Regional District of

Okanagan-Similkameen

Sawmill Road Area
Sanitary Sewer Feasibility Study

Regional District of Okanagan-Similkameen
101 Martin Street
Penticton, BC   V2A 5J9

November 2008
Project No. 104258

EARTH TECH | AECOM

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SECTION TITLE PAGE NO.

DEFINITIONS AND ACRONYMS

ADF	Average Day Flow
BOD	Biological Oxygen Demand
DCC	Development Cost Charge
LWMP	Liquid Waste Management Plan
MOE	Ministry of Environment
ML	Mega Litres (1,000,000 litres or 1,000 m^3)
IPF	Instantaneous Peak Flow
RDOS	Regional District of Okanagan-Similkameen
ROW	Right-of-Way
RI	Rapid Infiltration
STP	Sewage Treatment Plant
TRUE	T.R. Underwood Engineering
TSS	Total Suspended Solids
STP	Sewage Treatment Plant
WMP	Waste Management Plan

EXECUTIVE SUMMARY

Sanitary sewer servicing of the Sawmill Road area was assessed under three servicing scenarios. The first option considered was to install a conventional gravity sewer system. The second option involved installation of a low-pressure sewer system and individual grinder pumps at each service. The third option involved installation of an air vacuum collection system. A summary of the key decision considerations for the options is provided in **Table 1**.

The preferred option is installation of a low-pressure sewer system with individual grinder pumps. This option results in the lowest capital, operation and maintenance and life-cycle costs.

The estimated capital cost for implementing the preferred option is $1,960,000. This includes provision of a low pressure sewage collection system, individual grinder pumps for each serviced lot, and a low pressure main to convey the collected wastewater to the Town of Oliver sanitary sewer system, and then on to the sewage treatment plant.

It is recommended that the RDOS pursue a servicing option for Sawmill Road which involves a low pressure collection system with individual grinder pumps and connection to the Town of Oliver sewage treatment plant.

***Table 1**: Summary of Major Considerations for Various Servicing Options*

	Capital Cost **Servicing & Conveyance**	**Annual RDOS O&M Costs**	**Life Cycle Cost (20 Years)**	**Engineering Considerations**	**Environmental/Social Considerations**
Option 1: Gravity System	2,965,000	73,000	3,980,000	-most conventional system -additional energy required to run lift station -constructability may be an issue in high water table	-no odour nuisances -no resident education required -minimal chance of failures
Option 2: Low-Pressure System with Grinder Pumps	1,960,000	40,000	2,540,000	-low initial costs -low RDOS O&M costs; however compared to other options, more effort for O&M is placed on homeowner	-electrical works on private property; high homeowner costs -susceptible to power outages -education of residents is important -closed system mitigates all environmental impacts
Option 3: Air Vacuum System	2,835,000	73,000	3,850,000	-additional energy required to run vacuum station -proper construction and maintenance required -multiple homes typically share a pump unit	-electrical works centralized -closed system mitigates environmental impacts and odour nuisances at residences -odour nuisance possible at vacuum station

1.0 INTRODUCTION

The Regional District of Okanagan-Similkameen (RDOS) has undertaken this study to update their 20-year old Waste Management Plan and to identify and investigate various options available for implementation of a sewage collection system for the Sawmill Road area, just south of the Town of Oliver. The subject area includes 89 lots on and around Sawmill Road between the Okanagan River and old Kettle Valley Railway right-of-way, approximately 2.3 kilometres south from the Oliver town boundary.

1.1 SCOPE OF WORK

Preparation of the feasibility study includes the following specific tasks:

- Definition of an appropriate sanitary sewer collection system for the Sawmill Road area;
- Preliminary layout and sizing of a collection piping network to provide sanitary sewer services to the area;
- Preliminary layout of any required sewage pump stations and pre-treatment stations;
- Assessment of any existing facilities in the context of the proposed options;
- Preliminary capital cost estimates and corresponding operation and maintenance cost estimates;
- Preliminary cost per parcel estimates;
- Identification of environmental issues and mitigation measures;
- Determination of all current government agency approvals required to complete the recommended servicing scheme;
- Assessment of needs for odour control; and
- Consideration of the methods of construction and consequent impacts to residents.

2.0 BACKGROUND

The Sawmill Road area is predominately rural residential with the majority of its density located in the southern end of the sector. There is low density development in this area with most of the land use consisting of existing residential homes or farms. This area is located within the Okanagan River's flood plain, resulting in a high water table and flat topography. The study service area is shown in **Figure 2.1**.

A Waste Management Plan (WMP) for this area was undertaken by T.R. Underwood Engineering (TRUE) in 1987-88. The TRUE report presented two options for providing sanitary sewer service to the Sawmill Road area. The first scheme entailed the provision of a low pressure septic tank effluent collection system and individual effluent pumps on each serviced lot, with connection to the Town of Oliver sewage treatment plant. The individual pumps would account for the static lift needed to convey sewage to the treatment plant, eliminating the need for a community lift station.

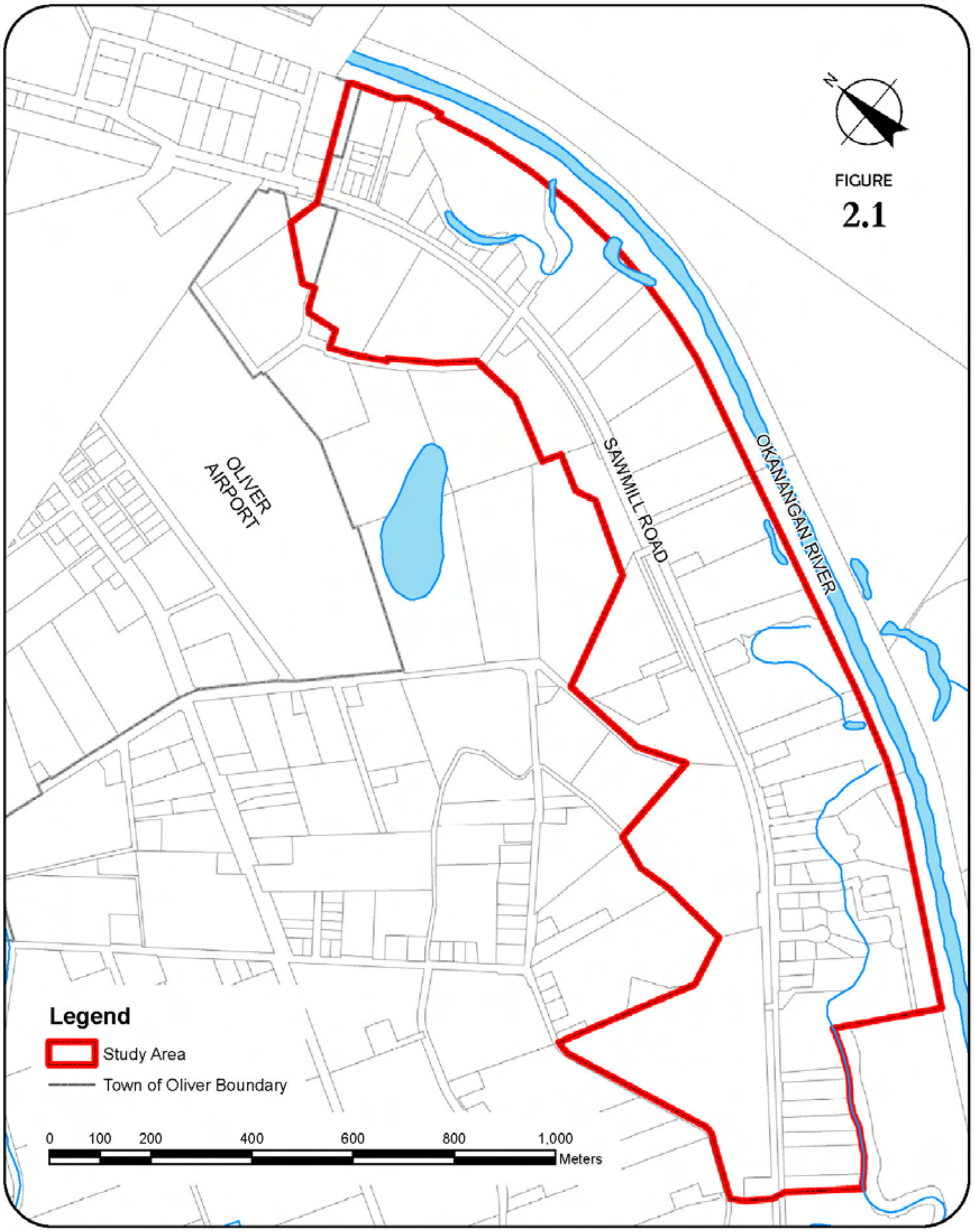
A conventional gravity sewer system was also presented in Option 1, but was discounted due to the cost of additional lift stations necessary considering the flat topography of the area.

The other scheme presented, Option 2, was essentially the same collection system as the gravity option, but with a different termination site. The collected wastewater would accumulate at a lift station located at the south end of the service area, and then be pumped 300-500 metres westward to a septic field disposal system. The 1988 report explained that there were no suitable areas to the west of the service area for a septic disposal field to be installed and did not discuss any further options for a site.

The two variations of Option 1 presented in the 1988 TRUE report have been re-evaluated with consideration given to current populations and wastewater flows. An additional option using an air vacuum sewer system has also been evaluated under the current flow conditions.

The three sewering options discussed in this report involve connection to the Town of Oliver's sanitary sewer system and treatment plant. Due to the service area location, installation of a local treatment and disposal system is not a viable alternative. Local treatment plants depend heavily on the provision of a suitable effluent disposal location. The high water table and flat topography of this area prevents nearby effluent disposal and dictate long-distance effluent disposal piping. Thus, no local treatment facilities are investigated in this report.

SAWMILL ROAD STUDY BOUNDARY



3.0 SANITARY SEWER SERVICING OPTIONS

In this section, design assumptions are developed and assessment is made of three servicing options for the Sawmill Road service area.

3.1 LAND USE

The Sawmill Road service area is approximately 100 hectares in size. The area consists of approximately 89 lots, the majority of which are Low Density Residential and Agricultural. The land-use map for the area is provided as **Figure 3.1**.

Table 3-1 provides a summary of the land-use coding and parcel distribution.

Table 3-1*: Parcel Summary – Land-use*

Land Use	No. Parcels
Low Density Residential (LR)	44
Agriculture (AG)	32
Small Rural Holdings (SH)	7
Industrial (I)	5
Conservation Area (CA)	1
Total No. Parcels	**89**

SAWMILL ROAD AREA LAND-USE MAP

3.2 ASSUMED WASTEWATER GENERATION RATES

Table 3-2 provides a summary of the wastewater generation rates for each of the various types of land-uses found in the Sawmill Road area.

***Table 3-2**: Assumed Future Build-Out Wastewater Generation Rates by Land-Use*

Land-Use	Unit	Average Daily Wastewater Generation (Litres/Day/Unit)
LR (Low density residential)[1]	Parcel	1,125
AG (Agricultural)[1]	Parcel	1,125
SH (Small rural holdings)[1]	Parcel	1,125
I (Industrial)[2]	Parcel	2,250
CA (Conservation Area)[2]	Area	2,250

Notes: 1) Based on 2.5 persons per parcel
2) Assumes a nominal wastewater input

The RDOS' design standard of 450 L/capita/day was used to derive the average daily wastewater generation rates summarized in **Table 3-2**. It should be noted, the assumed average per capita design rate used here is higher than most other municipalities in the Okanagan (the City of Penticton uses 400 L/capita/day and City of Kelowna, 300 L/capita/day). The per capita wastewater generation rate should be reviewed at the pre-design stage to assess whether it could be reduced.

As per Bylaw 2000, a peaking factor of 4 will be used to calculate instantaneous peak flows.

3.3 WASTEWATER FLOW RATE ESTIMATES

This section presents calculations for design wastewater flow rates generated under a build-out scenario, given the allowable densities provided in the RDOS' Zoning Bylaw (No. 2123).

Table 3-3 provides a summary of design wastewater volume calculations for the build-out scenario.

Table 3-3: Wastewater Generation for Future Build-Out Conditions

Land-Use	No. Parcels	Average Daily Wastewater Generation (L/parcel/day)	Average Wastewater Flow (L/day)	Peak Wastewater Flow (L/day)	Infiltration/Inflow Allowance[3] (L/day)
LR	44	1,125	49,500	198,000	105,000
AG	32	1,125	36,000	144,000	
SH	7	1,125	7,875	31,500	
I	5	2,250	11,250	45,000	
CA	1	2,250	2,250	9,000	

Notes: 3) Based on 30,000 litres per km of pipe and 3.5 km of pipe

The infiltration and inflow (I/I) allowance is provided in RDOS' Bylaw 2000 as 30,000 litres per kilometer of pipe. As a result, the total wastewater flowrate will depend on the length of pipe calculated and contributing area. Using a maximum estimated trunk length of 3.5 kilometres, wastewater generation rates in **Table 3-2** and service parcel information summarized in **Table 3-3**, design flow rates can be established for assessing the servicing options. It should be noted that the actual I/I value for each option discussed in this report will vary based on the length of gravity main and forcemain. Pumped mains generally do not allow the infiltration or inflow of gravity mains. For purposes of this report, the same I/I rate and corresponding ADF rate was used for all options. At the pre-design stage, a more detailed assessment of the I/I allowance should be completed for each option.

Average Day Flow (ADF) = Average Wastewater Flow + Infiltration/Inflow Allowance
= 106,875 L/day + 105,000 L/day
= 211,875 L/day
= ***212,000 L/day** (2.45 L/s)*

Peak Instantaneous Flow (PIF) = Peaking Factor x Average Wastewater Flow + I/I Allowance
= 4 x 106,875 L/day + 105,000 L/day
= 427,500 L/day + 105,000 L/day
= 532,500 L/day
= ***533,000 L/day** (6.17 L/s)*

The Average Day Flow for the Sawmill Road service area is estimated at 212,000 L/day. The Peak Instantaneous Flow estimate is 533,000 L/day.

3.4 OPTIONS ASSESSMENT

Three options for servicing the Sawmill Road area are described and assessed below. The options are based on different approaches for providing a sanitary sewer collection network. All servicing options presented in this report involve connection to the Town of Oliver's sanitary sewer system.

Option 1: Gravity Main with Connection to Oliver Sanitary System

The first option involves installation of a conventional gravity sewer system with a connection to the Town of Oliver sanitary sewer system. The 1988 TRUE WMP report presented a conventional gravity system but quickly discounted this option due to capital cost reasons. Since the completion of the TRUE report, there have been advances in the adaptability of gravity systems, including the ability to install at minimal grades, location-specific installation techniques, and pipe material improvements. In light of these recent advances, the gravity system option has been reconsidered.

The logical place to construct a gravity trunk is on the low side of the service area, adjacent to the Okanagan River. Connections from individual lots would be fed by gravity to the main trunk. To construct the trunk in this location, extensive dewatering would be necessary. As well as constructability challenges, environmental regulations may prevent construction in this area; the winding oxbows associated with the Okanagan River are classified as a riparian area, where a setback of 30 metres is required for any construction.

Considering this information, an alternate location for the gravity trunk is in the adjacent roadway. In this scenario, sewage would flow by gravity to the south end of the service area where it would be collected at a community liftstation and then pumped via forcemain northward to the treatment plant. The majority of homes in the service area are located in the southern end of the sector, at a lower elevation than the roadway. For these homes, individual grinder pumps would be necessary to convey wastewater to the gravity trunk. **Figure 3.2** provides a schematic of this option.

Table 3-4 summarizes capital cost estimates for servicing the Sawmill Road area with conventional gravity collection system.

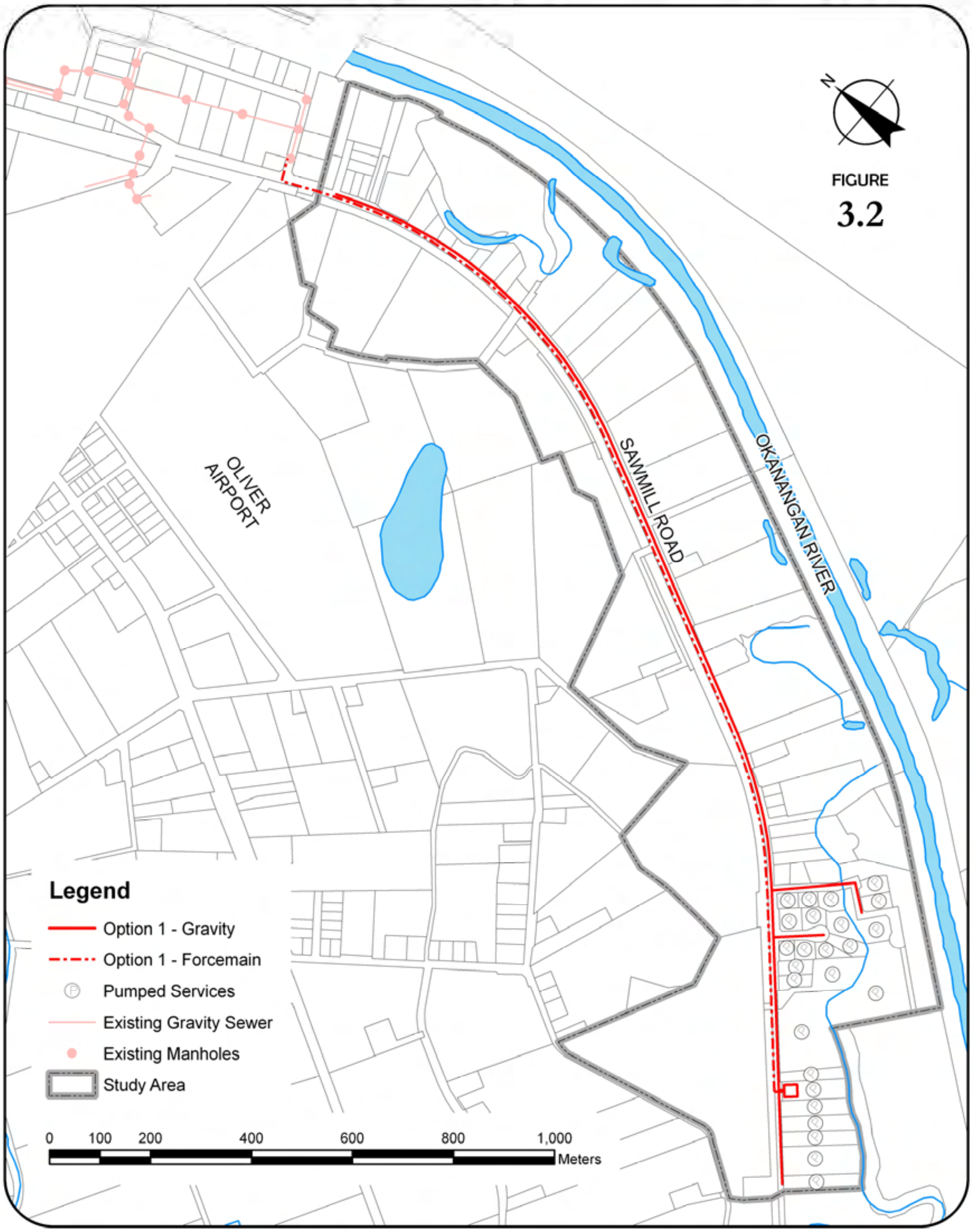
***Table 3-4**: Capital Cost Estimate for Option 1- Gravity System*

Servicing & Conveyance

Item	Unit	Quantity	Cost/Unit	Total Cost
1) 75mm dia. Gravity Trunk (incl. service to property & road restorations)	lm	2100	$280	$588,000
2) Manholes	ea	15	$1,900	$28,500
3) Liftstation	LS	1	$215,000	$215,000
4) Standby Generator	ea	1	$20,000	$20,000
5) 75mm dia. Forcemain	lm	2200	$240	$528,000
6) Dewatering Allowance	LS	1	$200,000	$200,000
7) Grinder Pumps (incl. installation, lateral & restoration)	ea	25	$8,250	$206,250
8) Gravity Service Connection c/w I.C. (incl. installation, lateral & restoration)	ea	64	$6,425	$411,200
9) D.C.C.- Connect to Oliver Sewer	ea	89	$690	$61,410
			Subtotal	$2,258,360
			Engineering & Contingencies (25%)	$564,590
			GST (5%)	$141,148
			Total (Rounded)	**$2,965,000**

The annual operation and maintenance costs for this option are estimated to be $73,000 and include a part-time operator to maintain the system, power consumption for the liftstation and general expenses.

OPTION 1 - GRAVITY SEWER SYSTEM



Option 2: Low-Pressure System with Connection to Oliver Sanitary System

Option 2 involves installation of a low-pressure forcemain system with individual grinder pumps at each serviced lot. The individual grinder pumps convey wastewater from the lot to a small forcemain trunk and on to the Town of Oliver sanitary sewer system. **Figure 3.3** provides a schematic of this option.

In most cases, additional lift stations are not required for these systems because the grinder pumps can transport sewage horizontally up to 1,600 metres and vertically up to 50 metres. The individual pump is incorporated into a compact, low-maintenance and waterproof unit. They are typically installed in the homeowner's basement, or outdoors, adjacent to the house. In some situations, a pump can be sized to accommodate more than one home. These units are ideal in locations with high water tables and where flat grades present installation challenges for conventional gravity systems. Given the grades and nearby location of a sanitary sewer connection, the Sawmill Road area would an ideal location for low-pressure collection system.

This type of low-pressure system has the ability to expand for future growth and additional flows. Studies completed on the total number of pumps in a given system number vs. the number of pumps operating at one time show that for pump populations from 100 to 1,000, a maximum of 35 pumps would ever be operating simultaneously. This allows room for additional services to be connected to the original system.

Unlike conventional gravity sewers which typically contain liftstations and centralized electrical works, low-pressure systems require an electrical connection at each service, supplied by the homeowner. Consequently, electrical costs to the Regional District are eliminated, but are increased for the homeowner. As well, due to the electrical dependence of these units, the system is susceptible to power outages. Residents with grinder pumps must be properly educated about the workings of the unit to ensure proper care during outages and proper use in general.

Table 3-7 summarizes capital cost estimates for servicing the Sawmill Road area with a low-pressure collection system and individual grinder pumps.

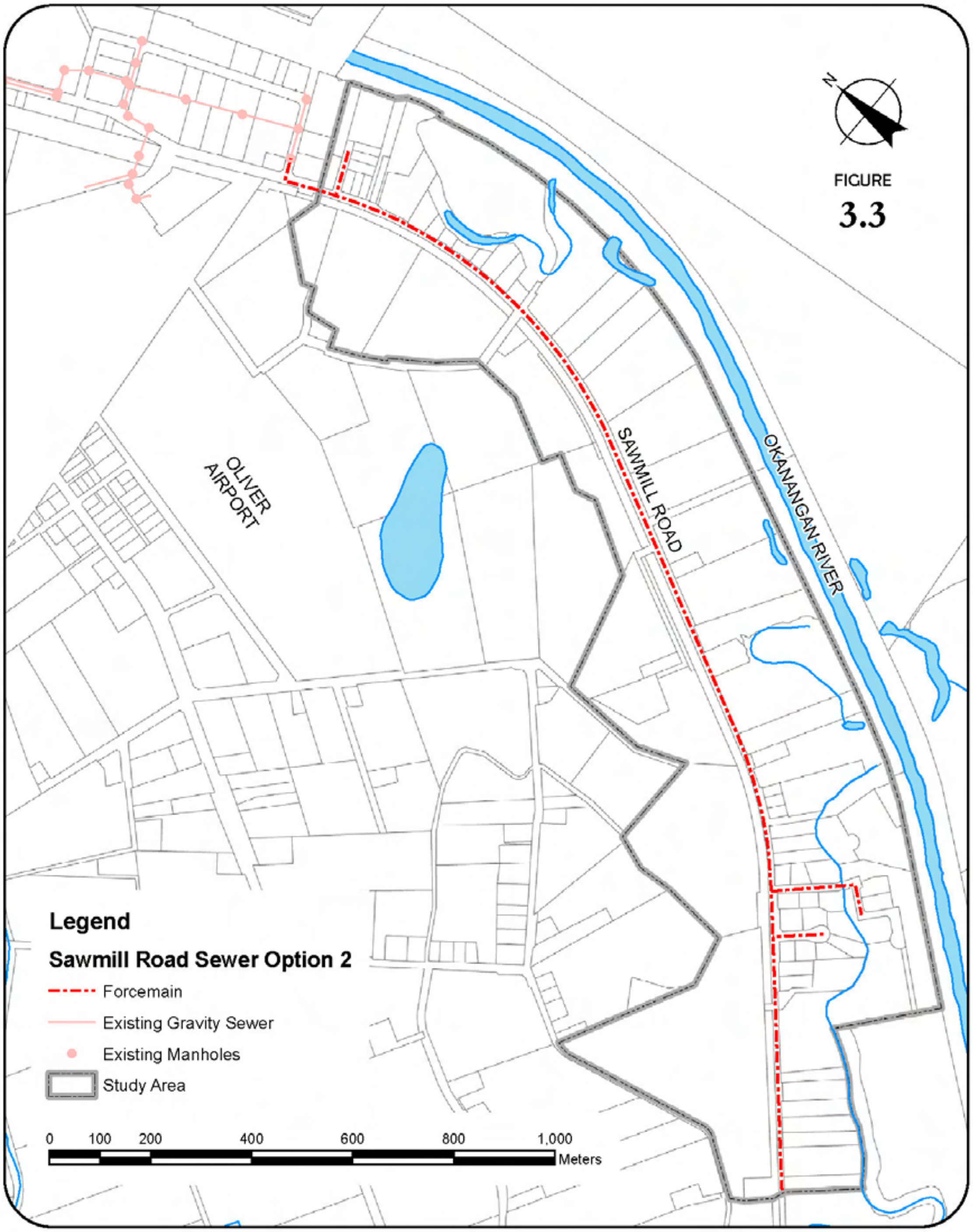
***Table 3-7**: Capital Cost Estimate for Option 2 – Low Pressure System*

Servicing & Conveyance

Item	Unit	Quantity	Cost/Unit	Total Cost
1) 50mm dia. Forcemain (incl. service to property & road restorations)	lm	150	$215	$32,250
2) 75mm dia. Forcemain (incl. service to property & road restorations)	lm	2300	$240	$552,000
3) Cleanout	ea	2	$2,000	$4,000
4) Air Release Valve	ea	1	$1,200	$1,200
5) Odour Control (Dosing Kiosk)	LS	1	$100,000	$100,000
6) Grinder Pumps (incl. installation, lateral & restoration)	ea	89	$8,250	$734,250
7) D.C.C.- Connect to Oliver Sewer	ea	89	$690	$61,410
8) Resident Education Program	LS	1	$8,000	$8,000
			Subtotal	$1,493,110
			Engineering & Contingencies (25%)	$373,278
			GST (5%)	$93,319
			Total (Rounded)	**$1,960,000**

The annual operation and maintenance costs for this option are estimated to be $40,000 for a part-time maintenance person and general expenses.

OPTION 2 - LOW PRESSURE SYSTEM



Option 3: Air Vacuum System with Connection to Oliver Sanitary System

A third option for providing collection of wastewater from the Sawmill Road area is installation of an air vacuum system. This system is similar to the low-pressure system in that a package unit is installed on each serviced lot which conveys sewage to a vacuum station collection tank and then is pumped by forcemain to the treatment plant or sewer system. **Figure 3.4** provides a schematic of this option.

The valve pit package is installed outdoors, adjacent to the house. The unit acts as a sump for sewage to collect. When sewage levels reach a certain point in the sump, the air vacuum valve opens and sewage flows by differential pressure to the vacuum main. The wastewater is conveyed through the small vacuum main into a collection tank (within the vacuum station). Here, the wastewater is retained in the common tank until it reaches a predetermined level, when it is transferred to the sewer system via forcemain.

The air vacuum system reduces the need for lift stations due to its ability to be installed in areas of minimal grade. Similar to the low-pressure/grinder pump system, vacuum sewer systems have shallow burial depths, narrow trenches and the flexibility to alter alignments based on terrain. The individual valve pit packages also contain no electrical works; all electrical systems are contained in one location at the vacuum pump/collection tank station. This reduces the number of maintenance issues with individual homeowners and centralizes all serviceable equipment. As well, valve pit packages are often used to service more than one home.

Similar to Option 2, air vacuum collection systems have the ability to expand for future growth and additional flows. The collection tank in the vacuum station stores and equalizes flow and only pumps to the treatment plant when necessary.

Vacuum systems are also susceptible to power outages. Dependence on grid power can be minimized with the installation of a generator at the vacuum station.

Table 3-8 summarizes capital cost estimates for servicing the Sawmill Road area with an air vacuum system.

OPTION 3 - AIR VACUUM SYSTEM

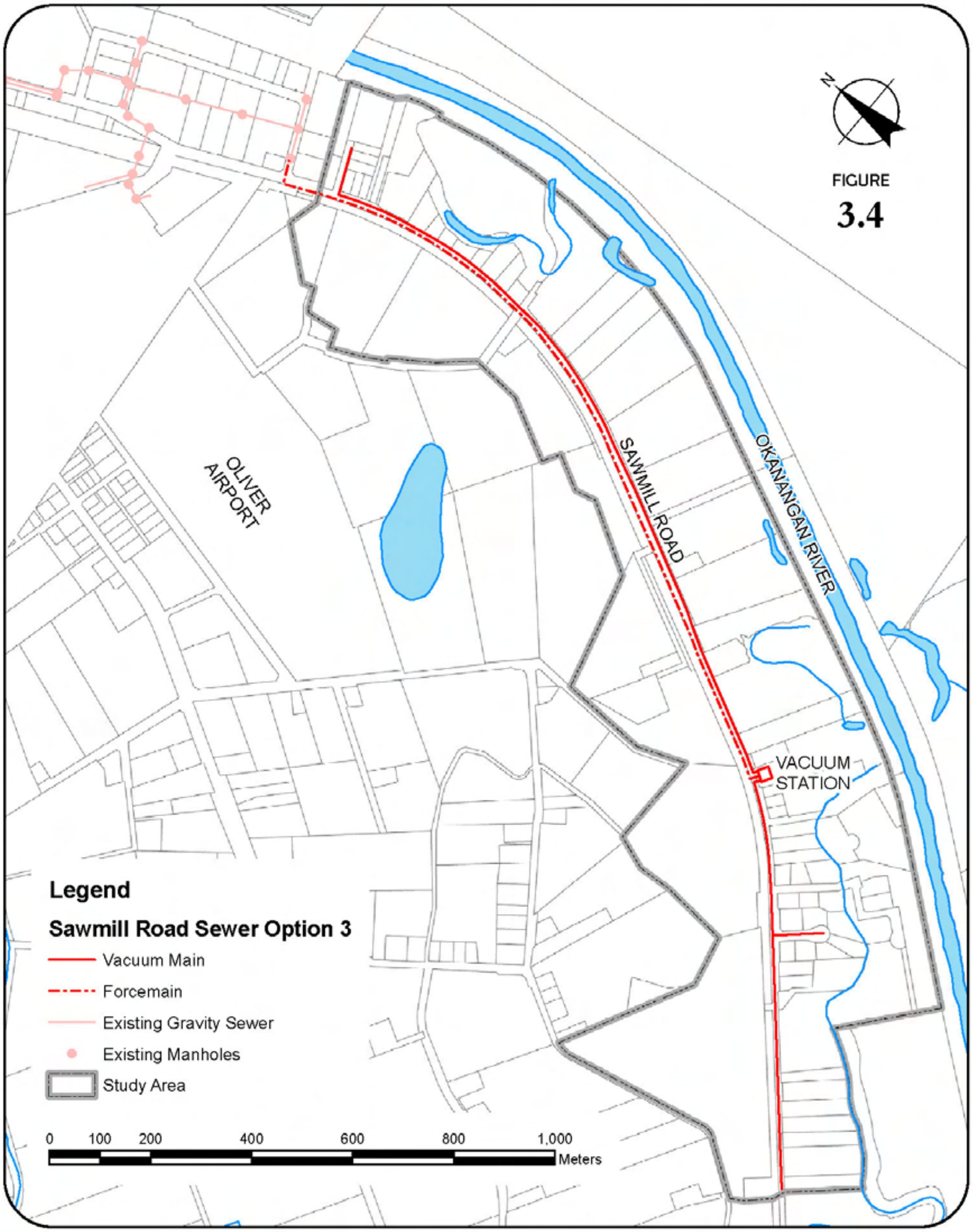


Table 3-8: Capital Cost Estimate for Option 3 – Air Vacuum System

Servicing & Conveyance

Item	Unit	Quantity	Cost/Unit	Total Cost
1) 100mm dia. Vacuum Main (incl. service to property & restorations)	lm	1000	$265	$265,000
2) 150mm dia. Vacuum Main (incl. service to property & road restorations)	lm	1400	$285	$399,000
3) 100mm dia. Forcemain (incl. road restorations)	lm	1623	$255	$413,865
4) Division Valve	ea	3	$900	$2,700
5) Vacuum Station (incl. vacuum pumps, collection tank, sewage pumps, odour control & installation)	ea	1	$390,000	$390,000
6) Standby Generator	ea	1	$20,000	$20,000
7) Valve Pit Package (incl. installation, lateral & restoration)	ea	45	$13,500	$607,500
8) D.C.C.- Connect to Oliver Sewer	ea	89	$690	$61,410
			Subtotal	$2,159,475
			Engineering & Contingencies (25%)	$539,869
			GST (5%)	$134,967
			Total (Rounded)	**$2,835,000**

The annual operation and maintenance costs for this option are estimated to be $73,000 and include a part-time operator to maintain the vacuum station, power consumption for the station and general expenses.

Connection to Town of Oliver Sanitary Sewer System

All options discussed in this report involve connection to the Town of Oliver's sanitary sewer system. The Town's plant is located just north of the Sawmill Road service area in the industrial area. Tie-in to the system would occur just south of the treatment plant, into an existing gravity main.

The D.C.C. charge listed in the capital cost estimates is a standard connection fee for parcels within the Town of Oliver boundary connecting to the system. Since the Sawmill Road area is outside of town boundaries, this fee may not be valid. Currently, the Osoyoos Indian Band (OIB) and Bin-Corp have agreements with the Town to discharge into the system. There is little precedence for single-family lots connecting to the system. It is assumed an agreement similar to that of the OIB and Bin-Corp could be reached with the Town of Oliver and a similar D.C.C. would be charged. Before further design is undertaken, an agreement should be established with the Town of Oliver regarding connection to the Town's system.

Summary of Options Assessment

A summary of the various considerations is provided in **Table 3-9**. Included in this summary is the life-cycle cost based on the capital and O&M costs for each of the options assessed above. Detailed O&M cost estimates can be found in **Appendix B**. The life-cycle cost provides an objective measure of the cost to construct and operate each of the options. Other important considerations include engineering, environmental and social factors.

Option 1, the conventional gravity collection system has the greatest capital, O&M and life-cycle costs. These high costs are primarily due to the major excavation requirements associated with gravity main and dewatering costs. On the basis of costing and site conditions, this option is eliminated from further consideration.

Options 2 and 3 have similar advantages in construction methods, environmental and social considerations, risks and reliability. Since the two are virtually equal in all other categories, the preferred option is chosen based on economic considerations.

Option 2, a low-pressure system with individual grinder pumps, has the lowest capital, life-cycle and operation and maintenance costs of the three options.

***Table 3-9**: Summary of Major Considerations for Various Servicing Options*

	Capital Cost **Servicing & Conveyance**	**Annual RDOS O&M Costs**	**Life Cycle Cost (20 Years)**	**Engineering Considerations**	**Environmental/Social Considerations**
Option 1: Gravity System	2,965,000	73,000	3,980,000	-most conventional system -additional energy required to run lift station -constructability may be an issue in high water table	-no odour nuisances -no resident education required -minimal chance of failures
Option 2: Low-Pressure System with Grinder Pumps	1,960,000	40,000	2,540,000	-low initial costs -low RDOS O&M costs; however compared to other options, more effort for O&M is placed on homeowner	-electrical works on private property; high homeowner costs -susceptible to power outages -education of residents is important -closed system mitigates all environmental impacts and odour nuisances
Option 3: Air Vacuum System	2,835,000	73,000	3,850,000	-additional energy required to run vacuum station -proper construction and maintenance required -multiple homes typically share a pump unit	-electrical works centralized -closed system mitigates environmental impacts and odour nuisances at residences -odour nuisance possible at vacuum station

3.5 COST PER PARCEL ESTIMATES

Table 3-10 below provides an estimate for the capital cost per parcel under each servicing scenario. This cost does not include the annual operation and maintenance costs. Should the Regional District receive grant funding for this project, the cost per parcel value would decrease based on the amount of funding. Figure 1A in **Appendix A** shows the distribution between homeowner and non-homeowner costs, should grant funding become available.

***Table 3-10**: Cost Per Parcel Estimate*

	Capital Cost	Cost per Parcel
Option 1: Gravity System	$2,965,000	$33,300
Option 2: Low-Pressure System	$1,960,000	$22,000
Option 3: Air-Vacuum System	$2,835,000	$31,900

3.6 REGULATORY REQUIREMENTS

Construction of the majority of these works may occur within the 30 metre setback allowance of the Ministry of Environment's Riparian Area Regulation (RAR). Therefore, application may need to be made for a variance to the set-back. The specific location of encroachments will need to be assessed at the pre-design stage.

3.7 CONSTRUCTION CONSIDERATIONS

The unobtrusive construction methods used in low-pressure systems significantly reduces excavation, disturbance of existing terrain, and need for restorations. Given the low-density makeup of the Sawmill Road area, typical construction nuisances should have little impact on the surrounding residents and businesses.

Before installation, an extensive resident education program should be conducted to inform residents about the workings of the new sewer system. Proper use and care of the system can greatly reduce maintenance calls and increase the life span of the system and its parts.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Sanitary sewer servicing of the Sawmill Road area was assessed under three servicing scenarios. The first option involved a gravity collection system with connection to the Town of Oliver sanitary sewer system. This option is eliminated due to constructability and cost considerations. The second option considered was to provide a low-pressure forcemain with individual grinder pumps at each lot, with connection to the Town of Oliver sanitary system. The third option involved an air vacuum collection system with a centralized vacuum station which regulated and pumped sewage via forcemain to the Town of Oliver sanitary system.

Although Options 2 and 3 share similar constructability, environmental and social considerations, Option 2 is a more economical scenario. With a significantly lower capital, O&M and life-cycle cost, Option 2 is the favored option.

The preferred option is Option 2, a low-pressure forcemain and individual grinder pumps with connection to the Town of Oliver sanitary sewer system. The estimated capital cost for implementing the preferred option is $1,960,000. This includes provision of forcemain trunks for sewage collection and a grinder pump for each serviced lot.

It is recommended that the RDOS implement a low-pressure system with grinder pumps to service the Sawmill Road area. As well, discussions with the Town of Oliver should begin as soon as possible to develop a servicing agreement for this area.

Appendix A

TABLE A-1: COSTING ASSUMPTIONS

Gravity Sewer*

Diameter	Pipe Cost	Base Gravels	Asphalt Cutting & Placement	Total Unit Cost
(mm)	($/m)			
75	125	70	85	280

*Pipe bury avg. 2.5m deep and WCB maximum side slopes

Low-Pressure Forcemain$^{\alpha}$

Diameter	Pipe Cost	Base Gravels	Asphalt Cutting & Placement	Total Unit Cost
(mm)	($/m)			
50	130	40	45	215
75	155	40	45	240
100	170	40	45	255

Vacuum Main$^{\alpha}$

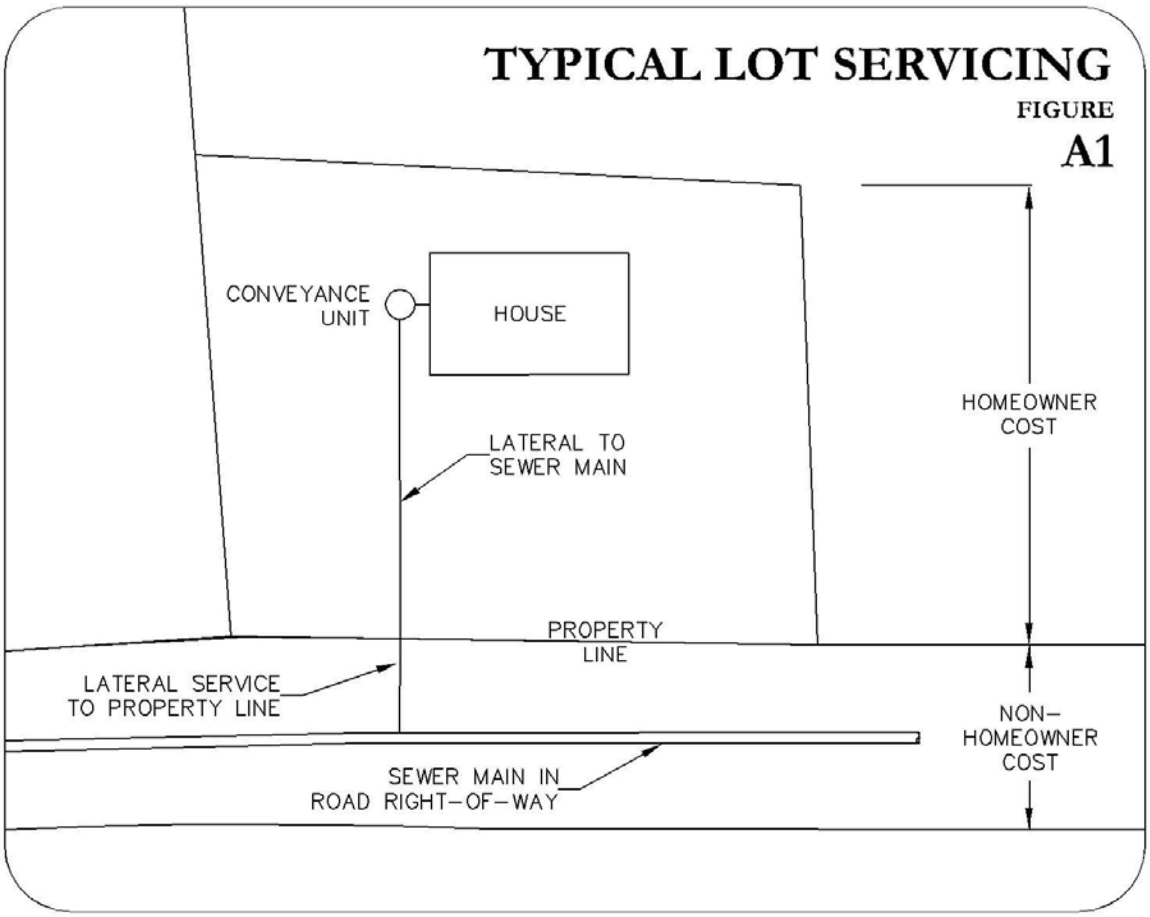
Diameter	Pipe Cost	Base Gravels	Asphalt Cutting & Placement	Total Unit Cost
(mm)	($/m)			
100	180	40	45	265
150	200	40	45	285

$^{\alpha}$Pipe bury avg. 1m deep and WCB maximum side slopes

Service Connections†	
Gravity	75mm dia
Low-pressure	50mm dia
Vacuum	100mm dia

†Service Connection costs are included in Grinder Pump, Gravity Connection or Valve Pit Package; estimated at 25 metres per parcel and $10 per square metre for restorations

FIGURE A1: TYPICAL LOT SERVICING



Appendix B

20-Year Life Cycle Cost Estimates

TABLE B-1: 20-YEAR LIFE-CYCLE COSTS – OPTION 1

Year	Operation & Maintenance Costs			Capital Cost
	Option 1 - Gravity System			
	Labour	Electricity	Expenses (materials, insurance, etc.)	
2009	50,000	3,000	20,000	2,965,000
2010	51,000	3,060	20,400	0
2011	51,400	3,120	20,800	0
2012	51,800	3,180	21,200	0
2013	52,200	3,240	21,600	0
2014	52,600	3,300	22,000	0
2015	53,000	3,360	22,400	0
2016	53,400	3,420	22,800	0
2017	53,800	3,480	23,200	0
2018	54,200	3,540	23,600	0
2019	54,600	3,600	24,000	0
2020	55,000	3,660	24,400	0
2021	55,400	3,720	24,800	0
2022	55,800	3,780	25,200	0
2023	56,200	3,840	25,600	0
2024	56,600	3,900	26,000	0
2025	57,000	3,960	26,400	0
2026	57,400	4,020	26,800	0
2027	57,800	4,080	27,200	0
2028	58,200	4,140	27,600	0

Net Present Value = $3,980,000

TABLE B-2: 20-YEAR LIFE-CYCLE COSTS – OPTION 2

Year	**Operation & Maintenance Costs**		**Capital Cost**
	Option 2 - Low-Pressure System		
	Labour	Expenses (materials, insurance, etc.)	
2009	20,000	20,000	1,960,000
2010	20,400	20,400	0
2011	20,800	20,800	0
2012	21,200	21,200	0
2013	21,600	21,600	0
2014	22,000	22,000	0
2015	22,400	22,400	0
2016	22,800	22,800	0
2017	23,200	23,200	0
2018	23,600	23,600	0
2019	24,000	24,000	0
2020	24,400	24,400	0
2021	24,800	24,800	0
2022	25,200	25,200	0
2023	25,600	25,600	0
2024	26,000	26,000	0
2025	26,400	26,400	0
2026	26,800	26,800	0
2027	27,200	27,200	0
2028	27,600	27,600	0

Net Present Value = $2,540,000

TABLE B-3: 20-YEAR LIFE-CYCLE COSTS – OPTION 3

Year	Operation & Maintenance Costs			Capital Cost
	Option 3 - Air Vacuum System			
	Labour	Electricity	Expenses (materials, insurance, etc.)	
2009	50,000	3,000	20,000	2,835,000
2010	51,000	3,060	20,400	0
2011	51,400	3,120	20,800	0
2012	51,800	3,180	21,200	0
2013	52,200	3,240	21,600	0
2014	52,600	3,300	22,000	0
2015	53,000	3,360	22,400	0
2016	53,400	3,420	22,800	0
2017	53,800	3,480	23,200	0
2018	54,200	3,540	23,600	0
2019	54,600	3,600	24,000	0
2020	55,000	3,660	24,400	0
2021	55,400	3,720	24,800	0
2022	55,800	3,780	25,200	0
2023	56,200	3,840	25,600	0
2024	56,600	3,900	26,000	0
2025	57,000	3,960	26,400	0
2026	57,400	4,020	26,800	0
2027	57,800	4,080	27,200	0
2028	58,200	4,140	27,600	0

Net Present Value =$3,850,000