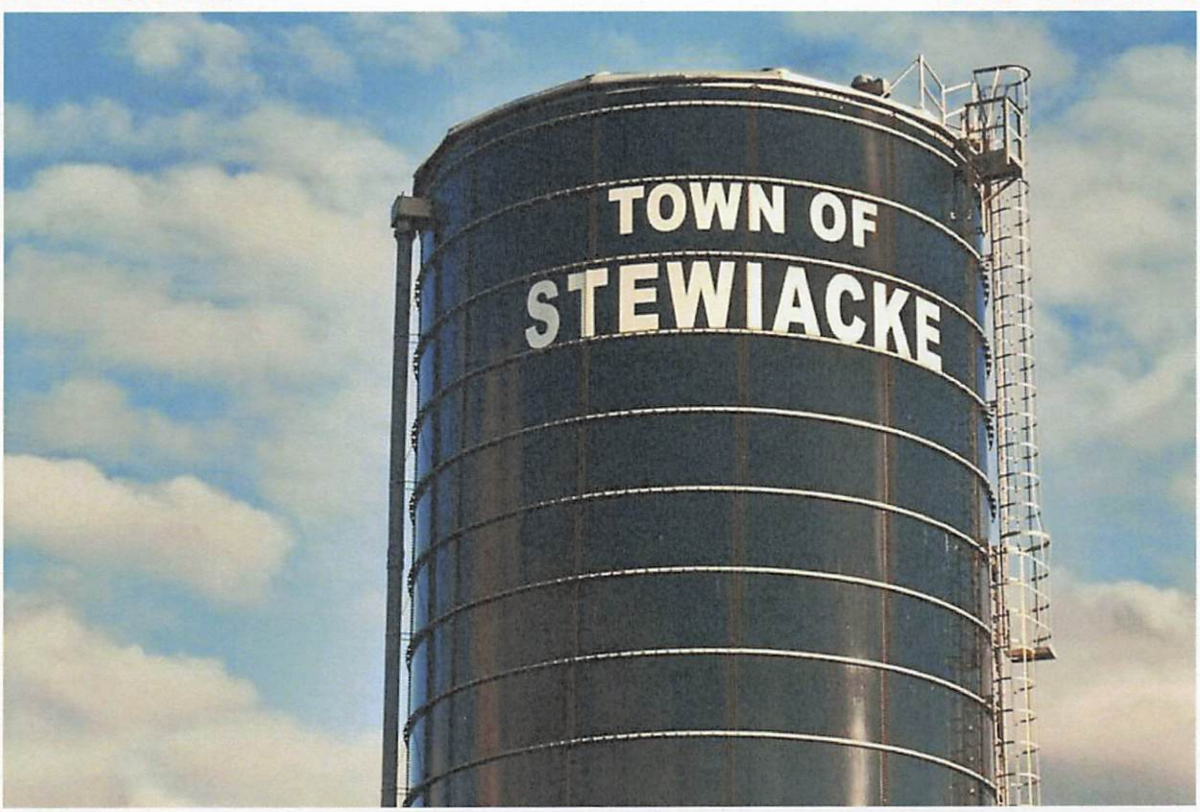
TOWN OF STEWIACKE WATER SUPPLY SYSTEM

PHASE 4 CONCEPT DESIGN REPORT – REV. 02

JULY 05, 2024

CONFIDENTIAL



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PHASE 4 CONCEPT DESIGN REPORT – REV. 02

TOWN OF STEWIACKE

REPORT REV. 02
CONFIDENTIAL

PROJECT NO.: CA0001941.4259
DATE: JULY 05, 2024

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July 5, 2024

Confidential

Town of Stewiacke
295 George Street
PO Box 8
Stewiacke, NS, B0N 2J0

Attention: Jeff Sibley

Subject: Town of Stewiacke - Phase 4 Concept Design Report

Dear Sir:

Attached for your records, review and distribution to the Town Council and Staff is a copy (.pdf) of our **Phase 4 Concept Design Report - Rev. 02** for the Town of Stewiacke's proposed Water Supply System project. This report replaces our previously issued February 22, 2024, report in its entirety.

The primary focus of this Phase 4 report is the proposed water treatment processes and their general relationship with upstream and downstream infrastructure components. Please note that previous WSP Phase 1, 2 and 3 Reports provide additional information pertaining specifically to the development of the wellfield and proposed production well(s).

If you have any questions or comments regarding this report, please contact the undersigned.

Yours sincerely,

Colin Fogarty, P. Eng.

REVISION HISTORY

FIRST ISSUE		
November 8, 2023	**Draft Issue – Phase 4 Concept Design Report - WTP**	
Prepared by	**Reviewed by**	**Approved by**
Kevin O'Leary, P. Eng.	Colin Fogarty, P. Eng.	Kevin O'Leary, P. Eng.
REVISION REV. 01		
February 22, 2024	**Final Issue – Phase 4 Concept Design Report**	
Prepared by	**Reviewed by**	**Approved by**
Stephen Pyke, M.A.Sc., P. Eng.	Colin Fogarty, P. Eng.	Stephen Pyke, M.A.Sc., P. Eng.
REVISION REV. 02		
July 05, 2024	**Final Issue – Phase 4 Concept Design Report – REV. 02**	
Prepared by	**Input by**	**Approved by**
Stephen Pyke, M.A.Sc., P. Eng.	Hany Abraham, M.Sc., P.Eng., PMP	Colin Fogarty, P. Eng.

SIGNATURES

PREPARED BY

July 05, 2024

Stephen R. Pyke, M.A.Sc., P. Eng. | Date

APPROVED[1] BY

July 05, 2024

Colin Fogarty, P.Eng. | Date

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EXECUTIVE SUMMARY

This report summarizes a general approach for improving hydraulic and treatment capabilities of the Town of Stewiacke's existing potable water infrastructure. It identifies specific treatment processes recommendations for achieving acceptable water quality, as well as provides Preliminary Opinion of Probable Construction Costs to achieve an upgraded water supply system.

Details of the Town's future groundwater supply source, Production Well PW21-01, are presented in this project's Phase 3 Production Well Drilling/Testing Exploration Program. PW21-01 hydraulic capacity was confirmed at a minimum of **2 440 m^3/d** (448 USgpm).

The Town's current (2021) serviced population is approximately 1 560 people. Future water demands have been based on the Town's preference for a 35-year horizon serviced population projection to 5 100 people. Using the Town's 2020 Water System Assessment Data as a template, the primary hydraulic capacity sizing criteria (i.e., Max. Day Raw Water Design Flow) representing a future design population of 5 100 people is **3 570 m^3/d** (655 USgpm). This flow exceeds the groundwater hydraulic capacity currently available (see above), thus requiring further PW21-01 pump testing or further production well exploration/testing/development.

Water quality analysis performed on PW21-01 indicates the need for treatment to reduce iron, manganese, sulphates, total dissolved solids, turbidity, and hardness. The water treatment processes recommended and discussed in this report are greensand filtration and nanofiltration. Chlorination, dechlorination and antiscalant chemical dosing is also required. These processes will need to be supported by backwash and high lift pumping systems. Note: A biological filtration process option previously considered has been omitted due to the equipment vendor confirming PW21-01 water quality as being unsuitable for their biological treatment process.

Overall, an upgraded Town of Stewiacke water supply system would generally consist of:

- Groundwater supply well PW21-01, an assumed secondary production well and associated well control buildings.
- New water treatment processes (WTP), residual waste storage tankage, backwash, and high lift pumping systems, and WTP control building.
- New water storage reservoir.
- Water transmission/distribution piping interconnecting the above components to the Town's existing water distribution piping network.
- Supervisory Control and Data Acquisition (SCADA) system.

An Opinion of Probable Construction Costs is presented in Table 4-1. Anticipated Total Capital Construction Costs for the Town's water supply system is **$ 20 140 000**. This cost figure is based on a Class D level estimate (i.e., -20 to +30%) and includes a 20% construction contingency, and costing for preliminary/detailed design engineering, contract administration, site observation and start-up/commissioning services.

1. INTRODUCTION

1.1 PURPOSE

This report, titled - **Phase 4 Concept Design Report - REV. 02**, was prepared by WSP Canada Inc. (WSP) on behalf of the Town of Stewiacke (Town) under TASK B scope-of-work for this project.

The purpose of this report is to present potential upgrades to replace the Town's existing potable water treatment, storage, and transmission/distribution piping infrastructure. The primary focus of this report is to:

- Determine the Town's required future treatment capacity based on future population projection assumptions.
- Identify water treatment processes capable of achieving acceptable potable water quality based on currently known water quality analytical results for the source water, Production Well PW21-01.
- Prepare an Opinion of Probable Construction Costs for the potential water supply system infrastructure upgrades.

In addition, potential water storage and transmission piping options forming part of the Town's future water supply system are also presented herein.

The primary change to this report (i.e., REV. 02) as compared to the previously issued report (i.e., Rev. 01, Feb. 2024) is an increase in hydraulic capacity requirements resulting from increased future design serviced population projections.

1.2 BACKGROUND

The Town's existing potable water supply is sourced from the St. Andrews River. In recent years, the Town has experienced environmental challenges with this water source, including:

- Ecological river maintenance flows that limit water supply availability during summer.
- River sediment increase that negatively impact on the water treatment process.
- A partially collapsed water supply intake pipe gallery.

In 2012, the Town commenced a water source planning process to create a groundwater-based water supply to replace the St. Andrews River surface water source. Previous phase investigations associated with this planning process have focused on locating and developing a groundwater source capable of providing quality water in sufficient quantities to meet the Town's future long-term needs.

To date, groundwater source investigations have included:

- **Phase 1** - Desktop study (June 2019 report).
- **Phase 2** - Monitoring well drilling/testing exploration program (June 2021 report).
- **Phase 3** - Production well drilling/testing exploration program (June 2022 report).

Phase 2 and 3 groundwater test well drilling and testing exploration programs identified a potential groundwater aquifer and production well positioned on the Densmore property located off of St. Andrews Road. Following initial exploration, testing, and modeling results, this aquifer and production well are under review for regulatory approval as a groundwater source for the Town's future potable water supply needs.

Production, test and monitoring well locations identified by the Town's water source planning process are provided in **Appendix A - Town of Stewiacke Zoning Mapping and Water Supply Well Locations.**

1.3 PROJECT UNDERSTANDING

It is proposed the Town's new potable water supply system will consist of the following primary infrastructure components, all of which are to be positioned within the Town's existing municipal boundaries:

- Groundwater production well(s).
- Water treatment process.
- Water storage reservoir.
- Water transmission/distribution piping system.

The Opinion of Probable Construction Costs provided herein for Phase 4 includes probable costing for each of the primary infrastructure components outlined below.

Groundwater Production Well(s):

During the Phase 3 production well drilling/testing exploration program, Production Well 21-01 (PW21-01) was drilled in December 2021 at 250 mm (10") diameter and was pump tested in January 2022 at a flow rate of **2 440 m^3/d** (1 680 L/min., 448 USgpm). This was the maximum pump equipment flow rate available during the well testing procedures. These pump tests confirmed the aquifer water bearing zone was not significantly stressed. Whereas PW21-01 is considered capable of a production flow in excess of the amount stated above, additional pump testing will be required to definitively confirm a higher rated safe-yield pumping capacity.

Nova Scotia Environment (NSE) permitting requirements necessitate a secondary (redundant) production well capable of producing 100 percent stand-by capacity for PW21-01. This second production well can be positioned within the existing PW21-01 aquifer, or in an alternate aquifer. Therefore, further well drilling and testing exploration will be required to establish an additional production well(s).

Detailed engineering design will be required to determine preferences and details for specific production wellhead infrastructure, including wellhead chambers, well pumps, well pump controls, well drop piping/valving, pitless adapters, well control building, wellhead power supply, instrumentation, and a Supervisory Control and Data Acquisition (SCADA) system. Infrastructure will also include local yard piping to connect the production well to water transmission piping linking the wellhead to the water treatment facility.

An access roadway will be required to connect from St. Andrews Road through the Densmore property to the PW21-01 site. Electrical power supply and communication lines will also be routed along this access roadway alignment.

Provision of a groundwater supply well concept design is not considered part of this Phase 4 Concept Design Report. This will need to be developed in a subsequent project phase.

Water Treatment Process:

The Water Treatment Process (WTP) is the key component of Phase 4 and the primary focus of this report.

Water quality results obtained to date for Production Well Pw21-01 have been used to identify potential water treatment unit processes capable of producing acceptable potable water quality. In developing potential water treatment processes, consideration was given to technologies and equipment that have the following attributes:

- Considered as 'tried and true' treatment technologies.
- Currently used in Atlantic Canada municipal water treatment systems.
- Supported by local equipment vendors/suppliers.
- Possess modular capacity expandability, automation, and remote monitoring capabilities.
- Capable of low power operation.
- Capable of relatively low operation and maintenance costs.

It is intended that a WTP Control Building will house the following water treatment process components:

- Raw water inlet and treated water outlet piping systems, including isolation valving.
- Water treatment processing equipment and associated electrical control equipment.
- Temporary on-site treated water storage tankage.
- High-lift and backwash pumping.
- Chlorination disinfection system.
- Emergency back-up power supply.

- Instrumentation, including pressure, flow, pH, residual chlorine, turbidity.
- Supervisory Control and Data Acquisition (SCADA) system.
- Operations amenities, including central control room, operations offices, washrooms, equipment storage, etc.

Water Storage Reservoir:

The Town's existing water treatment system incorporates two (2) water storage reservoirs, one which was constructed in 2003 (approx. capacity = 500 m^3) and the other constructed in 2009 (approx. capacity = 2 400 m^3). The ability to incorporate theses existing reservoir into the new water supply system will best be determined as part of a hydraulic modeling of the overall water supply/treatment/storage/transmission system. Provision of hydraulic modeling is not considered part of this Phase 4 Concept Design Report. This will need to be developed in a subsequent project phase.

It is intended that a new Water Storage Reservoir will be incorporated as part of the Town's upgraded potable water supply system to provide for adequate treated water volumetric capacity. Cost provisions have been incorporated for a new water storage reservoir in the Opinion of Probable Construction Costs table, Table 4-1.

Water Transmission/Distribution Piping:

New water transmission/distribution piping components will be required to connect from Production Well PW21-01 to the WTP Control Building, from the WTP Control Building to the Water Storage Reservoir, and from the Water Storage Reservoir to the Town's existing water distribution piping network.

Routing locations for the transmission/distribution piping will impact on overall water supply system hydraulics. Hydraulic modeling of the preferred pipeline routing will be necessary to determine optimum pipe sizing and configuration.

1.4 GUIDELINES

Water Quality Guidelines:

Water quality regulations for potable water production in Canada are governed by the Guidelines for Canadian Drinking Water Quality (GCDWQ). Health Canada established these guidelines in collaboration with the Federal-Provincial-Territorial Committee on Drinking Water and other federal government departments. Each GCDWQ parameter was established based on current, published scientific research related to health effects, aesthetic effects, and operational considerations.

The GCDWQ include Maximum Acceptable Concentrations (MAC) established based on health effects, Aesthetic Objectives (AO) set for water quality acceptance by consumers (i.e., taste and odour), and Operational Guidance (OG) values set for parameters that may affect water treatment processes or the water distribution system (i.e., corrosion of pipes).

The GCDWQ are reviewed periodically to assess the current guidelines to determine if the scientific evidence has changed and to determine if new parameters need to be added to the guidelines. The review period typically follows a five-year cycle that includes publication of under review parameters.

Design and Operation Guidelines:

Engineering design of the Town's water supply system shall be undertaken in accordance with the latest version of the Atlantic Canada Water Supply Guidelines (2022). These Guidelines represent a collaborative effort among the participating provinces and are intended to provide a guide for developing drinking water supply projects in Atlantic Canada.

The Guidelines are intended to be used in the evaluation of water supply, treatment, and distribution projects, and including the design and preparation of contract drawings and technical specifications. The Guidelines suggest minimum design requirements and establish, as far as is practical, a best practice design approach.

The operation of water supply, treatment, storage, distribution, and operation of drinking water systems in Nova Scotia is regulated jointly by the Nova Scotia Utilities and Review Board (NSUARB) and Nova Scotia Environment (NSE).

1.5 UPDATES TO SYSTEM DESIGN CRITERIA

This Phase 4 Concept Design Report - Rev. 02 incorporates the Town's preference for a revised future design population of 5 100 people and the use of measured flow data obtained from the Town of Stewiacke 2020 Water System Assessment Report. The previous version of this report (i.e., Rev. 01, Feb. 2024) was based on a projected future design serviced population of 3 000 people.

To illustrate the relative change in design flows of Rev. 02 (this report) versus Rev. 01 (previous report), a comparison of System Design Criteria is provided below in Table 1-1 for general reference.

System Design Criteria parameters include:

- Calculated Average Per Capita Water Demand (i.e., consumption).
- Maximum (Max.) to Average (Avg.) Day Ratio.
- Avg. Daily Treated Design Flow.
- Avg. Daily Raw Water Design Flow.

- Max. Day Treated Design Flow.
- Max. Day Raw Water Design Flow.

Design flow calculations are summarized in Section 2 - System Design Criteria.

Table 1-1: Concept Design Report Comparative Summary: Rev. 01 vs. Rev. 02 System Design Criteria

System Design Criteria Parameter	*Units*	Concept Design Report – Rev. 01	Concept Design Report – Rev. 02
Design Population	*people*	3 000	**5 100**
Per Capita Water Consumption:			
Calculated	*Lpcd*[1]	374	**329**
Assumed (for prelim. design)	*Lpcd*[1]	400	**350**
Max to Avg. Day Ratio *(for prelim. design)*	*NA*	1.50	**1.50**
Avg. Daily Treated Water Design Flow	*m³/d*	1 200	**1 785**
Avg. Daily Raw Water Design Flow	*m³/d*	1 600	**2 380**
Max. Day Treated Water Design Flow	*m³/d*	1 800	**2 680**
Max. Day Raw Water Design Flow	*m³/d*	2 400	**3 570**

Notes:

1. *Litres per capita/day*

2. SYSTEM DESIGN CRITERIA

2.1 SERVICE BOUNDARY AREA

It is the Town's preference to proceed with establishing a centralized domestic water supply system to service residential, commercial, and institutional users within its current municipal boundaries. A map of the Town of Stewiacke showing its municipal zoning, street network and boundaries is provided in **Appendix A - Town of Stewiacke Zoning Mapping and Water Supply Well Locations.**

It is currently understood the Town is not planning to extend central water supply services to and existing or future developments positioned beyond the Town's proposed water service area boundaries. However, depending upon the new proposed water supply system configuration, the Town could consider extending water services in the future to accommodate residential, commercial, institutional, or industrial developments located beyond the current water service area boundaries.

For the purposes of Phase 4, it has been assumed that domestic water services will be limited to users located within the existing water service area boundary.

2.2 FUTURE POPULATION PROJECTIONS

The financial and design implications of the Town's new water supply system require the Town to carefully consider its future serviced population expectations. Existing serviced populations and potential future residential, commercial, institutional, and industrial growth will directly impact on the hydraulic capacities of water treatment, pumping, storage, and pipeline convenance components.

System component capacities are based on existing and anticipated average day and maximum (peak) day water demands. These parameters are directly affected by connected (serviced) population figures. In turn, water supply system capital, operation and maintenance costs are determined in large part from the overall system design capacities.

Population figures for the Town of Stewiacke are outlined below in Table 2-1. These figures are based on the Town's census data as presented by Statistics Canada for 1991 to 2021. The census data shows:

- Current (2021) residential population = 1 557 people and 739 private dwelling units.
- Current (2021) average number of persons per dwelling unit (ppu) is 1 557 people ÷ 739 dwelling units = 2.11 ppu.
- The Town's average annual growth rate at 0.63%, ranging from a high of 13.4% (2016 to 2021) to a low of -4.5% (2011 to 2016) during the 30-year period from 1991 to 2021.

Table 2-1: Statistics Canada Census Data - Town of Stewiacke, NS

Census Year	Population	No. of Dwelling Units	Average Persons per Dwelling Unit (ppu)
1991	1,309	-	-
1996	1,405	-	-
2001	1,388	565	2.46
2006	1,421	618	2.30
2011	1,438	644	2.23
2016	1,373	681	2.02
2021	1,557	739	2.11

Based on feedback received from our Phase 4 Concept Design Report - Rev. 01, it is the Town's preference to proceed with sizing the new water supply system based on the following assumptions for determining the future design population:

- Design horizon projection = **35-years**.
- Commencement population (i.e., year zero) based on 2021 Statistics Canada Census Data of **1 557 people**.
- Doubling of the 2021 census population to 1 557 x 2 = 3 114 people during project design years 1 to 10, inclusive.

  Therefore, the 10-year horizon projection design serviced population = **3 100 people**.
- Average annual growth rate of 2.0% over a 25-year period from project design years 11 to 35, inclusive, resulting in a design population of $3\,114 \times (1 + 0.02)^{25} = 5\,109$ people.

  Therefore, the 35-year horizon projection design serviced population = **5 100 people**.

For this Phase 4 Concept Design Report - Rev. 02, the 35-year horizon projection for serviced population is assumed as **5 100 people.** This represents a population increase of approximately 3 440 people compared to the current (2021) census population.

Assuming the current (2021) dwelling unit population density of 2.11 persons per dwelling unit (see Table 2-1), the anticipated number of future dwelling units is calculated as 2 417 (i.e., 5 100 ÷ 2.11). This represents an increase of approximately 1 680 dwelling units compared to the current (2021) census.

The average annual serviced population growth rate over the 35-year horizon projection is **3.45%**.

2.3 WATER DEMAND

Based on the Town's review of Phase 4 Concept Design Report - Rev. 01, the Town expressed its preference for utilizing the Town of Stewiacke's 2020 Water System Assessment Data for basing future water demands.

The Town's 2020 Water System Assessment Data is summarized below in Table 2-2.

Table 2-2: Town of Stewiacke Water System Assessment Data Summary

Month	Measured Water Flow to Town's Water Distribution System			
	Total m^3	Avg. Day m^3/d	Max. (Peak) Day m^3/d	Max : Avg. Day Ratio
Jan.	11 143	359	421	1.17
Feb.	10 572	365	399	1.09
Mar.	11 199	361	471	1.30
Apr.	10 620	354	455	1.29
May	12 265	396	487	1.23
Jun.	14 155	472	586	1.24
Jul.	15 509	500	621	1.24
Aug.	13 236	427	578	1.35
Sep.	11 350	378	501	1.32
Oct.	11 806	381	442	1.16
Nov.	-	-	-	-
Dec.	-	-	-	-
Yearly Average	*12 186*	*399*	*496*	*1.24*
Yearly Maximum	*15 509*	*500*	*621*	*1.35*

The 2020 Water System Assessment Report flow data presented above in Table 2-2 identifies the largest Average Day water demand occurring in July at 500 m^3/d, and the largest Maximum (Peak) Day water demand occurring in July at 621 m^3/d. The largest Max. to Avg. Day ratio occurred in August and was 1.35 : 1. For preliminary design purposes the Max. to Avg. Day water demand ratio (i.e., peaking factor) of 1.50: 1 is assumed.

The Average Per Capita Water Demand represented by the 2020 Water System Assessment Report flow date was calculated based on:

- 2020 population interpolated at 1 520 people from 2016 census data (i.e., 1 373 people) and 2021 census data (i.e., 1 557 people).
- Highest 2020 Avg. Day water demand = 500 m^3/d.

Therefore, the Average Per Capita Water Demand is calculated as:

$$500\ m^3/d \div 1\,520\ persons \times 10^3 = 329\ Lpcd\ (litres\ per\ capita/day).$$

For preliminary design the Average Day Per Capita Water Demand is assumed at **350 Lpcd**.

2.4 WATER TREATMENT DESIGN CAPACITIES

Future serviced population and per capita water demand design criteria presented above in Sections 2.2 and 2.3 were used to develop preliminary water treatment hydraulic design capacities for 10-year and 35-year horizon projections.

The rationale and calculation details for preliminary water treatment hydraulic design capacities are presented in **Appendix B - WTP Hydraulic Design Criteria**. Design flow criteria for 10-year and 35-year horizon projections are summarized below in Table 2-3.

Table 2-3: Summary of Water Treatment Process Hydraulic Design Capacity Criteria

Design Flow Criteria	Design Capacity Criteria			
	m^3/d	L/min.	L/s	USgpm
10-Year Horizon Projection - *Serviced Population = 3 100 people*				
Average Daily Treated Water[1] Design Flow	**1 085**	750	13	200
Average Daily Raw Water[2] Design Flow	**1 450**	1 010	17	270
Maximum (Peak) Day Treated Water[1]Design Flow	**1 630**	1 130	19	300
Maximum (Peak) Day Raw Water[2] Design Flow	**2 170**	1 510	25	400
35-Year Horizon Projection - *Serviced Population = 5 100 people*				
Average Daily Treated Water1 Design Flow	**1 785**	1 240	21	327
Average Daily Raw Water[2] Design Flow	**2 380**	1 650	28	436
Maximum (Peak) Day Treated Water[1] Design Flow	**2 680**	1 860	31	490
Maximum (Peak) Day Raw Water[2] Design Flow	**3 570**	2 480	41	655

Notes:

1. *Treated Water quantities represents the water flow delivered directly to the serviced population.*
2. *Raw Water qualities are greater than Treated Water quantities. They account for water flow loss resulting from inherent treatment process waste reject flow streams.*

For the 10-year horizon projection, the Max. (Peak) Day Raw Water Design Flow is 2 170 m^3/d (400 USgpm). This flow rate falls within the water supply capacity currently confirmed for Production Well PW21-01 of 2 440 m^3/d (448 USgpm).

For the 35-year horizon projection, the Max. (Peak) Day Raw Water Design Flow is 3 570 m^3/d (655 USgpm). This flow rate exceeds the water supply capacity currently available from Production Well PW21-01 of 2 440 m^3/d (448 USgpm). Until an upper pumping capacity limit (i.e., rated safe-yield capacity) is determined for the PW21-01 aquifer, there currently is insufficient data to confirm that this well can accommodate the Max. (Peak) Day Raw Water Design Flow for the 35-year horizon projection.

NSE will impose groundwater allocations and limitations on municipal groundwater aquifer water withdrawal permits. Typically, groundwater allocations are based on the applicant's current water needs, rather than potential future needs. The applicant (i.e., Town) must demonstrate the need for the volume of water requested. The applicant cannot typically reserve water for future use beyond the expiry date of the approval, which is up to 10-years under the Approvals Procedure Regulations.

Whereas the current available PW21-01 pumping capacity is capable of accommodating the initial 10-year horizon projection for the Max. (Peak) Day Raw Water Design Flow, it has not been established that it is capable of accommodating the 35-year horizon projection for the Max. (Peak) Day Raw Water Design Flow. Therefore, the Town must undertake further development and pump testing of the PW21-01 aquifer in order to establish a suitable upper limit of its rated safe-yield capacity, as well as undertake further wellfield exploration to establish a secondary (redundant) water supply production well or wells.

2.5 WATER QUALITY

Production Well PW21-01 water quality analytical results for six (6) samples collected between January 31 and February 10, 2022, are provided in **Appendix C - Production Well PW21-01 Water Quality Analytical Results**.

PW21-01 water quality meets all criteria under Health Canada Guidelines for Canadian Drinking Water Quality (GCDWQ). These guidelines consist of two (2) primary water quality categories, namely Maximum Acceptable Concentrations (MAC) and Aesthetic Objectives (AO).

For PW21-01 water quality, no parameters exceed the MAC. Noted AO exceedances involve the following parameters:

- Dissolved iron - 3 of 6 samples.
- Dissolved manganese - 6 of 6 samples.
- Dissolved sulphates - 6 of 6 samples.
- Total dissolved solids - 6 of 6 samples.

- Turbidity - 6 of 6 samples.
- True colour - 1 of 6 samples.
- *Note: Hardness, although not an AO, is reported as being very high in 6 of 6 samples.*

Based on Appendix C water quality results, those PW21-01 parameters identified as requiring treatment to achieve an acceptable potable water quality are summarized in Table 2-4 below.

Table 2-4: Summary of Key PW21-01 Parameters Requiring Treatment

Parameter	GCDWQ[1]				
	Units	MAC[2]	AO[3]	Avg. Conc.	Range
Dissolved Iron (Fe)	*µg/L*	-	300	**433**	59 – 1 040
Dissolved Manganese (Mn)	*µg/L*	120	20	**74**	66 - 85
Dissolved Sulphates (SO_4)	*mg/L*	-	500	**962**	800 – 1 270
Total Dissolved Solids (TDS)	*mg/L*	-	500	**1 590**	1 410 – 1 890
Turbidity	*NTU*	0.1 – 1.0[4]		**9.5**	5.7 – 12.4
Hardness (as $CaCO_3$)	*mg/L*	-	-	**1 260**	1 120 – 1 360

Notes:

1. *Health Canada Guidelines for Canadian Drinking Water Quality*
2. *Maximum Acceptable Concentration*
3. *Aesthetic Objectives*
4. *Range covers membrane technology to traditional gravity sand.*

PW21-01 contains elevated iron (Fe) and manganese (Mn) concentrations. Whereas no MAC is established for iron, manganese does not exceed the MAC. However, iron and manganese removal is required to meet acceptable AO water quality. Unless reduced less than AO concentrations, iron and manganese will undoubtedly produce objectionable aesthetic effects, such as staining of plumbing fixtures and laundry.

Elevated sulphate (SO_4) concentrations occur in PW21-01. At current concentrations, water taste will be impacted. Sulphate can also result in sulphide formation within the distribution system, which can render water taste and odour unpalatable at concentrations above the aesthetic objective. Therefore, sulphate removal is required to achieve acceptable potable water quality.

Total dissolved solids (TDS) are typically composed of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, sulphate, and nitrate. Excessive water pipe, water heater, boiler and appliance scaling will result based on current PW21-01 TDS concentrations. TDS removal is required to achieve acceptable potable water quality.

Current PW21-01 turbidity concentrations are considered excessive for acceptable potable water quality. However, turbidity results obtained during typical pump testing programs can be misleading as much lower turbidity is usually consistently achieved during normal well operation. The most important health-related function of turbidity is as an indicator of drinking water treatment filtration process effectiveness with respect to removal of potential microbial pathogens. Health Canada identifies turbidity reduction, particle removal and pathogen removal as dependent upon the source groundwater quality and the selection and operation of the treatment technology. Therefore, the proposed water treatment technology must consider turbidity removal/reduction.

3. WATER SUPPLY SYSTEM CONFIGURATION

3.1 WATER TREATMENT APPROACH

Selection of water treatment processing to achieve acceptable potable water quality for the Town is based on two (2) separate unit processes operated in series.

Each unit process will address specific water quality parameters. One unit process focuses primarily on the removal/reduction of iron (Fe), manganese (Mn, and sulphates (SO_4). The other unit process focuses primarily on the removal/reduction of total dissolved solids (TDS), turbidity and hardness. Water treatment will also include chlorine disinfection to achieve an acceptable chlorine residual throughout the water supply storage and distribution piping systems.

Where possible and where permitted by the selected treatment process technologies, a continuous hydraulic line as established from groundwater well pumps to water treatment and through to clearwell storage within the WTP Control Building will be considered as part of the overall water supply system design. It is recommended that confirmation of water treatability be established as part of a comprehensive on-site pilot study for the preferred water treatment technologies.

Water treatment technologies considered capable of producing acceptable potable water quality based on PW21-01 water quality characteristics are discussed in the following sub-sections.

3.2 IRON, MANGANESE AND SULPHATE REMOVAL

Two (2) separate iron and manganese (Fe/Mn) treatment technologies were identified as part of the previous Phase 4 Concept Design Report – Rev. 01. These technologies were greensand filtration and biological filtration.

As follow-up for updating this Phase 4 Concept Design Report – Rev. 02, iron and manganese treatment vendors were again contacted to provide process equipment sizing and costing updates to accommodate the revised future design population of 5 100 people.

Discussions with the biological filtration vendor revealed their apprehension and concerns regarding the capability of their treatment system to adequately achieve an acceptable treated water quality. Their rationale was based specifically on Well PW21-01 having an elevated pH range (i.e., 7.6 to 7.9). The vendor's biological filtration experience is for a water quality consistently at a pH less than 7.2. It is the vendor's opinion that PW21-01 water quality would be unsuitable for their biological treatment processes. As such, the vendor expressed their preference for withdrawing the biological filtration process from further project consideration.

Given that this equipment vendor is the only known manufacturer of an iron and manganese biological filtration process, this specific process has been removed from further consideration as a potential treatment option for the Town of Stewiacke. As a result, discussion of biological filtration as a treatment option has been omitted from this report.

Moving forward, consideration of potential iron and manganese removal technology is now limited to greensand filtration.

Greensand Filtration:

Greensand filtration technology is commonly used across North America, including in Atlantic Canada, as an effective Fe/Mn treatment solution. A typical greensand filtration process is shown below in Figure 3-1.

Figure 3-1: Three Vessel Greensand Filtration Process

Greensand filters typical include a multi-layered proprietary coated media and anthracite within a steel pressure vessel. Chlorine (typically sodium hypochlorite) and/or potassium permanganate are injected (metered) into the raw water flow stream upstream of the greensand filters to serve as a strong chemical oxidant. This chemical oxidation process facilitates Fe/Mn precipitation from solution and also serves to maintain overall reactiveness of the greensand media.

In addition to Fe/Mn removal, greensand filtration also achieves oxidation and subsequent precipitation of sulphates (SO_4).

It is proposed that the greensand filtration process be configured as multiple (typically three) pressurized filter vessels operated in parallel. Sufficient filter through-put hydraulic capacity shall be provided to accommodate the maximum (peak) day design flow with one (1) filter vessel removed from service for maintenance purposes.

A control panel will be mounted to each filter vessel. A master control panel will house a programmable logic controller (PLC) and human machine interface (HMI) panel for local system control. The greensand filtration process will also be integrated into a centralized SCADA system.

Precipitated Fe, Mn, and SO_4 solids are captured (filtered) within the greensand filter vessel media. These solids are held within the media until they are eventually removed during filter backwashing procedures. On-site storage of treated water in Clearwell Basins will be required for filter backwashing purposes (see Section 3.4 – Clearwells, Backwash and High Lift Pumping).

Spent backwash water will represent a residual waste stream requiring off-site disposal. Typically, this waste stream is routed to a communal wastewater treatment system for disposal. Subsurface disposal may also be an option but will require further discussions with NSE. Disposal options for spent backwash water are not discussed herein. Further development of this item is deferred to a future project phase.

A preliminary process flow schematic showing the greensand filtration process is provide in **Appendix D - Simplified Greensand Filtration Process Flow Schematic**.

Biological Filtration:

As noted above in Section 3.2, the equipment vendor has withdrawn biological filtration from further consideration as a water treatment process option for the Town of Stewiacke. Therefore, the biological filtration technical discussion previously presented in Phase 4 Concept Design Report – Rev. 01 has been removed for this report. The biological filtration treatment option for iron and manganese removal is no longer considered for the Town of Stewiacke.

3.3 SO_4, TDS, TURBIDITY AND HARDNESS REMOVAL

Membrane technology has been selected as a single process approach to effectively remove total dissolved solids (TDS), turbidity, and hardness from the greensand effluent stream. The selected membrane technology for the Town's water quality is nanofiltration (NF).

Nanofiltration:

NF uses a semi-permeable membrane with a small pore size and is operated under high pressure (i.e., 150 - 200 psi) to remove dissolved solids. Feed water passes through a cartridge pre-filtration, and then is pressurized within the NF membrane housings. Two (2) flow stream outlets are created, a treated water flow stream (at 10 - 15 psi), and a reject flow stream (at 120 - 150 psi). The treated flow stream will be blended with a by-pass slipstream from the upstream greensand filtration process. The reject flow stream, consisting of a brine solution containing high concentrations of captured sulphates, total dissolved solids, turbidity, and hardness particulate matter, will be sent to waste.

A typical nanofiltration process skid is shown below in Figure 3-2.

[redacted]

Figure 3-2: TDS/Turbidity/Hardness Nanofiltration Membrane Treatment Process

Based on a preliminary membrane selection, a feed water recovery efficiency of 75 to 85% is expected for the Town's water quality. The recovery efficiency will depend primarily on pretreatment, type of membrane, water quality, and temperature. Thus, 15 to 25% of the feed water entering the NF process is expected be wasted in the reject flow stream.

Assuming a Maximum (Peak) Day Raw Water Design Flow throughput of 3 570 m^3/d for the 35-year horizon projection (see Table 2-3), and a reject flow of 15 to 25%:

- The expected maximum treated water flow stream is in the **2 680 to 3 030 m^3/d** range. This is the available treated water flow available for delivery to the serviced population.

- The expected reject (waste) flow stream is in the **540 to 890 m^3/d** range. This flow stream will need to be directed to waste for eventual treatment in the Town of Stewiacke's wastewater treatment system.

It is anticipated that the NF process will consist of two (2) membrane skids. Each skid would be designed and sized to a minimum flow rate capacity of **2 500 m^3/d**. When operated together the total available capacity would be 5 000 m^3/d (i.e., 2 x 2 500), which would readily accommodate the Maximum (Peak) Day Raw Water Design Flow of 3 570 m^3/d. Should a skid be removed from service for maintenance purposes, the 2 500 m^3/d capacity of the remaining skid would be able to accommodate the Average Daily Raw Water Design Flow of 2 380 m^3/d.

Under low demand flow conditions one (1) skid would be operated and the second train would serve as a standby unit. Under peak flow conditions the two (2) skids would be operated.

Each skid is expected to consist of cartridge pre-filtration, a high-pressure feed pump, sample sink, valves, and instrumentation. Local controls will include including a programmable logic controller (PLC) and human machine interface (HMI) panel. An antiscalant chemical injection upstream of the NF process is typically recommended to minimize membrane scaling/fouling, loss of operating performance and to extend runtime between membrane cleanings.

A complete nanofiltration membrane skid package will typically include the following ancillary NF process equipment:

- Clean-in-place system skid (i.e., tank, heater, circulation pump, valves, instrumentation).
- Antiscalant system (i.e., dosing pumps, valves, instrumentation).
- pH adjustment system (i.e., dosing pumps, valves, instrumentation).
- Disinfection system (i.e., dosing pumps, valves, instrumentation).

Membrane treatment technology will require de-chlorination of the flow discharged from the greensand filtration process prior to it entering the NF process. De-chlorination can be achieved effectively by sodium bi-sulphate injection positioned upstream from the NF process.

Membrane technology will result in a high percent removal of the all target parameters (i.e., TDS, turbidity, hardness). As such, this will result specially in near zero hardness concentrations. It will be important to maintain hardness concentrations in the range of 80 to 100 mg/L (as $CaCO_3$) to provide an acceptable balance between protecting piping systems from corrosion and preventing excessive scaling and incrustation.

To maintain adequate hardness concentrations in the final treated water, a flow slipstream representing approximately 5% +/- of the feed water flow entering the NF process will be purposely by-passed around the NP process and re-blended with be final treated water flow stream discharged from the NF process. The high hardness concentrations in the by-pass slipstream will impart a final hardness concentration of in the blended flow stream.

A simplified process flow schematic showing the NF membrane technology process in combination with the greensand filtration process is provide in **Appendix E - Preliminary Schematic of the Overall Water Supply System**.

3.4 CLEARWELLS, BACKWASH AND HIGH LIFT PUMPING

Treated flow from the NF membrane process will be combined (blended) with a by-pass slipstream flow from the greensand filtration process to provide for hardness adjustment (see discussion above in Section 3.3). These combined flow streams will then be chlorinated using sodium hypochlorite and directed into a series of Clearwell Basins.

The Clearwell Basins will be constructed as in-ground concrete tankage as part of the WTP control building foundation structure. The Clearwell Basins will provide for the following process features:

- A hydraulic break to atmosphere of the pressurized flow stream.
- Tankage in which to establish the necessary chlorine disinfection contact time.
- Necessary water storage volumetric capacity for greensand filtration backwashing.
- Flow balancing between water treatment process production and high-lift pumping.
- High lift and backwash pump basins.

Sizing and configuration of the Clearwell Basins will be determined during detailed design.

Two (2) backwash pumps (one duty, one stand-by) will be positioned within the Clearwell Basins to access treated water for greensand filtration backwashing purposes. The backwash pumps will convey treated water from the clearwell basins through the greensand filtration unit process and will discharge the spend backwash flow to waste.

Two (2) high lift pumps (one duty, one stand-by) will also be positioned within the Clearwell Basins. These pumps will convey the final treated water from the WTP Control Building through interconnecting water transmission piping to the Water Storage Reservoir.

High lift pump flow output and ON/OFF operation will be automated to maintain adequate Water Storage Reservoir operating levels. This will require automated coordination with the water treatment process throughput flow rate and the Clearwell Basin operating liquid level.

3.5 RESIDUAL WASTES

Residual waste streams will be created from backwashing of the greensand filtration treatment process, and from the NF membrane technology reject flow stream. These waste streams will be initially discharged to an in-ground Residual Waste Storage Tank positioned at the WTP Control Bldg. site. This tankage will provide temporary storage and flow equalization prior to the residual waste stream being conveyed to the Town's wastewater treatment system for ultimate disposal. Further evaluation will be required regarding the means of conveying the waste flow stream (i.e., gravity, pumping, trucking) to the Town's wastewater treatment system and the capability of the wastewater treatment system to effectively manage this waste stream.

Membrane technology will generate a reject waste stream of significant volume. This residual waste stream is anticipated to represent 15 to 25% of the feed water throughput flow, or up to 600 m^3/d. Described as a concentrated brine solution, the reject waste stream will require off-site disposal at the Town's wastewater treatment facility. Given the potential impact of a large and concentrated brine solution on the communal wastewater treatment system operations, further evaluation of how to properly accommodate this waste stream is required.

Subsurface disposal of spent backwash and/or the membrane reject flow stream may represent a potential residual waste disposal option. However, consideration of this option will require further evaluation and follow-up discussions with NSE.

Please Note: This Phase 4 report does not incorporate specific treatment solutions for either spent backwash or membrane reject flow streams. As such, handling and treatment of these waste streams will be deferred to future study prior to detailed design.

3.6 WATER STORAGE RESERVOIR

For the purposes of this report, it is assumed that a new Water Storage Reservoir will be constructed and configured as a water standpipe. The standpipe shall be sized to provide adequate volumetric capacity to accommodate the Town's water supply needs, including:

- Diurnal flow demands.
- Peak flow balancing to accommodate flow demands in excess of the water treatment process design capacity.
- Emergency storage to accommodate water demand needs to enable:
  - Taking the production well and/or water treatment process temporarily offline (scheduled or unscheduled).
  - Provision of water supply should the water transmission or network distribution piping systems suffer major a leak due to line breakage.
  - Regularly scheduled system maintenance, such as a network pipe maintenance flushing program.

- Fire flow demands based on the Fire Underwriters Survey (2020), assuming fire flow protection is required or desired by the Town.
- Dead storage to provide for adequate geodetic elevation within the standpipe to maintain usable system pressure.

A typical bolted steel tank water reservoir/standpipe is shown in Figure 3-3.

Figure 3-4: Glass-lined Bolted Steel Water Storage Reservoir/Standpipe

It is anticipated that a standpipe having a total storage volume of approximately 3 300 m^3 will be required to meet the various water demand conditions noted above, including fire flow protection. Water reservoir storage volumetric calculations are presented in **Appendix F – Water Storage Reservoir Volumetric Calculations**. Assessment of the optimum reservoir diameter to height ratio will be required during detailed design.

Municipal water storage reservoirs are typically constructed using coated welded steel plates or glass lined bolted steel plates. Internal hydraulic or mechanical operated mixing systems are often provided to ensure thorough mixing, minimal thermal stratification and preventing ice formation at the water surface interface.

The Water Storage Reservoir will be equipped with a chlorine analyzer and chlorine dosing equipment to continuously monitor and maintain adequate chlorine residuals within the discharge flow stream. Continuous water level monitoring will also be provided. Reservoir operating level and chlorine residual data will be conveyed to a central SCADA system.

Location of the water storage reservoir is critical for effective delivery of the Town's water supply. Positioning it at a suitably elevated and readily accessible location within the Town, will be critical for establishing adequate water pressures (typically 40 to 90 psi) under gravity flow conditions throughout the water distribution piping network. In such circumstances, supply of potable water throughout the Town will continue uninterrupted in the event of a power outage.

Final confirmation of the reservoir size, construction type, mixing, instrumentation and geodetic elevations of operating water levels will be made during the detailed design phase.

3.7 OVERALL WATER SUPPLY SYSTEM LAYOUT

A conceptual layout of the overall water supply system is provided as a preliminary schematic in **Appendix E - Preliminary Schematic of the Overall Water Supply System**. This schematic identifies the primary system components as briefly described below.

- **Production Well and Associated Well Control Building:** A submersible well pump will extract raw water from the production well and routes it through the Well Control Building where water flow and pressure are monitored. This building will also contain well pump controls and a SCADA communication system. An emergency back-up power supply will be provided for uninterrupted well pump operation during power outages.

- **Water Transmission Piping – Part 1:** Water transmission piping will interconnect with the Well Control Building to convey raw water under pressure to the Water Treatment Process (WTP) Control Building. This piping will be supplied as either polyvinylchloride (PVC) or ductile iron (DI) pipe, depending upon the Town's preference.

- **WTP Control Building:** This building will contain the selected water treatment unit process for iron/manganese and sulphate removal (i.e. greensand filtration), and for total dissolved solids, turbidity, and hardness removal (i.e., nanofiltration). The building will also house Clearwell Basins, backwash pumps and high lift pumps, along with electrical controls for the associated process equipment and a SCADA communication system. Chemical dosing pump systems will be provided for sodium hypochlorite (chlorination) and sodium bi-sulphate (dechlorination) injection requirements. Instrumentation will include flow, pressure, water level, residual chlorine, and turbidity monitoring.

  Residual waste management facilities (i.e., solids settling/waste flow equalization tankage) will also be provided at this building location. Additional building features will include an operations control room, operations staff office(s), electrical room, mechanical room, washrooms, and chemical and spare equipment storage areas. An emergency back-up power supply will be provided to maintain water treatment process and pumping operations during power outages.

- **Water Transmission Piping – Part 2:** Water transmission piping will interconnect with the WTP Control Building to convey treated water under pressure from the Clearwell Basins through to the Water Storage Reservoir. This piping will be supplied as either polyvinylchloride (PVC) or ductile iron (DI) pipe, depending upon the Town's preference.
- **Water Storage Reservoir:** This reservoir will include an internal mixing system, chemical dosing pumps, instrumentation for pressure, water level, flow and residual chlorine monitoring, and a SCADA communication equipment.
- **Water Distribution Piping:** Water distribution piping will interconnect from the Water Storage Reservoir to the Town's existing water distribution network to convey treated water under gravity flow throughout to serviced areas. This piping will be supplied as either polyvinylchloride (PVC) or ductile iron (DI) pipe, depending upon the Town's preference.

Proposed preliminary routing of the water transmission/distribution pipeline is provided in **Appendix G - Water Transmission Plan and Profile Drawings** as a series of preliminary plan and profile drawings.

3.8 ELECTRICAL POWER SUPPLY

A reliable power supply will be essential for operation of the wellfield pump(s), the water treatment process, and SCADA communications equipment. It is understood that 600VAC, 3-phase electrical power is available within the Town. Should only single-phase power be available, use of transformers and variable frequency drives (VFDs) can be used to provide 3-phase power.

Emergency back-up power will be incorporated at each of the Well Control and WTP Control Buildings to provide for near uninterrupted power supply.

Follow-up with Nova Scotia Power Inc. (NSPI) will be required to confirm power supply availability, condition, and location prior to detailed design.

3.9 ITEMS FOR FURTHER CONSIDERATION

This Phase 4 report provides treatment options for producing an acceptable potable water quality based on the water quality results presented for Production Well Pw21-01. This report also outlines the major infrastructure components of an overall water supply system concept that will convey raw water to treatment, treated water to storage and treated water to the Town's water distribution system.

Based on the concepts presented herein, there are additional key factors that will require follow-up, evaluation or study prior to the Town commencing detailed design of a new water supply system. These factors are identified below for the Town's further consideration.

1. Confirm the Town's preference for extending water services to existing and/or future developments beyond its current water service area boundaries.
2. Additional pump testing to confirm the upper safe-yield capacity limit for Production Well PW21-01 beyond the currently establish flow of > 2 400 m^3/d (448 USgpm).
3. Undertaken further wellfield exploration and well drilling/development to establish a second, redundant production well capable of providing 100 percent stand-by capacity for Production Well PW21-01.
4. Follow-up discussions with NSE to obtain confirmation of the 10-year projection water withdrawal permit and associated conditions for the PW21-01 aquifer.
5. Confirm optimum/preferred locations for each of the major water supply system components, including PW21-01 Control Building, WTP Control Building, Water Storage Reservoir, and routing of water transmission/distribution pipelines. Explore options for property purchase and/or obtain right-of-way access to the various proposed sites, including Production Well PW21-01 and the Well Control Building.
6. Perform a detailed hydraulic computer modeling of the proposed water system supply system to determine the optimum grade line and geodetic positions for key water supply pumping and treatment process components. This modeling will also provide hydraulic analysis for sizing of well, backwash and high lift pumps, and pipelines.
7. Confirm fire flow requirements in accordance with Fire Underwriters Survey (2020).
8. Undertake evaluation and assessment of treatment/conveyance/disposal options for residual waste flows generated from the water treatment processes (i.e., backwash, reject brine flow stream), including follow-up discussions with NSE to assess the potential for a sub-surface disposal option.
9. Undertake evaluation and assessment of anticipated hydraulic and organic loading impacts of the water treatment process residual waste flows on the Town's existing wastewater treatment system.
10. Undertake bench-scale and on-site pilot studies of the preferred water treatment unit process in conjunction with the selected equipment manufacturers and local vendors.

11. Commence discussions for obtaining project financial support from the applicable provincial and federal infrastructure funding regulators.
12. Perform a detailed groundwater supply well concept design.
13. Follow-up with Nova Scotia Power Inc. (NSPI) to confirm power supply availability, condition, and location.

4. OPINION OF PROBABLE COSTS

An update of the Preliminary Opinion of Probable Construction Costs previously presented (in Concept Design Report - Rev. 01) for the proposed water supply system is presented below in Table 4-1. This update incorporates the 35-year future design serviced population projection of 5 100 people and revised water demand data based on the Town of Stewiacke 2020 Water System Assessment Report.

Costing for wellfield development components, Well Control Building, WTP Control Building, water treatment process components, Water Storage Reservoir, water transmission/distribution piping, electrical, mechanical, instrumentation/controls, pre-design engineering, detailed design engineering, tendering/award, contract administration, and contingencies are summarized in Table 4-1.

This Preliminary Opinion of Probable Construction Costs is based on a Class D level of accuracy of -20 to +30 percent. Costs have been developed based on WSP's database of recent construction unit costs, our understanding of the current construction market conditions and budgetary costing obtained from equipment suppliers for specific treatment process equipment.

Cost figures presented in Table 4-1 represent 2024 costing. WSP's recent experiences with cost variability due to supply chain and inflationary pressures for other similar municipal water infrastructure projects, it is recommended that the Town apply a suitably conservative cost escalation factor when extrapolating project costs into future years.

Updated and detailed Opinion of Probable Construction Costing is recommended during the Preliminary Engineering Design and Detailed Engineering Design phases to reflect the updated system and building layouts and configuration, selected process equipment and the Town's preferred features and amenities.

Table 4-1: Preliminary Opinion of Probable Construction Costs

No.	Preliminary Opinion of Probable Construction Costs[1]	Cost[2] (2024 $)
1.	**Wellfield Development of Production Well PW21-01:** Well pump; downhole well piping/equipment; Well Control Bldg. (concrete foundation, pre-engineered bldg. superstructure, HVAC, electrical, mechanical); above floor slab process piping; electrical power distribution; electrical control panels/wiring; instrumentation/controls; site civil works; security fencing.	$ 600 000
2	**Wellfield Development of Secondary Production Well:** Well pump; downhole well piping/equipment; Well Control Bldg. (concrete foundation, pre-engineered bldg. superstructure, HVAC, electrical, mechanical); above floor slab process piping/valving system; electrical power distribution; electrical control panels/wiring; instrumentation; site civil works; security fencing.	600 000
3.	**Water Treatment Process (WTP) Control Bldg.** *(approx. 5000 sq. feet):* Concrete foundation; pre-engineered bldg. superstructure (HVAC, electrical, mechanical,); in-ground concrete clearwell basins; access hatches/vent piping; above floor slab process piping/valving system; electrical power distribution; electrical control panels and control wiring; instrumentation; site civil works; security fencing.	2 000 000
4.	**Iron/Manganese/Sulphate Treatment Process** *(based on greensand filtration process located in WTP Control Bldg.):* Multiple filter vessels; interconnecting filter vessel process piping/valving; by-pass piping; multiple chemical injection systems; electrical control panels and control wiring; instrumentation.	1 400 000
5.	**Total Dissolved Solids/Turbidity/Hardness Treatment Process** *(based on nanofiltration membrane process located in WTP Control Bldg.):* Dual nanofiltration process trains (12:6) , 6 element array per train); antiscalant/clean-in-place skid; chemical dosing systems for pH adjustment, chlorination, dechlorination; reject flow piping; electrical control panels/wiring; instrumentation.	2 500 000
6.	**Clearwell Basin Pumping/Piping Equipment:** High lift pumps and control panels; backwash pumps and control panels; internal interconnecting basin piping/valves; internal overflow piping; electrical control panels/wiring; instrumentation.	600 000
7.	**Residual Waste Storage Tankage** *(for greensand, nanofiltration treatment processes):* In-ground concrete waste storage tankage constructed at exterior of WTP Control Bldg.; access hatches/ladders/vent piping; interconnecting process piping/valving; internal storage tank mixing/pumping systems; electrical power distribution; electrical controls and control wiring; instrumentation.	400 000
8.	**Water Storage Reservoir/Standpipe:** Concrete foundation; glass-lined, bolted steel plate tank construction; geodesic aluminum dome roof; internal active mixing system; access ladders; overflow piping; cathodic protection; hydraulic testing; site civil works; fencing; on-site assembly of reservoir/standpipe tankage/piping; electrical control panels/wiring; instrumentation.	2 200 000
9.	**Water Transmission/Distribution Piping:** Supply and installation of 150/300mm diameter pipeline from Production Well PW21-01 and Secondary Production Well to the WTP Control Bldg.; treated water pipeline from WTP Control Bldg. to Water Storage Reservoir/Standpipe, and: pipeline from Water Storage Reservoir/Standpipe to existing community water distribution network; trench excavation/backfilling and pipeline hydraulic testing.	2 500 000
10.	**Process Equipment Installation:** Installation of process equipment at Production Well PW21-01, Secondary Production Well, WTP Control Bldg. (incl. Residual Waste Storage Tankage), Water Storage Reservoir/Standpipe.	500 000

No.	Preliminary Opinion of Probable Construction Costs[1]	Cost[2] (2024 $)
11.	**Supervisory Control and Data Acquisition (SCADA):** SCADA system, incl. programmable logic controllers (PLCs), software, hardware, licensing and computer programming for overall water supply system.	400 000
12.	**Electrical Site Power:** Nova Scotia Power Inc. supply to Production Well PW21-01 site; Secondary Production Well site; WTP Control Bldg.; Water Storage Reservoir/Standpipe site.	400 000
13.	**Process and Process Equipment Start-up/Commissioning:** Start-up/commissioning procedures by process equipment and instrumentation vendors/suppliers at Production Well PW21-01, Secondary Production Well, WTP Control Bldg., and Water Storage Reservoir/Standpipe; on-site operator instructions and training.	300 000
14.	**On-site Piloting of Preferred Water Treatment Processes:** Incl. on-site supervision/operation of pilot equipment by selected equipment vender, water sampling/analyses; interim/final reporting.	300 000
15.	**Sub-total Capital Construction Cost** *(Sum of Item Nos. 1. to 14.; not incl. HST)*	**$ 14 700 000**
16.	**Construction Contingency** *(20% of Item No. 15.)*	**$ 2 940 000**
17.	**Preliminary Engineering Design:** Preliminary engineering of overall water supply system, incl. engineering calculations/sketches/drawings for water treatment process development/evaluation/final selection; on-site equipment piloting coordination; layout/sizing of buildings/structures, property investigations, water transmission and distribution pipeline alignment/routing, hydraulic modelling, geotechnical site investigations; ongoing liaison w. Town officials, governing authorities.	600 000
18.	**Detailed Engineering:** Detailed engineering design of overall water supply, incl. engineering calculations for buildings/structures, water treatment processes, mechanical systems, electrical systems, and SCADA system. Preparation and review submittal of contract drawings/technical specifications at approx. 30%/75%/100% of design. Preparation of tender package; tendering, bids evaluation and award process, issuing of construction package.	1300 000
19.	**Contract Administration/Site Observation/Start-up and Commissioning Services:** Contract management services and full/part-time on-site observation services for full duration of the various construction phase. Start-up/commissioning of process equipment, processes and overall water supply system. Operator instructions and training services.	600 000
20.	**Total Capital Construction Cost** *(Sum of Item Nos. 15. To 19.; not incl. HST)*	**$20 140 000**

Notes:

1. *Costs based on treatment capacity for a 35-year horizon design serviced population of 5 100 people.*
2. *Based on Class D estimate (i.e., -20 to +30%).*

APPENDIX

A

TOWN OF STEWIACKE ZONING MAPPING AND WATER SUPPLY WELL LOCATIONS

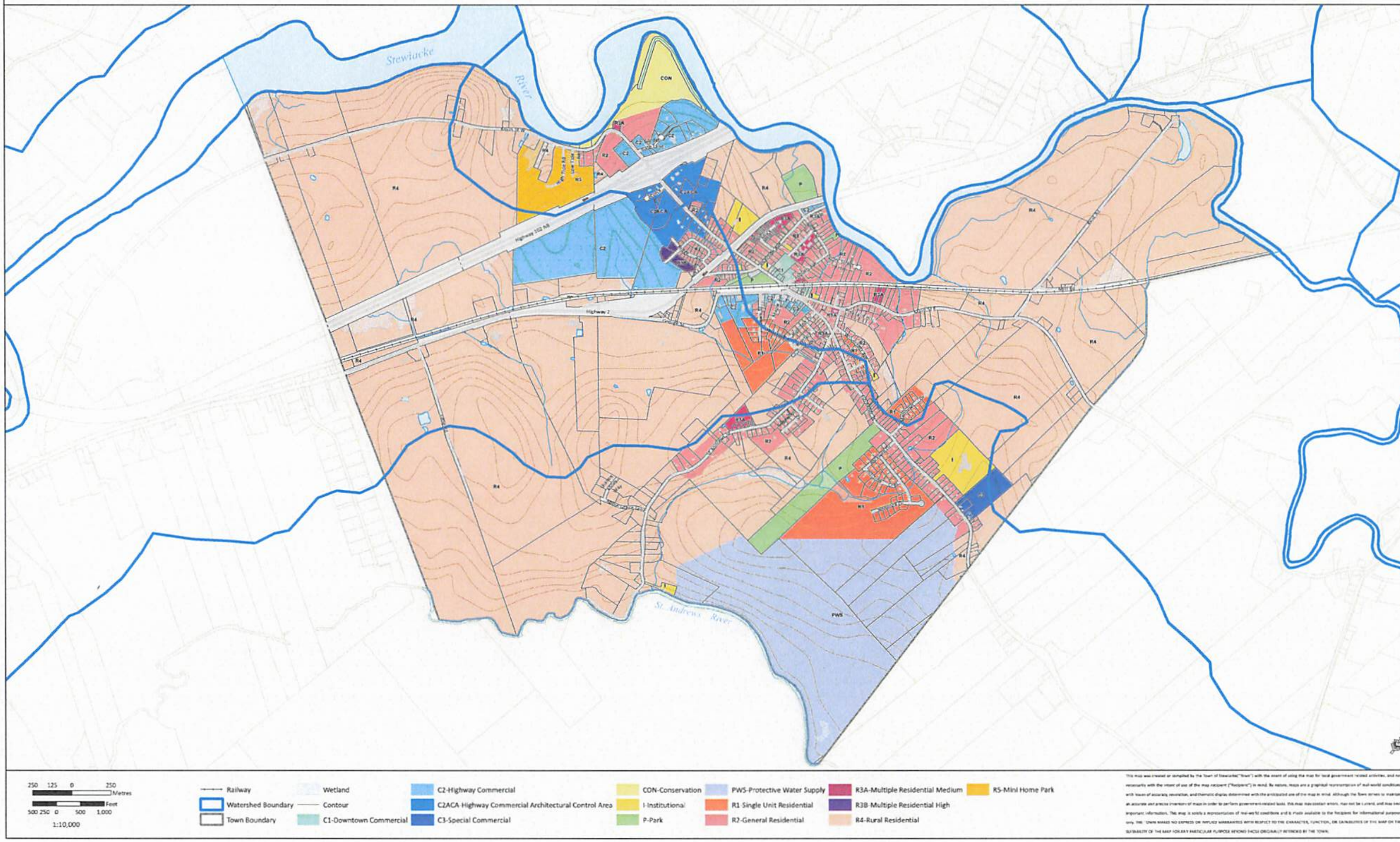
PLANNING SERVICES

TOWN OF STEWIACKE

ZONING MAP

MAP 3

9/26/2018



LEGEND:

WELL TYPE

- MONITORING WELL
- 10" PRODUCTION WELL
- 6" WELL
- WATERCOURSE
- TOWN OF STEWIACKE BOUNDARY
- PROPERTY BOUNDARIES (NSDNR, 2017)

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PROJECT:

PROJECT:	GROUNDWATER SUPPLY PROJECT
PROJECT NO.:	191-03686
CLIENT:	TOWN OF STEWIACKE

FIGURE:

TITLE:	WELL LOCATIONS		
FIGURE NO.:	4	REVISION NO.:	0
SCALE: 1:12,500 (0 100 200 400 600 Meters)			
DATUM:	NAD 83 CSRS	PROJECTION:	UTM ZONE 20 NORTH
DRAWN BY:	T. MOREHOUSE	CHECKED BY:	M. NOSEWORTHY
CREATED DATE: (YYYY-MM-DD)	2020-12-07	REVISION DATE: (YYYY-MM-DD)	03/06/2022

WSP Canada Inc.
1 Spectacle Lake Drive,
Dartmouth, Nova Scotia
www.wsp.com

PATH: S:\GIS\2_PROJECTS\2019\191_03686_TownofStewiacke_GWSupply_NS\6_MXD\20220603_191_03686_FIG04_WellLocation.mxd

APPENDIX

B

WTP HYDRAULIC DESIGN CRITERIA

Appendix B

The following is a summary of calculations for determining 10-year and 35-year horizon design flow criteria projections for the Town of Stewiacke's future water supply system.

10-Year Horizon Projections:

Design Capacity Criteria:

- Future serviced design population = **3 100 people.**
- Average daily per capita consumption/demand = 329 Lpcd. **350 Lpcd** assumed for preliminary design purposes.
- Assumed Max to Avg. Day ratio = **1.5** (peaking factor).
- Assumed reject flow stream (diverted to waste) = 15 to 25% of Average Daily Raw Water Design Flow. *Note: Membrane reject flow stream of **25%** assumed for preliminary design.*

Design Flow Calculations:

- Average Daily Treated Water Design Flow discharged from water treatment process:
    - 3 100 people x 350 Lpcd = 1 085 000 L/d, or **1 085 m^3/d (200 USgpm).**
- Average Daily Raw Water Design Flow entering water treatment process from groundwater supply well:
    - Average Daily Treated Water Design Flow ÷ 0.75 (to account for 25% of feed water flow diverted to waste as a membrane reject flow stream)
    - 1 085 m^3/d ÷ 0.75 = **1 450 m^3/d (270 USgpm).**
- Maximum (Peak) Day Treated Water Design Flow = Average Daily Treated Water Design Flow x 1.5 (peaking factor):
    - 1 085 m^3/d x 1.5 = **1 630 m^3/d (300 USgpm).**
- Maximum (Peak) Day Raw Water Design Flow entering water treatment process from groundwater supply well:
    - Maximum (Peak) Day Treated Water Design Flow ÷ 0.75 (to account for 25% of feed water flow diverted to waste as a membrane reject flow stream)
    - 1 630 m^3/d ÷ 0.75 = **2 170 m^3/d (400 USgpm).**
- Production Well PW21-01 Pumping Capacity > **2 440 m^3/d** (448 USgpm).

  *Note: Available pumping capacity available from Production Well PW21-01 is currently established as being greater than 2 440 m^3/d. Therefore, sufficient capacity is available from PW21-01 to accommodate the 10-year horizon Max. (Peak) Day Treated Water Design Flow projection of **2 170 m^3/d.***

35-Year Horizon Projections:

Design Capacity Criteria:

- Future serviced design population = **5 100 people**.
- Average daily per capita consumption/demand = 329 Lpcd. **350 Lpcd** assumed for preliminary design purposes.
- Assumed Max to Avg. Day ratio = **1.5** (peaking factor).
- Assumed reject flow stream (diverted to waste) = 15 to 25% of Average Daily Raw Water Design Flow. *Note: Membrane reject flow stream of **25%** assumed for preliminary design.*

Design Flow Calculations:

- Average Daily Treated Water Design Flow discharged from water treatment process:
  - 5 100 people x 350 Lpcd = 1 785 000 L/d, or **1 785 m^3/d** (327 USgpm).
- Average Daily Raw Water Design Flow entering water treatment process from groundwater supply well:
  - Average Daily Treated Water Design Flow ÷ 0.75 (to account for 25% of feed water flow diverted to waste as a membrane reject flow stream)
  - 1 785 m^3/d ÷ 0.75 = **2 380 m^3/d** (436 USgpm).
- Maximum (Peak) Day Treated Water Design Flow = Average Daily Treated Water Design Flow x 1.5 (peaking factor):
  - 1 785 m^3/d x 1.5 = **2 680 m^3/d** (491 USgpm).
- Maximum (Peak) Day Raw Water Design Flow entering water treatment process from groundwater supply well:
  - Maximum (Peak) Day Treated Water Design Flow ÷ 0.75 (to account for 25% of feed water flow diverted to waste as a membrane reject flow stream)
  - 2 680 m^3/d ÷ 0.75 = **3 570 m^3/d** (655 USgpm).
- Production Well PW21-01 Pumping Capacity > **2 440 m^3/d** (448 USgpm).

  *Note: Available pumping capacity available from Production Well PW21-01 is currently established as being greater than 2 440 m^3/d. However, until a pumping capacity upper limit is confirmed in the field for PW21-01, there is insufficient data to confirm that the 35-year horizon Max. (Peak) Day Treated Water Design Flow of **3 570 m^3/d** can be accommodated by PW21-01.*

APPENDIX

C

PRODUCTION WELL PW21-01 WATER QUALITY ANALYTICAL RESULTS

Groundwater Analysis - General Chemistry & Metals
Town of Stewiacke, Stewiacke, Nova Scotia
Project No.: 191-03686

Parameter	Units	RDL	CDWQ[1]	Water Samples					
				PW21-01 S1 3470271 31-Jan-22	PW21-01 S2 3471805 1-Feb-22	PW21-01 S3 3487335 6-Feb-22	PW21-01 S5 3500775 10-Feb-22	PW21-01 S6 3500777 10-Feb-22	PW21-01 S7 3500778 10-Feb-22
pH	-	-	7.0-10.5	7.8	7.88	7.85	7.6	7.7	7.67
Reactive Silica as SiO2	mg/L	0.5	-	9.9	8.6	9.8	7.7	7.1	7.1
Chloride	mg/L	1.0	250 AO	27	28	28	34	34	34
Fluoride	mg/L	0.1	1.5	0.47	0.47	0.41	0.49	0.19	0.17
Dissolved Sulphate (SO4)	mg/L	2.0	500 AO	**1250**	**1270**	**847**	**802**	**800**	**803**
Total Alkalinity (as CaCO3)	mg/L	25.0	-	114	116	113	114	114	115
True Color	TCU	5.0	15 AO	<5.00	**17.3**	<5.00	<5.00	<5.00	<5.00
Turbidity	NTU	1.0	0.1 - 1.0[2]	5.7	10.6	12.4	7	10.7	10.5
Electrical Conductivity	uS/cm	1.0	-	2070	2010	2070	2020	2060	2030
Nitrate + Nitrite as N	mg/L	0.05	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrate as N	mg/L	0.05	10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrite as N	mg/L	0.01	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ammonia as N	mg/L	0.05	-	<0.03	<0.03	<0.03	<0.03	0.14	<0.03
Total Organic Carbon	mg/L	0.5	-	0.8	1.1	1.6	0.9	1.1	1.2
Ortho-Phosphate as P	mg/L	0.01	-	<0.01	<0.01	0.07	<0.01	<0.01	<0.01
Dissolved Sodium	mg/L	0.1	200 AO	40.1	37.7	37.8	42	36.8	42.6
Dissolved Potassium	mg/L	0.1	-	0.9	0.9	<0.1	1.7	1.5	1.6
Dissolved Calcium	mg/L	0.1	-	463	456	403	507	457	488
Dissolved Magnesium	mg/L	0.1	-	30.8	27.8	27.8	22.3	30.5	21.3
Dissolved Phosphorous	mg/L	0.01	-	<0.02	<0.02	<0.1	<0.02	<0.02	<0.02
Bicarb. Alkalinity (as CaCO3)	mg/L	1.0	-	114	116	113	114	114	115
Carb. Alkalinity (as CaCO3)	mg/L	1.0	-	<10	<10	<10	<10	<10	<10
Hydroxide	mg/L	5.0	-	<5	<5	<5	<5	<5	<5
Calculated TDS	mg/L	1.0	500 AO	**1880**	**1890**	**1410**	**1480**	**1430**	**1460**
Hardness	mg/L	1.0	-	1280	1250	1120	1360	1270	1310
Langelier Index (@20C)	NA	-	-	0.81	0.89	0.81	0.66	0.71	0.72
Langelier Index (@ 4C)	NA	-	-	0.49	0.57	0.49	0.34	0.39	0.4
Saturation pH (@ 20C)	NA	-	-	6.99	6.99	7.04	6.94	6.99	6.95
Saturation pH (@ 4C)	NA	-	-	7.31	7.31	7.36	7.26	7.31	7.27
Anion Sum	me/L	-	-	29.1	29.5	20.7	19.9	19.9	20
Cation sum	me/L	-	-	27.5	26.8	24.1	29.1	27	28
% Difference/ Ion Balance (NS)	%	-	-	2.8	4.9	7.6	18.7	15.2	16.8
Dissolved Aluminum	ug/L	5.0	100 OG AO	<5	<5	<5	<5	<5	<5
Dissolved Antimony	ug/L	1.0	6	<2	<2	<2	<2	<2	<2
Dissolved Arsenic	ug/L	1.0	10	<2	<2	<2	<2	<2	<2
Dissolved Barium	ug/L	1.0	2000	15	16	15	15	13	15
Dissolved Beryllium	ug/L	1.0	-	<2	<2	<2	<2	<2	<2
Dissolved Bismuth	ug/L	2.0	-	<2	<2	<2	<2	<2	<2
Dissolved Boron	ug/L	50	5000	145	133	118	137	124	127
Dissolved Cadmium	ug/L	0.01	7	<0.017	<0.017	<0.017	<0.09	<0.017	<0.017
Dissolved Chromium	ug/L	1.0	50	2.00	2.00	2.00	<1	2.00	2.00
Dissolved Cobalt	ug/L	0.4	-	<1	<1	<1	<1	<1	<1
Dissolved Copper	ug/L	0.5	1000 AO	<2	<2	<2	<1	<2	<2
Dissolved Iron	ug/L	50	300	**607**	**755**	77	**1040**	59	62
Dissolved Lead	ug/L	0.5	5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dissolved Manganese	ug/L	2.0	120	**80**	**75**	**66**	**85**	**67**	**68**
Dissolved Molybdenum	ug/L	2.0	-	2	2	2	2	2	2
Dissolved Nickel	ug/L	2.0	-	9.00	9.00	11.00	13.00	15.00	7.00
Dissolved Selenium	ug/L	0.5	50	2.00	1.00	2.00	2.00	2.00	1.00
Dissolved Silver	ug/L	0.1	-	0.20	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Strontium	ug/L	20.0	7000	4320	4360	4610	4900	4610	4860
Dissolved Thallium	ug/L	0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Tin	ug/L	2.0	-	<2	<2	<2	<2	<2	<2
Dissolved Titanium	ug/L	2.0	-	<2	<2	<2	<2	<2	<2
Dissolved Uranium	ug/L	0.1	20	0.5	0.3	0.2	0.4	0.2	0.3
Dissolved Vanadium	ug/L	2.0	-	<2	<2	<2	<2	<2	<2
Dissolved Zinc	ug/L	5	5000 AO	22.00	8.00	6.00	14.00	7.00	7.00

Notes:

1 Health Canada Guidelines for Canadian Drinking Water Quality , September 2020. AO denotes an exceedance in aesthetic guidelines.

2 Health Canada guideline for distribution systems / treated water. Not applicable to current samples but used for reference.

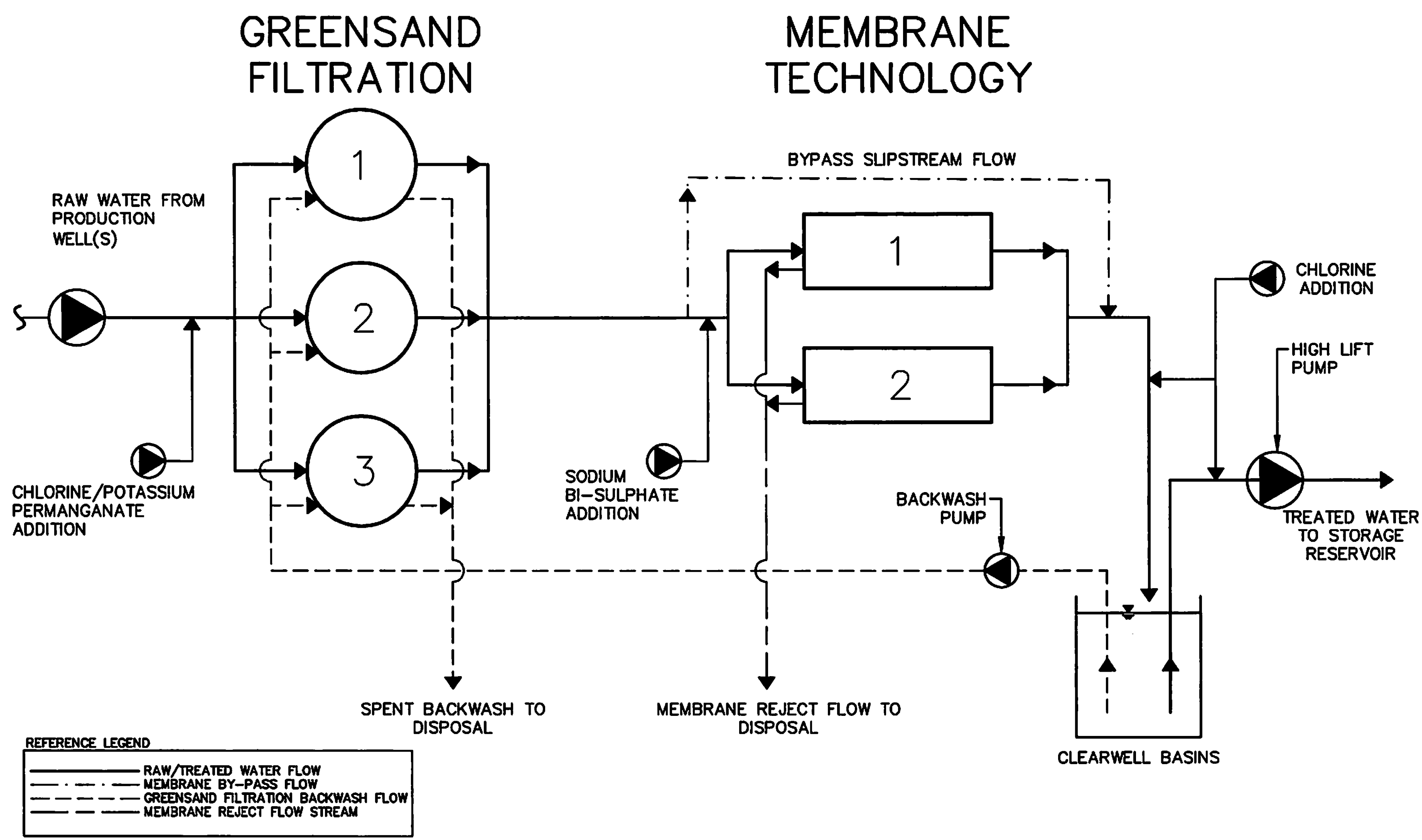
(shaded)	shading denotes a guideline exceedance
BOLD	bold lettering denotes a guideline exceedance in aesthetic objectives
RDL	denotes laboratory reported detection limit
-	denotes no value/not analysed

S1	WSP Sample ID
LEK354	Laboratory Sample ID
29-Oct-19	Sampling date

APPENDIX

D

SIMPLIFIED GREENSAND FILTRATION PROCESS FLOW SCHEMATIC



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1 Spectacle Lake Drive
Dartmouth, Nova Scotia, Canada B3B 1X7
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TITLE:

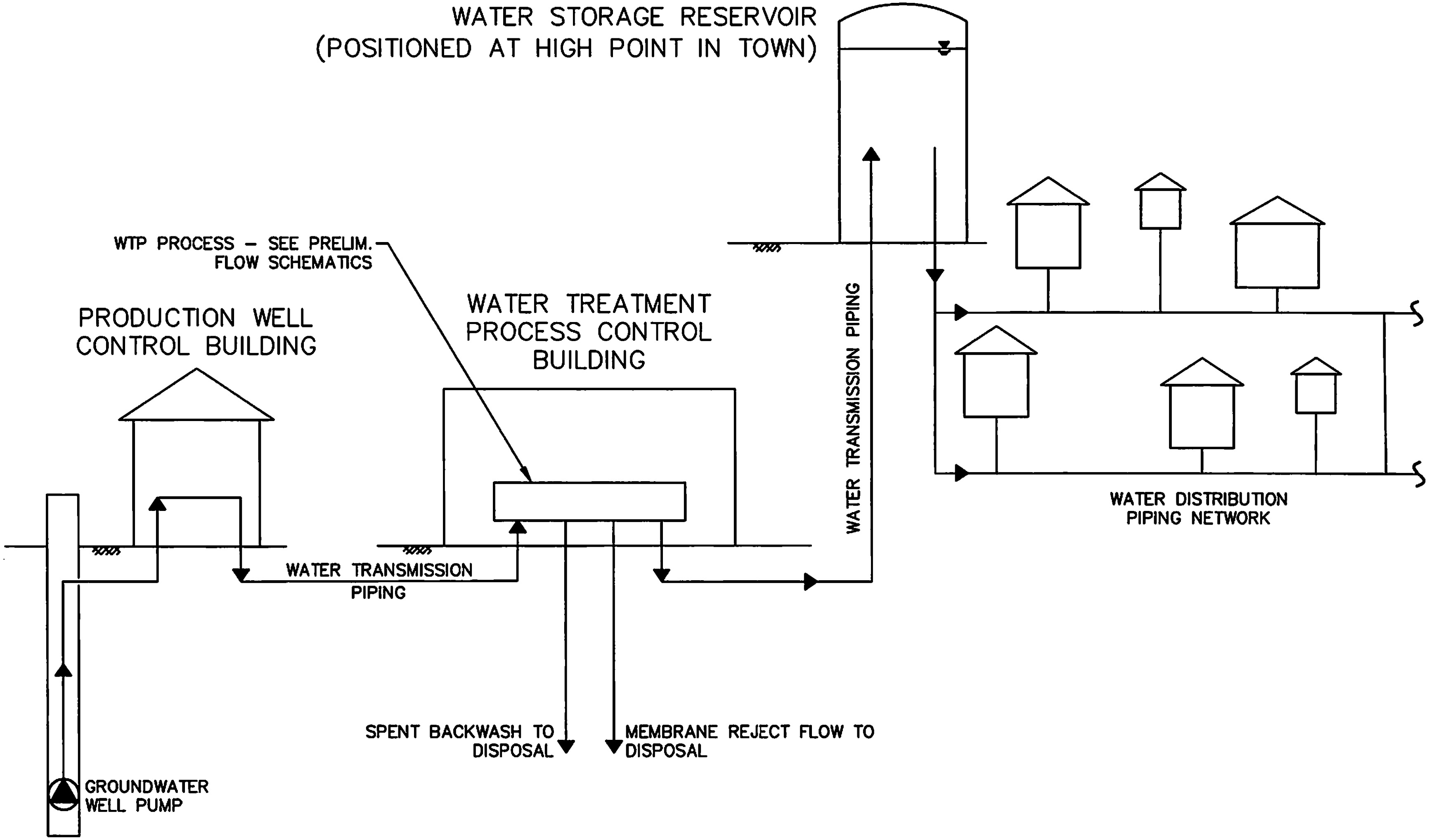
PRELIMINARY WATER TREATMENT PROCESS FLOW SCHEMATIC GREENSAND FILTRATION + MEMBRANE TECHNOLOGY

SCALE: N/A	REVISION: 0
DATE: (YYYY/MM/DD) 202402/22	DRAWING NO: SK02
PROJECT NO: CA0001941.4259	

APPENDIX

E

PRELIMINARY SCHEMATIC OF THE OVERALL WATER SUPPLY SYSTEM



WSP WSP Canada Inc. 1 Spectacle Lake Drive Dartmouth, Nova Scotia, Canada B3B 1X7 T 902-835-9955 F 902-835-1645 www.wsp.com	TITLE: PRELIMINARY WATER SUPPLY SYSTEM SCHEMATIC	SCALE: N/A DATE: (YYYY/MM/DD) 2024/02/22 PROJECT NO: CA0001941.4259	REVISION: 0 DRAWING NO: SK03

WSP REF. NO.: ---- C:\USERS\SAM.MACDONELL\ONEDRIVE - WSP O365\STEWIACKE WATER STUDY\WATER TREATMENT SKETCH.DWG DIST SCHEM PRINTED: 8:42 PM 2024/02/22 BY: SAM.MACDONELL

APPENDIX

F

WATER STORAGE RESERVOIR VOLUMETRIC CALCULATIONS

Appendix F

The following is a summary of calculations for determining revised Water Storage Reservoir sizing. Reservoir sizing is based on the 35-year horizon Treated Water design flow criteria projections for the Town of Stewiacke's future water supply system. These flow criteria are summarized below.

Design Flow Criteria	Design Capacity Criteria			
	m^3/d	L/min.	L/s	USgpm
35-Year Horizon Projection - *Serviced Population = 5 100 people*				
Average Daily Treated Water Design Flow	**1 785**	1 240	21	327
Average Daily Raw Water Design Flow	**2 380**	1 650	28	436
Maximum (Peak) Day Treated Water Design Flow	**2 680**	1 860	31	490
Maximum (Peak) Day Raw Water Design Flow	**3 570**	2 480	41	655

For preliminary design purposes, it is assumed that a new Water Storage Reservoir will be configured as a bolted steel standpipe type structure.

Total water storage volumetric requirements are based, in part, on the maximum (peak) day demand for Treated Water using the following formula:

Total Storage = Fire Storage + Peak Balancing Storage + Emergency Storage + Dead Storage

Where:

Fire Storage = assumed at a 2 000 Igpm fire flow rate over a 2-hour (120 minute) duration

= 2 000 Igpm x 120 minutes

= 240 000 Igal, or **1 090 m^3**

Peak Balancing Storage = 25% of the total maximum (peak) day demand (for Treated Water)

= 0.25 x 2 680 m^3, or = **670 m^3**

Emergency Storage = 25% of Peak Balancing Storage and Fire Flow Storage

= 0.25 x (670 m^3 + 1 090 m^3), or = **440 m^3**

Dead Storage = assumed as 33.3% of the overall total Water Storage Reservoir volume

= [(1 090 + 670 + 440) ÷ 0.67] - (1 090 + 670 + 440)

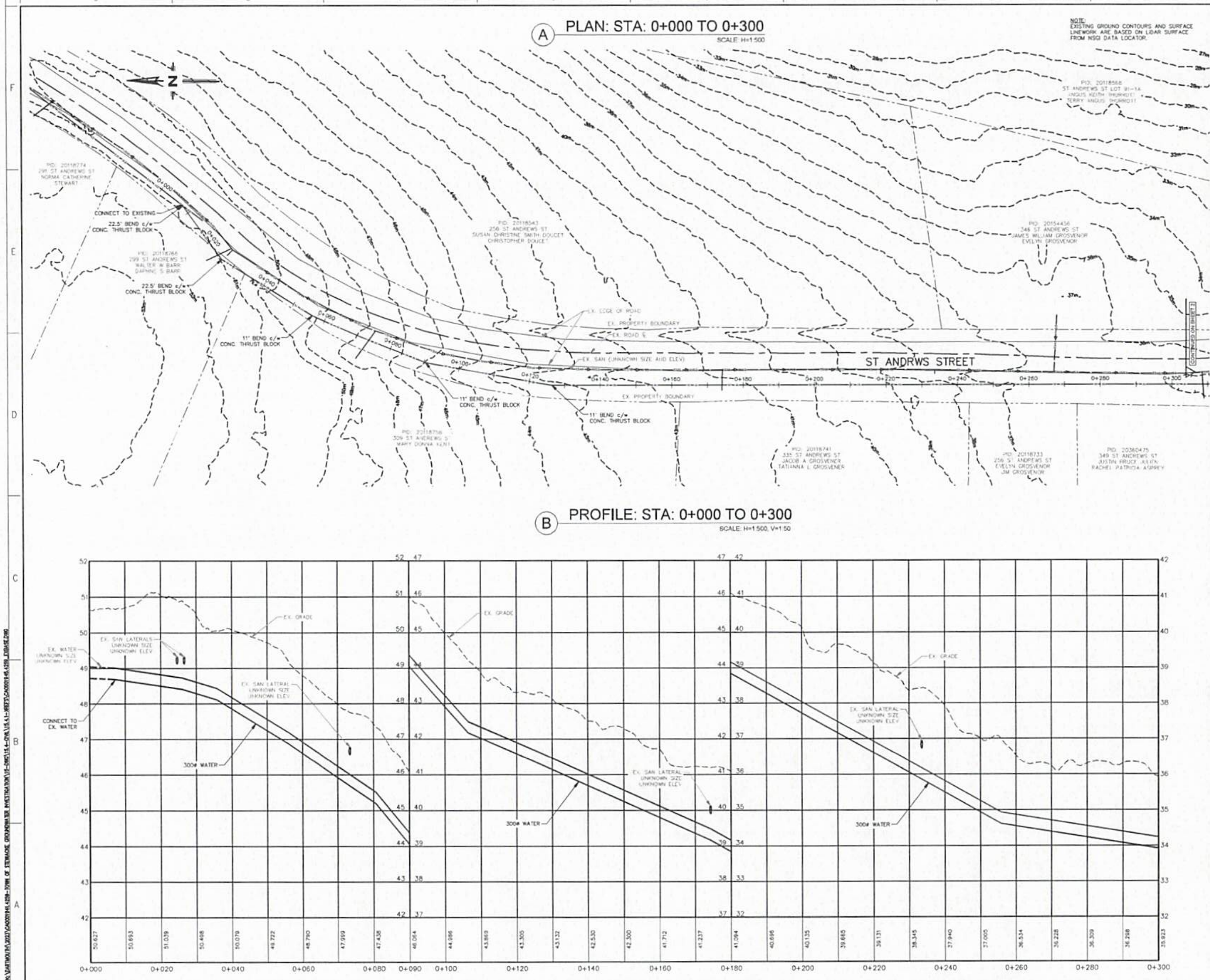
= 3 280 m^3 – 2 200 m^3, or **1 080 m^3**

Therefore: Total Storage = 1 090 m^3 +670 m^3 + 440 m^3 + 1080 m^3, or = **3 300 m^3**

APPENDIX

G

WATER TRANSMISSIOM PLAN AND PROFILE DRAWINGS



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DRAWN BY: M. KIDD
CHECKED BY: C. FOGARTY
APPROVED BY: K. O'LEARY
SCALE: 1:500 METRIC
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CLIENT:
STEWIACKE
RIVERS OF OPPORTUNITY
HALF WAY BETWEEN THE NORTH POLE & EQUATOR

CLIENT REF. #

PROJECT:
PUMPING STATION WATER TRANSMISSION LINE
STEWIACKE, NS

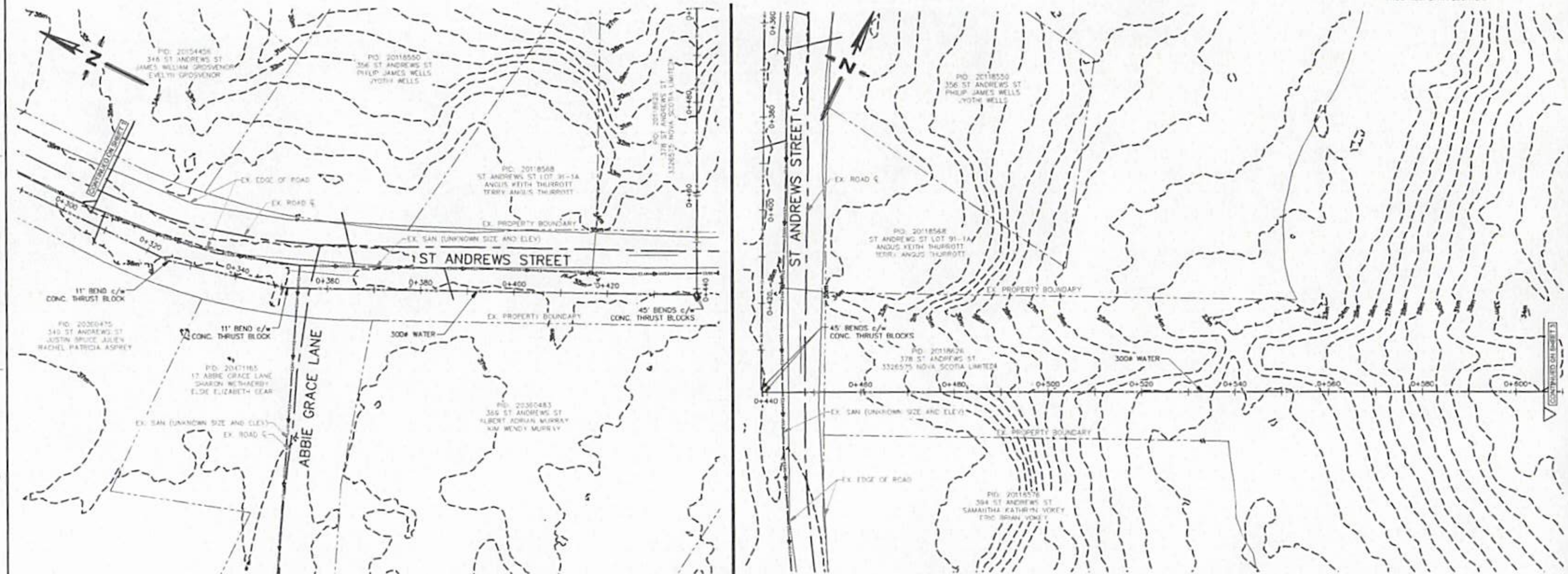
TITLE:
PLAN AND PROFILE
WATER TRANSMISSION LINE
0+000 to 0+300

SHEET NUMBER: 1
SHEET # 1 OF 3
ISSUE: ISSUED FOR 30% DESIGN
DATE OF: 2023/10/05
REV # 0

(A) PLAN: STA: 0+300 TO 0+600

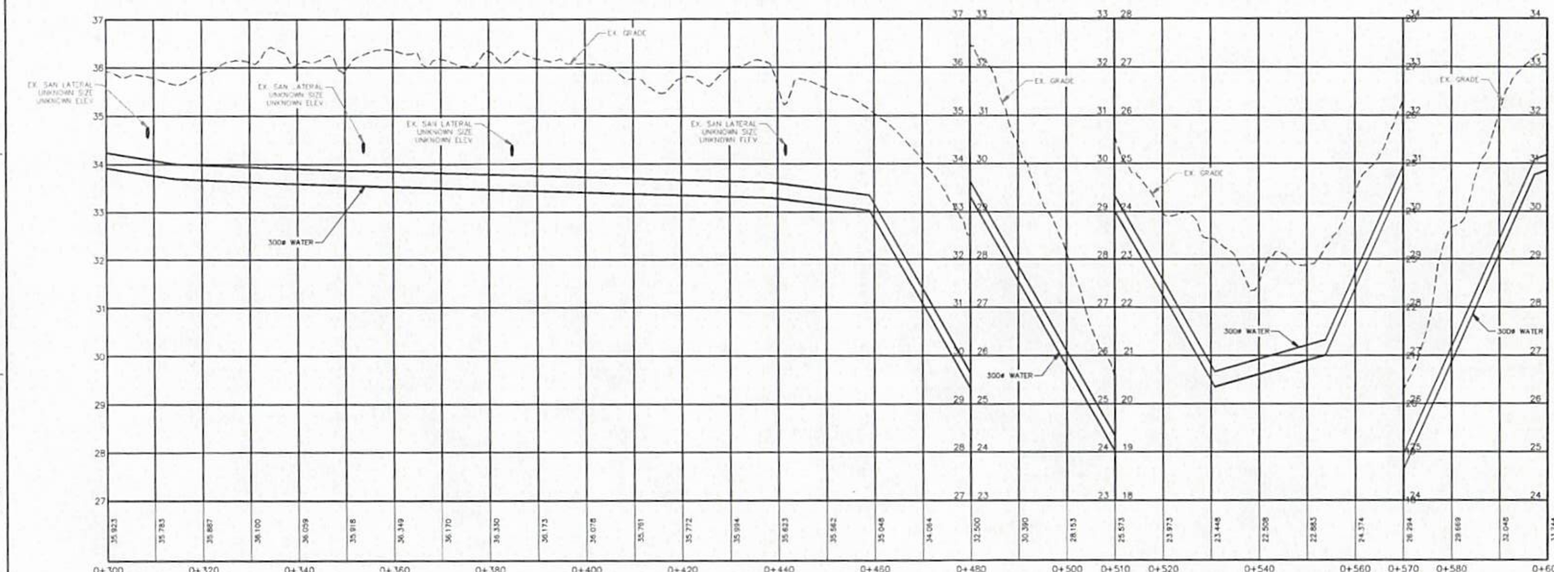
SCALE: H=1:500

NOTE:
EXISTING GROUND CONTOURS AND SURFACE LINEWORK ARE BASED ON LIDAR SURFACE FROM NSGI DATA LOCATOR.

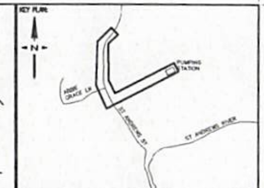


(B) PROFILE: STA: 0+300 TO 0+600

SCALE: H=1:500, V=1:50



KEY PLAN



LEGEND	PROPOSED	EXISTING
EDGE OF PAVEMENT		
LOTLINE		
WATERMAIN & GATE VALVE		
SANITARY PIPE & MANHOLE		
STORM PIPE & MANHOLE		
UTILITY LINES & POLE		
STREET BOUNDARY		SANITARY LATERAL
PROPERTY BOUNDARY		STORM LATERAL
EASEMENT		WATER LATERAL
CURB & DRIVEWAY CUT		CATCH BASIN LEAD
CATCH BASIN	ENDCAP	CULVERT
FIRE HYDRANT	LIGHT STANDARD	HEADWALL
STREET TREE	PHONE PEDESTAL	SIDEWALK
ROAD SIGN	URD BOX	FENCE

SEAL:

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CLIENT: STEWIACKE RIVERS OF OPPORTUNITY

CLIENT REF. #

PROJECT: PUMPING STATION WATER TRANSMISSION LINE
STEWIACKE, NS

TITLE: PLAN AND PROFILE
WATER TRANSMISSION
0+300 to 0+600

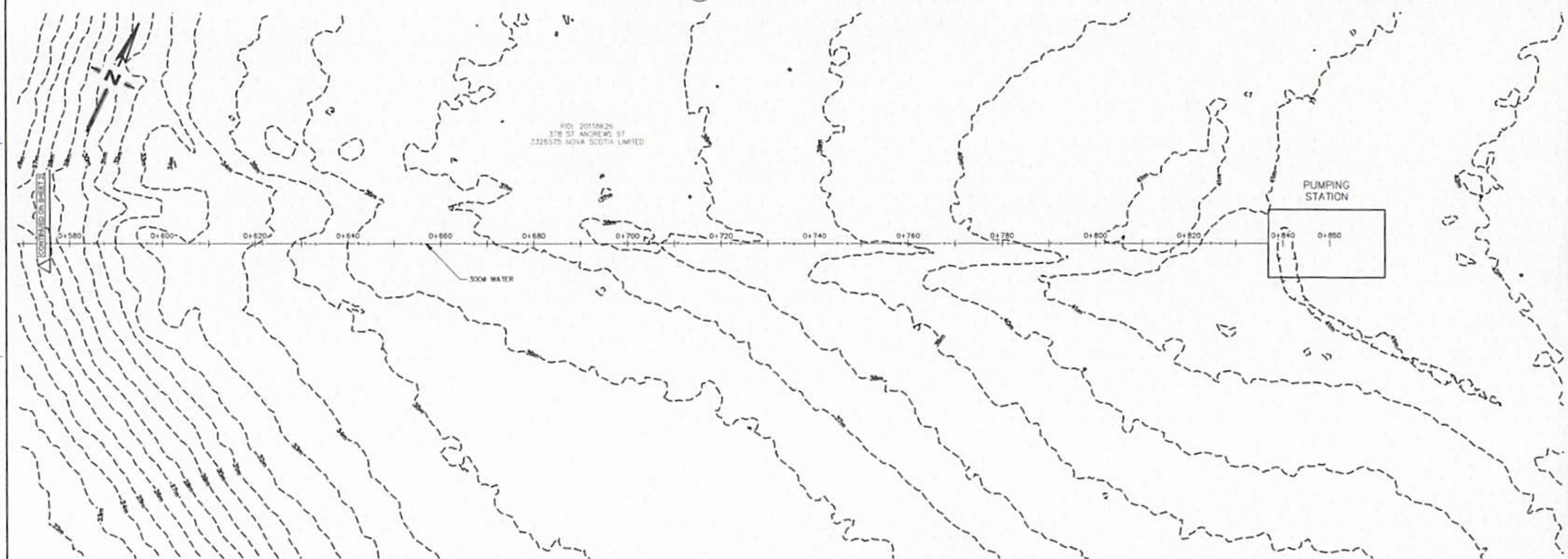
SHEET NUMBER: 2
SHEET # 2 OF 3

ISSUE: ISSUED FOR 30% DESIGN
DATE ISSUED: 2023/10/05
REV # 0

(A) PLAN: STA: 0+600 TO 0+850

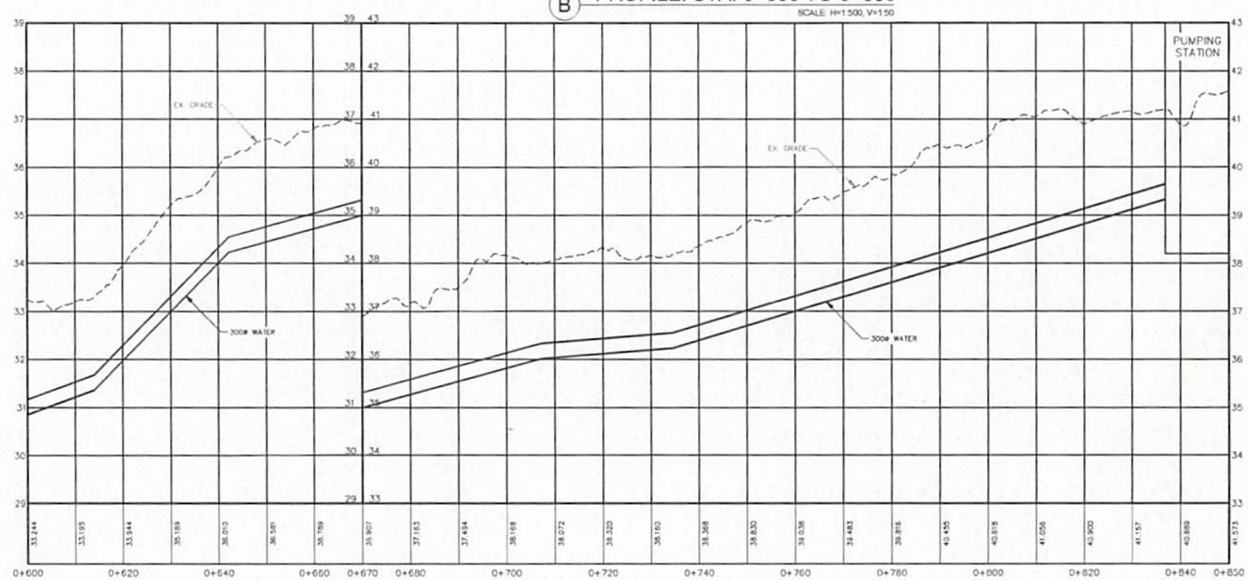
SCALE: H=1:500

NOTE:
EXISTING GROUND CONTOURS AND SURFACE LINEWORK ARE BASED ON LIDAR SURFACE FROM NSGI DATA LOCATOR.



(B) PROFILE: STA: 0+600 TO 0+850

SCALE: H=1:500, V=1:50



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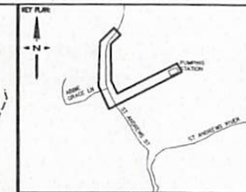

LEGEND:	PROPOSED	EXISTING
EDGE OF PAVEMENT		
LOTLINE		
WATERMAIN & GATE VALVE		
SANITARY PIPE & MANHOLE		
STORM PIPE & MANHOLE		
UTILITY LINES & POLE		
STREET BOUNDARY	SANITARY LATERAL	
PROPERTY BOUNDARY	STORM LATERAL	
EASEMENT	WATER LATERAL	
CURB & DRIVEWAY CUT	CATCH BASIN LEAD	
CATCH BASIN	ENDCAP	CULVERT
FIRE HYDRANT	LIGHT STANDARD	HEADWALL
STREET TREE	PHONE PEDESTAL	SIDEWALK
ROAD SIGN	UND BOX	FENCE

SEAL:

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DESIGNED BY: M. KIDD
DRAWN BY: M. KIDD
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STEWIACKE, NS

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WATER TRANSMISSION LINE
0+600 to 0+850

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