2021 Wastewater Collection and Treatment Report

CITY OF
SALMON ARM

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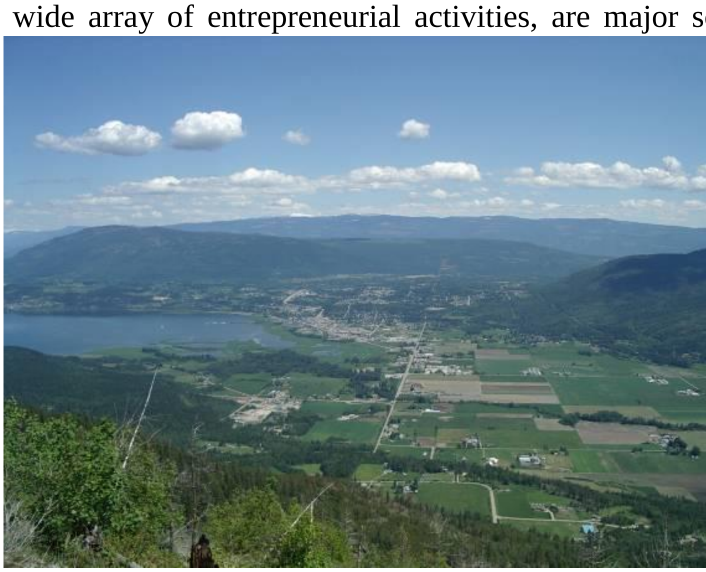
1.0 Community General

The City of Salmon Arm is located in the southern interior of British Columbia on the southwest shoreline of the extensive Shuswap Lake system. With over 19,000 residents, Salmon Arm is the largest urban centre in the Columbia Shuswap Regional District. It serves as the commercial, cultural and administrative hub for an additional 35,000 residents of the Shuswap Lake region. Located at the junction of the Trans Canada Highway (TCH) and Highway 97B, Salmon Arm is a one-half day drive to Vancouver or Calgary and a 70 minute drive to Kelowna or Kamloops.

With a land base of 175 km², Salmon Arm is a relatively large municipality by area with most of the population concentrated within a few kilometers of the Trans Canada Highway and the downtown core. The surrounding terrain varies from the low lying marsh flats of Salmon Arm Bay to the extinct volcanic peak of Mt. Ida and the ridge lines of Fly Hills to the west and Larch Hills to the east. These highlands form the Canoe Creek and Salmon River watersheds which empty into Shuswap Lake. Sustainable land use planning over the years has resulted in the formation of an attractive, bustling, compact community surrounded by thousands of hectares of arable farmland, green space and natural shorelines.

Salmon Arm's commercial and industrial base is continuing to diversify. The housing market continues to remain tight. Retail, construction, professional services and healthcare, along with a wide array of entrepreneurial activities, are major sources of employment. Small businesses flourish in Salmon Arm's business friendly environment. Key economic drivers are value-added wood processing, high tech and traditional manufacturing, tourism and agri-business. The continuing surge in construction activity points to a healthy market demand for new housing and floor space for commercial, industrial and institutional uses. The 2021 Census indicates a percentage growth in population of 9.7% from the previous 2016 Census. This compares to the provincial average growth of 7.6%.



1.1 Staffing

The City of Salmon Arm Engineering and Public Works Department is responsible for this municipal function. The Utilities Division is responsible for the operation and maintenance of the sanitary collection system and the Water Pollution Control Centre (WPCC) staff is responsible for the operation and maintenance of the Wastewater Treatment facility and the main lift Station located at Wharf Street. The WPCC is manned seven days of the week with 24-hour standby provisions for after hour alarm response.

Table 1 - Staff Overview

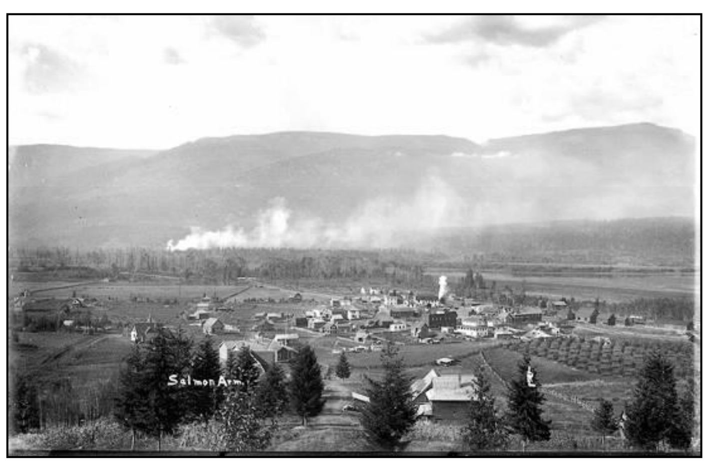
Engineering and Public Works	
Robert Niewenhuizen, A.Sc.T., Director of Engineering and Public Works	
Jenn Wilson, P.Eng., LEED® AP, City Engineer	
Utilities Division	
Gerry Rasmuson, B.Sc. ***Utilities Manager*** ◆ Level IV - Water Distribution ◆ Level IV - Wastewater Treatment ◆ Level I - Wastewater Collection	***Larry Kipp*** ***Utilities Supervisor*** ◆ Level I - Wastewater Collection ◆ Level II – Water Distribution
Mervin Arvay ◆ Level II - Wastewater Collection	**Devon Tulak** ◆ Level I - Wastewater Collection
Jason Baker ◆ Level I - Wastewater Collection	**Jason Philps** ◆ Level I - Wastewater Collection
Josh Yurkowski ◆ Level I - Wastewater Collection	**Corey Hockman** ◆ Level I - Wastewater Collection
Water Pollution Control Centre	
Hart Frese ***Chief Operator*** ◆ Level IV - Wastewater Treatment	**Doug Stalker**, Dip. Water Quality ***Operator III*** ◆ Level IV - Wastewater Treatment ◆ Level I - Wastewater Collection
Daryl Warnock, A.Sc.T., RSE, Dip. Water Engineering Technology ***Operator III*** ◆ Level IV - Wastewater Treatment	**Ray Muller,** ***Operator II*** ◆ Level I - Wastewater Treatment ◆ Level I - Wastewater Collection

2.0 Wastewater Treatment & Collection System History

2.1 Wastewater Collection System - History

The District of Salmon Arm and the Village or Salmon Arm amalgamated in 1971 to form the District Municipality of Salmon Arm on January 1, 1971, and then became the City of Salmon Arm in 2005. The Village was the original urban core area and sewer lines were installed during the 1930's to collect septic tank effluent and some crude wastes which were then discharged into an open ditch leading into Shuswap Lake. The surrounding District Municipality relied on septic systems as sewer collection was not an issue until the urban development of the Village overflowed into the surrounding Municipality. By 1964, the Village had initiated plans for sewage treatment which included the construction of a lagoon along the waterfront for treatment. The lagoons would also service the Adams lake Indian Band lands. Concerned about the level of treatment that a lagoon offered, the Village decided to review their plans and objectives. By 1966, the review board recommended that the Village and District combine in their efforts to collect and treat wastewater. However, unable to agree upon implementation of various plans the Village applied to the Pollution Control Board for a permit to discharge highly treated effluent into Shuswap Lake. By the time this permit was granted in 1972, the Village and District had amalgamated.

Ultimately the Engineering firm of Dayton and Knight Ltd were hired to undertake a Wastewater survey in 1972 to study various different treatment and effluent disposal methods. The Survey resulted in the construction and official opening of the existing Water Pollution Control Centre on May 14, 1977. Furthermore, the survey identified collection system priorities and set in motion the construction of the infrastructure that currently exists. The City's sewage collection and treatment systems have evolved into a well maintained collection system and a state of the art Wastewater Treatment Centre.



2.2 Wastewater Treatment Plant History

The original plant was constructed on the current site, 121 Narcisse Street NW, in 1977 after the proposed site at Minion Field, 2191 30th Street SW was rejected by the B.C. Agricultural Land Commission and Provincial Pollution Control Board. It was constructed at a cost of $0.9 M and consisted of primary sedimentation, activated sludge, secondary clarification with chlorine disinfection. Solids were aerobically digested and stored in two 1 acre lagoons. Capacity of the plant was 3,000 m^3 per day for a design service population of 6,250.

In 1982, phosphorus removal was added at a cost of $0.1 M and consisted of precipitating phosphorus out of the effluent by the addition of ferrous chloride. Phosphorus was determined to be the limiting nutrient which contributes to the eutrophication and degradation of water quality in Shuswap Lake, particularly, Salmon Arm Bay. Currently the Salmon Arm WPCC contributes less than 4% of the phosphorus loading in the bay.

Aerial Photo Stage IIIB prior to Landscaping

In 1986 the $1.8 M Stage II Upgrade was the first major upgrade to the facility. The liquid process was altered from a common activated sludge process to an experimental trickling filter biological nutrient removal (BNR) system (Fixed Growth Reactor – Suspended Growth Reaction or FGR-SGR. As well, the aerobic digester was upgraded to an Autothermal Thermophilic Aerobic Digester (ATAD). Plant Capacity was increased to 3,500 m^3 per day for a design service population of 8,750.

Improvements were made in 1991 to the solids process at a cost of $0.5 M. The improvements consisted of changing aeration and solids pumping equipment. Rebuilding the ATAD tanks and added waste biological sludge thickening.

The Stage III Upgrade was split into two upgrades with the first part, Stage IIIA completed in 1998 at a cost of $5.2 M. It consisted of improvements to the FGR- SGR process, new secondary clarifier, Supervisory Control and Data Acquisition system, increased ATAD capacity and biosolids dewatering. These improvements led to better control and monitoring, the ability to beneficially recycle biosolids and the decommissioning of the solids storage lagoons. Capacity was increased to 5,000 m^3 per day for a design service population of 12,900. Stage IIIB was completed in 2005 without the Laboratory/Administration expansion. Of the $7.4 M upgrade, $2.3 M was funded by the Federal and Provincial Governments.

The upgrade consisted of a complete rebuild of the main lift station at Marine Drive with odour control, added redundancy to critical equipment, stand-by power, effluent filtration, replacement of the chlorination/de-chlorination system with Ultra Violet disinfection, an elaborate odour control system and architectural improvements to the original exterior of the original building.

Capacity was increased to 6,700 m^3 per day average flow for a design service population of 15,000. Stage IIIB was completed in 2008 with the $0.4 M expansion of the Laboratory/Administration area. The Water Reclamation project was completed in 2010. This project utilizes the highly treated effluent for process water at the facility resulting in a 110 ML annual reduction in potable water use. In 2011, the Trickling Filter Media Upgrade was completed. The total cost of the project was $0.55 M and entailed removing approximately 1,560 m^3 of crossflow media and replacing with vertical flow media. This project was the result of the September 2007 pilot study (Dayton & Knight Ltd.) designed to reduce the impact of sloughing conditions problematic at the facility.

In 2017 an Engineering Audit was carried out on the WPCC. The Audit concluded that the biological process is currently working well, with the plant showing very efficient removal of BOD,TSS and phosphorus. The plant is currently at about 90% of its 15,000 person equivalent projected design capacity, based on service population, which is projected to reach 15,000 people by between 2020 and 2025 based on current rates of growth. The design capacity of the plant is primarily based on biological and phosphorous loading to the plant, not flows. The primary trigger for plant upgrades will be the performance of the phosphorus removal process.

Based on the capacity assessment of the major plant unit processes, most have capacity well in excess of the 15,000 person equivalent design capacity. The unit processes with limited capacity and no redundancy include the anaerobic and anoxic reactors, which form part of the phosphate removal process. They currently have no redundancy, and are approaching their capacity limits.

The best estimate of when these capacity upgrades will be required is between 2024 and 2027 as the service population approaches 15,000 people; however, precise timing of upgrades is dependent on how the phosphorus removal process continues to perform. These upgrades are likely to be required in the next 5 years, with this in mind, the City began planning the Stage IV Plant Upgrades starting with a site selection study as per the City's Liquid Waste Management Plan in 2019.

Table 2 - Cost Summary Table

Project	Cost	Year
Stage I - 6,250 connected population	$0.9 M	1977
Chemical Phosphorus Removal	$0.1 M	1982
Stage II - 8,250 connected population	$1.8 M	1986
Solids Improvements	$0.5 M	1991
Stage IIIA - 12,500 connected population	$5.3 M	1998
Stage IIIB – 15,000 connected population	$7.4 M	2004
Laboratory/Administration Expansion	$0.4 M	2008
Reclaimed Water	$0.1 M	2009
Trickling Filter Media Upgrade	$0.55 M	2011

UV System Upgrade	$0.82 M	2018
Total	**$17.87 M**	
Estimated Insurable/Replacement Value (2018)	$52 M	

3.0 Wastewater Collection System

3.1 Overview of Collection System

The Utilities Division, through a schedule of systematic new improvements, upgrades and replacements strives to maintain and improve the sanitary sewer collection system. This Division plays an integral role in maintaining the health, safety and well-being of the community. The sewer utility is a self-liquidating funded system which must provide for their own revenues through fees, taxes and other charges to support the expenditures required to operate and maintain infrastructure on a daily basis and long into the future.

3.2 Collection System

The City of Salmon Arm's sanitary sewer collection system consists of 14 sewerage sub areas and 127 km of gravity and force main sanitary sewer pipes covering approximately 1800 hectares. There are approximately 6180 residential, commercial, industrial and institutional lots fronting onto the sanitary sewer system (2019 Court of Revision Report). There are seven (7) sewer lift stations that collect and pump sewerage to the Lakeshore Sewer Interceptor located on the foreshore where the main lift station, Wharf Street Pump Station, pumps the sewerage directly to the WPCC (see Map 3.2). The Interceptor provides storage and flow equalization capabilities.

3.3 Lift Stations

All seven of the tributary Lift stations are inspected once a week by the City of Salmon Arm's Utilities Division. All lift stations are thoroughly inspected and cleaned on a monthly basis. The stations are monitored using the City's SCADA system which enables staff to troubleshoot and trend data on the system.

Table 3 - Wastewater Facilities

No.	Wastewater Lift Stations & Facilities	Address
1	Water Pollution Control Centre	121 Narcisse Street NW
2	Mosquito Park Lift Station	4290 Canoe Beach Drive NE
3	Clare's Cove Lift Station	5391-75 Avenue NE
4	Captain's Cove Lift Station	2251-73 Avenue NE
5	Canoe Beach Lift Station	7720-36 Street NE
6	Wharf Street Pump Station	1000 Marine Park Drive NE
7	Rotten Row Lift Station	681-10 Avenue SW
8	10 Avenue SW Lift Station	2270-10 Avenue SW [TCH]

3.4 Wharf Street Lift Station

The Wharf Street Lift station is gravity fed by the Lakeshore Interceptor. Three 30 Hp pumps with variable speed drives are used to feed the wastewater facility at rates determined by WPCC operators. The station was upgraded in 2002 with each pump rated at 80 liters/sec flow. The foul air is treated by utilizing ultraviolet light which catalyses the breaking of ambient oxygen and water vapor molecules into O^+ and OH^- ions. These free radicals oxidize the odourous contaminants in the air. This reaction results in a sequential and instantaneous gas breakdown of the contaminants with minimal by-products, such as elemental sulfur, CO_2, water vapor, molecular oxygen and trace ozone. In the event of an extended power outage, there is the capability to connect the City's portable generator to the station to run the pumps. A second portable generator was purchased in 2011 primarily to service this critical lift station. This generator was utilized in July of 2012 when a primary Hydro feed to the electrical sub station failed resulting in a localized 33 hour power outage.

3.5 Lift Station Repairs and Modifications

Significant repairs or upgrades in 2021 included the purchase of a new pump for Rotten Row lift station and a new impellor for one of the 10^{th} Ave lift station pumps.

3.6 Sanitary Flushing

Approximately 10.7 km of sanitary mains were flushed in 2021 as part of the maintenance program. Certain main lines and services of concern are flushed quarterly.

3.7 Main and Service Interruptions

There were two sanitary mainline blockages within the sanitary collection system in 2021 as well as a handful of service interruptions which are typically attributed to grease build up within the service pipe from the homeowner's residence or root infiltration from nearby trees and shrubbery.

3.8 Inflow and Infiltration Monitoring Program

The program identifies locations where storm water or ground water enters the sanitary system. We continue to provide system improvements in an effort to reduce the amount of rainwater and groundwater entering the sanitary sewer system when it is cost-effective to do so. Reduction of Inflow & Infiltration (I&I) in the system lowers the risk of sanitary sewer overflows and can decrease the costs of conveying and treating wastewater. Part of this program includes smoke testing of all the sewer appurtenances within the City in search of cross connections.

3.9 Wastewater Collection Capital Projects

Table 4 - Capital Project Information

Capital projects completed in 2021
◆ 75th Ave NE Sanitary main renewal
◆ Sani Renewal Hudson - TCH
◆ Raven Forshore F/M replacement
◆ Canoe Beach Drive Design
Capital Projects scheduled for 2022
◆ Lakeshore Drive Sanitary Main upgrade (Alexander St.)
◆ Ross St Underpass Sanitary line
◆ Lakeshore Drive sanitary upgrade design
◆ Canoe Beach Drive Sanitary main reroute/interceptor
◆ Wharf St Pump Station trunk line liner
◆ Foreshore Main Rehab Design Phase 2
◆ Sanitary Main extension TCH West (MoTI project)

4.0 Wastewater Treatment - Water Pollution Control Centre (WPCC)

The City of Salmon Arm WPCC is located at 121 Narcisse Street N.W. which is located west of the City's Town Centre adjacent to the Shuswap Lake. This section of the report will detail the performance and operational strategies of the plant during the past year.

WPCC – After renovations

Wharf Street Lift Station

4.1 Process Overview

The process of wastewater treatment can be separated into two flow streams – liquid and solids also referred to as the liquid train and solids train.

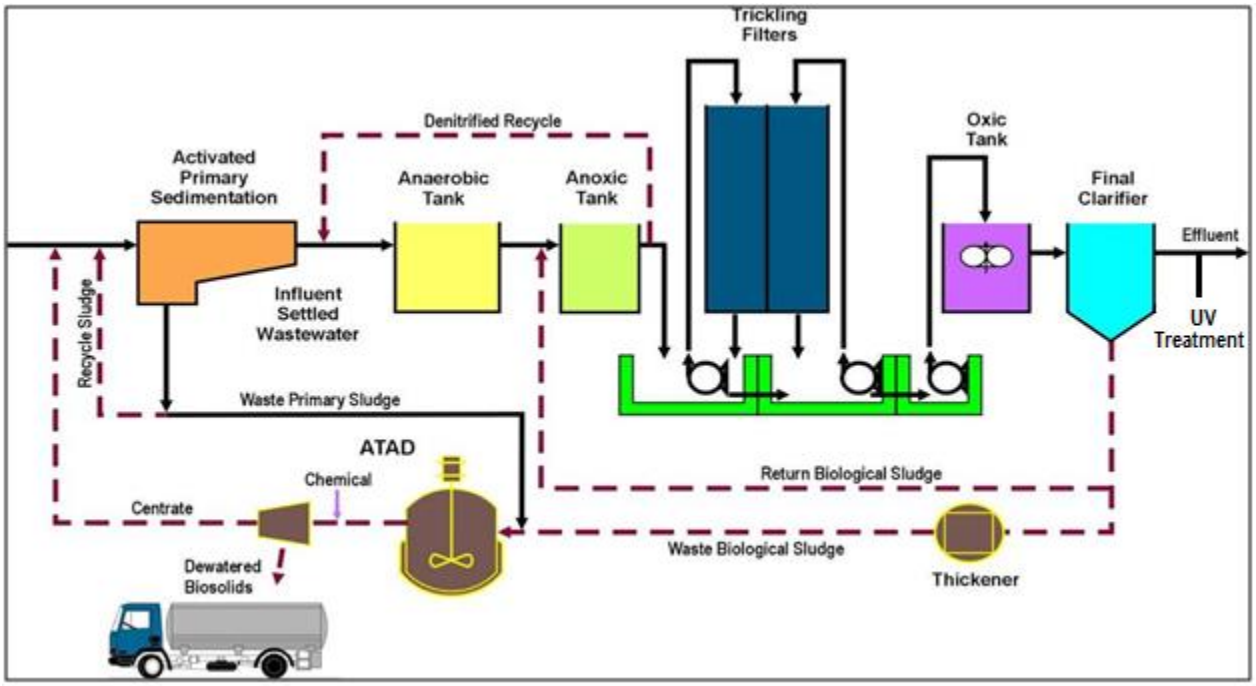


Figure 1: Wastewater Treatment Overview

Initially the wastewater is pumped into the plant from a sewage lift station (Wharf Street) located at Marine Park Drive. The influent then passes through several mechanical devices to remove large particles including rocks, rags, plastics and grit. This is done in the headworks of the facility and prevents damage to downstream equipment.

Headworks

Primary Sedimentation Tanks

The flow then enters one of two Primary Sedimentation Tanks where heavier organic and inorganic solids are settled out of the liquid stream. These particles are then pumped to the ATAD for stabilization. The liquid, on the other hand, then enters the tertiary BNR and SGR-FGR part of the facility for further treatment.

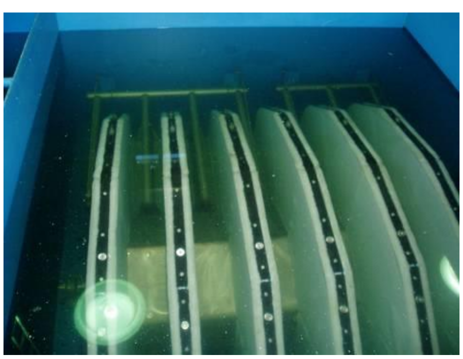
SGR's

FGR

The tertiary treatment involves the use of bacteria to convert degradable organic matter into bacterial cells. These cells are then separated from the liquid in the secondary clarifiers.

The growth portion of the bacteria is removed from the process by thickening and pumped to the ATAD while the remainder is recycled back to the incoming wastewater. This is essential to maintain a balance of food (wastewater organics) to micro organisms.

The secondary effluent then passes through the Aqua Aerobics disk filtration system which provides 10 micron filtration. The effluent is then disinfected using a TrojanUV3000Plus™ Ultra Violet Light (UV) disinfection system prior to it being discharged into the Salmon Arm Bay in the Shuswap Lake.



Cloth Disk Filters

Secondary Clarifiers

UV Treatment System

UV HMI

The primary solids and waste biological solids are digested (broken down) in the ATAD cells. This process uses high temperature bacteria (60 to 70 degrees Celsius) to stabilize and pasteurize the biosolids. Following processing, the biosolids are thickened with the use of high speed centrifuges and then hauled to landfill for potential site reclamation.

Centrifuge

Train B Odour Scrubber

Odour control is another major component of the plant operation. The odour control has been separated into two trains based on the concentration of odour generating compounds. One train deals with a large air volume of low odour concentration while the second train deals with a low air volume with a high concentration of odour compounds. The latter system uses a multi treatment system – biofilter, ozone contact, four (4) stage chemical scrubber and dilution while the other train uses a single stage chemical scrubber to oxidize the odour producing compounds.

Single Stage Chemical Scrubber

ATAD & Piping

Generator Set, Train B - Odour Control and Filtration Building

4.2 Flows

Plant flows decreased by 0.6% in 2021 from 2020. The average daily flow was 4,479 m^3/d while in 2020 it was 4,508 m^3/d. The highest flow of 6,287 m^3/d was recorded on January 13, 2021 when snow melt increasing the inflow and infiltration into the collection system.

Outfall with marker buoy

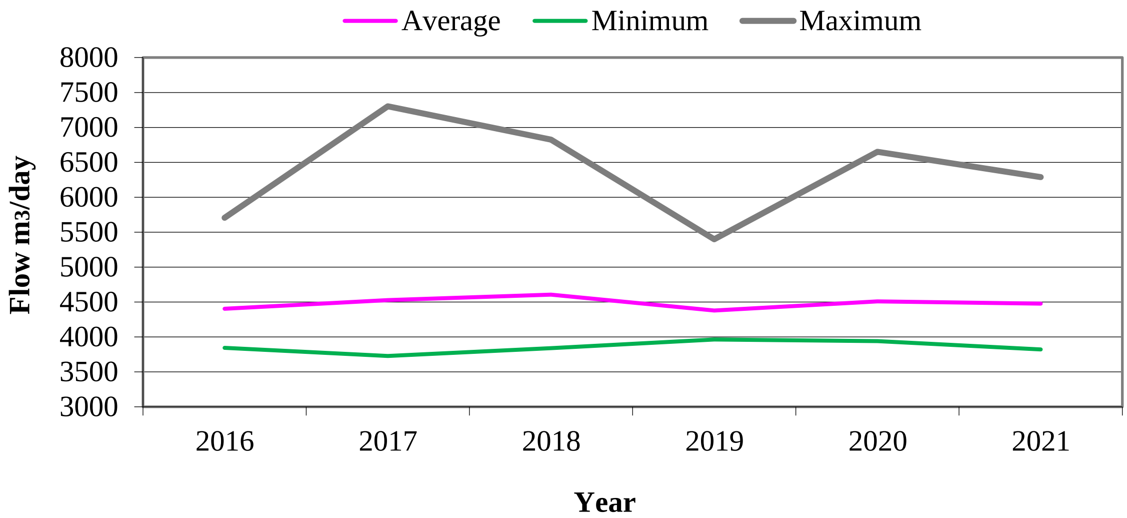


Figure 2: Minimum, Maximum and Average Daily Flows

4.3 Nutrient Removal

Phosphorus concentration is the key nutrient contributing to poor water quality in the Salmon Arm Bay as it is in most lakes in British Columbia. The WPCC contributed approximately 2.5% of the phosphorus loading to the Salmon Arm Bay in 2020. Addition information on the health of the entire Shuswap Lake is available from the **Summary: 2011–2013 Water Quality Monitoring Results for Shuswap and Mara Lakes** and can be viewed at:

https://www.fraserbasin.bc.ca/_Library/TR_SLIPP/SLIPP_Water_Quality_Summary_2011_2013.pdf

Key points contained in the Summary are:

- The most significant source of phosphorus and other nutrients to the Shuswap and Mara Lakes is the Shuswap River. The Salmon and Eagle Rivers contribute the second and third largest loadings of phosphorus to the lakes.
- The largest non-point source of nutrients (over 95%) comes from seepage and run-off from agricultural lands in the Shuswap, Salmon and Eagle River watersheds. This source affects water quality in the lakes much more significantly than other sources do.
- If all wastewater treatment plants in the Shuswap increased their capability to tertiary treatment (some are now operating at secondary treatment levels), this would likely achieve the largest reduction in nutrients from a permitted point-source.
- Within Shuswap and Mara Lakes, the largest direct nutrient inputs occur naturally from decaying salmon following spawning.

*Shuswap Lake Integrated Planning Process,"***Summary: 2011–2013 Water Quality Monitoring Results for Shuswap and Mara Lakes"** *Pages 9, 10*

Table 5 – Phosphorus Mass Loading to Salmon Arm Bay from Salmon River, White Creek, Tappen Creek and Salmon Arm WPCC at 2020 Concentration and Flow – Daily Annual Averages

Total Mass Load (kg/d)	Salmon River* 1985 - 1999		White Creek* 1987 - 1990		Tappen Creek* 1988 - 1990		WPCC Year 2021	
	(kg/d)	% of Total	(kg/d)	% of Total	(kg/d)	% of Total	(kg/d)	% of Total
75.4	65.7	87.1%	6.9	9.2%	0.9	1.2%	1.9	2.5%

- *Data supplied from WPCC Outfall Impact Study, August 2002 (Dayton & Knight Ltd.)

Table 6 - Effluent Quality Summary - Yearly

Parameter *(mg/l)*	2013	2014	2015	2016	2017	2018	2019	2020	2021	OC
Flow (m^3)	4318	4355	4388	4406	4528	4605	4378	4508	4479	8200
Total Phosphorus (mg/l)	1.13	0.77	0.25	022	0.32	0.45	0.35	0.33	0.42	0.5
Kg P per Day	4.88	3.35	1.09	0.95	1.47	2.05	1.52	1.51	1.90	4.1
Kg P per Year	1781	1224	397	347	536	749	556	551	694	1497
Suspended Solids (mg/l)	7.2	5.4	4.4	4.8	5.6	7.0	5.9	5.6	6.3	20.0
BOD_5 (mg/l)	6.5	8.3	5.8	6.7	8.7	9.1	9.7	12.2	12.2	15.0
Ortho Phosphorus (mg/l)	0.51	0.32	0.04	0.03	0.10	0.14	0.04	0.06	0.09	N/A
Ammonia (mg/l)	6.6	9.4	5.5	7.0	9.4	11.2	10.5	13.7	12.7	N/A
Nitrate & Nitrite (mg/l)	8.8	8.3	10.8	11.6	10.9	9.1	8.3	8.1	8.9	N/A
NH_4 NO_3 NO_2 (mg/l)	15.4	17.0	16.3	18.4	20.1	20.6	20.6	21.8	22.3	N/A

Table 7 - Effluent Quality Summary - Weekly

Test Data	S.S. mg/l	BOD mg/l	Ortho P mg/l	Total P mg/l	NH_4 mg/l	NOx mg/l
January 7, 2021	4.2	6.7	0.01	0.233	16.6	7.9
January 14, 2021	3.8	6.1	0.01	0.242	14.9	7.2
January 21, 2021	4.6	6.1	0.01	0.253	17.3	8.2
January 28, 2021	6.2	7.6	0.06	0.296	18.5	5.7
February 4, 2021	4.8	6.8	0.02	0.249	20.0	5.1
February 11, 2021	2.3	9.1	0.01	0.305	31.6	5.6
February 18, 2021	1.1	10.2	0.05	0.37	31.4	2.6
February 25, 2021	5.8	9.8	0.00	0.369	22.3	1.2
March 4, 2021	7.6	12.9	0.10	0.427	N/A	3.4
March 11, 2021	8.9	14.0	0.14	0.482	N/A	4.2
March 18, 2021	13.4	15.1	0.15	0.542	22.5	2.5
March 25, 2021	N/A	15.6	0.14	0.490	24.0	0.6
April 1, 2021	6.9	10.3	0.31	0.629	N/A	1.1
April 8, 2021	13.1	23.0	0.35	0.767	N/A	0.3
April 15, 2021	16.2	18.2	0.10	1.04	22.5	3.9
April 22, 2021	8.4	13.9	0.17	0.521	21.7	5.6
April 29, 2021	6.3	12.2	0.14	0.444	N/A	1.0
May 6, 2021	N/A	18.5	0.05	1.63	21.0	4.7

Test Data	S.S.	BOD	Ortho P	Total P	NH_4	NOx
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
May 14, 2021	9.1	13.8	0.08	0.552	N/A	12.2
May 20, 2021	6.1	8.8	0.07	0.354	10.8	14.2
May 27, 2021	5.7	11.8	0.07	0.365	N/A	7.8
June 3, 2021	8.7	14.0	0.08	0.537	15.7	11.3
June 10, 2021	8.5	12.4	0.06	0.416	5.4	13.8
June 17, 2021	5.1	11.3	0.06	0.268	8.2	14.9
June 24, 2021	5.9	9.3	0.05	0.296	5.4	11.8
June 29, 2021	4.3	10.7	0.06	0.276	5.3	11.6
July 8, 2021	4.7	12.2	0.02	0.265	8.8	11.4
July 15, 2021	5.5	13.8	0.09	0.448	6.5	10.6
July 22, 2021	3.8	10.1	0.06	0.265	8.0	11.0
July 29, 2021	5.9	13.1	0.07	0.329	13.1	10.9
August 5, 2021	6.1	12.8	N/A	0.334	2.3	12.6
August 12, 2021	2.6	12.6	0.08	0.596	6.6	12.0
August 19, 2021	5.1	13.9	0.07	0.311	6.4	12.1
August 26, 2021	7.1	5.1	0.03	0.293	7.4	11.7
September 2, 2021	N/A	4.6	0.06	0.300	8.2	9.2
September 9, 2021	5.1	8.3	0.08	0.328	6.3	10.7
September 16, 2021	5.4	9.2	0.07	0.309	8.3	10.6
September 23, 2021	6.2	10.3	0.13	0.417	8.9	11.0
September 29, 2021	6.6	15.1	0.25	0.535	10.1	13.9
October 7, 2021	5.6	16.4	0.64	0.965	8.7	9.7
October 14, 2021	5.1	13.2	0.12	0.412	10.6	12.4
October 20, 2021	6.0	14.4	0.10	0.395	14.2	10.3
October 28, 2021	6.3	11.5	0.09	0.364	9.6	12.8
November 4, 2021	4.7	13.3	0.05	0.338	7.0	15.4
November 10, 2021	5.3	15	0.07	0.440	12.8	11.7
November 18, 2021	4.6	14	0.05	0.318	10.5	12.8
November 25, 2021	4.3	14.3	0.00	0.298	8.3	11.7
December 2, 2021	4.4	12.4	0.05	0.271	7.0	13.0
December 9, 2021	0.9	14.5	0.07	0.297	6.0	10.0
December 16, 2021	6.3	11.4	0.06	0.104	4.6	9.9
December 22, 2021	10.0	12.7	0.07	0.345	14.4	9.5
December 29, 2021	12.0	21.0	0.06	0.441	23.3	5.3
Average	**5.6**	**12.2**	**0.06**	**0.335**	**13.7**	**8.1**
Maximum	**15.8**	**24.4**	**0.20**	**0.820**	**26.4**	**18.2**
Minimum	**0.7**	**3.0**	**0.00**	**0.007**	**4.8**	**2.3**

Table 8** - **Tests performed by Caro Environmental Services on split sample.

Test Data	S.S. mg/l	BOD mg/l	Ortho P mg/l	NH_4 mg/	NO_3 mg/l	NOx mg/l	E.Col	Fec. Col.
7-Jan	3.2	8.9	N/A	N/A	N/A	N/A	<3.0	<3.0
14-Jan	14.2	2.8	N/A	N/A	N/A	N/A	9.1	9.1
21-Jan	3.0	<7.1	0.0291	13.5	6.57	7.76	N/A	N/A
28-Jan	4.4	<7.4	N/A	16.2	N/A	N/A	N/A	N/A
4-Feb	6.0	13.4	N/A	15.3	N/A	N/A	N/A	N/A
11-Feb	5.0	8.9	N/A	N/A	N/A	N/A	23	23
18-Feb	5.0	9.2	0.0409	23.0	1.09	1.81	N/A	N/A

Test Data	S.S. mg/l	BOD mg/l	Ortho P mg/l	NH_4 mg/	NO_3 mg/l	NOx mg/l	E.Col	Fec. Col.
25-Feb	5.2	11.0	N/A	N/A	N/A	N/A	N/A	N/A
4-Mar	7.4	10.2	N/A	N/A	N/A	N/A	N/A	N/A
11-Mar	7.8	16.0	N/A	N/A	N/A	N/A	23	43
18-Mar	9.2	19.0	0.0453	19.0	1.27	2.07	N/A	N/A
25-Mar	8.0	15.0	N/A	N/A	N/A	N/A	N/A	N/A
1-Apr	5.0	12.0	N/A	N/A	N/A	N/A	N/A	N/A
8-Apr	9.8	21.1	N/A	N/A	N/A	N/A	23	43
15-Apr	11.6	11.0	0.0474	15.5	3.99	4.43	N/A	N/A
21-Apr	7.0	9.1	N/A	N/A	N/A	N/A	N/A	N/A
29-Apr	3.8	6.1	N/A	N/A	N/A	N/A	N/A	N/A
6-May	32.8	14.0	N/A	N/A	N/A	N/A	N/A	N/A
15-May	6.3	<5.9	0.182	6.90	10.8	11.9	3.6	3.6
20-May	4.0	7.3	N/A	N/A	N/A	N/A	N/A	N/A
27-May	3.6	6.0	N/A	N/A	N/A	N/A	N/A	N/A
3-Jun	7.8	8.0	N/A	N/A	N/A	N/A	<3.0	3.0
10-Jun	4.6	8.0	0.0137	3.87	11.3	12.2	N/A	N/A
17-Jun	3.2	<6.2	N/A	N/A	N/A	N/A	N/A	N/A
24-Jun	5.0	<6.2	N/A	N/A	N/A	N/A	N/A	N/A
30-Jun	3.8	<6.4	N/A	N/A	N/A	N/A	3.6	3.6
8-Jul	3.8	<6.6	0.0342	5.84	9.77	10.5	N/A	N/A
15-Jul	4.2	12.1	N/A	N/A	N/A	N/A	N/A	N/A
22-Jul	3.6	<5.8	N/A	N/A	N/A	N/A	N/A	N/A
29-Jul	4.2	<5.4	N/A	N/A	N/A	N/A	<3.0	<3.0
5-Aug	6.3	<7.2	N/A	N/A	N/A	N/A	N/A	N/A
12-Aug	23.0	5.5	N/A	N/A	N/A	N/A	N/A	N/A
19-Aug	5.0	6.5	N/A	N/A	N/A	N/A	N/A	N/A
26-Aug	5.6	<7.2	N/A	N/A	N/A	N/A	<3.0	<3.0
2-Sep	<2.0	<7.5	0.0456	6.52	10.2	11.2	N/A	N/A
9-Sep	5.2	<6.5	N/A	7.21	N/A	N/A	N/A	N/A
16-Sep	5.0	6.1	N/A	N/A	N/A	N/A	N/A	N/A
23-Sep	5.0	5.0	0.0787	7.45	N/A	N/A	<3.0	<3.0
29-Sep	5.2	8.9	0.128	8.84	10.7	11.7	N/A	N/A
7-Oct	6.0	7.1	N/A	6.49	N/A	N/A	N/A	N/A
14-Oct	4.4	<6.6	N/A	N/A	N/A	N/A	N/A	N/A
20-Oct	6.7	12.0	N/A	N/A	N/A	N/A	3.6	3.6
28-Oct	5.8	8.1	<0.005	7.93	11.5	12.6	N/A	N/A
4-Nov	5.6	17.0	N/A	N/A	N/A	N/A	N/A	N/A
10-Nov	4.4	6.0	N/A	N/A	N/A	N/A	N/A	N/A
18-Nov	3.4	15.4	N/A	N/A	N/A	N/A	<3.0	<3.0
25-Nov	3.2	5.0	0.0092	8.68	10.1	11.7	N/A	N/A
2-Dec	3.8	<6.9	0.0363	6.76	9.88	11.6	N/A	N/A
9-Dec	4.4	11.4	N/A	N/A	N/A	N/A	N/A	N/A
16-Dec	10.8	<7.1	N/A	N/A	N/A	N/A	7.3	7.3
22-Dec	6.0	11.7	0.0159	11.9	8.87	10.3	N/A	N/A
29-Dec	10.6	16.4	N/A	N/A	N/A	N/A	N/A	N/A
Avg.	**6.6**	**9.1**	**0.051**	**10.6**	**8.2**	**9.2**	**N/A**	**N/A**

4.4 Fecal Coliform

There were no fecal coliform failures for 2021 as all results were well below the 200 CFU (or MPN) per 100 millilitres (mL), maximum.

4.5 Toxicity

As part of the Environment Canada's Wastewater Systems Effluent Regulations which came into effect January 1, 2013, the City was initially required to test the effluent for toxicity quarterly. However, having never failed a toxicity analysis, the frequency was reduced to annually. This was completed on effluent collected on December 14th, 2021 where once again analysis concluded that the effluent discharged from the facility is nontoxic.

4.6 Biosolids

The City of Salmon Arm produced approximately 350 dry tonnes of Class B biosolids during 2021. The biosolids are used by the Columbia Shuswap Regional District for local landfill reclamation. Testing of the biosolids by CARO Environmental Services for nutrients, metals and fecal coliform occurred on November 25th. Test results, once again, verified the biosolids produced by the Auto Thermophilic Aerobic Digester (ATAD) were of the highest quality managed under the Organic Matter Recycling Regulation.

4.7 Operating Certificate

The City operates the WPCC under Operating Certificate issued by the BC Ministry of Environment on June 1st, 2018. The certificate is attached as **Appendix B**.

In addition, The City's system must also comply with Environment Canada's Wastewater Systems Effluent Regulations. The goal of the Regulation is to standardize wastewater treatment across Canada. The Regulation specifies conditions to be met in order for the discharge of wastewater including setting limits on the concentration of deleterious substances that are authorized to be deposited, as well as requirements concerning effluent monitoring, toxicity, record keeping and reporting. Since the City's Operation Certificate is generally more stringent, only additional monitoring by an accredited laboratory and reporting is required to meet the Regulation.

4.8 Liquid Waste Management Plan

The City's Liquid Waste Management Plan (LWMP) was adopted by City Council on November 2, 2004 and was subsequently approved by the Ministry of Environment (MOE). One of the commitments contained in the approved LWMP was to carry out a LWMP update during 2009 to review progress, update the schedule, and make any required revisions in consultation with MOE. The City has been working with WSP Consulting Engineer to update LWMP. In the fall of 2010 meetings were held with MOE staff in an effort to review the proposed updates and amendments. Resulting from these discussions a draft LWMP update memorandum has been prepared and submitted for MOE review and comment.

4.9 WPCC Pilot Study

The aerobic granular sludge (AGS) pilot study at the City of Salmon Arm's Water Pollution Control Centre (WPCC) is part of the process selection exercise for the Stage IV expansion. Following the Process Selection Options review, AGS technology proved the most suitable option to meet the Stage IV expansion objectives such as high-quality effluent, small footprint, energy efficient and low odour potential. AGS technology is relatively new in North America and currently not utilized in Canada. As a result, WSP Consulting Engineers recommended the piloting of the AGS technology to better understand the process in terms of operation and maintenance and to validate the full-scale design criteria and verify the expected treatment performance of the technology specific to Salmon Arm.

AquaNereda®

AEROBIC GRANULAR SLUDGE TECHNOLOGY

The AquaNereda® Aerobic Granular Sludge Technology is an innovative wastewater treatment technology that provides advanced biological treatment using the unique features of aerobic granular biomass. The unique process features of the AquaNereda technology translate into a flexible and compact process that offers energy efficiency and significantly lower chemical consumption.

The Development of Nereda®

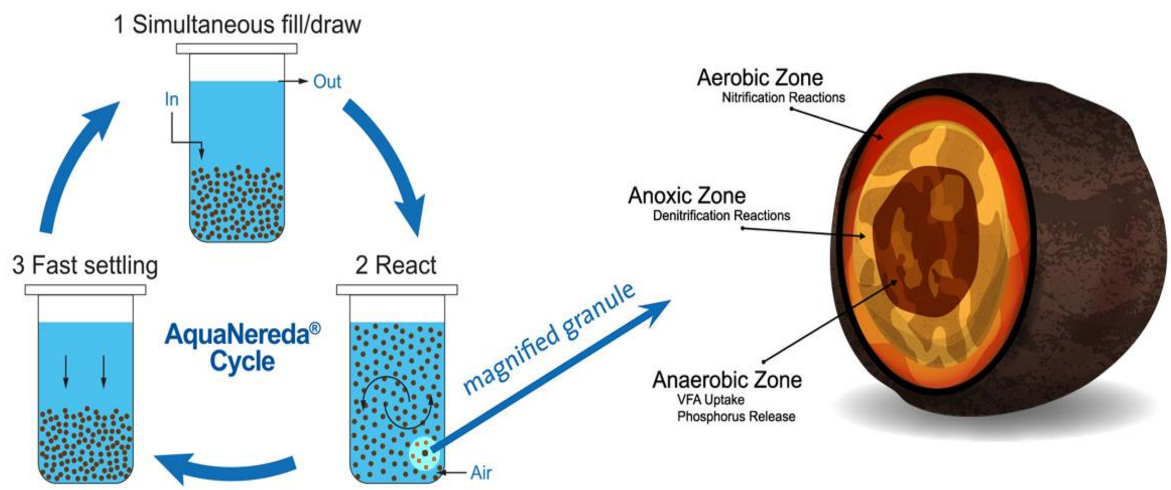
A public-private research partnership in the Netherlands between the world-renowned Delft University of Technology, research institutes, water authorities and Royal HaskoningDHV led to the invention of the first technology applying Aerobic Granular Sludge Technology for the biological treatment of wastewater.

Since its development, Royal HaskoningDHV has transferred the process into an internationally applied, sustainable and cost-effective wastewater treatment technology. After 20 years of research and development, this innovative biological solution is now proving to be one of the most sought–after, progressive wastewater biological treatment technologies.

In 2016 Aqua-Aerobic Systems partnered with Royal HaskoningDHV to expand Aerobic Granular Sludge Technology into North America and is the exclusive provider of this technology in the United States.

Batch Cycle Structure

Based on the unique characteristics of granular biomass, the AquaNereda® Aerobic Granular Sludge Technology uses an optimized batch cycle structure. There are three main phases of the cycle to meet advanced wastewater treatment objectives (Fill/Draw, React, Settling). The duration of the phases will be based upon the specific waste characteristics, the flow and the effluent objectives.



FEATURES & SPECIFICATIONS

- Robust structure of granule withstands fluctuations in chemical spikes, load, salt, pH and toxic shocks
- No secondary clarifiers, selectors, separate compartments, or return sludge pumping stations
- Settling properties at SVI values of 30-50 mL/g allow MLSS concentrations of 8,000 mg/l or greater
- Proven enhanced biological nutrient removal (ENR)
- Simplified operation with fully automated controls

BENEFITS

- Optimal biological treatment is accomplished in one effective aeration step
- Four times less space required compared to conventional activated sludge systems
- Energy savings up to 50% compared to activated sludge processes

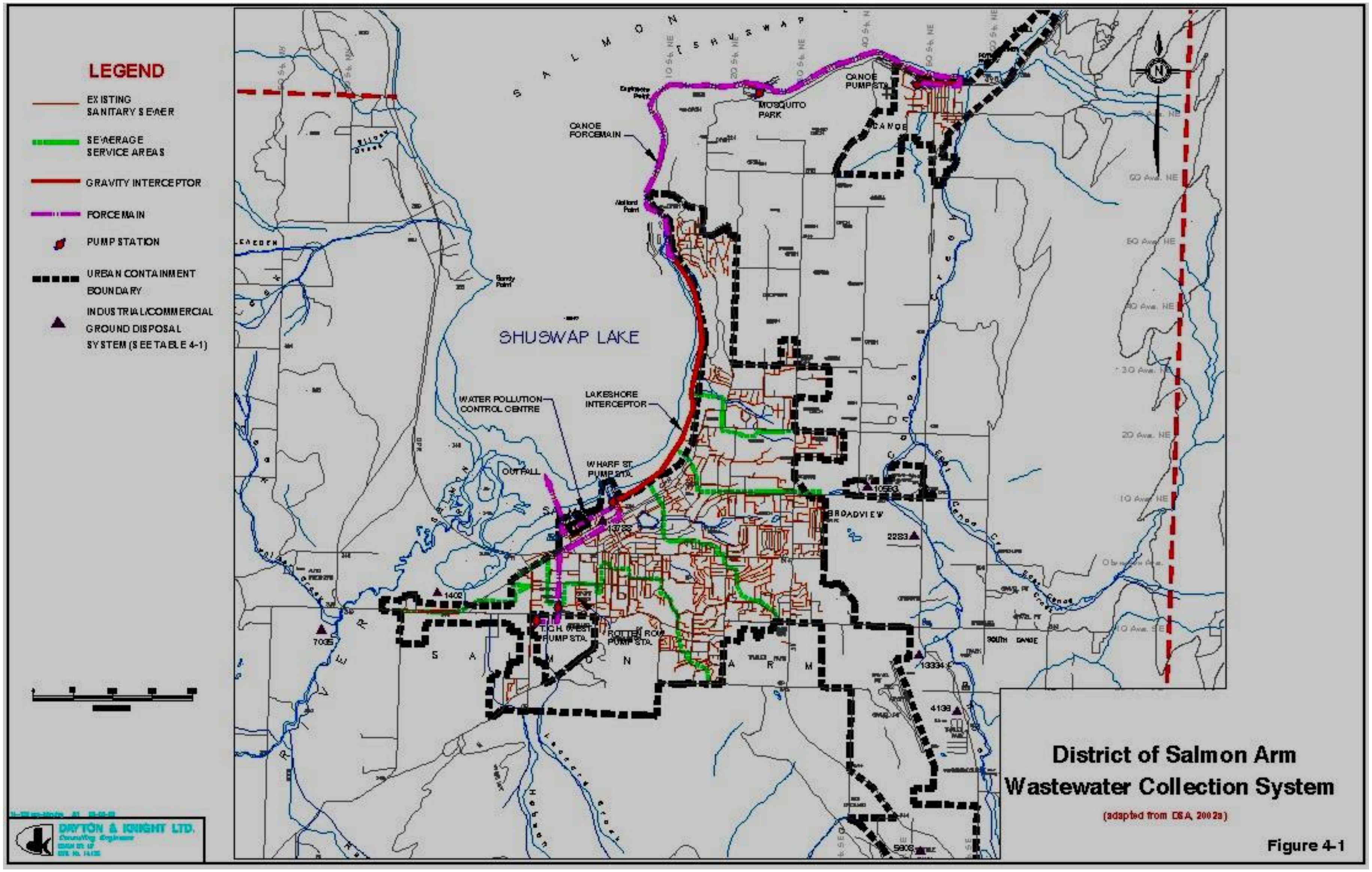
- Robust process without a carrier
- Significant reduction of chemicals for biological nutrient removal due to the layered structure and biopolymer backbone of the granule
- Lowest life-cycle cost

5.0 WPCC Capital Projects

Table 9 – WPCC Capital Project Information

WPCC Capital Projects completed in 2021
◆ AquaNereda Pilot Study
Staff Initiated WPCC Projects Completed in 2021
◆ Replace Filter Cloths on Disc Filter 1
WPCC Capital Projects scheduled for 2022
◆ Complete Centrifuge No. 1 Installation
◆ Determine the Suitability of AquaNereda Process
◆ Replace Filter Cloths on Disc Filter 2

APPENDIX A


LEGEND
EXISTING SANITARY SEWER
SEWERAGE SERVICE AREAS
GRAVITY INTERCEPTOR
FORCEMAIN
PUMP STATION
URBAN CONTAINMENT BOUNDARY
INDUSTRIAL/COMMERCIAL GROUND DISPOSAL SYSTEM (SEE TABLE 4-1)
SHUSWAP LAKE
CANOE FORCEMAIN
MOSQUITO PARK
CANOE PUMP STN
CANOE
WATER POLLUTION CONTROL CENTRE
LAKESHORE INTERCEPTOR
OUTFALL
WHARF ST. PUMP STN
BROADVIEW
T.C.H. WEST PUMP STA.
ROTTEN ROW PUMP STA.
DAYTON & KNIGHT LTD.
District of Salmon Arm
Wastewater Collection System
(adapted from DSA, 2002a)
Figure 4-1