to the East Selkirk WWTL via the LPS system.

With the additional 900 dwellings added from the HCA (173.3 kg-BOD_5/d), and applying the reduction of the truck-hauled wastewater and septage, the total organic loading on the East Selkirk WWTL will be 242.5 kg-BOD_5/d.

With the additional organic loading from the HCA, the Municipality will utilize 112% of the facility's allowable daily organic loading.

3.5.2 HYDRAULIC LOADING WITH HCA

From section 2.3.2, the current hydraulic loading on the East Selkirk WWTL for the 227-day winter storage period is 54,000 m^3. The additional 900 dwellings from the HCA will contribute 173,700 m^3, once they are connected to the East Selkirk WWTL.

As previously mentioned, the HCA currently contributes 25% and the RM of St. Andrews contributes 50% of the volume of the truck-hauled wastewater and septage. With both of these areas no longer anticipated to be contributing truck-hauled wastewater, this will reduce the hydraulic loading by approximately 7,100 m^3.

Therefore the total hydraulic loading on the East Selkirk WWTL for the 227 day winter storage period will be approximately 220,600 m^3.

Will the additional hydraulic loading from the HCA, the Municipality will utilize 104% of the facility's allowable hydraulic loading capacity.

3.6 FUTURE EAST SELKIRK WWTL LOADINGS

The future East Selkirk WWTL will need to accommodate an additional 1,100 dwellings in the HCA (for a total of 2,000 dwellings) as well as an anticipated growth in the Community of East Selkirk. From the May 2012 EAP, an additional 280 dwellings were projected as future growth, which would connect to the LPS. This will bring the number of dwellings connected to the LPS in East Selkirk from a current 260 to a future total of 540.

3.6.1 FUTURE ORGANIC LOADING

The following criteria was used to calculate the organic loading of the wastewater generated by the existing and future residents of the HCA and East Selkirk:

EXISTING HOMES

— From Section 2.5.1, organic loading = 242.5 kg-BOD_5/day

NEW HOMES

— Average daily BOD_5 value of 0.077 kg per person
— Number of future dwellings is (1,100 + 280) = 1,380
— Average 3.0 persons per dwelling as per StatsCan data
— Population = (3.0 x 1,380) = 4,140

The future organic loading was determined as follows:

— (4,140 persons x 0.077 kg-BOD_5/d/person) = 318.8 kg-BOD_5/day

Therefore the future organic loading generated is 562 kg-BOD_5/day.

3.6.2 FUTURE HYDRAULIC LOADING

The following criteria was used to calculate the wastewater generated by the existing and future residents of the HCA and East Selkirk:

EXISTING HOMES

— From Section 2.5.2, hydraulic loading = 220,600 m^3 for the 227 day winter storage period.

NEW HOMES

— Average per capita wastewater flow rate of 200 L/c.d
— Average infiltration rate of 100 L/d per dwelling
— Number of future dwellings is 1,380
— Average 3.0 persons per dwelling as per StatsCan data
— Population = 4,140

The wastewater generated by day was determined as follows:

— (200 L/c.d x 4,140 persons) + (1,380 dwellings x 100 L/d) = 966,000 L/d

Therefore the wastewater generated by the existing and future residents of the HCA and East Selkirk during the 227 day winter storage period is approximately 440,000 m^3.

4 EXISTING INFRASTRUCTURE

4.1 LOCKPORT SEWER SYSTEM

The original sewer system, lift station and treatment plant were constructed and commissioned in 1997.

4.1.1 COLLECTION SYSTEM

The original Lockport sewer system consists of conventional gravity sewers. Since it was originally constructed, some low pressure extensions have been constructed southward along Henderson Highway. In addition, one of the Donald Road forcemains has been connected to the gravity system to convey the ORR district wastewaters from the 20 connected dwellings there.

4.1.2 LIFT STATION & FORCEMAIN

The existing lift station is located on the east side of Henderson Highway north of PTH #44. It is 2.4m in diameter, 7.5m deep, with an incoming gravity sewer at 5.2m below ground level. The station pumps were recently replaced by 7.5hp Flygt NP3127MT439 units with 1Ø (single-phase) electric motors, discharging through a 200m long 150mm forcemain, and rated at approximately 25 L/s at 12m TDH (total dynamic head). The net lift (lift station liquid level to wastewater treatment plant liquid level) is approximately seven metres.

The station could accommodate slightly larger pumps but the available equalisation capacity in the 2.4m Ø (diameter) wetwell (approx. 6.5m^3) is a limiting factor in terms of maintaining a standard of no more than four starts per pump, per hour. A significant increase in pumping capacity could not be realistically implemented.

Another issue is that the north end of the HCA is served by LPS. As more homes are connected, the incoming wastewater to the LS will be predominantly septic, saturated with hydrogen sulphide. The proximity of the LS to residential and commercial development will cause significant odour complaints. In addition, the LS was designed as part of a gravity sewer system, meaning that it was intended for “fresh” wastewater, not highly septic LPS effluent. This creates a highly corrosive atmosphere in the LS, where condensing water vapours dissolve the hydrogen sulphide, forming a dilute sulphuric acid.

The short-to-medium term role for this LS would be limited to serving only the Lockport gravity sewer system and limited LPS contributions from the district between Lockport and Church Road. Significant volumes of LPS effluent must be conveyed to treatment via a purpose-built station like that at Donald Road, which was designed and built specifically to deal with the challenges of septic effluent. Such a larger station would also be able to replace the Lockport station, as there is an advantage in not having multiple lift stations in the community.

4.2 DONALD ROAD SUB CATCHMENT SEWER SYSTEM

The construction of the lift station, forcemains and associated low pressure sewer mains was completed in 2015.

4.2.1 COLLECTION SYSTEM

The collection system consists of low pressure sewer mains ranging in size from 75mm to 200mm diameter. The pipe is high density polyethylene (HDPE).

4.2.2 LIFT STATION & FORCEMAINS

The Donald Road station is a relatively complex facility. The wetwell can accommodate three pumps; two Flygt NP3202HT465 pumps with 70hp 3Ø motors are currently installed, with a third unit to be installed when demand increases sufficiently. Each pump has a capacity of 55 L/s at 54m TDH when operating through a 200mm forcemain. There are two 200mm forcemains, although one is currently not connected to a discharge point at the Lockport end. While two pumps are installed, one is considered a duty pump while the other is a standby unit, with 55 L/s firm capacity. When the third pump is installed and the second forcemain is connected, it will allow two pumps to function in duty mode, for a firm capacity of 110 L/s.

It should be noted that at 54m TDH, the forcemain system is operating at a very high pressure in the context of municipal sewer forcemains. Most water distribution systems operate a lower pressure than this. The consequence is that the extremely high operating pressures are sufficient only to convey wastewater to Lockport. It is not possible to upsize the pumps even further to convey the wastewater all the way to the treatment facility at East Selkirk.

4.3 CONCLUSIONS RESPECTING THE LIFT STATIONS

4.3.1 LOCKPORT LS

The existing Lockport station cannot be used in its present form to convey large quantities of LPS effluent as it was not designed to be compatible with the aggressive, corrosive, odourous nature of LPS wastewater. The existing pumps do not generate enough head to overcome the significant pressures generated by the Donald Road LS pumps, if both stations discharge into a common 300mm forcemain to East Selkirk.

4.3.2 DONALD ROAD LOCKPORT LS

Because its pumps are already high head units, the existing Donald Road station cannot be upgraded with the even higher pressure pumps needed to convey the medium-to-long term peak wastewater volumes through a significantly longer forcemain to East Selkirk. Even if the forcemain extension northward is larger diameter pipe, to minimise additional head losses, would require pumps of at least 150hp, generating pressures exceeding 1000kPa, which is more than the existing forcemains were designed to withstand. However, these pumps can be used for the short term, to convey Donald catchment area wastewaters directly to East Selkirk through an extended forcemain to East Selkirk, as detailed below.

4.4 MEDIUM—TO-LONG TERM PUMPING STRATEGY

While some short-term implementation strategies may be developed to convey HCA and Lockport effluent to East Selkirk, the medium-to-long term solution will involve new facilities. As noted in Sec 2.2, the long-term peak wastewater flows for the Lockport and Donald Road subcatchment areas have been estimated to be 22.5 L/s and 82.5 L/s respectively, for a total 105 L/s. However, because the Donald Road station can deliver at significantly higher rates to Lockport (110 L/s) it is suggested that if a single facility is built, it should have a capacity equivalent to at least 125 L/s, and the Donald Road station could be throttled back somewhat to more nearly match anticipated peak inflows from its catchment area.

It is always prudent to conceive an even longer-term future, such that there is a strategy in place to deal with the potential need to increase the regional system capacity beyond the 125 L/s target. As such, any new regional LS should be designed to allow installation of pumps at least one size larger than the forecast long-term needs, say a target of 150 L/s.

4.4.1 REGIONAL PUMPING STATION

As noted above, a 125 L/s long-term flow has been established as the long-term target, with the ability to stretch to 150 L/s if needed eventually. Since neither the Lockport nor Donald Road stations will be able to convey effluent all the way to East Selkirk, it makes sense that all wastewaters be collected in a new regional Lockport LS.

This could be configured in a way that the existing Lockport and Donald Road LSs simply discharge into the new regional station. There is no choice for the Donald Road LS FM but for the Lockport subcatchment, there will be an opportunity to simply extend the gravity sewers to the new regional LS, allowing the existing Lockport LS to be abandoned and decommissioned.

The new regional station would ideally be located somewhere toward the eastern edge of the community, adjacent to the Floodway. This will facilitate a forcemain route across the Floodway and northward to East Selkirk. It will also mitigate against any odour issues, being farther away (and generally downwind) of commercial and residential development. The configuration and conceptual design of the new regional LS will be described in a subsequent section of this report.

4.4.2 REGIONAL (LOCKPORT TO EAST SELKIRK) FORCEMAIN SYSTEM

It is prudent that the twin forcemain concept implemented for the Donald Road system, will be extended for the Lockport-East Selkirk system, as this will help maintain scour velocities in the piping over the relatively long distance to East Selkirk. Preliminary calculations indicate that two 300mm forcemains will be required. As the forcemains are expected to be HDPE DR17 pipe, the effective inside diameter will be 275mm. It is possible that initially, there will be only one FM constructed for the short term, with the second constructed later for the medium-to-longer term. The configuration and conceptual design of the new regional FM system will be described later in this report.

4.5 INTERIM SHORT-TERM STRATEGY

It may be financially desirable to construct a new regional LS-FM system for long-term needs, in stages. It is possible to devise a strategy whereby short-term needs are addressed without an all-new LS, or with only one of the longer-term twin forcemains.

4.5.1 LOCKPORT LS SHORT-TERM STRATEGY

The existing lift station can accommodate larger pumps that could convey short-term flows through a new single forcemain to East Selkirk. It would require much more powerful pumps, and an upgrade to 3Ø electrical power. There will also be some potential operating problems in that such pumps will not be sufficient to create a scour velocity in a forcemain system designed to handle large long-term flows to East Selkirk. Alternatively, both forcemains for the long-term twin forcemain system could be constructed in the first phase with one connected to the Lockport LS and the other to the existing in-service FM from the Donald Road LS. They cannot be interconnected because of incompatible pump characteristics between the Lockport and Donald Road stations. These options will be described further in subsequent sections.

4.5.2 DONALD ROAD LS SHORT-TERM STRATEGY

The existing pumps are as large (in terms of operating pressure) as they can be, and they cannot convey 82.5 L/s flows over the extended distance to East Selkirk. However, they currently are only operating a few hours per month, and they do have the potential to convey at least 20 L/s, enough for some 250 existing dwellings, directly through the proposed forcemain to East Selkirk. This could allow several years to pass before a large regional station is built. This concept will be explored further in subsequent sections.

5 WASTEWATER CONVEYANCE SCHEMES

5.1 LONG-TERM SCENARIO

As described previously, it is anticipated that the peak wastewater loading from the Lockport catchment will be 22.5 L/s and from Donald catchment 82.5 L/s, for a total 105 L/s. A design target of 125 L/s has been suggested to allow for both a margin of safety and for the fact that the existing Donald Road pumping station will deliver 110 L/s when the second existing 200mm forcemain is put into service.

5.1.1 NEW REGIONAL LIFT STATION

A new regional pumping facility will be required in the medium-to-long term. It must convey both LPS from rural districts as well as conventional ("gravity") wastewaters from Lockport, meaning solids handling and scour velocities must be considered.

Calculations indicate that two 85hp Flygt NP3301HT464 pumps will convey the design target of 125 L/s through a pair of 300mm HDPE forcemains. Each pump would convey 62.5 L/s at 46m TDH, with a velocity of just over 1 m/s (metre per second), which exceeds the minimum 0.6 m/s required to maintain wastewater solids in suspension. The station will be designed for three pumps, like Donald Road LS. The third pump will maintain redundancy (backup) when the collection system's growth generates inflows approaching 60 L/s, which condition would require two pumps to run through two forcemains.

The station location will be along PTH #44 east of Lockport, on the west side of the Floodway. It would be best located on the north side of PTH #44 to avoid additional highway crossings, but if there are specific requirements imposed by Manitoba Infrastructure or by geotechnical conditions, the station could be on either side of the highway.

The general station configuration will follow that of the Donald Road station, with a prefabricated FRP wetwell housing the submersible sewage pumps. It is suggested that the costly ($0.75M) control building as constructed at Donald Road be either deferred or eliminated altogether. The check and shut-off valves can be accommodated within the wetwell. A small building could be provided for electrical panels if the Municipality wishes, or to save cost, the panels may be externally mounted. A standby generator is recommended to ensure operation during Hydro service disruptions.

The complex odour control system implemented at Donald Road LS may not be needed if the new regional station is located sufficiently far away from residences and businesses. It is helpful that prevailing north, west and south winds will tend to disperse odours in favourable directions. If system operation suggests that odour control is needed, it may be added at a later stage to defer costs. A cost-effective Unisorb activated carbon-based system may be considered, in place of the chemical injection used at Donald Road.

5.1.2 NEW REGIONAL FORCEMAIN

The new regional forcemain system will consist of two 300mm HDPE pipelines. The length of each forcemain will be about 7500m, depending upon the exact route and alignment which is ultimately selected. The effective equivalent length for hydraulics design purposes will be about 8000m, to allow for head losses within lift station piping systems. It is assumed at this point that the forcemain route will follow PTH #44 east from Lockport to the CEMR right-of-way, then northward on an easement on the CEMR RoW, then west on PR #212 to the East Selkirk wastewater treatment facility. The forcemains would be primarily installed by directional drilling to address potential impacts on rail bed stability and minimise restoration costs. It would also be mandated by Manitoba Infrastructure to avoid any damage to or threats to the integrity of the Floodway. The forcemains will extend into the existing aerated primary cell, with capped tees provided as needed to allow for future connections to a new primary cell.

5.2 MEDIUM-TERM SCENARIO

As previously discussed, there is a medium term scenario whereby initially, the new regional lift station would incorporate two pumps (one duty, one standby), and only one forcemain would be operational.

5.2.1 FORCEMAIN SCENARIOS

Until the regional peak wastewater flows approach 60 L/s, only one 300mm forcemain would be needed by the new regional LS. However, due to the challenges of tunneling under the Floodway, it would be prudent to install both forcemains under that facility in the first stage. The challenges include the width of approximately 400m requiring horizontal boreholes which approach the usual limits of such shots, high groundwater and possible challenging stony ground conditions. Staff from MI met with the project team on Oct 2 and they will attempt to provide the geotechnical data from the former Floodway Authority. A testhole drilled by Trek for the 200mm Donald forcemain northwest of the intersection of the Floodway and PTH #44, suggests that the soil conditions may not be too challenging in the area, but that remains to be confirmed when the current project enters the predesign stage.

It will also be prudent to consider bringing both forcemains into the primary wastewater treatment cell, as that type of work is particularly messy and is best done only once if possible. It may be considered acceptable to join both 300mm pipes into just one entering the cell. Upsizing a “joint” pipe to 350mm to minimise head loss is possible but a 400mm pipe is not advisable as the wastewater velocity in that pipe would be less than scour velocity.

5.3 SHORT-TERM SCENARIO #1

It is theoretically possible that in the short term, the existing Donald Road LS and the Lockport LS (with upsized high-head pumps) could discharge into a single 300mm regional forcemain before the new regional lift station is built. The following section deals with the way that could be done.

5.3.1 DONALD ROAD LS OPERATING ALONE

The high head characteristics of the Donald Road LS pumps lend themselves well to conveying wastewater to East Selkirk, but with limits. The net lift (elevation difference) between the normal pumping level of the Donald Road LS (236m MSL) to the East Selkirk primary cell operating level (228.8m MSL) is only about three metres. The head losses through the one operating 200mm FM from Donald to Lockport, plus anticipated head losses in the proposed 300mm FM from Lockport to East Selkirk, combined with the 70hp Donald Road pump characteristics, will allow just over 25 L/s to be conveyed, adequate for about 325 connections. However, it is necessary to consider the impact of the Lockport LS running at the same time, meaning the capacity of the 300mm pipe must be shared between two stations.

5.3.2 UPGRADED LOCKPORT LS OPERATING WITH DONALD ROAD LS

The high head characteristics of the Donald station, combined with the low head performance of the existing Lockport LS pumps, would result in a totally incompatible operation if they are joined to a single forcemain. However, if the Lockport LS is upgraded with 30hp NP3171HT454 high head pumps, that station could discharge about 35 L/s simultaneously while the Donald Road LS discharges about 20 L/s. These pumps are physically larger than the existing pumps, requiring major upgrading inside the station to allow them to be accommodated. They will also require a new 3Ø 600V Hydro service, electrical panel and cabling. A preliminary budget for this work is $300,000.

5.3.3 UPGRADED LOCKPORT LS OPERATING ALONE

The above-mentioned high head pumps would allow the Lockport LS to discharge about 50 L/s if operating on its own. It should be noted that for determination of the population that may be served by these pumps, it is necessary to assume that from time to time, both lift stations will be discharging simultaneously, so the condition suggested in Sec 4.3.2 is the scenario which will govern.

5.3.4 CAPACITY LIMITS OF SHORT-TERM SCENARIO

The above-mentioned scenario of upgrading the existing Lockport LS and connecting both it and the 200mm Donald Road forcemain to a new 300mm forcemain to convey wastewater to East Selkirk, will allow 35 L/s pumping from Lockport simultaneously with 20 L/s pumping from the Donald Road LS. This will support all 418 existing and proposed dwelling units in the Lockport subcatchment area and about 250 dwelling units in the Donald Road subcatchment. When that number of connections is exceeded, the capacity of the short-term interim system will be exceeded.

Another potential limitation in this scenario might have been the potential for flow velocities in the new 300mm forcemain to be below the 0.6 m/s minimum required for scour, to prevent solids deposition. At a combined 55 L/s (both lift stations operating simultaneously) the wastewater velocity will be 0.85 m/s, and with Lockport running alone, 0.79 m/s. While these look adequate, there is still a potential challenge in that the volume of the forcemain is about 450m^3, whereas the volume of the sump in the Lockport LS is only about 7m^3. About 65 pumping cycles will be required to displace the entire wastewater volume contained within the 300mm forcemain. This scenario is not unusual for long forcemains. The solids which settle out in the pipe between pumping cycles should be resuspended when the pumps start again. In the long term, the construction of the new regional lift station will tend to address the situation, as it will have a much larger sump and the volumes of LPS effluent from the Donald subcatchment will dilute the solids-carrying wastewater from the Lockport gravity sewers.

5.3.5 VALUE LIMITATIONS OF SHORT-TERM SCENARIO

The above-mentioned scenario will require upgrading of the 10hp Lockport pumps to high head 30hp units, complete with an all-new 3Ø Hydro service, electrical panel and wiring. The cost will be in the order of $300,000. This investment will be lost as soon as the number of connected dwelling units in the Donald Road subcatchment exceeds 250, as that will require construction of the new regional LS. It will have to be determined by the Municipality whether a $300,000 investment which will have only a few years of value, is worth considering, when weighed against the $1M+ cost of the regional lift station which will be required in the medium-term once over 250 dwellings are connected in the Donald subcatchment area.

5.4 SHORT TERM SCENARIO #2

Since it may not be attractive to consider a $300,000 upgrading to a lift station which will be redundant in a few years, there is another possible strategy, as follows.

5.4.1 RETAIN LOCKPORT WWTP & CONVEY DONALD WW TO EAST SELKIRK

In the short term, we know that the Donald Road station can convey wastewater from its subcatchment through a new 300mm forcemain to East Selkirk. We also know that the only way that the Lockport LS could use that same FM would be to upgrade it with new high-head pumps, electrical, etc., at considerable cost, with no long term value. A possible solution would be to continue to use the Lockport treatment plant for the Lockport subcatchment area while the Donald Road subcatchment would be diverted to East Selkirk. The drawback is having to continue operation of the plant for a few more years.

5.5 SHORT TERM SCENARIO #3

Another potential short term strategy would involve building both new 300mm forcemains to East Selkirk, and dedicating one to the Donald Road subcatchment and the other to Lockport.

5.5.1 TWIN FORCEMAINS DEDICATED TO EACH SUBCATCHMENT LS

The primary challenge of connecting both the Lockport and Donald Road lift stations to one forcemain, is the need for the Lockport facility to be upgraded at significant cost, with no long term residual value once the new regional station is constructed. One way that could be mitigated is to construct both 300mm forcemains to East Selkirk, in the first phase of the project. One forcemain would connect to the operational 200mm forcemain from the Donald Road LS. If that is done, the Donald LS will be able to pump 25 L/s, under the same pump/pipe scenario noted in Sec 4.3.1. This would be compatible with serving about 300 dwelling units over and above the 20 currently connected.

If both forcemains are constructed and one is dedicated to the existing Lockport LS, the existing pumps could convey a flow rate of about 18 L/s through that dedicated 300mm forcemain to East Selkirk. The available capacity of 18 L/s should be able to handle the 13.7 L/s peak flows from the 182 existing dwellings, and perhaps another 35-40 connections additional connections in the Lockport subcatchment service area.

One drawback is that there will not be a minimum 0.6 m/s scour velocity achieved in the Lockport forcemain. At 0.2-0.3 m/s velocity, solids will tend to settle out. Forcemain swabbing will be needed when the regional lift station is built, in order that accumulated solids can be cleaned out. The new station will maintain scour velocities once it is operational.

5.6 SHORT-TERM IMPLEMENTATION STRATEGY

Based upon the foregoing, it seems best to implement scenario #3. Constructing two 300mm forcemains, one being connected to each of the existing lift stations, should allow 25 L/s flow rates from the Donald Road LS and 18 L/s from the Lockport LS, using existing pumps. This provides for a modest amount of short-term growth without having to invest in significant LS upgrading at Lockport, which would be lost in a few years when the regional station is built. It also allows for the immediate abandonment of the Lockport WWTP, and conveyance of existing HCA wastewaters to the East Selkirk facility which has capacity to assimilate that additional loading.

5.7 OPINION OF PROBABLE COSTS OF CONVEYANCE SCHEMES

Budgets have been prepared for implementation of the short and long-term conveyance scenarios. Unit prices are based upon recent tenders, adjusted for anticipated 2018 economic conditions.

5.7.1 *FORCEMAIN – SHORT-TERM, SINGLE 300Ø LINE*

The preliminary opinion of the probable cost of constructing a single 300mm forcemain from Lockport to East Selkirk is as follows:

Work Item	Units	Estimated Quantity	Unit Price - $	Total - $
Forcemain, 300mm Ø	Lin. metres	7000	150.00	$1,050,000
Forcemain, 300mm Ø, across G W Floodway	Lin. metres	400	300.00	120,000
Liner (casing) pipes across roads under MI jurisdiction	Each	3	15,000.00	45,000
Liner (casing) pipe across railway	Each	1	15,000.00	15,000
Shutoff valves	Each	8	8,000.00	64,000
Automatic air releases	Each	2	10,000.00	20,000
Manual air releases	Each	4	2,500.00	10,000
Flushouts complete with valves	Each	3	20,000.00	60,000
Allowance for piping connections	Lump Sum			25,000
SUBTOTAL				$1,409,000
Engineering design, submissions, contract admin -10%				140,000
Contingencies - 15%				210,000
Interim financing & project administration - 3%				42,000
TOTAL				$1,801,000

5.7.2 FORCEMAIN – TWIN 300Ø LINES

The preliminary opinion of the probable cost of constructing both forcemains to East Selkirk at the same time is as follows:

Work Item	Units	Estimated Quantity	Unit Price - $	Total - $
Forcemain, 300mm Ø	Lin. metres	14,000	130.00	$1,820,000
Forcemain, 300mm Ø, across G W Floodway	Lin. metres	800	300.00	240,000
Liner (casing) pipes across roads under MI jurisdiction	Each	6	15,000.00	90,000
Liner (casing) pipe across railway	Each	2	15,000.00	30,000
Shutoff valves	Each	16	8,000.00	128,000
Automatic air releases	Each	4	10,000.00	40,000
Manual air releases	Each	8	2,500.00	20,000
Flushouts complete with valves	Each	6	20,000.00	120,000
Allowance for piping connections	Lump Sum			25,000
SUBTOTAL				$2,513,000
Engineering design, submissions, contract admin -10%				250,000
Contingencies - 15%				375,000
Interim financing & project administration - 3%				75,000
TOTAL				$3,213,000

5.7.3 LOCKPORT LS – SHORT-TERM UPGRADING

The preliminary opinion of the probable cost of upgrading the lift station to be able to share with the Donald Road LS a single forcemain to East Selkirk is as follows:

Work Item	Units	Estimated Quantity	Unit Price - $	Total - $
Lift station structural renovations	Lump Sum			$10,000
Pump supply (2 x 30hp, NP3171HT454)	Lump Sum			60,000
Installation with piping, valves, discharge elbows, etc	Lump Sum			60,000
Electrical including new electrical panel & controls	Lump Sum			60,000
Miscellaneous	Lump Sum			10,000
Allowance for Hydro service upgrade (3Ø 600V)	Lump Sum			25,000
SUBTOTAL				$225,000
Engineering design, submissions, contract admin -15%				33,000
Contingencies - 15%				33,000
Interim financing & project administration - 3%				9,000
TOTAL				$300,000

This alternative is unattractive as the capacity of the upgraded station will be exceeded within a few years and there will be no residual value left, as it will need to be abandoned and replaced by a new regional lift station.

5.7.4 REGIONAL LS – MEDIUM-TO-LONG TERM

The preliminary opinion of the probable cost of constructing a new regional lift station at Lockport is as follows:

Work Item	Units	Estimated Quantity	Unit Price - $	Total - $
Lift station supply (prefab, three pumps, electrical)	Lump Sum			$400,000
Standby generator	Lump Sum			150,000
Station installation (civil, mechanical, electrical)	Lump Sum			350,000
Extend gravity sewer, 250mm Ø, 5-6m deep	Lin. metres	300	300.00	90,000
Manholes	Each	3	15,000.00	45,000
Allowance for Manitoba Hydro service (3Ø, 600V)	Lump Sum			30,000
SUBTOTAL				$1.065,000
Engineering design, submissions, contract admin -10%				106,000
Contingencies - 15%				159,000
Interim financing & project administration - 3%				32,000
TOTAL				$1,362,000

5.8 SUMMARY OF SHORT- AND LONG-TERM SCENARIOS FOR CONVEYANCE SCHEMES

5.8.1 *MEDIUM–TO-LONG TERM SCENARIO*

The preliminary opinion of the probable cost of constructing a regional lift station and forcemain system to the East Selkirk wastewater treatment facility is as follows:

Work Item	Units	Estimated Quantity	Unit Price - $	Total - $
Twin 300mm forcemains				$3,213,000
Regional Lift Station				1,362,000
Optional future control building (odour control etc)				350,000
TOTAL				$4,925,000

5.8.2 *RECOMMENDED INTERIM SCENARIO #1: SHORT-TERM*

The preliminary opinion of the probable cost of constructing a twin forcemain to East Selkirk is $3,213,000. This will allow both existing lift stations to serve existing connections without any upgrading, while allowing modest short-term growth in the catchment areas. This scenario imposes no "throw-away" costs, unlike the following alternative.

5.8.3 *ALTERNATIVE INTERIM SCENARIO #2: SHORT-TERM*

The preliminary opinion of the probable cost of constructing a single forcemain to East Selkirk and upgrading the Lockport lift station to operate with the Donald Road LS through that single FM is as follows:

Work Item	Units	Estimated Quantity	Unit Price - $	Total - $
Single 300mm forcemain				$1,801,000
Lockport LS upgrading				300,000
TOTAL				$2,103,000

This is not recommended as the $300,000 lift station upgrade will be abandoned when the regional LS is built, at which point the Lockport LS will have no long-term value.

5.8.4 ALTERNATIVE INTERIM SCENARIO #3: SHORT-TERM

The single forcemain can be constructed ($1,801,000) to serve only the Donald Road LS while the Lockport lift station and treatment plant would continue in operation for the short-term. This imposes no throw-away costs but has the disadvantage of having to operate the plant for several more years.

6 WASTEWATER TREATMENT SCHEMES

6.1 SHORT TO MEDIUM TERM SCENARIO

As previously described in Section 2.5, the current organic loading capacity for the East Selkirk WWTL is 216.3 kg-BOD_5/day and the storage capacity of the secondary cells is 211,500 m^3.

6.1.1 ORGANIC CAPACITY

The licensed organic loading limit of 216.3 kg-BOD_5/day will allow additional 750 dwelling connections (approx.) to the East Selkirk WWTL before needing an alteration of the EAL. As mentioned earlier, the BOD_5 from the truck-hauling is expected to be reduced by up to 75% of its current level (from 67.5 kg-BOD_5/day to 16.9 kg-BOD_5/day) as the RM of St. Andrews and the HCA stop contributing their truck-hauled wastewater to East Selkirk. The number of additional connections will vary depending on the actual amount of reduction of truck-hauled wastewater and it would be prudent for the RM to continue to document the location, amount and type of truck-hauled wastewater.

Other than applying for an alteration of the EAL, no changes will be necessary to the aeration system within the existing two primary cells as it will be able to treat up to 250 kg-BOD_5/day, which will provide the RM the capacity to connect over 900 dwellings. At this point, the limiting factor would then become the storage capacity of the secondary cells.

6.1.2 STORAGE CAPACITY

The East Selkirk WWTL is currently underutilized, using only 26% of its total storage capacity of 211,500 m^3. Thus, the lagoon has the capacity to add approximately 850 dwelling connections, after which additional storage will need to be constructed or significant modifications to the existing treatment system will need to be completed.

6.1.3 PHOSPHORUS TREATMENT

The current lagoon operates with a chemical dosing system, whereby alum is added to the wastewater between the primary cells and the secondary cells in a series of mixing chambers. This system was designed for the maximum operating capacity of the lagoon, thus should not need any modifications to the process to continue to treat for phosphorus.

Recently, there have been few communities constructing tertiary wetland cells as opposed to utilizing chemical dosing for phosphorus reduction. This method of phosphorus treatment may be considered for the East Selkirk WWTL as well, though it will require significant land acquisition as well as potentially redesigning how the lagoon currently discharges.

Generally, a wetland cell is designed to reduce phosphorus at a rate of 1 kg/ha.day. For the East Selkirk WWTL, when operating at maximum capacity, will have a hydraulic loading of approximately 932 m^3/day and the total phosphorus concentration of the wastewater is assumed to be 6 mg/L (though this can be refined and confirmed through more testing of the total phosphorus levels in the primary cells).

The following was used to determine the size of the wetland treatment area:

— Total phosphorus input = 6 mg/L
— Hydraulic loading = 932 m^3/day or 340,180 m^3/yr
— Number of treatment days (June 15 – November 1) = 138 days
— Annual phosphorus loading rate (6 mg/L * 340,180 m^3/yr) = 2,041 kg/yr
— Phosphorus removal rate = 1 kg/ha.day
— Treatment area needed: (2041 kg/yr) ÷ (138 days x 1kg/ha.day) = 14.8 ha (36.6 acres)

Taking into account the dykes around the perimeter of the wetland cell, the total footprint would be approximately 17 ha (42 acres). To put that in perspective, the current lagoon footprint is approximately 13.1 ha. To construct such a large wetland would require the RM to acquire the land to the south or east of the lagoon as the remaining land within the property boundaries would not be enough for a wetland cell of this size. Modifications to the lagoon discharge process will also have to be implemented.

6.2 LONG TERM SCENARIOS

Once the East Selkirk WWTL reaches its current storage capacity, there will be a need to expand to accommodate the total 2,000 dwellings in the HCA as well as any additional growth to the community of East Selkirk. From Section 2.6, the lagoon will need to be constructed with additional aeration to treat up to 562 kg-BOD_5/day and be able to store 440,000 m^3. This would effectively more than double the size of the current lagoon. As an alternative, the existing lagoon may be modified with SAGR (Submerged Attached Growth Reactors) units to allow for continuous discharge into the Red River, thus eliminating the need for storage.

6.2.1 ADDITIONAL AERATED AND STORAGE CELLS

The existing East Selkirk WWTL can be expanded with an additional aeration cell as well as one or two new storage cells. The project overview for the expansion is as follows:

— Retain the existing two primary aerations cells, with additional aeration
— Construct a new 3rd primary aeration cell, directly east of the 2nd primary cell
— Expand the existing blower building to accommodate additional blowers
— Construct one new large or two new equally sized storage cells with aeration, similar to the existing two storage cells
— Upgrade the pumps for the chemical dosing system for phosphorus removal

The new aerated primary cell will be larger than one of the existing primary cells, but smaller than the footprint of both existing primary cells combined. There will need to be a reconfiguration of the piping infrastructure that conveys the wastewater from the primary cells to the storage cells, as well as the chemical dosing infrastructure, though this will not be difficult to achieve. The new storage cell(s) will have a larger footprint than the existing two storage cells, thus available land may become an issue. The RM will most likely need to acquire land to the south or east of the existing lagoon property to allow for the construction of the new storage cell(s). Also, the existing southeastern portion of the lagoon property is known to have contaminated soils that may need remediation prior to any construction.

6.2.2 CONTINUOUS DISCHARGE WITH SAGR

Another option for the expansion of the existing East Selkirk WWTL can be a conversion to a continuous discharge with SAGRs. The project overview for the expansion is as follows:

— Retain the existing two primary aeration cells, with additional aeration
— Covert the 3rd cell (1st existing storage cell), to a partial mix aeration cell, similar to the primary aeration cells
— Keep the 4th cell (2nd existing storage cell) as is
— Construct a dual-cell aerated SAGR for nitrification, BOD_5, and TSS polishing following the lagoon system
— UV disinfection after the SAGR units
— Expand the existing blower building to accommodate additional blowers
— Construct a pipeline (and possible lift station) from the lagoon to the Red River for continuous discharge
— Upgrade the pumps for the chemical dosing system for phosphorus removal

A continuous discharge lagoon system is preferable from a land availability standpoint, as the previous long term option will require significant additional land. With the Red River within 800m of the site, it would be a short distance to construct a pipeline to the river to allow year-round discharging of the lagoon. The SAGR system has been implemented for use in continuously discharging lagoons in Manitoba, with little to no issues meeting Provincial and Federal effluent requirements. UV disinfection may also be necessary to complete the treatment process, although it has been demonstrated at other sites that not all SAGR systems require UV disinfection. This process will be situated after the SAGR units. The need for UV disinfection will have to be determined through further studying of this scenario. Chemical dosing will still be necessary to reduce the total phosphorus levels, though a chemical filtration system similar to what was installed for the Lorette WWTL in 2017 may also be considered for phosphorus treatment.

6.3 OPINION OF PROBABLE COSTS WASTEWATER TREATMENT SCHEMES

Budgets have been prepared for implementation of the short to medium term and long-term wastewater treatment scenarios. Unit prices are based upon recent tenders, adjusted for anticipated 2018 economic conditions.

6.3.1 SHORT TO MEDIUM TERM SCENARIO

It is anticipated that the RM will not have to make any changes to the existing East Selkirk WWTL in the short to medium term. The lagoon will be able accommodate approximately 850 dwelling connections, depending on the actual reduction in truck-hauled wastewater, until the lagoon has reached its storage capacity of 211,500 m^3.

The only perceived costs going forward will be the on-going operation and maintenance costs, and the costs associated with the supply of alum for phosphorus treatment. There will also be a small cost associated with applying for an alteration to the EAL to increase the allowable kg-BOD_5/day limit imposed within the current EAL once the RM reaches this limit.

6.3.2 LONG TERM SCENARIO #1 – ADDITIONAL AERATION AND STORAGE CELLS

The preliminary opinion of the probable cost of constructing additional aeration and storage cells is as follows:

Work Item	Units	Estimated Quantity	Unit Price - $	Total - $
Topsoil stripping and stockpiling	m^3	25,000	$5.00	$125,000
Excavation and embankment (including clay core)	m^3	110,000	$7.00	$770,000
Installation of piping, valves, etc	Lump Sum			$150,000
Rip rap with geotextile	m^2	25,000	$25.00	$625,000
Perimeter fencing and ditching	Lin.m.	1,500	$40.00	$60,000
Finish grading, topsoil placement and seeding	Lump Sum			$50,000
Electrical and civil upgrades for building	Lump Sum			$150,000
Miscellaneous items	Lump Sum			$150,000

Nexom aeration package (additional aeration, blower building upgrades, etc.)	Lump Sum			$639,000
SUBTOTAL				$2,719,000
Engineering design, submissions, contract admin -15%				$407,850
Contingencies - 15%				$407,850
Interim financing & project administration - 3%				$81,570
TOTAL				$3,616,270*

*This budget does not include any land acquisition costs needed for the expansion scenario.

6.3.3 LONG TERM SCENARIO #2 – CONTINUOUS DISCHARGE WITH SAGR

The preliminary opinion of the probable cost of constructing the SAGR units for continuous discharge is as follows:

Work Item	Units	Estimated Quantity	Unit Price - $	Total - $
SAGR system components (outside of Nexom package)	Lump Sum			$600,000
Installation of piping, valves, etc (at lagoon site)	Lump Sum			$250,000
Lift Station*	Lump Sum			$400,000
Forcemain for continuous discharge*	Lin.m	800	$200.00	$160,000
Electrical and civil upgrades for building	Lump Sum			$150,000
Miscellaneous items	Lump Sum			$150,000
Nexom SAGR package (SAGRs, blower building upgrades, etc.)	Lump Sum			$1,035,000
UV disinfection system	Lump Sum			$250,000
SUBTOTAL				$2,995,000
Engineering design, submissions, contract admin -15%				$449,250
Contingencies - 15%				$449,250
Interim financing & project administration - 3%				$89,850
TOTAL				$3,983,350

*Note: A larger diameter gravity discharge pipe may be considered as an alternative to a LS/FM system.

7 CONCLUSIONS

7.1 WASTEWATER CONVEYANCE SUMMARY AND RECOMMENDATIONS

The pumps in the existing Lockport and Donald Road lift stations have adequate performance characteristics to allow them to convey wastewaters from existing connected dwellings and buildings to the East Selkirk WWTL through two 300mm forcemains. The capacity will allow up to 40 additional dwelling units to be connected at Lockport and 300 more added to the 20 currently served by the Donald Road LS. Any growth beyond that would require the construction of the new regional lift station. It should be noted that due to low wastewater velocities in the forcemain connected to the Lockport LS, solids will tend to settle out. This is not a problem in the longer term as the regional station will achieve the necessary scour velocities when it is built. The preliminary opinion of the probable cost of constructing a regional lift station and forcemain system to the East Selkirk wastewater treatment facility is as follows:

Work Item	Units	Estimated Quantity	Unit Price - $	Total - $
Twin 300mm forcemains				$3,213,000
Regional Lift Station				1,362,000
Optional future control building (odour control etc)				350,000
TOTAL				$4,925,000

As noted, the forcemains would be constructed as a first phase, with the regional LS being built as capacity limits of the existing stations are reached.

7.2 WASTEWATER TREATMENT SUMMARY AND RECOMMENDATIONS

The East Selkirk WWTL currently has the organic and storage capacity to accept up to 850 dwelling connections (approx.) without any modifications to the existing system. This will provide the RM with enough treatment capacity for the short to medium term future and allow the connection of the majority of the existing dwellings within the HCA. Once the lagoon nears its storage capacity, there are two identified long term scenarios that will need to be further studied and considered by the RM.

7.2.1 SUMMARY OF WASTEWATER TREATMENT CAPACITY ASSESSMENT

The following summarizes the short to medium term wastewater milestones:

- At approximately 750 dwelling connections, the East Selkirk WWTL will reach the organic limit in the EAL of 216.3 kg-BOD_5/day.
  - A minor alteration to the EAL will be needed to allow for greater organic loading.
- At approximately 850 dwelling connections, the lagoon is expected to reach the storage capacity of 211,500 m^3.

To accommodate the future needs of the RM, including up to 2000 dwelling connections from the HCA and an additional 280 connections from the community of East Selkirk, the lagoon will need to have capacity to treat approximately 562 kg-BOD_5/day and store up to 440,000 m^3 of wastewater.

7.2.2 SUMMARY OF WASTEWATER TREATMENT SCHEMES AND COSTING

It is anticipated that there will be no significant costs associated with accommodating up to 850 dwelling connections to the East Selkirk WWTL in the short to medium term future.

In the long term, there are two proposed scenarios that were evaluated. The first scenario is an expansion of the existing lagoon, consisting of an additional aeration cell and one or two new storage cells. This scenario will require additional land to the south or east of the lagoon property for the expansion. The second scenario is converting the existing lagoon to a continuous discharge process with two SAGR units for polishing. No additional land requirements are needed for this scenario other than a potential easement for the discharge pipeline.

The summary of the opinion of probable costs for the two long term scenarios are as follows:

Scenario	Total - $
Long term scenario #1 - Additional aeration and storage capacity	$3,616,270*
Long term scenario #2 - Continuous discharge with SAGR	$3,983,350

* Does not include land acquisition costs

7.2.3 LONG TERM PLANNING AND RECOMMENDATIONS

The opinions of probable costs for the two long term scenarios, as summarized in the previous section, are comparatively similar other than the unknown land acquisition costs that may be necessary for the first scenario. Looking from purely a land availability point of view, the continuous discharge scenario would be the recommended approach going forward. The proximity of the Red River makes this option desirable as the cost of installing a discharge pipeline is relatively inexpensive, there is no major expansion needed to the existing lagoon footprint and the use of the SAGR process has been demonstrated to work in Manitoba while producing high quality effluent. Chemical dosing or chemical filtration for phosphorus treatment will still be necessary for this scenario, as continuous discharge is not compatible with a wetland.

If the RM is considering a tertiary wetland cell for phosphorus treatment, then the desirability of the first long term option increases. A wetland cell depends on plant growth which cannot occur in winter. Therefore, it cannot be used in a continuous discharge system, as total phosphorus will need to be removed on a year-round basis as opposed to just within the summer discharge period for a more conventional lagoon system. As discussed in Section 5.1.3, the size of a wetland cell for the current lagoon would be quite large and would require the acquisition of land to construct this proposed wetland cell. At this point, the RM could look at not only the cost of acquiring the land for a wetland cell, but additional land for a future lagoon and/or wetland expansion. Further studying of the feasibility of a wetland cell for phosphorus treatment will be necessary to determine the land requirements and estimated cost of construction.

In due course, the RM will need to determine which alternative better suits their long-term needs. A traditional lagoon expansion scenario may be able to work well with a wetland cell for phosphorus treatment, but will require a significant capital cost for the acquisition of land. While a continuous discharge with SAGRs scenario uniquely suits this location, as the proximity to the Red River and no land acquisition costs allows it to be cost competitive with the more traditional lagoon expansion option. The drawback to this would be the need to continue to use chemicals for phosphorus treatment, which will have on-going costs associated with the supply of alum and the accumulation of the alum sludge within the storage cells over time.

Prior to the lagoon reaching its storage capacity, the RM should undertake a more detailed study regarding the expansion of the lagoon. This may be completed around the same time as when the minor alteration to the EAL will be needed. At that point, the long term lagoon expansion scenarios can be better evaluated as there will be more data available from the lift stations (existing and future), truck-hauled wastewater, and nutrient loading. Ultimately, this more in-depth study on the future expansion of the lagoon system will be needed to fully evaluate the overall lifecycle costs of the different options presented in this report. This future report will provide the RM with the proper analysis needed to determine which options better suit their needs, and will also be able to reflect any changes in environmental licensing as may be implemented.

It may be noted that none of the foregoing envisions any role for the existing Lockport wastewater treatment plant. The East Selkirk treatment system is fully functional and cannot benefit from retention of the Lockport facility. The Lockport plant is maintenance intensive, in terms of labour, power and repairs. Its relatively shallow concrete tankage (treatment basins) are poorly suited for use as a lift station as the new regional station needs to be sufficiently deep to accommodate gravity flows from Lockport's sewer system. Major increases of low pressure sewer inflows would expose the facility to significant corrosion and noxious odours due to the nature of septic tank effluent, with its high concentrations of methane and hydrogen sulphide. It is recommended that when the forcemains are completed to allow the HCA wastewaters to be diverted to East Selkirk, the Lockport plant should be decommissioned, any useful equipment should be salvaged and sold and the structure should be demolished to allow for whatever development the RM should contemplate on what is otherwise an attractive site.

8 LIMITATIONS

WSP's Standard Terms and Conditions for Municipal Infrastructure Reports applies to this report, and a copy is appended to this report.

9 BIBLIOGRAPHY

Dillon Consulting Ltd (2015, July 15). Henderson Highway Sewer System Development Phase 1 Pre-design Report.

APPENDIX

A CONCEPTUAL PLANS

A-1 LOCATION PLAN SHOWING CONCEPTUAL FORCEMAIN ROUTE

wsp
1600 BUFFALO PLACE
WINNIPEG, MANITOBA
CANADA R3T 6B8
PHONE: 204-477-6650 FAX : 204-474-2864
WWW.WSPGROUP.COM

CONSULTANT:

SEAL:

CLIENT:

R.M. OF ST CLEMENTS

CLIENT REF. #: --

PROJECT:

PROPOSED REGIONAL WASTEWATER SYSTEM

KEY PLAN:

ISSUED FOR - REVISION:

IS	RE	DATE	DESCRIPTION
0		2017/10/17	ISSUED FOR REVIEW

PROJECT NO: 171-11066-00
DATE: 2017/10/17
ORIGINAL SCALE: 1:10000
DESIGNED BY: W.H.B.
DRAWN BY: A.L.M.
CHECKED BY: W.H.B./M.P.M.

IF THIS BAR IS NOT 25mm LONG, ADJUST YOUR PLOTTING SCALE.
25mm

DISCIPLINE: CIVIL

TITLE: LOCATION PLAN

SHEET NUMBER: C01

SHEET #: 1 OF 1

ISSUE: ISSUED FOR REVIEW
REV #: 0
DATE OF: 2017/10/17

A-2 NEXOM PROPOSALS FOR LONG TERM WASTEWATER TREATMENT SCENARIOS

Proposal for
Design, Supply and Installation of
OPTAER™ Wastewater Treatment System
October 24, 2017

EAST SELKIRK, MB

technologies for cleaner water

5 Burks Way · Winnipeg MB · R2J 3R8
888·426·8180 • **www.nexom.com**

Project Overview

An OPTAER™ Wastewater Treatment system is proposed for East Selkirk, MB. The proposed system would consist of the following processes and technologies:

- Retain existing partial mix aerated lagoon cells
- Construct one (1) new partial mix aerated cell (by others).
- Implement additional OPTAER ™ fine bubble partial mix aeration in existing cells 1 and 2.
- Implement OPTAER ™ fine bubble partial mix aeration in new cell 3.
- Retain existing chemical dosing after partially mixed cell 2. TP settling into partial mix cell 3
- Retain existing two (2) aerated storage cells
- Construct one (1) aerated storage cell (by others)
- Implement LINEAR aeration in storage cell
- Construct an addition to the existing prefabricated blower building

System Design Parameters

Preliminary design loads, flows, and effluent objectives are presented in the following tables:

		Design Total Influent	Effluent Requirements
Design Flow	m3/day	1,940	
cBOD5	mg/l	290	<25
cBOD5	kg/day	562	
TSS	mg/l	290	<25
TP	mg/l		<1

Approximate cell sizes and retention times are presented in the following table:

Cell	Reactor Type	Water depth (m)	Water volume (m3)	Retention / storagetime (days)
1	Partial Mix- existing	3.66	28,095	14.5
2	Partial Mix- existing	3.66	28,095	14.5
3	Partial Mix - new	3.66	40,041	20.6
1ST	Storage- existing	4.57	105,000	54.1
2ST	Storage- existing	4.57	108,000	55.6
3ST	Storage -new	4.57	230,000	118.6

Aeration design parameters are presented in the following table:

Aeration Design Parameters – OPTAER™ Lagoon Aeration System							
	Cell 1 (PM)	Cell 2 (PM)	Cell 3 (PM)	Cell 1 (ST)	Cell 2 (ST)	Cell 3 (ST)	Totals
Alpha	0.60	0.60	0.60	0.60	0.60	0.60	
Beta	0.95	0.95	0.95	0.95	0.95	0.95	
Theta	1.024	1.024	1.024	1.024	1.024	1.024	
Site elevation (m)	226	226	226	226	226	226	
Min. Dissolved Oxygen (mg/l)	2.0	2.0	2.0	2.0	2.0	2.0	
# HT25 diffusers (Fine Bubble)	75	28	24				127
SCFM per diffuser	12	12	12				
Total SCFM for PM	900	336	288				1,524
# of lines for LINEAR aeration				12	12	18	42
SCFM per line				5.0	5.0	5.0	
Total SCFM for Storage Cell				60	60	90	210

OPTAER™ Process

Partial Mix (PM) Cell

With aerated partial mix cells, the diffuser density is based upon oxygen demand. The OPTAER system does not rely on algae or natural surface aeration for providing oxygen to the wastewater.

The diffusers are suspended near the bottom of the cells. Through the rise of the bubbles and subsequent mixing, convection cells are created between the diffusers. Not only does the water rise with the bubbles, the solids settle out through the downward motion of the water between the diffusers where the circulation loop is completed. This combined with the slow rate of bubble rise contributes to the overall efficiency of the system. Because of low sludge production in the system, retention time is retained for long term BOD5 removal.

When the solids reach the bottom of the lagoon, additional oxygen for biodegradation is provided through the diffusers near the cell bottom. This process results in minimal organic bottom sludge accumulation. Aerobic digestion takes place within the aerated cells at the sludge water interface.

HT-25 Fine Bubble Membrane Diffusers (Partial Mix)

HT-25 fine bubble diffusers are used to provide oxygen to the wastewater. The diffusers consist of an HDPE air distribution body with individual tubular EPDM membranes extending outwards in a horizontal plane. This design prevents bubbles from coalescing, and results in an excellent oxygen transfer rate with minimal head loss.

The diffusers are suspended with a marine grade rope directly under the lateral, at a uniform depth. The rope is attached to the floating header for ease of diffuser retrieval. Each diffuser is attached to a small concrete weight, encased in HDPE pipe. Diffuser assemblies can be retrieved from a boat with no special equipment.

OPTAER™ Header System

A metal manifold and discharge piping are used to dissipate the heat produced by the blowers. Shallow buried HDPE header piping connects to the galvanized steel manifold, and supplies air to the floating laterals. The header has flanged connections for each lateral as shown on the drawings. Each lateral is individually valved for ease of maintenance.

Laterals connect to the shallow buried header, and float on the water surface. With floating laterals, there are no concrete weights required to be in contact with the bottom of the basin. Laterals are secured against wind action with a stainless steel cable system. The cables are fastened to anchors in the berm using a self-adjusting lateral tensioning assembly.

All header and lateral piping, joints, and fittings are thermally fused HDPE. With floating laterals, the cells do not have to be dewatered or taken out of service for system installation or maintenance.

All maintenance can be performed from a boat with a 2-person crew. All header, lateral, and feeder piping is designed to accommodate increased airflow for high pressure and volume cleaning without increasing header friction losses by more than 1 psi. This allows for management of additional organic load, improved diffuser maintenance and additional odor control.

LINEAR Aeration Tubing (Storage Cells)

Excellent oxygen transfer rates and mixing are achieved through the release of air as tiny controlled bubbles through the LINEAR tubing. LINEAR diffuser tubing has a weighted keel to keep the tubing in an upright position at the cell bottom.

The LINEAR diffusion tubing is laid on the bottom of the cell; oxygen is introduced at the sludge water interface. This will result in biodegradation of bottom sludge. Unlike other bottom laid aeration systems, the bubbles produced are so small that they will not roil up the sludge.

The effectiveness of an aeration system is directly related to the contact time between air and water. The LINEAR fine bubble diffuser maximizes this time. The importance of slowly rising bubbles, to mixing and oxygen transfer, becomes greater as water depths decrease. The larger the bubble, the faster it rises. Large bubbles rising quickly are thrown into a large pattern causing eddy currents to develop, and create a turbulent column of water.

Small bubbles rising slower minimize friction and turbulence to create more efficient laminar uplift.

OPTAER™ Blowers

Positive Displacement Blowers

Positive displacement blowers are used to provide air supply for the OPTAER™ treatment system. Blowers are designed to provide the required airflow at normal system operating pressure, and have the capability of operating at the maximum required pressure intermittently for diffuser purging. The blowers are equipped with sound attenuating enclosures.

Positive displacement claw type blowers will provide air for the storage cell. All four blowers are in operation, with no standby. The blowers will each provide 120 SCFM at 10.5 psi, with the ability to operate at 20 psi intermittently for diffuser purging.

Blowers are summarized in the following table:

		Existing Partial Mix Blowers	New Partial Mix Blowers	Existing LINEAR Storage Blowers	New LINEAR Storage Blowers
Number of blower's total		2	1	2	2
Number of blowers on duty		2	0	2	2
Number of blowers on standby		0*	1	0	0
Motor nameplate horsepower	hp	60	60	7.5	7.5
Design airflow per blower	SCFM	762	762	60	60
Normal operating pressure	psi	7.0	7.0	10.5	10.5
Maximum Required Pressure	psi	8.4	8.4	15	15
Actual Power Consumption	bhp	41.5	41.5	5.0	5.0
Actual Sound level	dB(A)	74	74	n/a	n/a

*New Partial Mix blower to provide standby for existing blowers

Operation and Maintenance

The anticipated operation and maintenance costs for the OPTAER system are presented in the following table:

					*Electrical Rate:	**0.08**	$/kW-h
	Quantity	**Hours per day**	**Motor Power bhp**	**Motor Power kW**	**Monthly cost**	**Unit cost**	**Annual Cost**
Aeration Lagoon Blowers	**3**						
Normal Operating Conditions	2	24	41.5	31.0	$3,616	-	$43,392
Filter Change (6 months)	**-**		-	-		$80	$320
Oil Change (12 months)	**-**		-	-		$70	$140
Belt Replacement (24 months)	**-**		-	-		$250	$250
100 DLR- Claw type Blower (LINEAR Aeration)	**4**						
Normal Operating Conditions	4	24	5	3.7	$871	-	$10,456
Oil Change (12 months)						$50	$200
Diffuser Membrane Replacement	**1016**		-	-		$30	$6,096
Life Cycle Annual Alum addition	**TBD**						
Total Operation & Materials							$60,854

* Electrical rate estimated by Nexom Inc

The aeration system will require one operator for approximately 0.5 hour per day for routine inspection & maintenance.

Prefabricated Blower and Chemical Feed Building addition

A 4.57 x 9.2 m (15' x 26') addition to the existing prefabricated steel sandwich panel building will be provided. The panels used for both wall and roof construction have the following characteristics.

- 38mm thick urethane injected panels (R-12 insulation rating)
- Pre-finished painted exterior metal finish
- 28 ga. galvanized steel skin
- Extruded aluminum channels to provide light, rigid frame for panel system

Engineered welded HSS internal frames provide the structural framework for the building, designed as dictated by local building codes and snow loading conditions.

The proposed addition would be constructed on a cast in place concrete slab to match existing.

HVAC Equipment included. Electrical by others.

Budgetary Capital Cost

INCLUDED IN THE OPTAER WASTEWATER TREATMENT SYSTEM CAPITAL COST ARE:

OPTAER LAGOON AERATION SYSTEM:

- Nexom System Process Design (Manitoba P. Eng. Stamped)
    - CAD Drawings (Manitoba P. Eng. Stamped)
- Aeration header piping, feeder piping, diffusers, valves, and fittings as required
- HDPE shallow buried main header piping
- Lateral support hardware and anchors, self-tensioning lateral anchor assemblies
- Two (2) 7.5 hp positive displacement claw type blowers with sound enclosures
- One (1) 60hp positive displacement blower with sound attenuating enclosure
    - Blower control panels
    - Galvanized metal blower header connection (heat dissipation)
- *Equipment installation / start-up/ commissioning/ training*
- Operation and maintenance manuals
- Project Record Drawings

PREFABRICATED BLOWER BUILDING ADDITION

- CAD Drawings and specifications (Manitoba P. Eng stamped)
- One (1) 4.57 x 9.2 m (15’ x 26’) prefabricated steel sandwich panel building addition
    - HVAC Equipment
    - CIP thickened edge concrete floor

BUDGETARY COST FOR THE DESIGN, SUPPLY AND INSTALLATION INSPECTION AS IN THE SCOPE ABOVE:

$639,000 CDN (FOB jobsite, plus applicable taxes)

All prices are subject to final design review.

ITEMS SPECIFICALLY NOT INCLUDED:

- Material offloading and secure on-site storage
- Civil works including Lagoon cell design and construction, liner, transport piping, inter-cell piping, discharge piping, manholes, valves, access roads to site, site roads and landscaping, lagoon desludging etc. if required

- Excavation and backfilling for shallow buried headers
- Building subgrade preparation
- All Electrical work including wiring of blowers and control panels in blower building
- Restoration

Questions or comments?

Any questions or comments can be directed to:

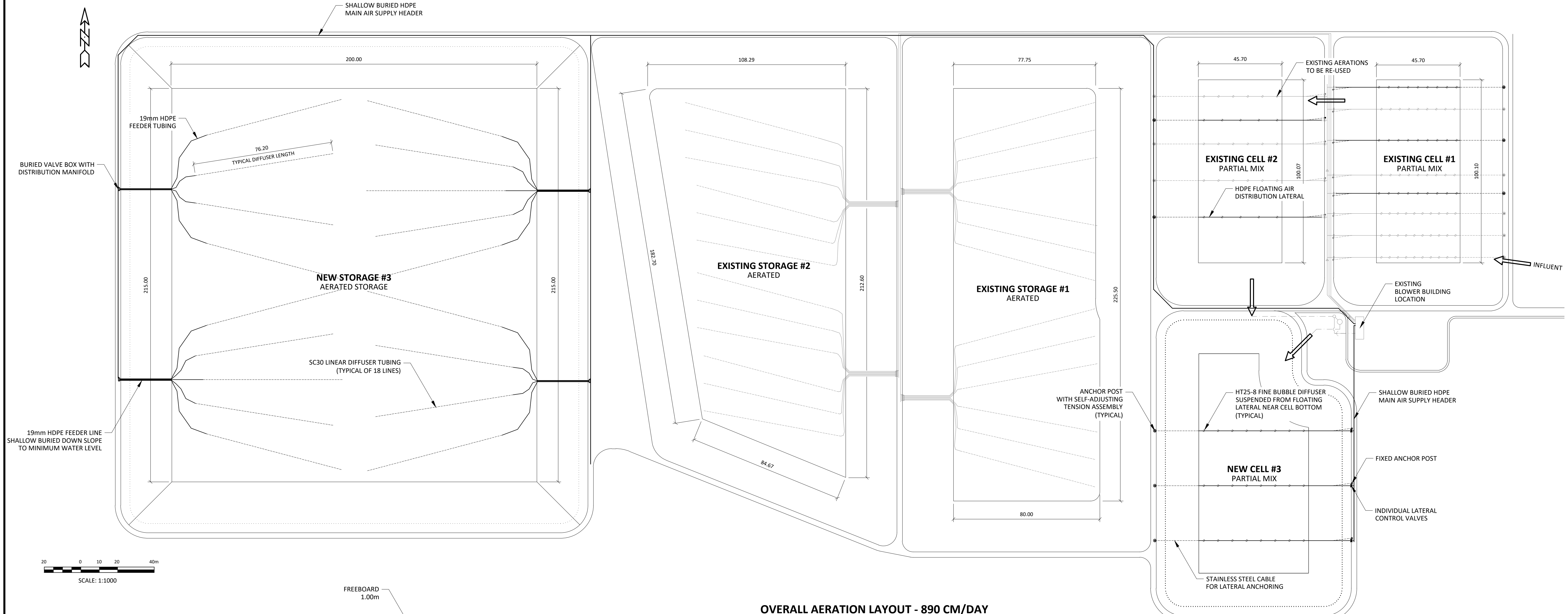
Nexom

5 Burks Way
Winnipeg, Manitoba, Canada
R2J 3R8

888-426-8180
www.nexom.com

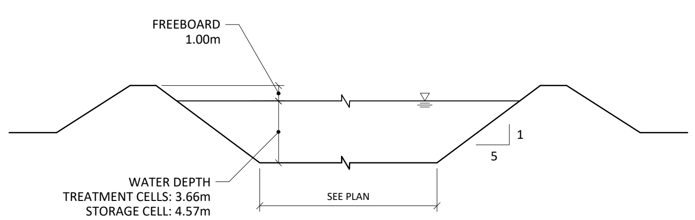
PLOT SIZE: 610mm x 914mm (24" x 36")

REDUCED SIZE PLOT - DO NOT SCALE



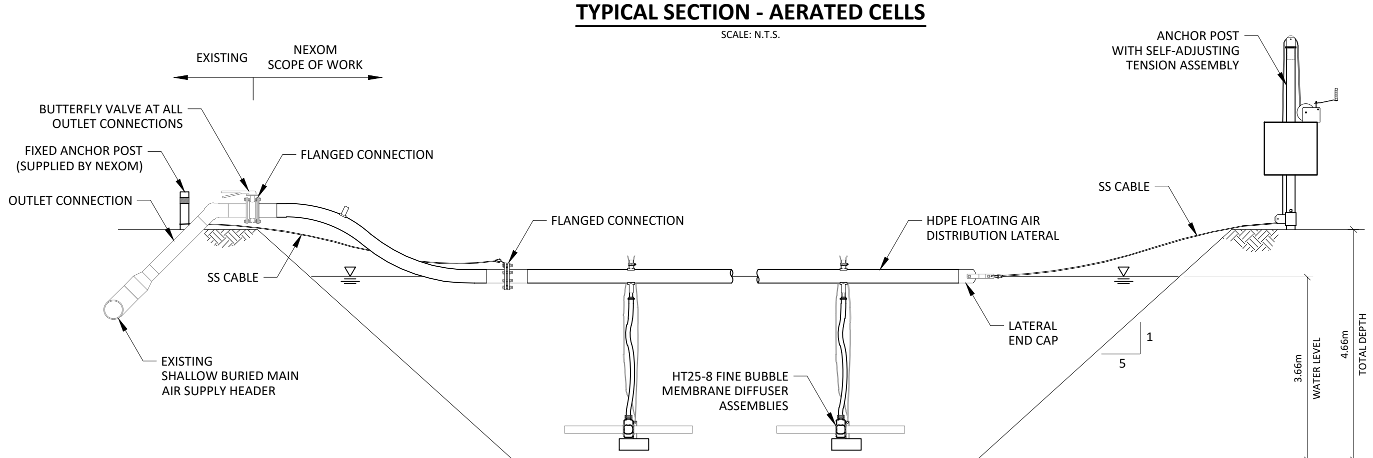
OVERALL AERATION LAYOUT - 890 CM/DAY

SCALE: 1:1000



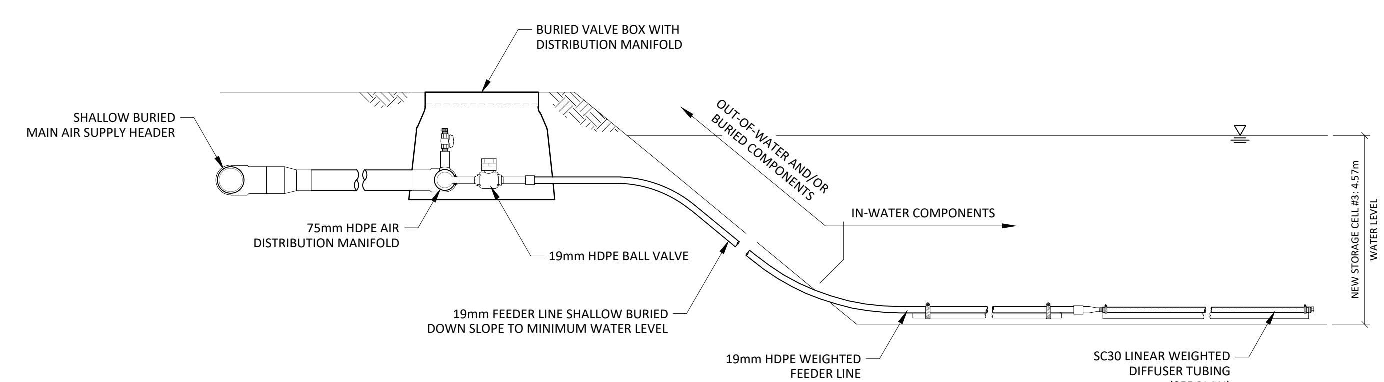
TYPICAL SECTION - AERATED CELLS

SCALE: N.T.S.



AERATED LAGOON SECTION

SCALE: N.T.S.



LINEAR DIFFUSER/FEEDER LINE DETAIL

SCALE: N.T.S.

Nexom
technologies for cleaner water

5 Burks Way
Winnipeg, Manitoba
Canada R2J 3R8
888-426-8180
www.nexom.com

PROJECT:	EAST SELKIRK EXPANSION, MB PROPOSED WASTEWATER TREATMENT SYSTEM
TITLE:	OPTAER SYSTEM AERATION LAYOUT, TYPICAL SECTIONS

DRAWN BY:	APPROVED BY:	SCALE:	DRAWING NO.	SHT.	REV.
AM	MH	AS NOTED	NE01	1 of 1	0
DATE: 2017/10/24	FILE # CD3732.02				

Proposal for
Design, Supply and Installation of
OPTAER™ Wastewater Treatment System
October 24, 2017

EAST SELKIRK, MB

technologies for cleaner water

5 Burks Way · Winnipeg MB · R2J 3R8
888·426·8180 • **www.nexom.com**

Project Overview

An OPTAER™ Wastewater Treatment system is proposed for East Selkirk, MB. The proposed system would consist of the following processes and technologies:

- Retain existing partial mix aerated lagoon cells.
- Implement additional OPTAER ™ fine bubble partial mix aeration in existing cells 1 and 2.
- Remove existing aeration equipment in storage cells 1.
- Implement OPTAER ™ fine bubble partial mix aeration in existing storage cell 1, to create partial mix cell 3.
- Retain existing LINEAR aeration in aerated cell 4 (formerly storage cell 2).
- Retain existing chemical dosing after partially mixed cell 2.
- Implement a dual-cell aerated SAGR® (Horizontal Flow Submerged Attached Growth Reactor) for nitrification (ammonia removal), BOD, and TSS polishing following the lagoon system. The SAGR process will also provide significant reductions in Fecal and Total Coliform.
- Construct an addition to the existing prefabricated blower building
- System would operate in continuous discharge mode.

System Design Parameters

Preliminary design loads, flows, and effluent objectives are presented in the following tables:

		Design Total Influent	Effluent Requirements
Design Flow	m3/day	1,940	
cBOD5	mg/l	290	<25
cBOD5	kg/day	562	
TSS	mg/l	290	<25
TKN	mg/l	58	
Total Ammonia	mg/l		1/5*
Un-unionized Ammonia	mg/l		<0.2**
TP	mg/l		<1

*summer/winter

**meets WSER requirements

Approximate cell sizes and retention times are presented in the following table:

Cell	Reactor Type	Water depth (m)	Water volume (m3)	Retention time (days)
1	Partial Mix	3.66	28,095	14.5
2	Partial Mix	3.66	28,095	14.5
3	Partial Mix	4.57	117,522	60.6
4	Partial Mix	4.57	120,572	62.2
	SAGR	2.3		
	Total		**294,283**	**151.7**

Aeration design parameters are presented in the following table:

Aeration Design Parameters – OPTAER™ Lagoon Aeration System					
	Cell 1 (PM)	Cell 2 (PM)	Cell 3 (PM)	Cell 4 (ST)	Totals
Alpha	0.60	0.60	0.60	0.60	
Beta	0.95	0.95	0.95	0.95	
Theta	1.024	1.024	1.024	1.024	
Site elevation (m)	226	226	226	226	
Min. Dissolved Oxygen (mg/l)	2.0	2.0	2.0	2.0	
# HT25 diffusers (Fine Bubble)	75	28	24		**127**
SCFM per diffuser	12	12	12		
Total SCFM for PM	900	336	288		**1,524**
# of lines for LINEAR aeration				12	**12**
SCFM per line				5.0	
Total SCFM for Storage Cell				60	**60**

SAGR design parameters are presented in the following table:

SAGR Design Parameters	
	Design
Alpha	0.70
Beta	0.95
Theta	1.024
Site elevation (m)	226
SAGR Loading Rate (g BOD/m^2/day)	95.9
SAGR Loading Rate (lbs NH_3/1000 ft^3)	0.615
Min. Dissolved Oxygen (mg/l)	3.0
Total SCFM	944

OPTAER™ Process

Partial Mix (PM) Cell

With aerated partial mix cells, the diffuser density is based upon oxygen demand. The OPTAER system does not rely on algae or natural surface aeration for providing oxygen to the wastewater.

The diffusers are suspended near the bottom of the cells. Through the rise of the bubbles and subsequent mixing, convection cells are created between the diffusers. Not only does the water rise with the bubbles, the solids settle out through the downward motion of the water between the diffusers where the circulation loop is completed. This combined with the slow rate of bubble rise contributes to the overall efficiency of the system. Because of low sludge production in the system, retention time is retained for long term BOD5 removal.

When the solids reach the bottom of the lagoon, additional oxygen for biodegradation is provided through the diffusers near the cell bottom. This process results in minimal organic bottom sludge accumulation. Aerobic digestion takes place within the aerated cells at the sludge water interface.

HT-25 Fine Bubble Membrane Diffusers (Partial Mix)

HT-25 fine bubble diffusers are used to provide oxygen to the wastewater. The diffusers consist of an HDPE air distribution body with individual tubular EPDM membranes extending outwards in a horizontal plane. This design prevents bubbles from coalescing, and results in an excellent oxygen transfer rate with minimal head loss.

The diffusers are suspended with a marine grade rope directly under the lateral, at a uniform depth. The rope is attached to the floating header for ease of diffuser retrieval. Each diffuser is attached to a small concrete weight, encased in HDPE pipe. Diffuser assemblies can be retrieved from a boat with no special equipment.

OPTAER™ Header System

A metal manifold and discharge piping are used to dissipate the heat produced by the blowers. Shallow buried HDPE header piping connects to the galvanized steel manifold, and supplies air to the floating laterals. The header has flanged connections for each lateral as shown on the drawings. Each lateral is individually valved for ease of maintenance.

Laterals connect to the shallow buried header, and float on the water surface. With floating laterals, there are no concrete weights required to be in contact with the bottom of the basin. Laterals are secured against wind action with a stainless steel cable system. The cables are fastened to anchors in the berm using a self-adjusting lateral tensioning assembly. All header and lateral piping, joints, and fittings are thermally fused HDPE. With floating laterals, the cells do not have to be dewatered or taken out of service for system installation or maintenance.

All maintenance can be performed from a boat with a 2-person crew. All header, lateral, and feeder piping is designed to accommodate increased airflow for high pressure and volume cleaning without increasing header friction losses by more than 1 psi. This allows for management of additional organic load, improved diffuser maintenance and additional odor control.

LINEAR Aeration Tubing (Storage Cells)

Excellent oxygen transfer rates and mixing are achieved through the release of air as tiny controlled bubbles through the LINEAR tubing. LINEAR diffuser tubing has a weighted keel to keep the tubing in an upright position at the cell bottom.

The LINEAR diffusion tubing is laid on the bottom of the cell; oxygen is introduced at the sludge water interface. This will result in biodegradation of bottom sludge. Unlike other bottom laid aeration systems, the bubbles produced are so small that they will not roil up the sludge.

The effectiveness of an aeration system is directly related to the contact time between air and water. The LINEAR fine bubble diffuser maximizes this time. The importance of slowly rising bubbles, to mixing and oxygen transfer, becomes greater as water depths decrease. The larger the bubble, the faster it rises. Large bubbles rising quickly are thrown into a large pattern causing eddy currents to develop, and create a turbulent column of water. Small bubbles rising slower minimize friction and turbulence to create more efficient laminar uplift.

OPTAER SAGR Process

Submerged Attached Growth Reactor (SAGR)

The Submerged Attached Growth Reactor (SAGR) is a patented process designed to provide nitrification (ammonia removal) in cold to moderate climates. The SAGR is a clean gravel bed with evenly distributed wastewater flow across the width of the cell, and a horizontal collection chamber at the end of the treatment zone. LINEAR aeration throughout the floor of the SAGR provides aerobic conditions that are required for nitrification. The gravel bed is covered with a layer of wood chips or mulch for insulation.

The following variables need to be considered during nitrification design:

- *Dissolved Oxygen Levels* - Nitrifying bacteria require aerobic conditions. A minimum dissolved oxygen concentration of 3 mg/L must be present for the process to occur.
- *BOD concentration* – Nitrifying bacteria require low BOD concentrations to be effective. Primary BOD removal occurs in the upstream lagoon system. The SAGR provides additional BOD polishing if necessary to reduce BOD concentrations below 25 mg/l.
- *Surface area* - Bacteria require a medium of some form to grow on. High surface area medium allows for higher-density nitrifying bacteria population.
- *Bacteria* - In order to convert ammonia (NH3) to nitrite (NO2-) and ultimately nitrate (NO3-) (nitrification) sufficient quantities of two bacteria are required, Nitrosomonas and Nitrobacter.
- *Alkalinity* - The nitrification process reduces pH levels and consumes alkalinity. In order for nitrification to occur, 7.1 mg of alkalinity must be available for each mg of ammonia removed.
- *Temperature* - Nitrification in a Submerged Attached Growth Reactor occurs at water temperatures as low as 0.5oC. The long sludge age inherent in an attached growth system allows for full nitrification at temperatures where bacterial reproduction is greatly inhibited.
- *pH* - Nitrification is enhanced at higher pH level. pH levels of 7.5 to 8.5 are ideal, although nitrifying bacteria can adapt outside of this range.
- *Aggregate Media* – Locally available aggregate may be used, provided it conforms to the aggregate media requirements specified.
- *Insulating material* – Peat Mulch, woodchips, or shredded rubber tires would be acceptable. Insulating material should conform to the conditions provided.

SAGR LINEAR Aeration System

LINEAR coarse bubble diffusers are used to provide oxygen to the wastewater. Diffuser lines are manufactured from LDPE (Low Density Polyethylene) with reinforced air releases along the tubing. The diffuser tubing is designed for direct burial in the SAGR bed. The diffuser locations have been spaced according to the projected oxygen demand in the SAGR. The design diffuser distribution is critical to ensure that nitrification occurs.

In addition to providing oxygen for nitrification the proposed aeration system brings numerous other long-term performance benefits to this sub-surface flow system.

- Full aeration grid ensures that wastewater channeling cannot occur in the gravel layer (maximize retention time and media contact).
- Sludge digestion in gravel layer is enhanced due to aerobic conditions.
- Year-around odor free operation.

SAGR HDPE Header & Feeder System

High Density Polyethylene (HDPE) laterals run along the top on each side of the SAGR. The laterals are located in the top layer of insulating mulch. All HDPE piping connections and fittings are thermally fused to ensure maximum strength and durability. A shallow buried header connects blowers to the SAGR laterals. HDPE service saddles are thermally fused to the lateral piping for each diffuser line. HDPE drop legs provide air to the individual diffuser lines.

All header and feeder piping is designed to accommodate increased airflow for high pressure and volume cleaning without increasing header friction losses by more than 1 psi. This allows for management of additional organic load, improved diffuser maintenance and additional odor control.

OPTAER™ Blowers

Positive Displacement Blowers

Positive displacement blowers are used to provide air supply for the OPTAER™ treatment system. Blowers are designed to provide the required airflow at normal system operating pressure, and have the capability of operating at the maximum required pressure intermittently for diffuser purging. The blowers are equipped with sound attenuating enclosures.

Positive displacement claw type blowers will provide air for the storage cell. All four blowers are in operation, with no standby. The blowers will each provide 120 SCFM at 10.5 psi, with the ability to operate at 20 psi intermittently for diffuser purging.

Blowers are summarized in the following table:

		Existing Partial Mix Blowers	Existing LINEAR Storage Blowers	New SAGR Blowers
Number of blower's total		2	2	2
Number of blowers on duty		2	1	1
Number of blowers on standby		0*	1	1
Motor nameplate horsepower	hp	60	7.5	60
Design airflow per blower	SCFM	762	100	944
Normal operating pressure	psi	7.0	10.5	5.5
Maximum Required Pressure	psi	8.4	15	9.0
Actual Power Consumption	bhp	41.5	5.0	37.2
Actual Sound level	dB(A)	74	n/a	73

*standby provided by SAGR blowers

Operation and Maintenance

The anticipated operation and maintenance costs for the OPTAER system are presented in the following table:

						*Electrical Rate:	0.08	$/kW-h
	Quantity	Hours per day	Motor Power bhp	Motor Power kW	Monthly cost	Unit cost	Annual Cost	
Aeration Lagoon Blowers	**2**							
Normal Operating Conditions	2	24	41.5	31.0	$3,616	-	$43,392	
Filter Change (6 months)	**-**		-	-		$80	$320	
Oil Change (12 months)	**-**		-	-		$70	$140	
Belt Replacement (24 months)	**-**		-	-		$250	$250	
Aeration SAGR Blowers	**2**							
Normal Operating Conditions	1	24	48.7	36.3	$2,122	-	$25,460	
Filter Change (6 months)	**-**		-	-		$80	$160	
Oil Change (12 months)	**-**		-	-		$70	$70	
Belt Replacement (24 months)	**-**		-	-		$250	$125	
100 DLR- Claw type Blower (LINEAR Aeration)	**2**							
Normal Operating Conditions	1	24	5	3.7	$218	-	$2,614	
Oil Change (12 months)						$50	$100	
Diffuser Membrane Replacement	**1016**		-	-		$30	$6,096	
Life Cycle Annual Alum addition	**TBD**							
Total Operation & Materials							$78,727	

Prefabricated Blower and Chemical Feed Building addition

A 4.57 x 9.2 m (15’ x 26’) addition to the existing prefabricated steel sandwich panel building will be provided. The panels used for both wall and roof construction have the following characteristics.

- 38mm thick urethane injected panels (R-12 insulation rating)
- Pre-finished painted exterior metal finish
- 28 ga. galvanized steel skin
- Extruded aluminum channels to provide light, rigid frame for panel system

Engineered welded HSS internal frames provide the structural framework for the building, designed as dictated by local building codes and snow loading conditions.

The proposed addition would be constructed on a cast in place concrete slab to match existing.

HVAC Equipment included. Electrical by others.

Budgetary Capital Cost

INCLUDED IN THE OPTAER WASTEWATER TREATMENT SYSTEM CAPITAL COST ARE:

OPTAER LAGOON AERATION SYSTEM:

- Nexom System Process Design (Manitoba P. Eng. Stamped)
    - CAD Drawings (Manitoba P. Eng. Stamped)
- Aeration header piping, feeder piping, diffusers, valves, and fittings as required
- HDPE shallow buried main header piping
- Lateral support hardware and anchors, self-tensioning lateral anchor assemblies
- *Equipment installation / start-up/ commissioning/ training*
- Operation and maintenance manuals
- Project Record Drawings

SUBMERGED ATTACHED GROWTH REACTOR (SAGR)

- Nexom System Process Design (Manitoba P. Eng. Stamped)
    - Process CAD drawings and specifications (Manitoba P. Eng. Stamped)
- Aeration header piping, feeder piping, diffusers, valves, and fittings as required
- SAGR Influent flow distribution piping/chambers and effluent collection chambers
- Two (2) 60 hp positive displacement blowers with full sound attenuating enclosures
    - Blower control panel
    - Galvanized metal blower header and connection pipe (heat dissipation)
- *Equipment installation/ start-up/ commissioning/ training*
- Operation and maintenance manuals
- Project Record Drawings

PREFABRICATED BLOWER BUILDING ADDITION

- CAD Drawings and specifications (Manitoba P. Eng stamped)
- One (1) 4.57 x 9.2 m (15' x 26') prefabricated steel sandwich panel building addition
    - HVAC equipment
    - CIP thickened edge concrete floor

BUDGETARY COST FOR THE DESIGN, SUPPLY AND INSTALLATION INSPECTION AS IN THE SCOPE ABOVE:

$1,035,000 CDN (FOB jobsite, plus applicable taxes)

All prices are subject to final design review.

ITEMS SPECIFICALLY NOT INCLUDED:

- Material offloading and secure on-site storage
- Civil works including Lagoon Cells/ SAGR basin design and construction, liner, transport piping, inter-cell piping, discharge piping, manholes, valves, access roads to site, site roads and landscaping, lagoon desludging etc. if required
- Excavation and backfilling for shallow buried headers
- Building subgrade preparation
- All Electrical work including wiring of blowers and control panels in blower building
- Modifications to Chemical treatment
- Materials and construction required for the SAGR:
    - granular material
    - insulating wood chips or mulch
    - Influent splitter structures with flow control weirs or standpipes
- Site Preparation and Restoration
- Disinfection

Civil Works Required for OPTAER Implementation

The intent of this proposal is not to provide details regarding civil works required but rather to provide a general overview as to the anticipated scope of work. The following quantities are not included in the Nexom scope of work, but are provided below for cost estimation purposes.

- Construct new SAGR cells
- Construct inter-cell piping for lagoon/SAGR
- Construct discharge control structure after SAGR
- Materials and construction required specifically for the SAGR (estimated material quantities are shown in the following table):

SUMMARY

Item Description	UOM	Quantity
Uniform Graded Clean Rock	m3	**10,680**
Insulating Wood Chips	m3	**1,370**
Non-Woven Geotextile (8oz)	m2	**9,940**
HDPE Liner (60mil)	m2	**5,580**
Wall Framing & Sheathing	m	**380**
Influent Flow Splitter Structure	ea	**1**
Piping, fittings, valves from splitter to SAGR	LS	**1**
Effluent Level Control MH	ea	**2**
Additional Civil Works (As Required)		
Common Excavation - Backfill	m3	**TBD**
New Berm Construction	m3	**TBD**
Piping from Lagoon to Splitter	LS	**TBD**
Piping from SAGR to discharge	LS	**TBD**

Questions or comments?

Any questions or comments can be directed to:

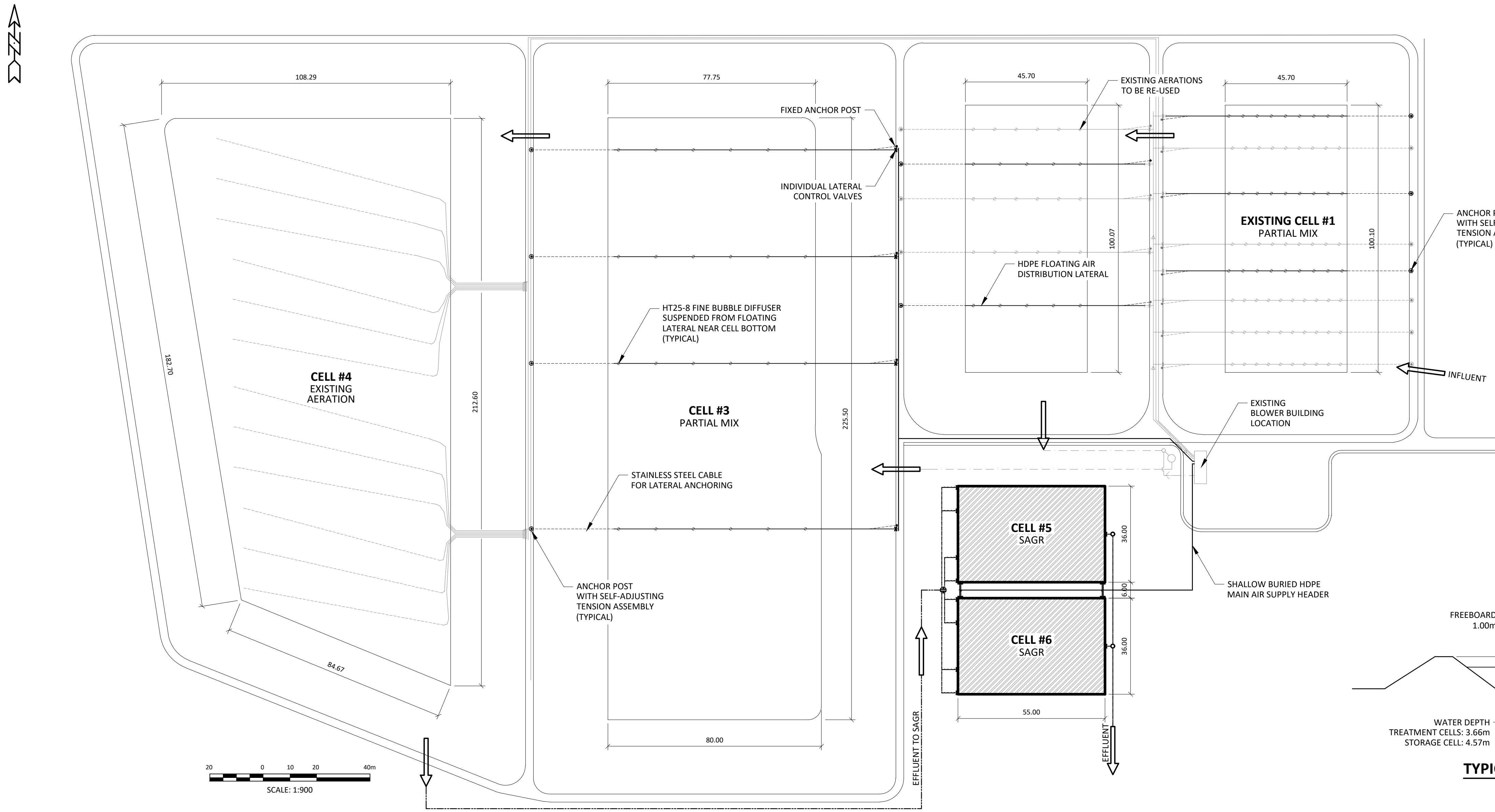
Nexom

5 Burks Way
Winnipeg, Manitoba, Canada
R2J 3R8

888-426-8180www.nexom.com

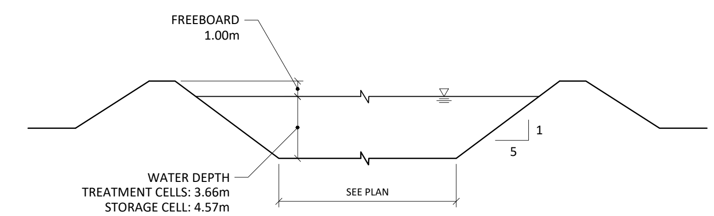
REDUCED SIZE PLOT - DO NOT SCALE

PLOT SIZE: 610mm x 914mm (24" x 36")



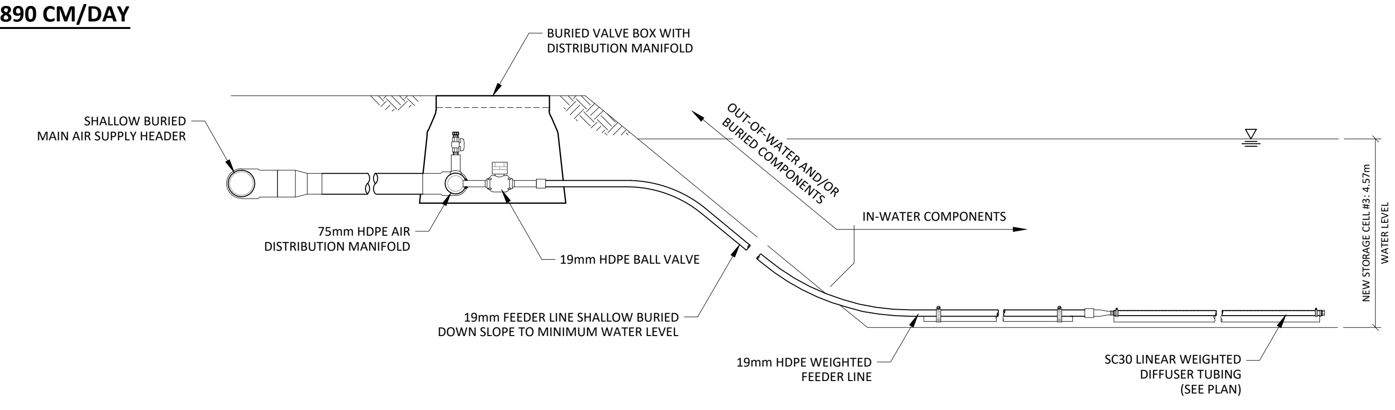
OVERALL AERATION LAYOUT - 890 CM/DAY

SCALE: 1:900



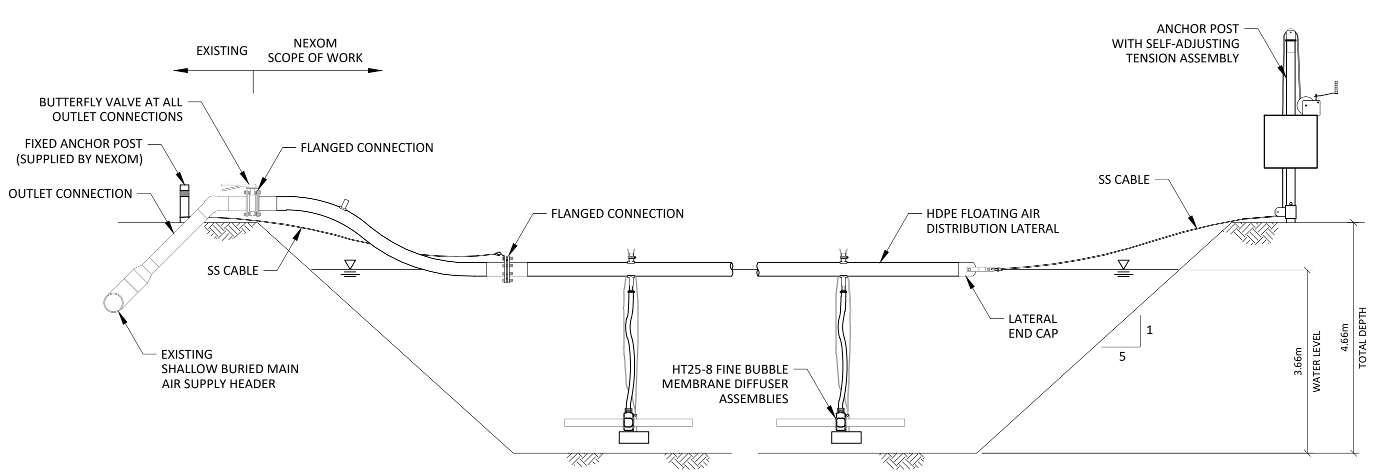
TYPICAL SECTION - AERATED CELLS

SCALE: N.T.S.



LINEAR DIFFUSER/FEEDER LINE DETAIL

SCALE: N.T.S.



AERATED LAGOON SECTION

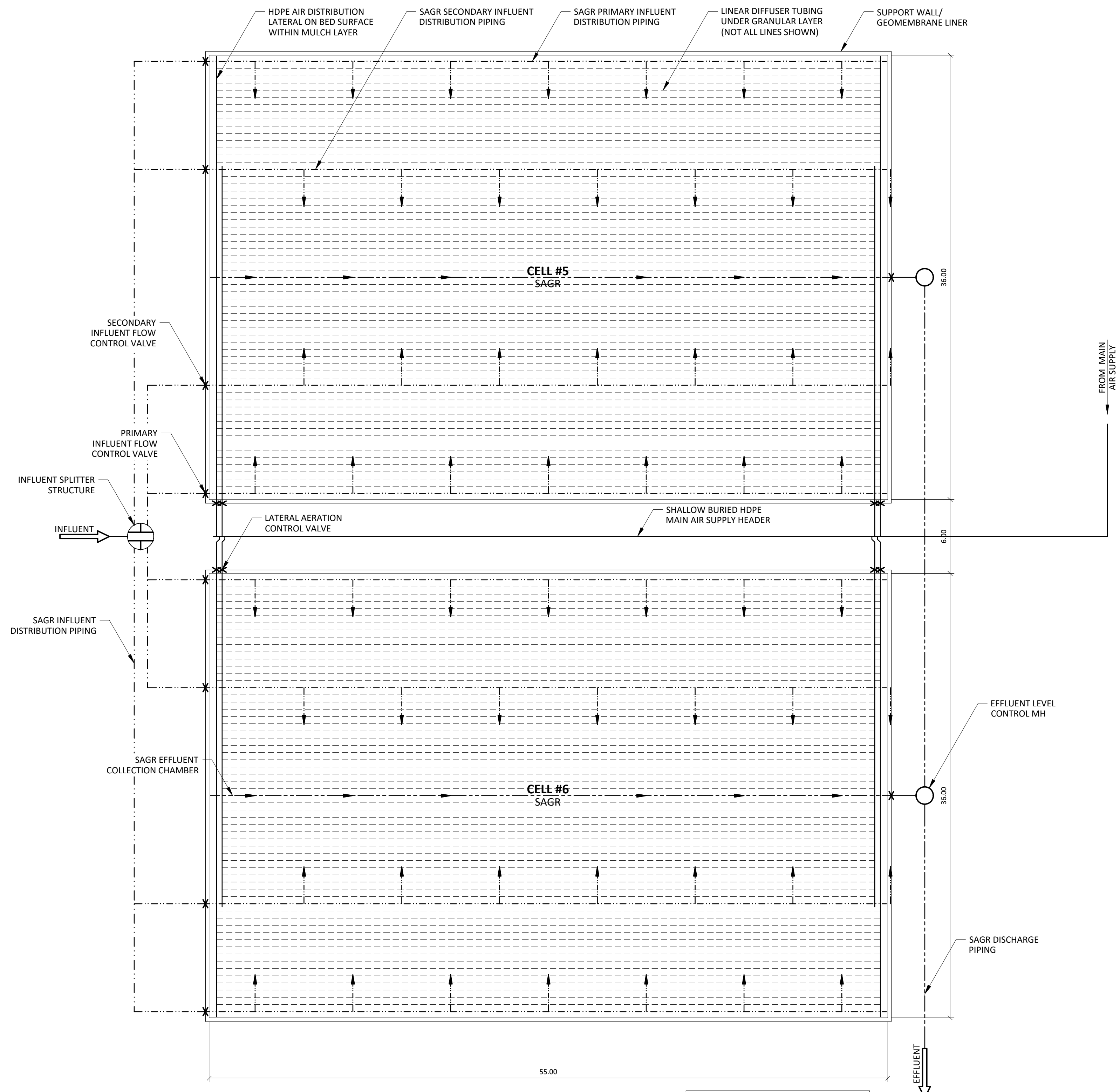
SCALE: N.T.S.

Nexom technologies for cleaner water
5 Burks Way
Winnipeg, Manitoba
Canada R2J 3R8
888-426-8180
www.nexom.com

PROJECT:	EAST SELKIRK EXPANSION, MB PROPOSED WASTEWATER TREATMENT SYSTEM			
TITLE:	OPTAER SYSTEM AERATION LAYOUT, TYPICAL SECTIONS			
DRAWN BY: AM	APPROVED BY: MH	SCALE: AS NOTED	DRAWING NO. NE01	SHT. 1 of 2 / REV. 0
DATE: 2017/10/24	FILE # CD3732.02			

PLOT SIZE: 610mm x 914mm (24" x 36")

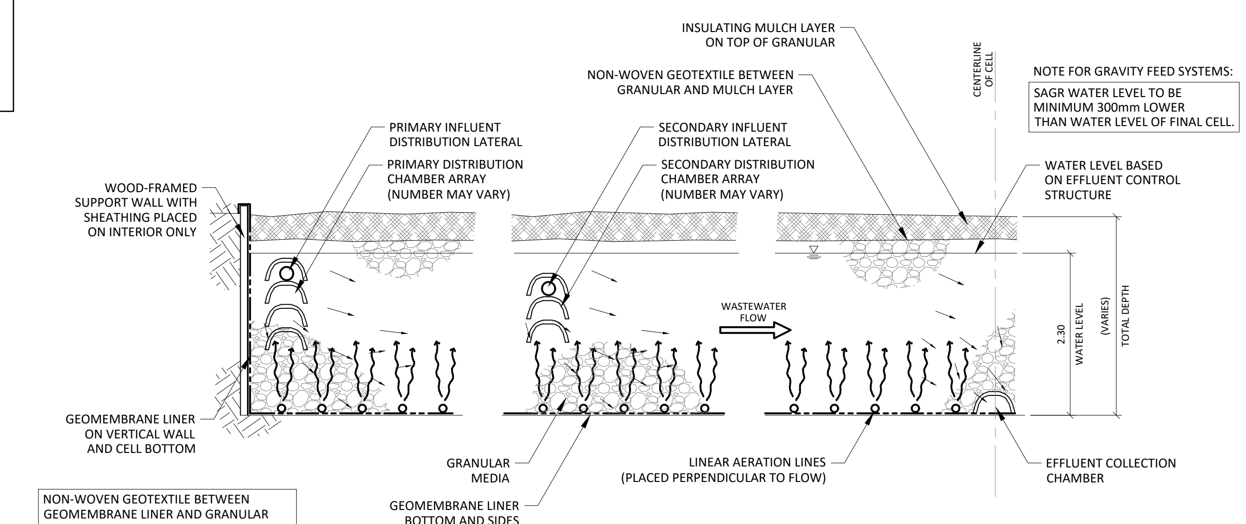
REDUCED SIZE PLOT - DO NOT SCALE



INFLUENT/EFFLUENT PIPING TO SAGR SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. EXACT PIPING ROUTING TO BE DETERMINED BASED ON FINAL LOCATION OF SAGR.

PROPOSED SAGR LAYOUT

SCALE: 1:200



NOTE FOR GRAVITY FEED SYSTEMS:
SAGR WATER LEVEL TO BE MINIMUM 300mm LOWER THAN WATER LEVEL OF FINAL CELL.

NON-WOVEN GEOTEXTILE BETWEEN GEOMEMBRANE LINER AND GRANULAR LAYER (BOTTOM AND SIDES) AND BETWEEN MULCH LAYER AND GRANULAR LAYER (TOP)

HORIZONTAL FLOW SAGR - SECTION

SCALE: N.T.S.

Nexom
technologies for cleaner water

5 Burks Way
Winnipeg, Manitoba
Canada R2J 3R8
888-426-8180
www.nexom.com

PROJECT: EAST SELKIRK EXPANSION, MB PROPOSED WASTEWATER TREATMENT SYSTEM					
TITLE: OPTAER SYSTEM AERATION LAYOUT, TYPICAL SECTIONS					
DRAWN BY: AM	APPROVED BY: MH	SCALE: AS NOTED	DRAWING NO. NE01	SHT. 1 of 2	REV. 0
DATE: 2017/10/24	FILE # CD3732.02				