CHRC WEST SUB-REGIONAL WASTEWATER FEASIBILITY STUDY

REPORT 1: OPTIONS ANALYSIS – FINAL – REV.1

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EXECUTIVE SUMMARY

The subregion Northwest of the City of Calgary is rapidly growing and requires additional wastewater servicing to accommodate the increase in population. The area includes the Town of Cochrane, Cochrane Lake, and the HAWSCo Franchise Area consisting of Harmony, Bingham Crossing, Springbank Airport, and some homes in North Springbank. Currently, Cochrane and Cochrane Lake (through a limited agreement) convey all wastewater through a pipeline to Calgary for wastewater treatment. Cochrane has plans to twin the existing pipe to accommodate growth within the Town. The HAWSCo Franchise area has flows treated at the wastewater treatment plant in Harmony, however this treatment facility is largely undersized for the Franchise Area's projected growth, as it was only originally sized for Harmony alone. Therefore, an informal subregional group – CHRC, representing the Town of Cochrane, HAWSCo, Rocky View County and the City of Calgary, was formed to begin investigating potential servicing options for the subregion's wastewater needs. The CHRC developed four options for comparison:

- **Option 1A: Subregional Wastewater Disposal System –** Harmony Franchise Area adds surplus wastewater flows to Cochrane's twinned pipeline via a pipeline tie-in from Harmony's existing main wastewater lift station. Harmony continues to service its Franchise Area to the extent of their current WWTP capacity.
- **Option 1B: Harmony Interim WWTP and Regional Wastewater Disposal System –** Harmony WWTP is upgraded to ultimate capacity to temporarily treat surplus Cochrane and Cochrane Lake flows that exceed the existing pipeline capacity. Once the WWTP capacity is exceeded surplus flows are diverted to the twinned pipeline as described in Option 1A.
- **Option 2A: Status Quo with Harmony Outfall Upstream –** Harmony expands it's WWTP to accommodate all Franchise Area flows and builds an outfall to the Bow River upstream of Bearspaw Water Treatment Plant (WTP) Intake. Cochrane twins it's Pipeline. CHRC members continue their individual paths without regional collaboration.
- **Option 2B: Status Quo with Harmony Outfall Downstream –** Harmony expands it's WWTP and to accommodate all Franchise Area flows and builds an outfall to the Bow River downstream of Bearspaw WTP Intake. Cochrane twins it's pipeline. CHRC members continue individual paths without regional collaboration.

These options have been analyzed and reviewed to determine their technical feasibility and the infrastructure requirements. This analysis was done by applying historical flow data to population growth projections over the next 35 years for each community. Conceptual level (Class E) capital cost estimates were developed to compare the options from a capital perspective. Finally, a multiple accounts assessment was completed by the CHRC team to understand and assess the political, economic, social, technical, legal and administrative, and environmental impact (PESTLE Analysis) of the options. Through the analysis, the following conclusions were made:

- Option 1A is the preferred option by the CHRC because it has the lowest comparative capital cost and the highest performance on the PESTLE criteria.
- Option 1B is not practical given the very short timeframe in which major upgrades the Harmony WWTP would need to be completed and a new outfall would be required.
- Option 2A is the second-best option after 1A only because Option 1B is not feasible.
- Option 2B is the least favourable option as it has significantly higher costs than the other options and performs the worst on the PESTLE criteria.

From the PESTLE and technical analysis, Option 1A is the preferred option by the CHRC and will be carried into the next stage of this feasibility study to explore cost sharing and governance options.

1.0 INTRODUCTION

In 2021, Harmony Advanced Water Systems Corporation (HAWSCo), the City of Calgary, Rocky View County (RVC), and the Town of Cochrane began discussions to explore the potential for regional water and/or wastewater solutions through the creation of an informal group referred to as the "CHRC". There was recognition that the region northwest and west of Calgary are expected to grow significantly in the future, and the members of the CHRC wanted to explore opportunities for collaboration on infrastructure that could result in cost savings and improved management of the environment within the region. While no significant opportunities were identified for subregional water (now), the CHRC agreed to explore avenues for a subregional wastewater system, given the major infrastructure investments required by all parties soon. The following describes the background context and needs of each member of the CHRC that lends itself to partnering on this feasibility study.

1.1 BACKGROUND NEED

1.1.1 SUBREGIONAL WASTEWATER CONTEXT

The region Northwest of Calgary is experiencing and projected to experience significant rapid growth. The study area (shown in Figure 1) includes the current legal boundaries of the Town of Cochrane, the communities of Cochrane Lake and Harmony, the Springbank Airport, 114 country residential homes in North Springbank, and the future development of Bingham Crossing.

Existing wastewater servicing infrastructure within the region is approaching capacity limits, and each community is planning for upgrades needed to accommodate continued growth for the future. Subregional wastewater solutions are being explored with the intent to prioritize the following values:

- Maximize use of existing infrastructure,
- Protect and steward the environment,
- Minimize new or duplicated infrastructure,
- Reduce total capital expenditures, and
- Improve regional relationships through collaboration.

Sections 1.1.2 and 1.1.3 describe the needs of each community and their existing wastewater infrastructure, including any current plans that are proposed for use in a potential subregional system.

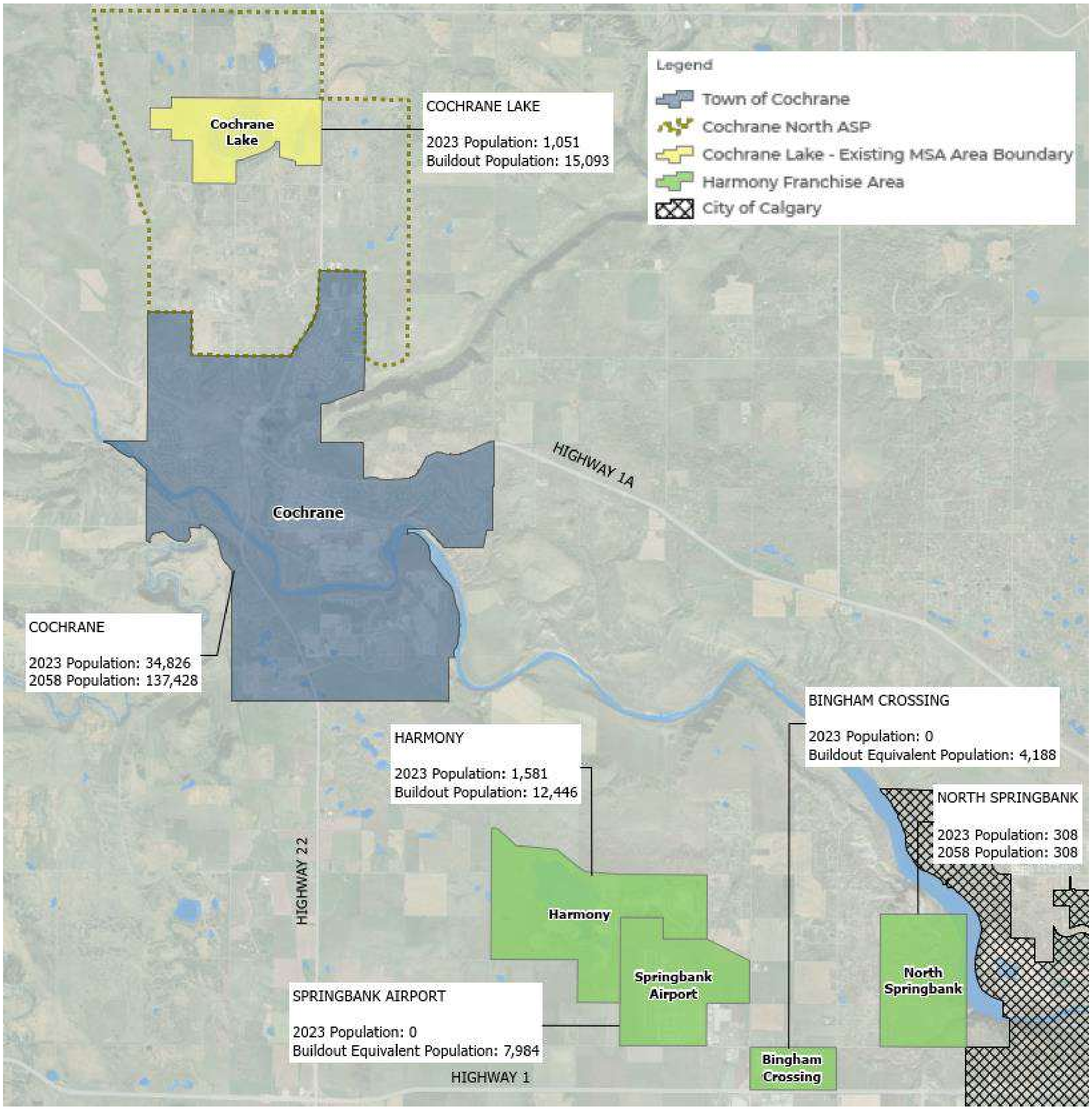

Figure 1: Subregional Study Communities

1.1.2 COCHRANE'S WASTEWATER DISPOSAL SYSTEM

The Town of Cochrane owns and operates a sanitary pump station and 20 km of pipeline that conveys all wastewater from the Town of Cochrane to the City of Calgary. This pipeline operates as a pressurized forcemain for approximately 15 km before transitioning to the gravity-driven siphon. The existing line is a 14" (nominal) line, constructed of steel, PVC, and HDPE. The Town also has a servicing agreement with Rocky View County to provide 48 L/s of sanitary capacity for Cochrane Lake, and to service Springbank School. The Town completed a comprehensive Sanitary Sewer Strategy in 2016 [1] which evaluated and compared different infrastructure options to meet Cochrane's long-term wastewater needs, including twinning the conveyance system to Calgary or building a local or regional wastewater treatment plant.

The result of this study, which was completed with input from Cochrane Town Council, determined that twinning the pipeline and pump station to Calgary was the best option for the Town.

Preliminary design for the twinned pipeline and pump station was completed in 2017 [2] and proposed a phased approach to the twinning to increase the system capacity gradually over time considering the large investment required. The pipeline construction phases are summarized in Figure 2. The first phase (Phase 0) was constructed in 2019 which increased peak wet weather influent storage capacity at Cochrane's Sanitary Transfer Station. This peak influent storage system will ultimately be the second wet well for the future twinned pump station. The 2017 preliminary design allowed for a 24" fully twinned line, primarily PVC with some sections of steel (high pressures) and HDPE (bored crossings).

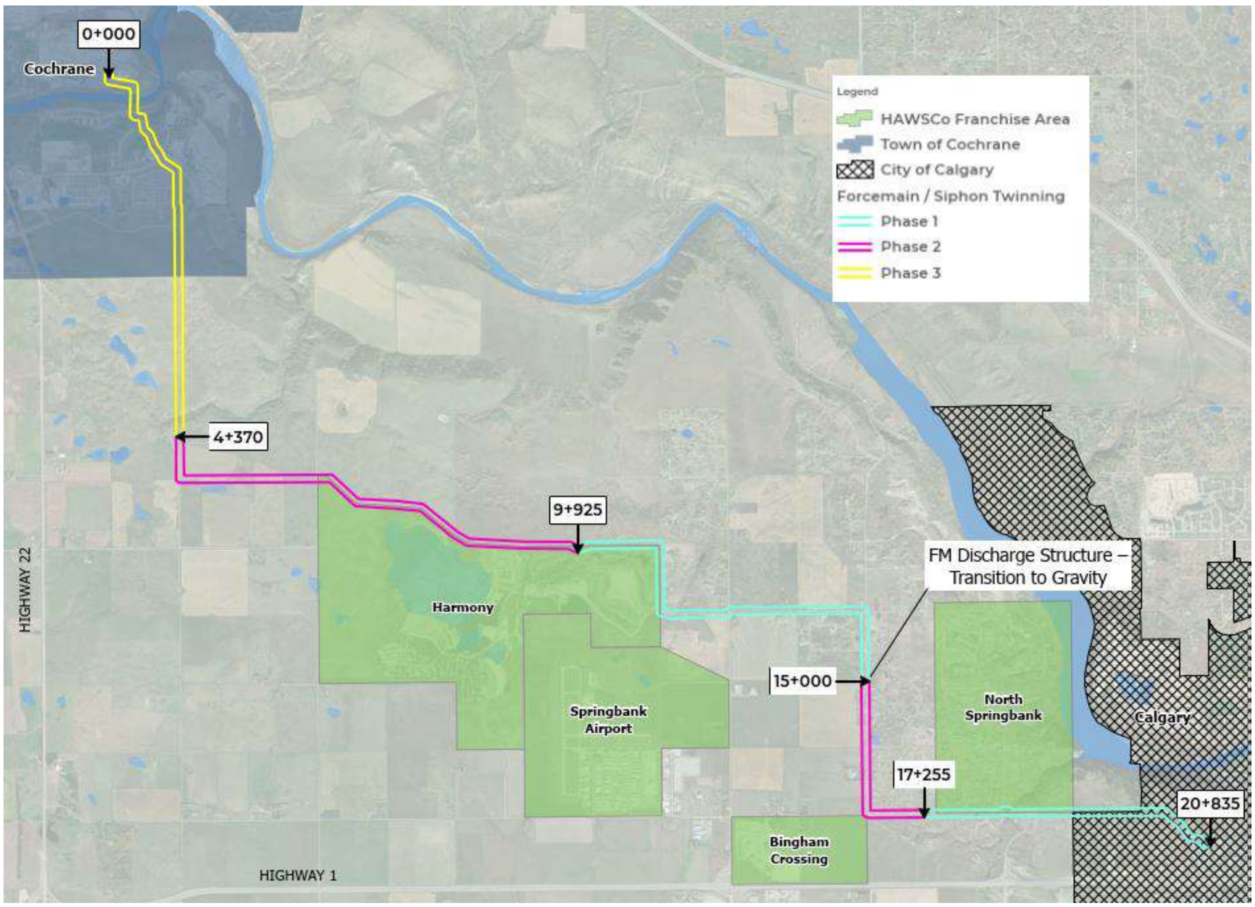

Figure 2: Current Planned Phases of Cochrane's Wastewater Pipeline Twinning

1.1.3 COCHRANE LAKE DISPOSAL SYSTEM

Cochrane Lake currently collects wastewater at a centralized lift station and conveys it via forcemain to Cochrane, tying into Cochrane's collection system near Heritage Hills on the northwest part of Town. The Cochrane Lake forcemain has a capacity of 65 L/s, and RVC currently has an agreement for servicing to a limit of 48 L/s with the Town of Cochrane, under the Master Servicing Agreement (MSA) between the Town of Cochrane and the City of Calgary. The MSA boundary for servicing of Cochrane Lake is depicted in Figure 3.

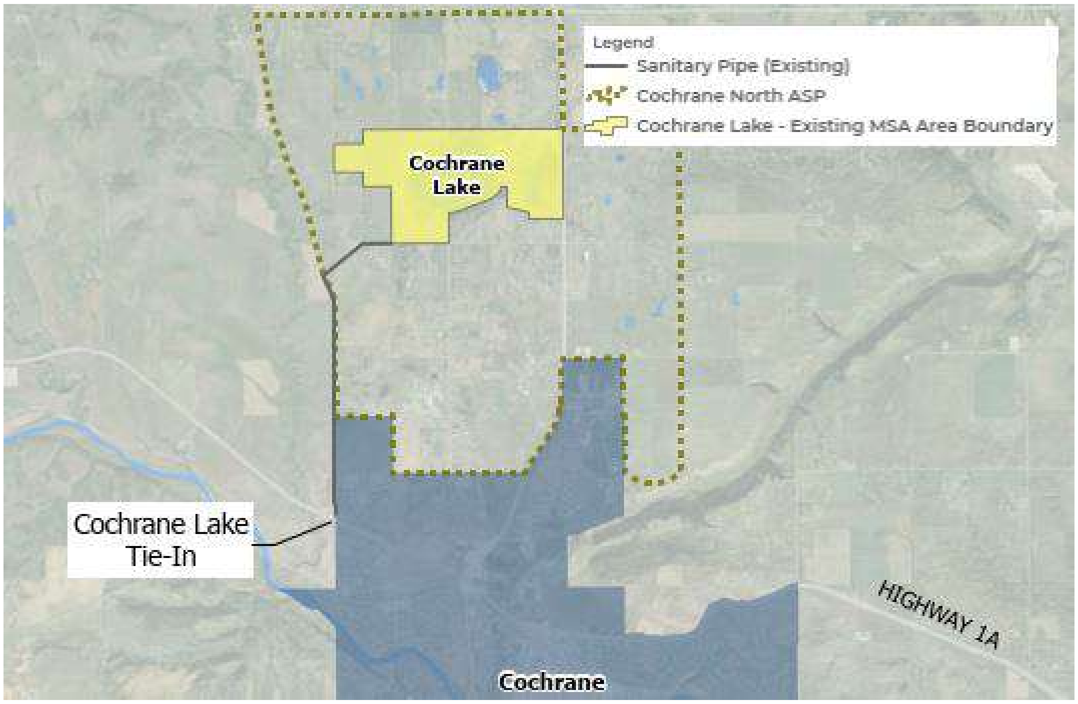

Figure 3: Cochrane Lake Existing Disposal System

1.1.4 HARMONY WASTEWATER TREATMENT & DISPOSAL SYSTEM

Harmony is a residential community under development, located 20 km southeast of Cochrane in Rocky View County. Harmony, as well as a few surrounding customers are serviced by a membrane bioreactor wastewater treatment plant (WWTP), owned, and operated by HAWSCo, a private utility corporation, formed and operating since 2017 to manage Harmony's water and wastewater utility services. Treated effluent from the plant is used for irrigation of the community's green spaces and private golf course. The WWTP was designed to allow for four stages of expansion, in which the system's capacity would gradually increase to meet the treatment demands of a growing community.

The expansion of the WWTP to its ultimate capacity is highly dependent on the ability to expand the disposal system (effluent discharge), as the limitation is currently the size of the effluent storage pond. Only so much effluent can be stored over winter months prior to the irrigation season, and in time, the irrigation needs will be surpassed by the volumes of effluent being produced. Therefore, to continue expanding, HAWSCo needs to discharge to a waterbody (via return-to-source permit on the Bow River) or create the demand for a significant increase in irrigation, which may not be practical. Furthermore, HAWSCo is expanding its service area and will provide wastewater servicing to the adjacent Springbank Airport, and the near-future development, Bingham Crossing. Managing these additional flows will require more treatment and disposal capacity, which when combined with Harmony's flows, will be beyond the WWTP's ultimate design capacity.

Harmony does not currently have an approval to discharge treated wastewater effluent into the Bow River and will eventually be limited by its effluent storage/disposal system. Therefore, HAWSCo is seeking a solution, which could be either increased effluent storage, an outfall and approval to discharge to the Bow River, or sanitary servicing by others to support continued growth of the community and franchise area. Given that Harmony is upstream of Calgary's Bearspaw WTP intake, the City of Calgary is interested in exploring solutions to prevent wastewater discharge upstream of their

WTP intakes. The inherent interconnectedness of these systems and the opportunity to mutually benefit from collaboration lends to desired collaboration of the CHRC partnership.

1.2 OBJECTIVE

The objective of stage 1 (and summarized in this Report 1) for this feasibility study was to determine the preferred wastewater servicing solution that the CHRC agrees on as a unified group. Possible options for servicing were identified by the group and will be further described in this Report. A technical analysis of the options was performed which included population projections, flow projections, hydraulic modelling and infrastructure sizing, capital cost estimating, and finally a qualitative multiple accounts assessment of each option by the CHRC members.

The options assessed are summarized as follows:

- **Option 1A: Subregional Wastewater Disposal System –** Harmony Franchise Area adds surplus wastewater flows to Cochrane's twinned pipeline via a pipeline tie-in from Harmony's existing main wastewater lift station. Harmony continues to service its Franchise Area to the extent of their current WWTP capacity.
- **Option 1B: Harmony Interim WWTP and Regional Wastewater Disposal System –** Harmony WWTP is upgraded to ultimate capacity to temporarily treat surplus Cochrane and Cochrane Lake flows that exceed the existing pipeline capacity. Once the WWTP capacity is exceeded surplus flows are diverted to the twinned pipeline as described in Option 1A.
- **Option 2A: Status Quo with Harmony Outfall Upstream –** Harmony expands it's WWTP to accommodate all Franchise Area flows and builds an outfall to the Bow River upstream of Bearspaw Water Treatment Plant (WTP) Intake. Cochrane twins it's pipeline. CHRC members continue their individual paths without regional collaboration.
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These options are described in detail in Sections 3.0, 1, 5.0, and 6.0, respectively, with the associated analysis. The multiple-accounts assessment of these options was completed anonymously by the CHRC in conjunction with the technical analysis to determine the preferred option.

2.0 DESIGN BASIS SUMMARY

To understand which options are feasible, it's important to capture the projected growth and wastewater flows specific to each community. To facilitate this, growth assumptions and historical raw wastewater flow data were provided by each member. Where gaps existed, assumptions were made and are summarized in each section below. Build-out for the various regions is considered to occur within the next 35 years, and therefore a design year of 2058 has been used for this study. The rationale for 35 years is that the main infrastructure being proposed as regional is the Cochrane pipeline, and it's twinned sizing was designed in 2017 for the year 2058. The growth rates presented are chosen based on engineering analysis and sizing of the system and is not a political position.

2.1 TOWN OF COCHRANE

2.1.1 POPULATION PROJECTIONS

The Town of Cochrane has been experiencing significant growth and development, and this rapid growth is expected to continue. An average annual growth rate of 4% was utilized for this study and aligns with other work being completed with the Town (i.e., the Town's Growth Study and Utility Master Plan). Over the build-out design horizon, this steady growth rate results in a final population that would likely exceed the Town's boundary given the current density, however, to understand the servicing limits of the sanitary system, the Town population has not been constrained by the boundary. The population projections for the Town of Cochrane are summarized in Table 2-1.

Table 2-1: Cochrane Population Projections

Year	Design Horizon	Population
2023	Current	34,826[1]
2028	5 Year	42,372
2033	10 Year	51,552
2043	20 Year	76,309
2048	25 Year	92,842
2058	35 Year	137,428

1. **The 2023 (Current) population was derived by applying the 4% growth rate to 2021 census data.**

2.1.2 DESIGN PARAMETERS FOR FLOWS & PROJECTIONS

The Town of Cochrane measures and monitors influent wastewater to the Sanitary Transfer Station and provided detailed flow information for 2018 through 2022. This included flowrate data polled hourly over this period, and flowrates polled every five minutes for 2022. This data, which inherently includes inflow and infiltration (as it's the endpoint of Cochrane's collection system) was used to derive the average daily flows, maximum day flow (MDF) factor, peak hour (PHF) flow factor, and the diurnal curve for the Town's sanitary flows. These flows include flows from Cochrane Lake which currently are minimal in relation to the Cochrane Flows.

The average wastewater generation rate per capita was determined by calculating the Average Annual Daily Flow (AADF) for each year and dividing it by the population.

Annual Average Daily Flow (L/Day) = Total Annual Flow (L) ÷ 365 Days

Average Wastewater Generation Per Capita (L/Capita/Day) = Annual Average Daily Flow (L/Day) ÷ Population (Capita)

For this study, it has been assumed that the average wastewater generation per capita will be constant over the 35-years to build-out. However, it should be noted this calculated average wastewater generation per capita represents the Town's current split of residential and industrial, commercial, and institutional (ICI) sources and if future growth is more concentrated in one of the two types of development, this value may no longer be accurate. If ICI development (i.e., microbrewery) outpaces residential development, the average wastewater generation per capita could increase. For that reason, flow projections should be re-evaluated annually, especially as they relate to determining the timing needed for system upgrades.

The MDF factor was determined by ratioing the maximum flow in 24-hours within a given year to the respective average annual daily flow and selecting the average across 2018 and 2022. The PHF factor was calculated by applying the diurnal curve data to the MDF and captures the peak demand on the system.

$$\text{Maximum Day Flow Factor} = \text{Highest 24-Hour Flow (L/Day)} \div \text{Average Annual Daily Flow (L/Day)}$$

The calculated parameters governing the flow projections are summarized in Table 2-2.

Table 2-2: Cochrane Sanitary Flow Design Parameters

Design Parameter	Value
Average wastewater generation per capita	200 (L/capita/day)
Maximum Day Factor (MDF:AADF)	2.0
Peak Hour Factor (PHF:AADF)	2.76

2.1.3 EXISTING INFRASTRUCTURE CAPACITIES AND CONSTRAINTS

The Town of Cochrane delivers its wastewater to the City of Calgary by pumping wastewater from the Sanitary Transfer Station through the existing sanitary pipeline, all of which will be twinned for the system to continue servicing the Town long-term.

Preliminary design was completed for the system twinning and upgrades in 2017 and identified the phasing and capacities of the upgraded system. These are summarized in Table 2-3.

During the initial phases of the upgrade, the storage volume in the Sanitary Transfer Station will provide flow attenuation during peak flow events and eliminate the need for the system to handle peak hourly flows. Instead, this attenuation will allow the system to operate between MDF and PHF. However, as the Town's population increases, and in turn the sanitary flows increase, the station's ability to attenuate flows will gradually decrease and cannot be relied upon. Therefore, the final phase of the upgrade is intended to be capable of handling peak hour flowrates of the design year.

Table 2-3: Cochrane Sanitary Pipeline and Transfer Station Preliminary Design Capacities

Phase	Description	Capacity	
		Flow (L/s)	Population[1]
0	Storage addition (Current Phase)	255 L/s	50,000
1	Pipeline Section Twin – First Phase	290 L/s	56,000
2	Pipeline Section Twin – Second Phase	350 L/s	66,000
3	Pipeline Section Twin – Third Phase	443 L/s	82,000
4A	Pump Train Addition (2 Duty, 1 Standby) New (second) Forcemain only operational	570 L/s	103,000
4B	Both Forcemains Operational	720 L/s	126,000
5	Additional Pump Train (3 Duty, 1 Standby) Both Forcemains operational	807 L/s	126,000

1. **Population estimates are based on Cochrane sanitary flow parameters, that are summarized in Table 2.2.**

Note that Phase 5 does not result in an increase in serviced population compared to Phase 4B despite having more physical capacity. This is due to the shift in operational philosophy between Phases 4 and 5, where Phase 4 relies on flow attenuation at the STS, whereas Phase 5 does not, and is intended to operate at PHF. Ultimately, Phase 5 upgrades aim to achieve a higher operational resiliency, not increased servicing capacity.

2.2 ROCKY VIEW COUNTY (COCHRANE LAKE)

2.2.1 POPULATION PROJECTIONS

The Cochrane Lake area refers to the Cochrane Lake Hamlet, the Cochrane North ASP area which resides in Rocky View County. Cochrane Lake is anticipating strong growth over the next 35- years, planning for a build-out population of 15,000 people. The population projections were provided by Rocky View County (RVC) and are summarized in Table 2-4. It is important to note that RVC is not in control of the rates of growth and emphasized uncertainty around it. Therefore, the buildout timeframe of the community was condensed to match this study's design period in order to derive a full understanding of the ultimate, long-term servicing needs of the region.

Table 2-4: Cochrane Lake Population Projections

Year	Design Horizon	Population
2023	Current	1,051[1]
2028	5 Year	2,188
2033	10 Year	2,878
2043	20 Year	5,171
2048	25 Year	7,706
2058	35 Year	15,093

1. **The 2023 (Current) population was derived by interpolating the data provided by RVC.**

2.2.2 DESIGN PARAMETERS FOR FLOWS & PROJECTIONS

Both Cochrane Lake and the Town of Cochrane measures the influent wastewater from the Cochrane Lake community and provided detailed flow information for 2018 through 2022. This information was used to derive the average wastewater generation per capita and MDF factor. The PHF factor was calculated by applying the Cochrane diurnal curve to the MDF factor for Cochrane Lake, as five-minute increment data was not available for Cochrane Lake flows. The calculated parameters governing the flow projections are summarized in Table 2-5.

Table 2-5: Cochrane Lake Sanitary Flow Design Parameters

Parameter	Value
Average wastewater generation per capita	312 L/capita/day
Maximum Day Factor (MDF:AADF)	1.99
Peak Hour Factor (PHF:AADF)	2.75

Although the average wastewater generation per capita for Cochrane Lake is significantly higher than Cochrane, it is within the normal industry range, especially given the residential type and density of the community and does not point to exceptional levels of I&I, and rather, Cochrane's per capita wastewater generation value is uniquely low. However, every community could benefit from further monitoring to better understand its water and wastewater flows and how they impact existing and potential future servicing contracts and infrastructure requirements.

2.2.3 EXISTING INFRASTRUCTURE CAPACITIES AND CONSTRAINTS

Sanitary flows are collected within Cochrane Lake and delivered to Cochrane's collection system via forcemain. It is understood that the design limitation of this main is 60 L/s before an upgrade will be needed. Additionally, the Town of Cochrane currently has a service agreement with Cochrane Lake to provide wastewater servicing for a peak flow of 48 L/s.

This study does not limit the flows from Cochrane Lake based on these two constraints, but rather explores what the subregional infrastructure needs to be sized for to accommodate the full buildout of the community.

2.3 ROCKY VIEW COUNTY (NORTH SPRINGBANK)

North Springbank is a small residential community within Rockyview County, and it was requested by RVC to explore the flow requirements for these homes as they are currently on septic systems that are expected to be nearing end of life. RVC anticipates reviewing servicing options for these homes in the future.

2.3.1 POPULATION PROJECTIONS

Population estimates for the Springbank Homes community were estimated based on the community's Area Structure Plan (ASP), which outlined approximately 114 homes with an occupancy density of 2.7 people per household. There is no growth or redevelopment currently anticipated in this area.

Table 2-6: Springbank Population Projections

Year	Design Horizon	Springbank Homes
2023	Current	308
2058	35 Year	308

1. **Population equivalent estimated from the flows provided for the community, assuming Harmony flow parameters.**

2.3.2 DESIGN PARAMETERS FOR FLOWS & PROJECTIONS

To estimate and project sanitary flows from the Springbank Homes community, residential flow parameters are used (average wastewater generation per capita (ADF) and peak dry weather flow (PDWF)) as the existing systems are septic and not subject to large infiltration and inflow rates. IF RVC decides to explore servicing options to these homes in the future, the peak wet weather flows will need to be estimated based on the collection system design.

At this time, the estimated flows for the homes are provided for information for RVC only and will not be included in the total subregional flow estimates.

Table 2-7: Springbank Homes Sanitary Flow Design Parameters

Parameter	Springbank Homes
Average wastewater generation per capita (L/capita/day)	312
Harmon's Peaking Factor	1.74

2.4 HARMONY (HAWSCO)

2.4.1 POPULATION PROJECTIONS

HAWSCo owns and operates the wastewater treatment and collection system primarily for the Harmony community but will be providing wastewater servicing for the residential Springbank community, Springbank Airport, and Bingham Crossing (the Harmony Franchise Area) within the next few years. Many of the communities that will be serviced by HAWSCo are expected to experience rapid growth and will be contributing significant flows within the next five years.

HARMONY

The Harmony community population was estimated and projected based on development plans provided by the community. These plans outlined the number and type of housing units expected to be constructed and occupied over the next 12 years. While the community is currently in its early phases with a population of 1,581, it expects to reach build-out at approximately 12,500 people by 2035.

SPRINGBANK AIRPORT

The Springbank Airport has communicated their estimated peak sanitary flows for the area over the next 35 years to HAWSCo. The initial servicing demand is expected to be about 10 L/s in 2024 and reaching 56 L/s in 2058. These flows were converted to equivalent populations based on Harmony's average wastewater generation per capita, MDF factor and PHF factor. The flows here were requested by the Airport and the area shown in Figure 1 is not representative of the servicing flow request.

BINGHAM COMMUNITY

Development and phasing plans for the community were provided to HAWSCo which indicated maximum daily flows and the MDF factor. These flows were converted to equivalent populations based on Harmony's average wastewater generation per capita, MDF factor and PHF factor.

Population and population equivalents for the HAWSCo servicing area are summarized in Table 2-8. Note that projections for Bingham Crossing were provided in the form of flow rates, which were converted to population equivalents. Also, Projected flows for Springbank Airport are based on contractual agreements between the Airport and Harmony Advanced Water Systems Corporation (HAWSCo) and were converted to population equivalents.

Table 2-8: HAWSCo Population Projections

Year	Design Horizon	Community		
		Harmony	Springbank Airport[1,2]	Bingham[1]
2023	Current	1,581	-	-
2028	5 Year	5,236	2,452	4,188
2033	10 Year	10,513	13,735	4,188
2043	20 Year	12,446	3,992	4,188
2048	25 Year	12,446	7,984	4,188
2058	35 Year	12,446	7,984	4,188

1. **Population equivalent estimated from the flows provided for the community, assuming Harmony flow parameters.**
2. **The anticipated flows from the Springbank Airport have significantly increased from the time of the Harmony WWTP design and construction completion in 2018. These flows were previously assumed to be a peak of 100 m3/day (1 L/s) but are now estimated to be 10 L/s in 2024, 28 L/s in 2035, and 56 L/s at ultimate (2044).**

2.4.2 DESIGN PARAMETERS FOR FLOWS & PROJECTIONS

HARMONY

Wastewater flows discharged to the Harmony WWTP are metered at the main lift station near the WTP. Flow data for 2020 through 2022 were used to determine the average wastewater generation per capita and the MDF factor. The diurnal curve for the Town of Cochrane was applied to the MDF to estimate the PHF factor, as detailed flow data was not available.

SPRINGBANK AIRPORT

Peak flows for the Springbank Airport were provided by HAWSCo, therefore no average wastewater generation per capita, MDF factor, and PHF factor were calculated for this study for this service area.

BINGHAM COMMUNITY

Development and phasing plans were provided to HAWSCo which indicated maximum daily flows from the community and MDF factor. The diurnal curve for the Town of Cochrane was applied to the MDF to estimate the PHF factor, as detailed flow data was not available.

The calculated parameters governing the flow projections for the HAWSCo-serviced communities are summarized in Table 2-9.

Table 2-9: Harmony Franchise Area Sanitary Flow Design Parameters

Parameter	Community		
	Harmony	Springbank Airport	Bingham
Average wastewater generation per capita (L/capita/day)	244	-	-
Maximum Day Factor (MDF:AADF)	1.80	-	1.33
Peak Hour Factor (PHF:AADF)	2.48	-	1.83

2.4.3 EXISTING INFRASTRUCTURE CAPACITIES AND CONSTRAINTS

The Harmony WWTP was originally constructed in 2018 and sized to meet the treatment demands of initial phase of development, with plans for upgrades and expansion in the future for the ultimate buildout of the community. The wastewater treatment system was designed specifically to have a low environmental impact and relies on wastewater reuse for effluent disposal. Harmony's golf course provides sufficient irrigation demands to accommodate the first stage of the plant, however, to support future growth, additional irrigation lands would be needed for effluent handling. Effluent disposal capacity is limited by the 412,000 m^3 storage pond, which is used to retain treated effluent when irrigation is not feasible (during winter months)- this is typically between October and April, for about 220 days.

The Harmony WWTP was designed to be upgraded over several stages to meet the treatment demands of the growing community. It is understood that the plant is currently in Stage 1. The plant's current and ultimate treatment capacities are summarized in Table 2-10.

Table 2-10: Harmony WWTP Capacities

WWTP Capacities	Stage 1 (current)	Ultimate
Average Daily Flow (m^3/day)	1,800	4,700
Maximum Day Flow (m^3/day)	2,880	7,520
Peak Hour Flow (L/s)	64	168

2.5 DESIGN PARAMETER SENSITIVITY

Historical raw data allowed the design parameters for each community to be calculated and provided a lot of insight in terms of each region's wastewater generation and peak events. However, it is important to understand that there are limitations in using past data to predict future flows, and the design parameters derived from historical data can be influenced by many external factors, all of which are difficult to control, but possible to trend.

Population Projections

Population growth values that were provided by each community were used to project the future wastewater flows that would be generated by a growing population. Although growth values were somewhat informed by historical trends, these values mainly reflect a prediction of development within the area, and these predictions range from being highly accurate ("shovels in the ground") to not yet confirmed (ASP planning only) and ultimately, growth rates within the communities depend on the regional economic activity and changing lifestyle trends.

Per Capita WW Generation Rate

Average wastewater generation per capita represents typical wastewater flows and is impacted by residential type (high vs. low density), residential water-use patterns, and local water conservation efforts, awareness, and engagement. As well, because raw data of wastewater flows were used for this study, the calculated values also include ICI wastewater flows and ultimately represent a blended rate of wastewater generation. Therefore, the average wastewater generation of each community can change over time, based on higher density urbanization, water-use patterns, water conservation efforts, and shifts in the proportional development of residential and ICI areas.

Maximum Day Flow (MDF)

Maximum day flows are typically observed during significant wet weather events, and the intent of applying a maximum day flow factor is to capture the high flows due to inflow and infiltration (I&I) on top of average wastewater flows that will occur within the year. Peak hour flows occur when there's a compounding of the diurnal curve and wet weather flow. Therefore, these factors can be influenced by changes in water use patterns (easy-to-predict residential usage vs. less predictable industrial usage) and climate change (storm events that may be more extreme, erratic, frequent, or of longer duration). Conversely, peak hourly flows are generally inversely proportional to population – that is, within larger populations, the peaks are typically dampened, and flows are more evenly distributed.

The variability and elasticity of these design parameters demonstrate the importance in monitoring trends in development, growth, water usage, and wastewater flows, and emphasize the need to understand how changes in these factors can impact infrastructure sizing and phasing. A high-level sensitivity analysis looked at the impact of varying growth rates, MDF factor, and wastewater generation per capita on phasing timelines, however it is recommended to take a more detailed look at the concept design phase.

2.6 FLOW PROJECTIONS SUMMARY

The projected flows for each community are summarized in Table 2-11.

Table 2-11: Sanitary Flow Projections for Cochrane, Rocky View and HAWSCo

Year	Cochrane		Cochrane Lake		Harmony Franchise Area		Springbank Homes[1]	
	MDF (L/s)	PHF (L/s)	MDF (L/s)	PHF (L/s)	AADF (L/s)	MDF[2] (L/s)	ADF (L/s)	PDWF (L/s)
2023	161	222	7.5	10	0	0	1.1	1.7
2028	196	270	15	21	23	29	1.1	1.7
2033	238	329	20	28	47	64	1.1	1.7
2043	353	487	37	51	54	76	1.1	1.7
2048	430	593	55	76	82	105	1.1	1.7
2058	636	878	108	150	82	105	1.1	1.7

1. **Springbank homes flows are considered extremely low in relation to the other three service areas and there is no immediate plan to provide servicing by RVC or a potential subregional system. This information is provided for information only for future servicing considerations, so will not be discussed or included further.**
2. **Maximum day flow is design case for Harmony because treatment plant peak hour capacity is higher in relation to max day treatment capacity (1.95), than PHF:MDF (1.37)**

The wastewater system will have to be capable of handling the maximum day flows for most phases, and peak hour flows at ultimate. A complete detailed breakdown of each community's flow projections is provided in Appendix B. **As shown in Table 2-11, the Harmony Franchise Area will require servicing for a peak capacity of 105 L/s.**

Flow impacts due to climate change cannot be accurately quantified at this time. Climate change impacts will be re-evaluated in the future by possibly implementing water reuse strategies, I&I mitigation, and water conservation measures to offset the impacts.

3.0 OPTION 1A: REGIONAL WASTEWATER DISPOSAL SYSTEM TECHNICAL ANALYSIS

3.1 DESCRIPTION

Option 1A considers a regional wastewater disposal system that uses Cochrane's wastewater pipeline to receive build out flows from Cochrane Lake, Springbank School, and the Harmony Franchise Area. The flows accommodated in Cochrane's wastewater pipeline will be sent to Calgary to be treated. In this scenario, flows received from the Harmony Franchise Area will be surplus flows above the capacity of Harmony's WWTP Stage 1 capacity. The general infrastructure requirements are shown in Figure 4.

Existing Option 1A infrastructure includes:

- The Sanitary Transfer Station (STS) in Cochrane.
- The single pipeline from Cochrane's STS to Calgary.
- Harmony's stage 1 WWTP and effluent storage pond.
- The Harmony main lift station.
- Cochrane Lake's forcemain connection to Cochrane's sanitary collection system.
- Springbank School's forcemain & connection to Cochrane's pipeline.

New/Required Option 1A infrastructure includes:

- The twinned pipeline from Cochrane's STS to Calgary.
- A pipeline to tie-in Harmony's main lift station to Cochrane's pipeline.

- Upgrades to Harmony's main lift station
- Cochrane Sanitary Transfer Station twinning.

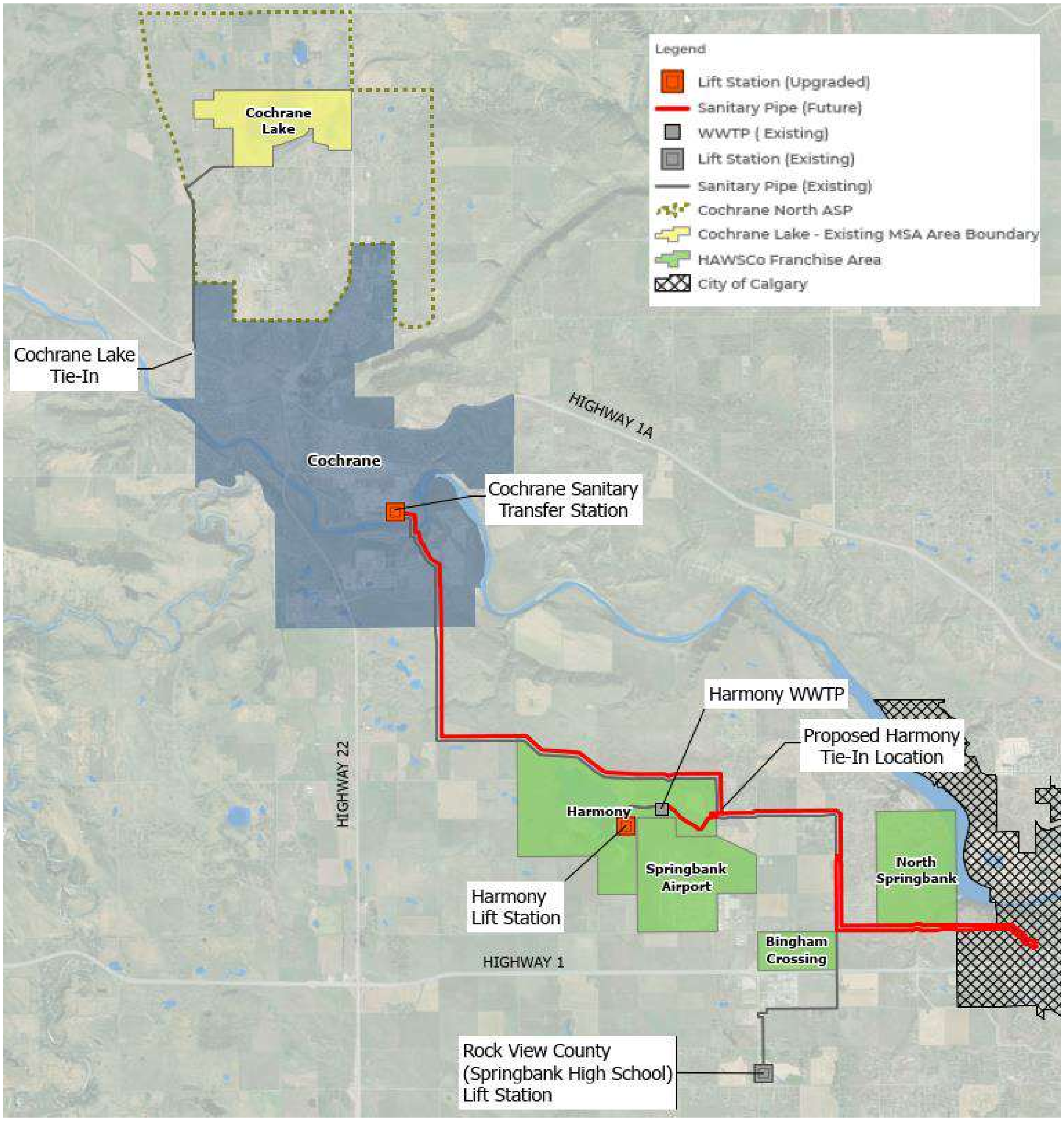

Figure 4: Option 1A - Regional Wastewater Disposal System

For Harmony, it is assumed that the WWTP will continue to operate at its current capacity and provide a source of irrigation water to the golf course, and that within the regional system, sanitary flows will be split, with a portion feeding into the Harmony WWTP, and the remainder entering the sanitary forcemain discharging in Calgary.

Treatment capacity is the limitation on the Franchise Area's maximum day and peak hour flows, as these will occur during the spring and summer months, while effluent storage is the limitation on average flows, which will be required to retain the plant's effluent from October through April when irrigation is not possible. Although the trigger for when a solution will be needed for Harmony is the average day flow (as winter storage capacity is the current system constraint), the sub-regional pipeline will ultimately need to handle HAWSCo's peak flows from the Harmony Franchise Area that exceed the treatment plant's capacity.

3.2 INFRASTRUCTURE REQUIREMENTS

3.2.1 COCHRANE PIPELINE

Forcemain

Hydraulic modelling for the pressurized portion of the pipeline (forcemain) including the Harmony tie-in was completed using the modelling software WaterCAD to determine infrastructure sizing, capacities, and operating parameters. The model includes the Sanitary Transfer Station but is limited to pressure piping, and therefore does not include the gravity pipe section terminating at Calgary. The non-pressurized section of the line was reviewed in PCSWMM. Inputs include the addition of HAWSCo Franchise Area and buildout Cochrane Lake flows, and Cochrane's projected flows to 2058. The model was run to determine pipe sizing based on maximum operating velocities, minimum cleansing velocities and maximum operating pressures within the system, which is used to inform what potential materials can be considered. The twinned pipe has been upsized from the pre-design size of 24", to a 30" line to accommodate Cochrane's growth to 2058. These are summarized in Table 3-1.

Table 3-1: Twinned Forcemain Pipe Size and Material

Phase[1]	Infrastructure	Quantity	Pipe Material	Size (OD)[2]
1	Cochrane FM	5,225 m	PVC DR 18	750 mm
	Harmony FM	2,500 m	PVC DR 18	450 mm
2	Cochrane FM	5,555 m	PVC DR 18	750 mm
3	Cochrane FM	2,980 m	PVC DR18	750 mm
	Cochrane FM (River Crossing)	890 m	Steel	750 mm
	Cochrane FM (Directional Drill)	500 m	HDPE DR 11	750 mm
	Total	**16,760 m**		

1. **Phasing of the pipeline assumes the same phasing as the preliminary pipeline design. Phasing will be optimized in later design stages.**
2. **Pipe material and size was determined by ensuring maximum operating pressures were within 67% of the pipe pressure rating to allow for ASME B31.1 pressure testing and ensuring a minimum cleansing velocity of 0.9 m/s was achieved.**

Syphon

Hydraulic modelling for the gravity pipe (and syphon) was completed in the modelling software PCSWMM to confirm pipe sizing and material for the pressurized syphon. The model was run to ensure is no surcharging of wastewater at the upstream forcemain discharge structure, minimum cleansing velocities are achieved, and design pressures are not exceeded.

The original preliminary pipeline design twinned the existing syphon, however, the review through this study determined that that pressures at the base of the syphon reach 68 psi at 169 L/s (the maximum recorded flowrate based on information received from the Town), which exceeds the pressure rating of the existing 450 mm HDPE DR 32.5 syphon (50 psi). Therefore, it is recommended to decommission the existing line and install a new, larger twinned syphon (two new pipes) to handle interim and ultimate flows. The pipe size and material for a new twinned syphon is summarized in Table 3-2 and assumes that twinned sections will be constructed at the same time for ease of construction.

Table 3-2: Syphon Pipe Size and Material

Phase[1]	Infrastructure	Quantity	Pipe Material	Size (OD)[2]
1	Cochrane Syphon – Line 1	2,290 m	HDPE DR11	900 mm
	Cochrane Syphon – Line 2	2,290 m	HDPE DR11	800 mm
2	Cochrane Syphon – Line 1	2,150 m	HDPE DR11	900 mm
	Cochrane Syphon – Line 2	2,150 m	HDPE DR11	800 mm
	Total	**8,880 m**		

1. **Phasing of the pipeline assumes the same phasing as the preliminary pipeline design. Phasing will be optimized in later design stages.**
2. **Pipe material and size was determined by ensuring maximum operating pressures were within 67% of the pipe pressure rating to allow for ASME B31.1 pressure testing (which requires testing at 1.5x the max operating pressure) and ensuring a minimum cleansing velocity of 0.9 m/s was achieved.**

Sanitary Transfer Station

The Sanitary Transfer Station conveys the Town's wastewater from Cochrane to Calgary. A second pump station is planned in the last phase of the pipeline twinning to pump ultimate projected flows and provided operational redundancy. Based on the hydraulic modelling of Option 1A, the current pumps and planned second pump station are sufficiently sized to handle the additional flows from the Harmony Franchise Area but reduce the pumping capacity available at the sewage transfer station by approximately 1%.

Option 1A Phasing

The phasing provided below generally follows the previous phasing plan for Cochrane's pipeline twinning, and the regional pipeline upgrades could occur in five phases, as described in Section 2.1.3. Phasing will ultimately be driven by the population growth of the regions, and especially by Cochrane's growth. The phasing used for this study for Option 1A is summarized in Table 3-3.

It should be noted that "Total System Capacity" refers to the total flow discharged to Calgary's sewer system and refers to the combined flow from Cochrane, Cochrane Lake, and Harmony's Franchise Area – it is not the total conveying capacity from the Sanitary Transfer Station in Cochrane. The capacity of the system available to Cochrane/Cochrane Lake at the Sanitary Transfer Station is ultimately reduced, although minimally, because of HAWSCo contributing flows downstream which causes higher frictional losses within remainder of the pipeline.

Table 3-3: Proposed Phasing for Option 1A

Phase	Total System Capacity[1] (L/s)	Capacity at STS (L/s)	Year Required to be in Service By	Population Trigger for Phase[1]
Phase 0	292 L/s	250 L/s	-	-
Phase 1	354 L/s	293 L/s	2027[2]	59,930
Phase 2	448 L/s	372 L/s	2034	76,650
Phase 3	629 L/s	553 L/s	2039	90,000
Phase 4	995 L/s	891 L/s	2047	120,910
Phase 5	1,155 L/s	1051 L/s	2057	171,170

1. **Total population for Town of Cochrane, Cochrane Lake and Harmony Franchise Area**
2. **2027 is based on assuming higher growth rates (5-6%) between now and when Phase 1 needs to be in service so that the Town can ensure Phase 1 is in place before the growth occurs. This allows the Town adequate time to design and obtain the regulatory approvals in time.**

The final phase of the system will be capable of providing service to an estimated population of 141,000 within the Town of Cochrane, and 177,914 across all the service areas – while this exceeds the current growth study design population, this demonstrates that the system would have capacity to accommodate variances in flow patterns over the next 35-years, which could result from more ICI-focused development or changes in water use patterns and peak flow events.

3.2.2 HARMONY WWTP

Option 1A does not require any upgrades to the Harmony WWTP but assumes that the plant will operate at its existing (stage 1) treatment and storage capacity shown in Table 3-4. HAWSCo will be required to maintain this capacity at a minimum since sizing of the FM and syphon accounts for wastewater flows in surplus of the WWTP capacity.

Table 3-4: Existing (Stage 1) Harmony WWTP Capacities

WWTP Capacities	Stage 1
Average Daily Flow (m^3/day)	1,800
Maximum Day Flow (m^3/day)	2,880
Peak Hour Flow (L/s)	64

3.2.3 HARMONY FORCEMAIN AND LIFT STATION

Flows from the Harmony Franchise Area will need to connect to the regional pipeline. It is assumed for this study that all flow will be directed from Harmony's main lift station via forcemain to Cochrane's Pipeline to Calgary. Harmony's main lift station currently sends flows to the WWTP and was designed for an ultimate capacity of 178 L/s. The projected ultimate flow from HAWSCo's Franchise Area is 168 L/s, which is within the designed capacity of the lift station. Therefore, the existing lift station can be used to convey Franchise Area flows to the Cochrane pipeline. However, the lift station will need to be retrofitted with larger pumps because the lift station FM will be tied into Cochrane's pressurized pipeline. Process instrumentation and piping modifications will be necessary to split flows between the Cochrane pipeline and Harmony WWTP. Approximately 2.5 km of 450 PVC DR 18 sanitary FM will be required to connect the lift station to the pipeline. This lift station upgrade and FM installation would be complete in the first phase of pipeline construction to meet HAWSCo's servicing needs. Figure 5 shows the proposed Harmony FM and tie-in alignment to connect Franchise Area flows to the Cochrane pipeline.

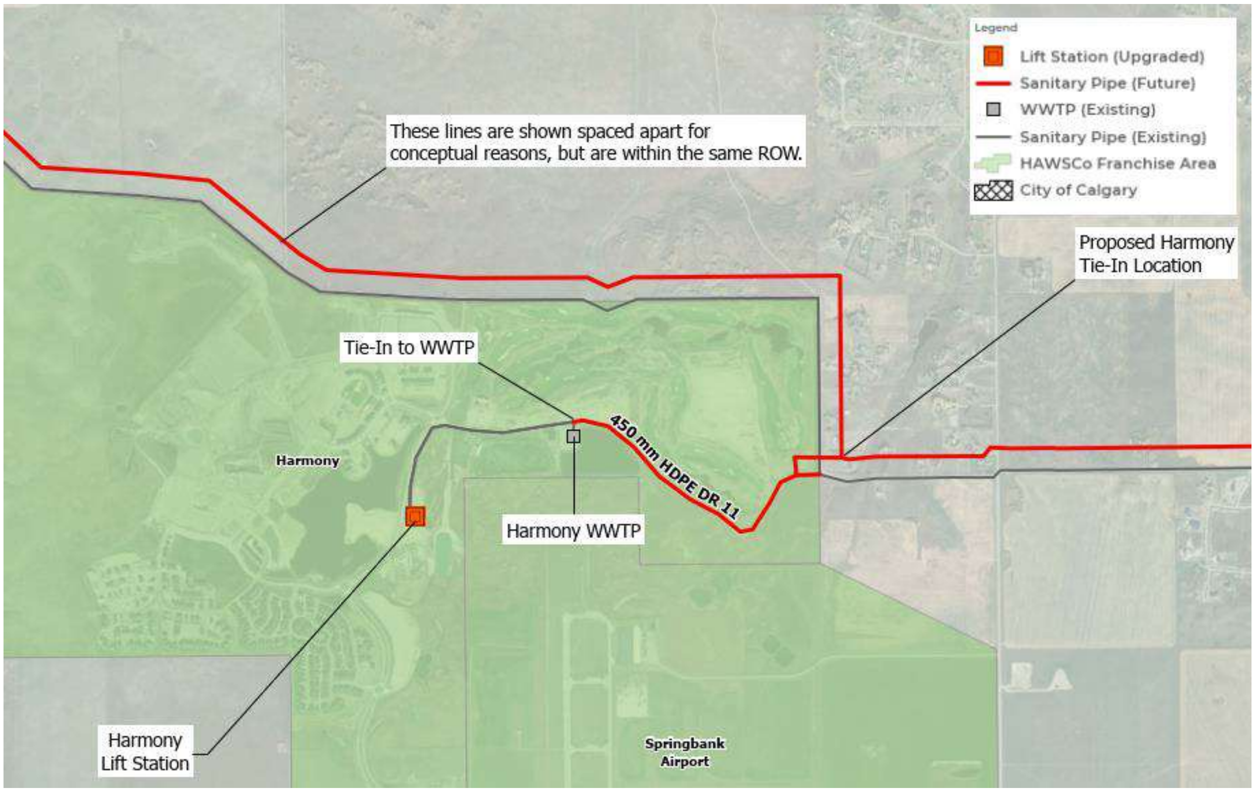

Figure 5: Proposed Harmony FM and Tie-in Alignment

3.3 CLASS E COST ESTIMATE

A feasibility level capital cost estimate (Class E) was completed for Option 1A for comparison between options. The cost estimate was broken into phases to be consistent with the pipeline preliminary design report and to allocate costs for when funds are projected to be needed. Given the estimate class, cost allocations of the total project cost of 10% for general construction requirements, 35% for contingency, and 15% for engineering were included. Table 3-5 and Table 3-6 show the sub regional infrastructure phased capital costs and Harmony's infrastructure capital costs included separately so that HAWSCo can financially assess the regional system compared to what is currently planned. The total capital cost for Option 1A is **$208.9 MM**.

At the beginning of the study, it was determined to exclude Cochrane Lake's future infrastructure needed to accommodate buildout flows because this work has already been planned for and is required in all potential options.

Table 3-5: Option 1A Sub-Regional Infrastructure Class E Cost Estimate

Sub-Regional Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Phase 1 Pipeline	2027	354 L/s	$78.4 MM
Phase 2 Pipeline	2034	448 L/s	$68.1 MM
Phase 3 Pipeline	2039	629 L/s	$33.2 MM
Phase 4/5 Cochrane PS	2057	1,155 L/s	$20.7 MM
		Sub-Total	**$200.4 MM**

Table 3-6: Option 1A Harmony Infrastructure Class E Cost Estimate

Harmony Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Pump Station Upgrade and FM	2027	178[1] L/s	$8.5 MM
		Total	**$8.5 MM**

1. 178 L/s is total capacity of the system, surplus flow of 105 L/s is pumped to Calgary for treatment.

Table 3-7: Option 1A Total Infrastructure Class E Cost Estimate

Option 1A Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Ultimate	2057	1,155 L/s	**$208.9 MM**

4.0 OPTION 1B: HARMONY INTERIM WWTP AND REGIONAL WASTEWATER DISPOSAL SYSTEM TECHNICAL ANALYSIS

4.1 DESCRIPTION

Option 1B proposes treating Cochrane and Cochrane Lake wastewater that are in surplus of the existing pipeline capacity (before Phase 1 pipeline expansion is triggered) at an expanded Harmony WWTP. Once the WWTP capacity is exceeded, those surplus flows will be diverted to Calgary through the twinned pipeline similar to Option 1A. The aim of Option 1B is to increase treatment capacity of the Harmony WWTP and defer pipeline twinning costs. The concept of this option is shown in Figure 6.

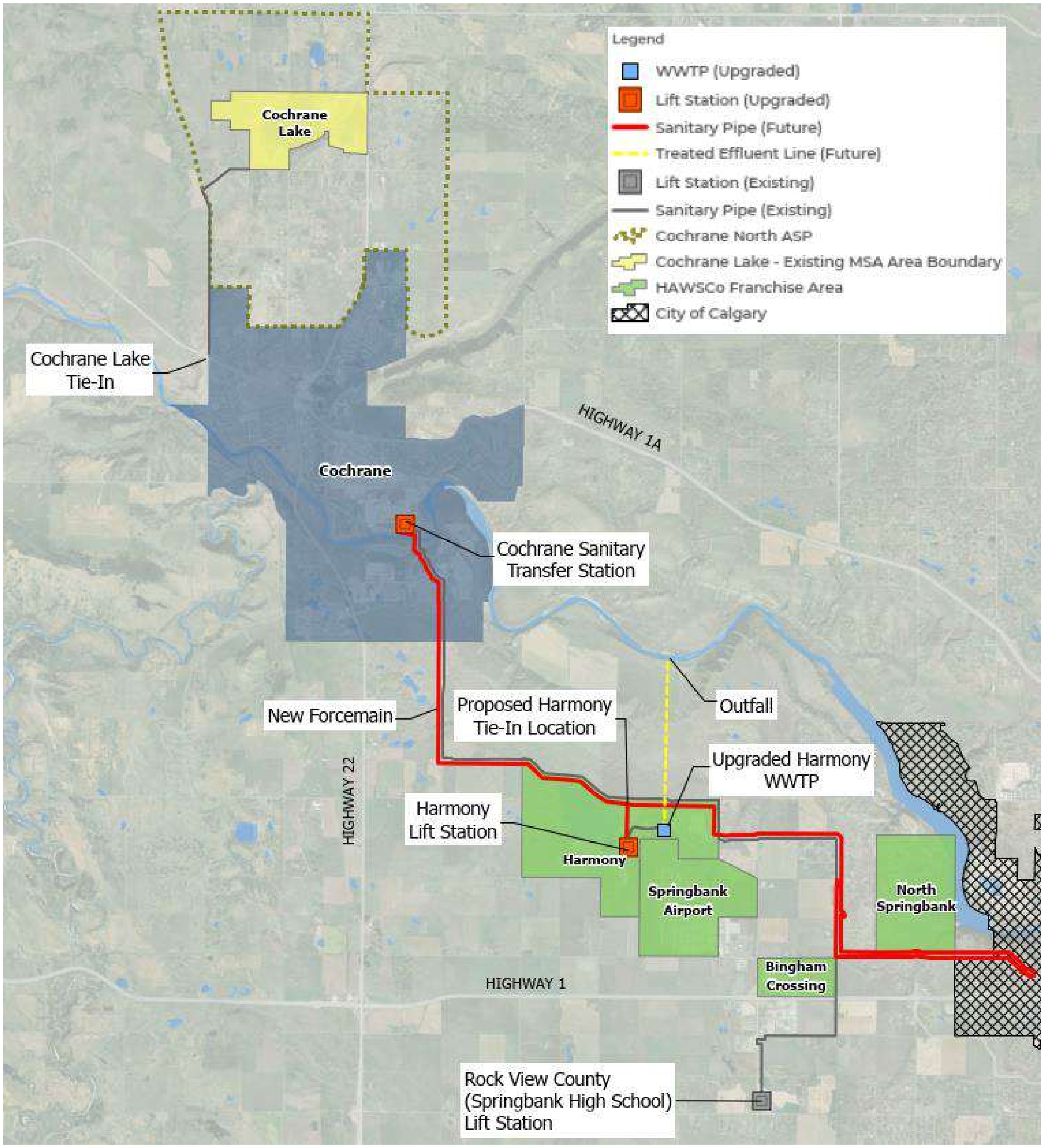

Figure 6: Option 1B - Regional Pipeline with Interim Treatment at Harmony WWTP

Option 1B requires the same infrastructure as Option 1A with the addition of an expanded WWTP to the Harmony Stage 4 capacity and a new outfall from the Harmony WWTP to the Bow River to accommodate the additional effluent as it exceeds the storage pond capacity. The WWTP expansion and outfall would be required immediately to accommodate HAWSCo Franchise Area flows.

4.2 INFRASTRUCTURE REQUIREMENTS

4.2.1 COCHRANE PIPELINE

Forcemain

The FM required in Option 1B has the same sizing and material type as Option 1A since the flow requirements are the same. However, in comparison to Option 1A a longer pipe must be constructed in the first phase to divert flows from Cochrane to the WWTP for interim treatment. Therefore, the proposed phasing for Option 1B defers from the original phasing and is indicated by the quantities in the tables below. Table 4-1 shows the FM pipe requirements with the associated phases.

Table 4-1: Option 1B FM Requirements

1B - Phase	Infrastructure	Quantity	Pipe Material	Size (OD)[1]
1	Cochrane FM	10,625 m	PVC DR 18	750 mm
	Cochrane FM (River Crossing)	890 m	Steel	750 mm
	Cochrane FM (Directional Drill)	500 m	HDPE DR 11	750 mm
2	Cochrane FM	9,735 m	PVC DR 18	750 mm
	Total	**20,360 m**		

1. **Pipe material and size was determined by ensuring maximum operating pressures were within 67% of the pipe pressure rating to allow for ASME B31.1 pressure testing and ensuring a minimum cleansing velocity of 0.9 m/s was achieved.**

Syphon

The syphon required in Option 1B will have the same size and material as Option 1A since the flows are the same. However, the 800 mm and 900 mm HDPE DR11 pipe will be installed completely in Phase 2 when the WWTP capacity is reached, and flows need to be diverted to Calgary for treatment. Table 4-2 summarizes the pipe infrastructure required.

Table 4-2: Option 1B Syphon Requirements

1B - Phase	Infrastructure	Quantity	Pipe Material	Size (OD)[1]
2	Cochrane Syphon – Line 1	4,440 m	HDPE DR11	900 mm
	Cochrane Syphon – Line 2	4,440 m	HDPE DR11	800 mm
	Total	**8,880 m**		

1. **Pipe material and size was determined by ensuring maximum operating pressures were within 67% of the pipe pressure rating to allow for ASME B31.1 pressure testing (which requires testing at 1.5x the max operating pressure) and ensuring a minimum cleansing velocity of 0.9 m/s was achieved.**

Sanitary Transfer Station

Option 1B has the same impact on the Sanitary Transfer Station as Option 1A. It was confirmed that the pumping requirements can be met with the existing pump station and the existing planned addition.

Option 1B Phasing

As previously discussed, a new pipe from the Cochrane transfer station to the Harmony WWTP would be required to divert flows for treatment. Once Harmony WWTP reaches capacity, the rest of the twinned pipeline to Calgary would be built to accommodate the remaining flows. The proposed phasing is shown in Table 4-3

Table 4-3: Option 1B Phasing

1B - Phase[1]	Total System Capacity[1] (L/s)	Year Required to be in Service By
1B - Phase 0	354 L/s	-
1B - Phase 1	448 L/s	2030
1B - Phase 2, 3	629 L/s	2031
1B - Phase 4, 5	1,155 L/s	2048

1. **Note that 1B phasing is specific to Option 1B only.**

4.2.2 HARMONY WWTP

For Harmony to treat any Cochrane and Cochrane Lake Flows, the WWTP would require all upgrades (to buildout) by 2027. This includes the addition of an outfall assumed to be directly north of Harmony, upstream of Calgary's Bearspaw WTP intake. An assessment was completed to determine when Harmony's WWTP could treat surplus Cochrane and Cochrane Lake flows. The results are summarized in Table 4-4. The existing (stage 1) WWTP max day treatment capacity is 2,880 m^3/day (33 L/s). At ultimate buildout, the WWTP is designed to treat 7,500 m^3/day (87 L/s).

Table 4-4: Option 1B Feasibility Assessment

Year	Cochrane and Cochrane Lake Excess[2] Flow (Max Day)	HAWSCo Max Day Flow	Total Max Day Flow	Harmony Ultimate Max Day Treatment Capacity	Notes
2030	0 L/s	73 L/s	73 L/s	**87[1] L/s**	Total flow is within ultimate treatment capacity. Note that Cochrane flows are not yet treated at Harmony.
2031	7 L/s	82 L/s	89 L/s		Harmony WWTP ultimate design capacity (87L/s) is exceeded.

1. **Maximum capacity of the Harmony WWTP is 87 L/s and is exceeded by the addition of surplus Cochrane, Cochrane Lake, and Harmony flows in 2031.**
2. **Flows that exceed the current pipeline capacity of 255 L/s.**

From Table 4-4 it can be concluded that:

- Harmony WWTP would require all upgrades (to ultimate) to be able to service HAWSCo Franchise Area flows by 2030.
- Harmony's WWTP ultimate capacity would be exceeded by 2031 with the addition of surplus Cochrane and Cochrane Lake flows.
- The ultimate design capacity of the WWTP (87L/s) is exceeded by projected flows (89 L/s) by 2031 with the addition of Cochrane and Cochrane Lake surplus flows in the same year. Therefore, surplus Cochrane and Cochrane Lake flows cannot be treated at the WWTP.

Additionally, Harmony's WWTP existing effluent storage capacity will be exceeded by 2025 and an outfall to the river or other form of effluent storage will be required.
Option 1B is logistically not feasible given the amount of infrastructure that must be constructed in a short time frame, with no long-term benefit.

4.2.3 HARMONY FORCEMAIN, LIFT STATION, AND OUTFALL

Like Option 1A, upgrades to Harmony's lift station pumps and a FM will be required to divert surplus Franchise Area flows to the Cochrane twinned pipeline. As mentioned in Section 1, an outfall to the Bow River is required to upgrade the WWTP to ultimate capacity. This outfall is assumed to be 450 mm PVC DR 18 that runs 4.3 km north along the same alignment as the storm drain from Harmony.

4.3 CLASS E COST ESTIMATE

Like Option 1A, a feasibility level capital cost estimate (Class E) was completed for Option 1B. Given the estimate class, cost allocations of the total project cost of 10% for general construction requirements, 35% for contingency, and 15% for engineering fees were included. Table 4-5, Table 4-6Table 3-5, and Table 4-7 show the sub regional infrastructure phase capital costs and Harmony's infrastructure capital costs. The total capital cost for Option 1B is **$232.7 MM**.

Table 4-5: Option 1B Sub-Regional Infrastructure Class E Cost Estimate

Sub-Regional Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Phase 1 Pipelines	2030	448 L/s	$83.1 MM
Phase 2, 3 Pipelines	2031	629 L/s	$99.9 MM
Phase 4, 5 Cochrane PS	2048	1,155 L/s	$21.3 MM
		Sub-Total	**$204.3 MM**

Table 4-6: Option 1B Harmony Infrastructure Class E Cost Estimate

Harmony Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Harmony WWTP Expansion + Outfall	2027	87 L/s (Ultimate)	$26.8 MM
Pump Station Upgrade	2030	178[1] L/s	$1.8 MM
		Total	**$28.6 MM**

1. **178 L/s is total capacity of the system, surplus flow of 105 L/s is pumped to Calgary for treatment.**

Table 4-7: Option 1B Infrastructure Class E Cost Estimate

Option 1B Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Ultimate	2048	1,155 L/s	**$232.7 MM**

5.0 OPTION 2A: STATUS QUO (OUTFALL UPSTREAM) TECHNICAL ANALYSIS

5.1 DESCRIPTION

Option 2A is a status quo option, meaning the CHRC members pursue individual paths towards infrastructure upgrades as currently planned for wastewater servicing. Cochrane proceeds with twinning the pipeline to Calgary and upgrading pumping capacity accordingly, with plans to service all of Cochrane Lake's buildout. HAWSCo would need to expand beyond the current WWTP Stage 4 design to accommodate ultimate Franchise Area flows and will require an outfall to the Bow River. For this option, an outfall directly north of the community (upstream of the Calgary Bearspaw WTP intake) is considered. Option 2A configuration is shown in Figure 7.

Existing Option 2A infrastructure includes:

- The Sanitary Transfer Station in Cochrane,
- The single pipeline to Calgary,
- Harmony's Stage 1 WWTP,
- The Harmony main lift station,
- Cochrane Lake's connection to Cochrane's disposal system,
- and Springbank School's connection to Cochrane's disposal system.

New Option 2A infrastructure required includes:

- Twinning the pipeline from Cochrane to Calgary (sized for Cochrane and Cochrane Lake's growth),
- Sanitary Transfer Station twinning and upgrades,
- Harmony outfall and pipeline upstream of the Bearspaw WTP,
- Expansion to the Harmony WWTP.

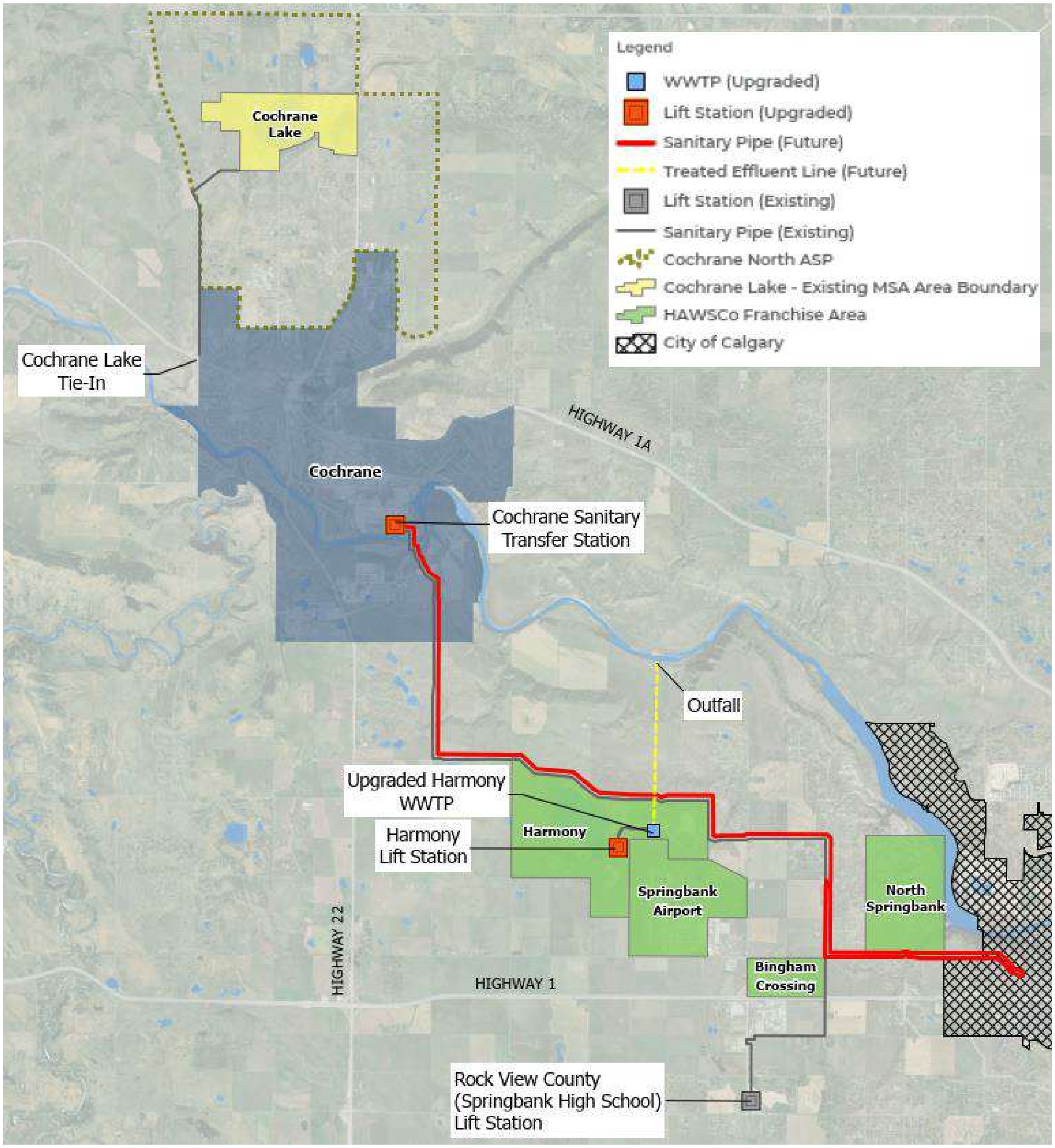

Figure 7: Option 2A - Status Quo with Harmony WWTP Outfall Upstream of Bearspaw WTP Intake

5.2 INFRASTRUCTURE REQUIREMENTS

5.2.1 COCHRANE PIPELINE

Forcemain

The FM design and phasing required for Option 2A will be consistent with the preliminary design of the Cochrane wastewater pipeline. The pipe size in Table 5-1 was confirmed through modelling and is the same size as calculated in Option 1A.

Table 5-1: Option 2A Forcemain Pipe Size and Material

Phase[1]	Infrastructure	Quantity	Pipe Material	Size (OD)[2]
1	Cochrane FM	5,225 m	PVC DR 18	750 mm
2	Cochrane FM	5,555 m	PVC DR 18	750 mm
3	Cochrane FM	4,370 m	Steel	750 mm
	Cochrane FM (River Crossing)	890 m	HDPE DR 11	750 mm
	Cochrane FM (Directional Drill)	500 m	PVC DR18	750 mm
	Total	**15,150 m**		

1. **Phasing of the pipeline assumes the same phasing as the preliminary pipeline design. Phasing will be optimized in later design stages.**
2. **Pipe material and size was determined by ensuring maximum operating pressures were within 67% of the pipe pressure rating to allow for ASME B31.1 pressure testing and ensuring a minimum cleansing velocity of 0.9 m/s was achieved.**

Syphon

The syphon design and phasing required for Option 2A will be consistent with the preliminary design of the Cochrane wastewater pipeline. However, as discussed in Section 3.2.1, modelling showed that the operating pressure is exceeding the pressure rating of the existing syphon. Therefore, it is recommended to install a twinned syphon, to replace existing. Pipe material and size are the same as in Option 1A.

Table 5-2: Option 2A Syphon Requirements

Phase[1]	Infrastructure	Quantity	Pipe Material	Size (OD)[2]
1	Cochrane Syphon – Line 1	2,290 m	HDPE DR11	900 mm
	Cochrane Syphon – Line 2	2,290 m	HDPE DR11	800 mm
2	Cochrane Syphon – Line 1	2,150 m	HDPE DR11	900 mm
	Cochrane Syphon – Line 2	2,150 m	HDPE DR11	800 mm
	Total	**8,880 m**		

1. **Phasing of the pipeline assumes the same phasing as the preliminary pipeline design. Phasing will be optimized in later design stages.**
2. **Pipe material and size was determined by ensuring maximum operating pressures were within 67% of the pipe pressure rating to allow for ASME B31.1 pressure testing (which requires testing at 1.5x the max operating pressure) and ensuring a minimum cleansing velocity of 0.9 m/s was achieved.**

Sanitary Transfer Station

The transfer station pump sizing and originally planned expansion is adequately sized to meet the projected flows from Cochrane and Cochrane Lake.

Proposed Phasing

Phasing for option 2A will be driven primarily by population growth and wastewater flow patterns within Cochrane and is summarized in Table 5-3.

Phasing for this option is similar to the Option 1A phasing, with exception for the Phase 1 and Phase 5 triggers, which would be one year later as a result of Franchise Area flows not entering the pipeline and instead being treated at Harmony's WWTP and discharged to the Bow River. The final phase of the system will be capable of servicing an estimated population of 143,400 within the Town of Cochrane.

Table 5-3: Proposed Phasing for Option 2A

Phase	Capacity at STS (L/s)	Year Required By	Population Trigger for Phase[1]
Phase 0	255 L/s	-	-
Phase 1	293 L/s	2031	50,240
Phase 2	375 L/s	2034	56,640
Phase 3	558 L/s	2039	69,240
Phase 4	902 L/s	2048	100,550
Phase 5	1066 L/s	2058	152,520

1. **Phasing of the pipeline assumes the same phasing as the preliminary pipeline design. Phasing will be optimized in later design stages.**

5.2.2 HARMONY WWTP

The Harmony WWTP currently has a max day capacity of 2,880 m^3/day (Stage 1). At ultimate buildout, the WWTP has a max day treatment capacity of 7,500 m^3/day. The HAWSCo Franchise Area projected flow for the ultimate buildout is 14,500 m^3/day, therefore, a significantly larger plant (approximately double) would have to be designed, approved, and constructed for this option. The larger plant also requires an outfall to the Bow River to discharge treated effluent.

5.2.3 HARMONY OUTFALL UPSTREAM OF BEARSPAW WTP INTAKE

Option 2A considers an expanded WWTP with an outfall upstream of the Bearspaw WTP intake. The outfall pipe is assumed to be 4.3 km of 450 mm PVC DR 18 and follows the alignment of the existing storm drain from Harmony, the same as Option 1B. An outfall upstream of the Bearspaw WTP intake is the shortest length to the Bow River.

5.3 CLASS E COST ESTIMATE

Similar to the other options, a feasibility level capital cost estimate (Class E) was completed for Option 2A. Given the estimate class level, cost allocations of the total project cost of 10% for general construction requirements, 35% for contingency, and 15% for engineering were included. The tables below show the Cochrane infrastructure phase capital costs and Harmony's infrastructure capital costs, respectively. The total capital cost for Option 2A is **$239.7 MM**.

Table 5-4: Option 2A Cochrane Infrastructure Class E Cost Estimate

Cochrane Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Phase 1 Pipelines	2031	293 L/s	$78.4 MM
Phase 2 Pipelines	2034	375 L/s	$68.1 MM
Phase 3 Pipelines	2039	558 L/s	$33.2 MM
Phase 4/5 Cochrane PS	2058	1066 L/s	$20.7 MM
		Sub-Total	**$200.4 MM**

Table 5-5: Option 2A Harmony Infrastructure Class E Cost Estimate

Harmony Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Harmony WWTP Expansion + Outfall	2030	79 L/s (Ultimate)	$39.3 MM
		Total	**$39.3 MM**

Table 5-6: Option 2A Infrastructure Class E Cost Estimate

Option 2A Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Ultimate	2058	1066 L/s	**$239.7 MM**

6.0 OPTION 2B: STATUS QUO (OUTFALL DOWNSTREAM) TECHNICAL ANALYSIS

6.1 DESCRIPTION

Option 2B is the same option as Option 2A – Status Quo, except this option considers a Harmony WWTP outfall downstream of the Bearspaw WTP intake. Option 2B was included in the analysis since it would be preferred by Calgary as part of their source protection plan. Figure 8 shows the general configuration of Option 2B and the possible alignment for an outfall downstream of the WTP intake as proposed by the City of Calgary.

This option requires the same infrastructure as Option 2A with the addition of a longer treated effluent pipeline that discharges downstream of the WTP intake in Calgary.

Existing Option 2B infrastructure includes:

- The Sanitary Transfer Station in Cochrane,
- The single pipeline to Calgary,
- Harmony's Stage 1 WWTP,
- The Harmony main lift station,
- Cochrane Lake's connection to Cochrane's disposal system,
- Springbank School's connection to Cochrane's disposal system.

New Option 2B infrastructure required includes:

- Twinning the pipeline from Cochrane to Calgary (sized for Cochrane and Cochrane Lake's growth),
- Sanitary Transfer Station twinning and upgrades,
- Harmony pipeline and outfall ***downstream*** of the Bearspaw WTP,
- Expansion to the Harmony WWTP.

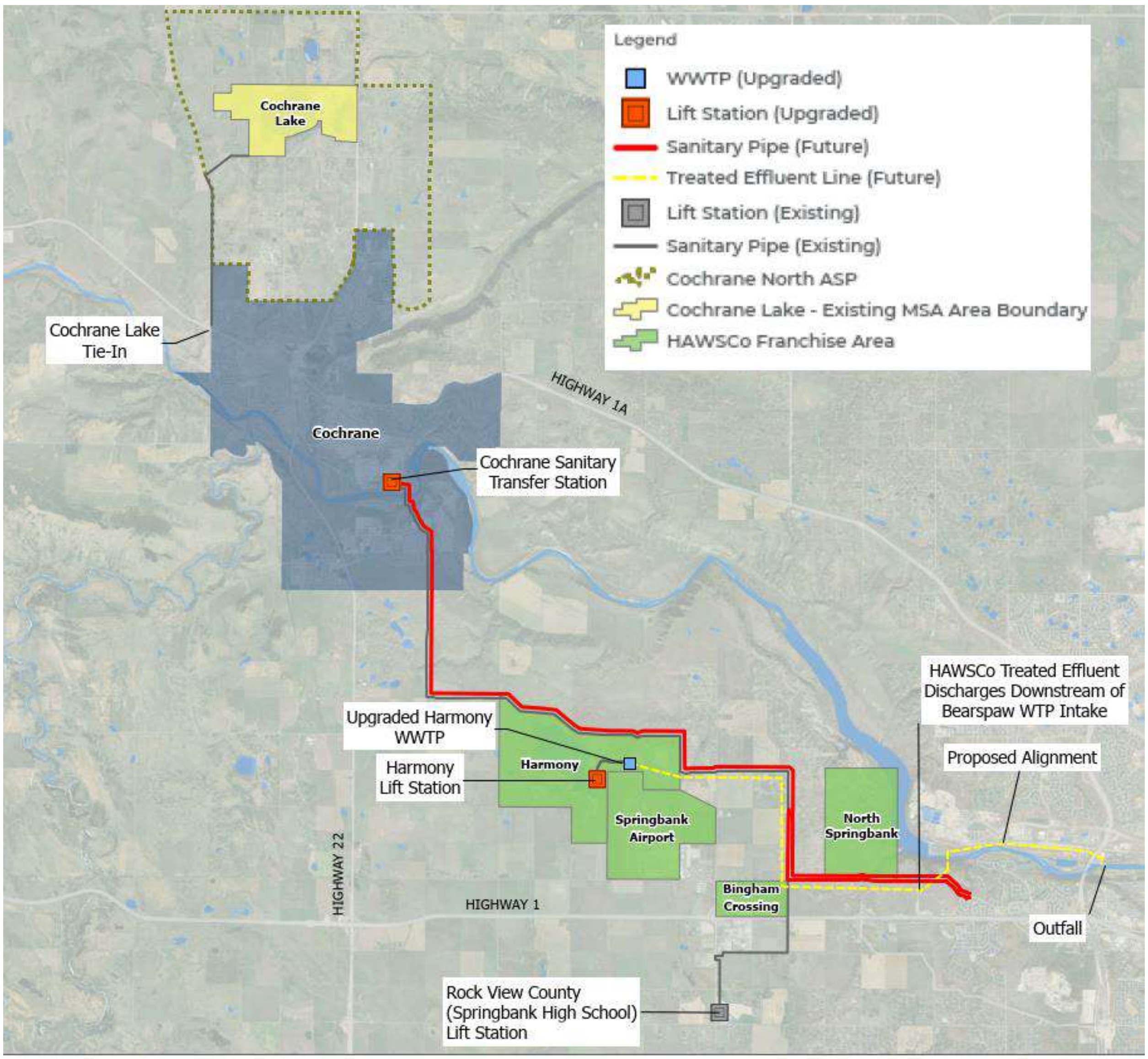

Figure 8: Option 2B - Status Quo with Harmony WWTP Outfall Downstream of Bearspaw WTP Intake

6.2 INFRASTRUCTURE REQUIREMENTS

6.2.1 COCHRANE PIPELINE

Forcemain

This option has the same FM sizing and material as Option 2A given the same flow conditions.

Table 6-1: Option 2B Forcemain Pipe Size and Material

Phase[1]	Infrastructure	Quantity	Pipe Material	Size (OD)[2]
1	Cochrane FM	5,225 m	PVC DR 18	750 mm
2	Cochrane FM	5,555 m	PVC DR 18	750 mm
3	Cochrane FM	4,370 m	Steel	750 mm
	Cochrane FM (River Crossing)	890 m	HDPE DR 11	750 mm
	Cochrane FM (Directional Drill)	500 m	PVC DR18	750 mm
	Total	**15,150 m**		

1. **Phasing of the pipeline assumes the same phasing as the preliminary pipeline design. Phasing will be optimized in later design stages.**
2. **Pipe material and size was determined by ensuring maximum operating pressures were within 67% of the pipe pressure rating to allow for ASME B31.1 pressure testing and ensuring a minimum cleansing velocity of 0.9 m/s was achieved.**

Syphon

This option has the same syphon sizing and material as Option 2A given the same flow conditions.

Table 6-2: Option 2A Syphon Requirements

Phase[1]	Infrastructure	Quantity	Pipe Material	Size (OD)[2]
1	Cochrane Syphon – Line 1	2,290 m	HDPE DR11	900 mm
	Cochrane Syphon – Line 2	2,290 m	HDPE DR11	800 mm
2	Cochrane Syphon – Line 1	2,150 m	HDPE DR11	900 mm
	Cochrane Syphon – Line 2	2,150 m	HDPE DR11	800 mm
	Total	**8,880 m**		

1. **Phasing of the pipeline assumes the same phasing as the preliminary pipeline design. Phasing will be optimized in later design stages.**
2. **Pipe material and size was determined by ensuring maximum operating pressures were within 67% of the pipe pressure rating to allow for ASME B31.1 pressure testing (which requires testing at 1.5x the max operating pressure) and ensuring a minimum cleansing velocity of 0.9 m/s was achieved.**

Sanitary Transfer Station

This Option has the same transfer station sizing has Option 2A. The transfer station pump sizing and originally planned expansion in the form of additional pumps is adequately sized to meet the projected flows from Cochrane and Cochrane Lake.

Option 2B Phasing

Option 2B has the same expected phasing as Option 2A and is summarized in Table 6-3.

Table 6-3: Phasing for Option 2B

Phase	Capacity at STS (L/s)	Year Required By	Population Trigger for Phase (Cochrane)
Phase 0	255 L/s	-	-
Phase 1	293 L/s	2031	47,662
Phase 2	375 L/s	2034	53,614
Phase 3	558 L/s	2039	65,229
Phase 4	902 L/s	2048	92,842
Phase 5	1066 L/s	2058	137,428

6.2.2 HARMONY WWTP

The WWTP has the same requirement as option 2A, meaning a significantly larger plant than the currently designed treatment capacity to treat ultimate franchise flows.

6.2.3 HARMONY OUTFALL DOWNSTREAM OF BEARSPAW WTP INTAKE

Option 2A considers a WWTP with an outfall downstream of the Bearspaw WTP intake. The outfall pipe is assumed to be 13 km of 450 mm PVC DR 18 would follow the alignment of the existing Cochrane wastewater pipeline then would follow the alignment as shown in Figure 8. An outfall downstream of the Bearspaw WTP intake is being considered as a treated effluent discharge upstream of a WTP intake may create challenges to receive approval.

6.3 CLASS E COST ESTIMATE

Like the other options, a feasibility level capital cost estimate (Class E) was complete for Option 2B. Given the estimate class level, cost allocations of the total project cost of 10% for general construction requirements, 35% for contingency, and 15% for Engineering fees were included. The Tables below show the Cochrane infrastructure phase capital costs and Harmony's infrastructure capital costs, respectively. The total capital cost for Option 2B is **$276.8 MM**.

Table 6-4: Option 2B Cochrane Infrastructure Class E Cost Estimate

Cochrane Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Phase 1 Pipelines	2031	293 L/s	$78.4 MM
Phase 2 Pipelines	2034	375 L/s	$68.1 MM
Phase 3 Pipelines	2039	558 L/s	$33.2 MM
Phase 4/5 Cochrane PS	2058	1066 L/s	$20.7 MM
		Sub-Total	**$200.4 MM**

Table 6-5: Option 2B Harmony Infrastructure Class E Cost Estimate

Harmony Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Harmony WWTP Expansion + Outfall	2030	79 L/s (Ultimate)	$76.4 MM
		Total	**$76.4 MM**

Table 6-6: Option 2B Infrastructure Class E Cost Estimate

Option 2B Infrastructure Required	When Required	Infrastructure Capacity	Capital Cost Estimate (Class E)
Ultimate	2058	1066 L/s	**$276.8 MM**

7.0 PESTLE ANALYSIS

7.1 HOW IT WORKS

While the infrastructure options for the CHRC can be compared quantitatively based on the capital costs, more discussion is required to evaluate the infrastructure on a qualitative and multiple accounts basis.

A multiple accounts workshop and evaluation took place with the CHRC to determine the main Political, Environmental, Social, Technical, Legal, and Economic (PESTLE) considerations of the options. The key objectives of the PESTLE workshop were as follows:

- Develop a framework for evaluating the options considering criteria agreed upon by the CHRC, that cannot be measured by cost.
- Ensure that upon selection of the preferred option, the guiding principles created by the group were considered and included.
- Document the process for transparency and confidence of administration and Councils.
- Evaluate the options based on framework to determine the overall best option for the CHRC.

The CHRC provided input on the key criteria that was of most importance for evaluation of the options and is found in Table 7-1.

Table 7-1: PESTLE Criterion Determined by the CHRC

PESTLE Criterion	
Political	Does the Option align with CMRB members plans and policies? (Collaboration?)
	Does the Option support Federal objectives?
	Does the Option support the Local objectives?
	Does the Option align with Provincial approvals and/or policy objectives?
Economic	Does the Option have opportunity for grant funding?
	Does the Option have opportunity for cost sharing?
	Does the Option provide the ability to phase to balance cash flow and reduce impact to debt limits?
	Does the Option consider the best value for the taxpayer?
Social	Does the Option minimize impacts to public during construction and operation?
	Does the Option have timely implementation for growth?
	Is the Option reliable & does it minimize risk of service interruptions?
	Does the Option minimize the potential for regional and social conflict?
Technological	Does the Option minimize the degree of operational responsibility and safety? (is the option less risky)
	Is the Option energy efficient? (pumps vs. gravity)
	Does the option effectively use existing infrastructure?
	Does the Option accommodate variability with growth patterns?
	Does the Option have simple overall asset renewal?
Legal	Does the Option require additional lands?
	Does the Option require additional staffing or complex administration? (Higher level operators, etc.)
	Does the Option require additional agreements and approvals?
	Does the Option have complex governance?
Environmental	Does the Option require environmental approvals?
	Does the option effectively manage the water resources in the region?
	Does the Option have Environmental impacts during and post construction (Land, Rivers, Seasonal)?
	Does the Option offer resiliency to long term climate change?

With the criteria provided, a rating matrix was developed, with each criterion being weighted equally. From this, each infrastructure option was compared to a "base option", in this case Option 2A, and provided a score from -2 to +2 based on the metrics in Table 7-2. **The base option is best as being the status quo option (Option 2A) because the members of the CHRC would pursue it without this analysis having taken place.**

Table 7-2: PESTLE Scoring Criteria

PESTLE SCORING CRITERIA	
-2	Significantly Worse than Base Option
-1	Worse than Base Option
0	Same as Base Option
+1	Better than Base Option
+2	Significantly Better than Base Option

Once evaluated, by each member, scores for each criterion were averaged, then all criteria for each option were calculated to obtain a final PESTLE score.

```
Final Pestle Score = Sum of [(Sum of Average Criterion Scores) x (Criterion Weighting)]
```

The final PESTLE score for each option is plotted on the Y-axis and the total capital costs are plotted on the X-axis of the evaluation matrix, shown in Figure 9 below, to indicate where each option falls in relation to the base option, which is plotted at (0, 0). Higher preference is then given to the option with a higher PESTLE score and lower total capital costs.

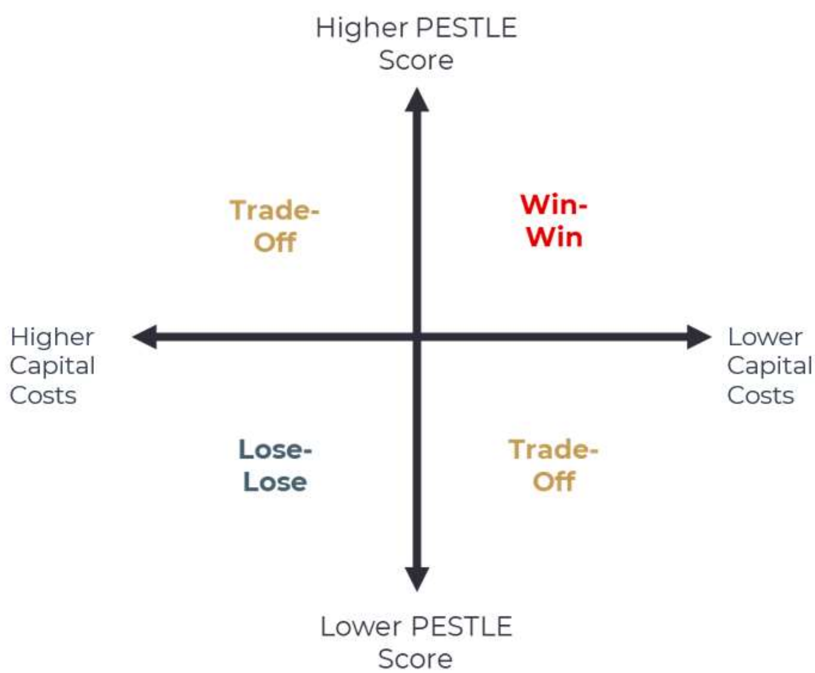

Figure 9: PESTLE Evaluation Matrix

This matrix provides a visual representation of the options, and how they have been evaluated based on the criteria provided. This guides decision making as to which infrastructure option is preferred to finalize the strategy.

7.2 RESULTS

The CHRC anonymously rated each option against the base case using PESTLE scoring. These scores were averaged, and comments compiled in Appendix A. The weighting for individual criterion was applied to each option to determine the overall score shown in Table 7-3.

Table 7-3: Options Final PESTLE Score

Option	Final PESTLE Score
1A – Subregional System	3.17
1B – Subregional System with Interim Treatment at Harmony	0.23
2A – Status Quo (Discharge Upstream of Bearspaw)	0
2B – Status Quo (Discharge Downstream of Bearspaw)	-0.48

The scores unanimously support Option 1A with little variance in criterion scores from the CHRC members. Options 1B, 2A, and 2B received a wider range of scores because these options impact the individual CHRC partners differently.

The final PESTLE score was plotted along with the option's capital cost, as shown in Figure 10. The capital costs are shown as a percent cost deviation from the base case.

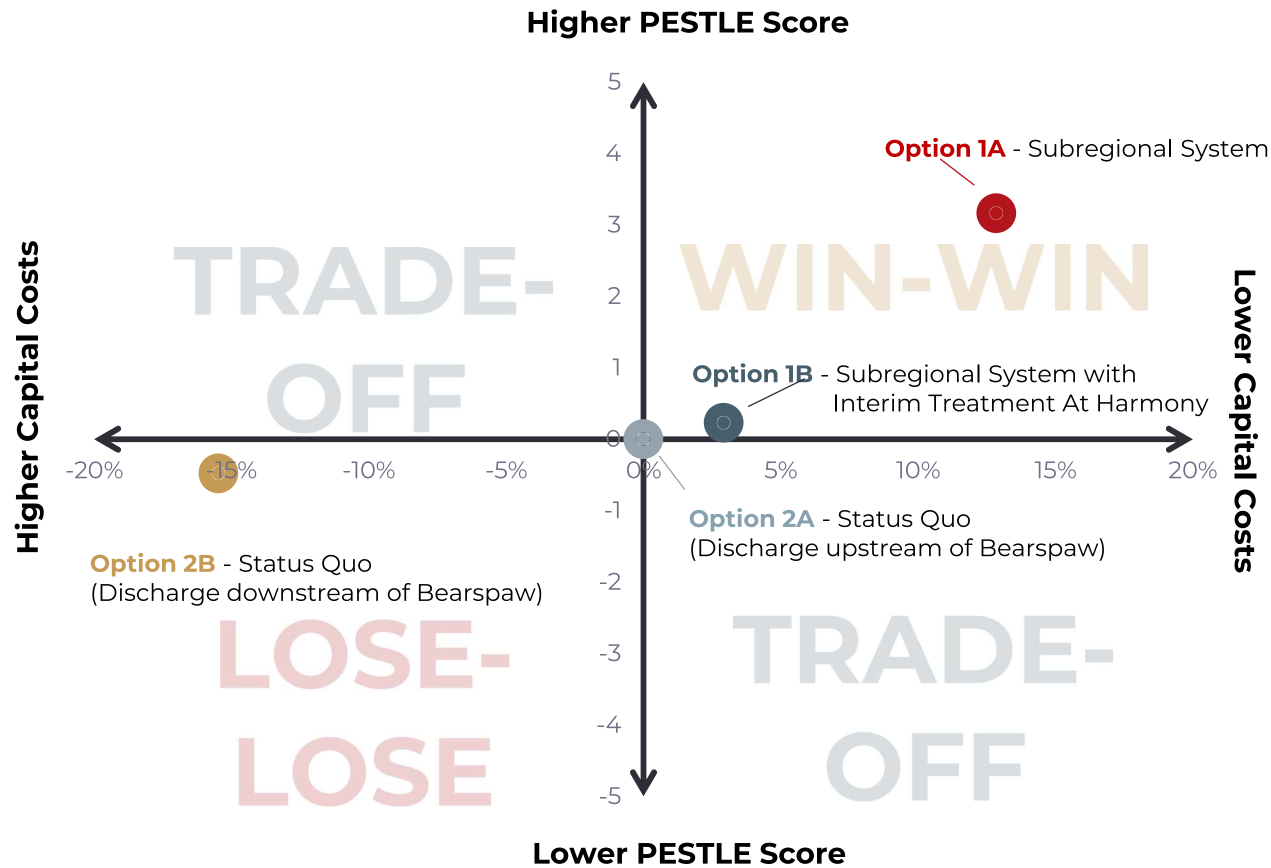

Figure 10: PESTLE Results

The following summarizes the analysis:

- **Option 1A is the preferred option** by the CHRC because it has the lowest overall capital cost and the best performance on the PESTLE criteria.
- Option 1B is not practical given the short timeframe needed to upgrade the Harmony WWTP and obtain a permit to add a new outfall.
- Option 2A is the second-best option after 1A only because Option 1B is not feasible.
- Option 2B is the least favourable option as it has significantly higher costs than the other options and performs the worst on the PESTLE criteria.

From the PESTLE and technical analysis, Option 1A is the preferred option by the CHRC and will be carried into the next stage of this feasibility study to explore cost sharing and governance options.

8.0 RECOMMENDATONS

8.1 OPTION 1A REFINEMENT

Now that a preferred option has been selected, the option should be further reviewed to determine and identify any potential opportunities to optimize costs. Additionally, the costing of Option 1A will be refined to better calculate and refine the cost-sharing options.

8.2 COST ALLOCATION ANALYSIS

Subregional systems such as the one being considered can have complicated ownership and capital expenditure allocations between Partners. The next stage of this analysis will look at what the infrastructure capacity allocations are for the shared infrastructure, and possible funding contributions by the individual partners. This will help inform the CHRC of the financial burden each party should consider.

8.3 GOVERNANCE OPTIONS AND DECISION MAKING

Different governance options have been investigated and presented up to this point, however the next stage of this feasibility study will work with the CHRC to choose an agreed upon governance methodology. The governance options descriptions will be included in the subsequent report with the associated decision made by the CHRC, with the intention to carry recommendations forward to Councils.

8.4 CHRC PARTNER CONSIDERATIONS

Each member of the CHRC has unique needs related to this project and different decision-making processes within their organizations. Therefore, it is critical to understand and manage efforts to ensure each member has the information they need to advance discussions regarding what is being proposed.

The needs and constraints for each Partner are summarized as:

- **City of Calgary:**
  - As the ultimate “receiver” of the wastewater, Calgary must review and approve a proposed regional solution for it to advance further.
  - Calgary required the regional flow projections to confirm that their sewer system or current capital planned upgrades would not be adversely impacted by what is being

    - proposed. This was confirmed and the proposed projections do not change their current capital plans or unduly advance them earlier.
    - To bring the recommendations forward to Council in Q1 2024, this report (Report 1) is being advanced before the cost allocation analysis to ensure timely review of Report 1 recommendations to allow administration to prepare for Council endorsement in early 2024.
- **Town of Cochrane:**
    - Town of Cochrane currently owns the wastewater pipeline and is beginning Phase 1 pipeline twinning detailed design in 2024. This is critical path for the Town as the pipeline is needed in 2027 based on current growth projections. Therefore, a decision must be made as early as possible in 2024 to avoid delaying detailed design and advancement of the project.
    - Town of Cochrane will need to understand their total costs for a regional system vs. the status quo, to advise and make recommendations to Council.
- **Rockey View County (Cochrane Lake)**:
    - Currently, Cochrane Lake has 48 L/s of capacity in the Cochrane system and is not yet approaching that limit, so is not under a specific time constraint from a servicing perspective.
    - If desiring to participate in the subregional system, RVC will need to evaluate their full costs to do so (including any upgrades needed to the Cochrane Lake existing Lift Station) and obtain approval for expanding the current MSA service area.
- **HAWSCo:**
    - Harmony needs to begin advancing design for the Stage 2 WWTP upgrades as soon as possible, as they will need to be in place by 2027. Therefore, HAWSCo needs to understand as soon as possible if the regional system is feasible, and the other partners are committed. Otherwise, they need to advance design on WWTP upgrades.

Based on the above, it was urgent to analyze the options to identify what worked best for the CHRC. It was agreed that sharing the analysis and recommended outcome via Report 1 would allow for the groups to advance internal discussions regarding what will be proposed immediately.

The next stage of work is optimizing the preferred option and developing cost sharing options and exploring governance models (Report 2).

9.0 CLOSING AND AUTHORIZATION

This report, titled "CHRC WEST SUBREGIONAL WASTEWATER FEASIBILITY STUDY REPORT 1: OPTIONS ANALYSIS", was prepared for the Town of Cochrane, Rocky View County, HAWSCo, and the City of Calgary by Urban Systems Ltd. The material in this report reflects the best judgment of Urban Systems Ltd. based on the information available at the time of preparation. Any use that a third party makes of this report, and any reliance on or decisions made based on its contents, is the sole responsibility of the third party. Urban Systems Ltd. shall bear no responsibility or duty in law for loss or damages, if any, suffered by a third party arising from reliance, decisions made, or actions taken based on this report without the express written authority of Urban Systems Ltd.

Sincerely,

URBAN SYSTEMS LTD.

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ALBERTA
APEGA# 135051
19 January 2024

Nathan Kristensen, E.I.T.
Water/Wastewater Engineer-in-Training

Anika Joshi, P.Eng.
Water/Wastewater Engineer

Reviewed by:

Leigh Chmilar, P.Eng.
Water/Wastewater Engineer

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RM Signature
RM APEGA ID# 80017
Date 2024-01-19
PERMIT NUMBER: P 3836
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

10.0 REFERENCES

[1] Urban Systems Ltd, "Sanitary Sewer Strategy," Town of Cochrane, 2016.

[2] Urban Systems Ltd., "Sanitary Sewer Strategy Preliminary Design Report," Town of Cochrane, 2017.

APPENDIX A: PESTLE ANALYSIS RESPONSE SUMMARY

CHRC SUB-REGIONAL WASTEWATER OPTIONS FEASIBILITY							
PESTLE Summary							
	Option 1A	Option 1B	Option 2A - Base	Option 2B			
Description	Subregional Wastewater Disposal System	Harmony Interim WWTP and Regional Wastewater Disposal System	Status Quo - (Outfall Upstream of Bearspaw WTP)	Status Quo - (Outfall Downstream of Bearspaw WTP)	Scoring Commentary		
Criteria	Average Consideration Points						
Political							
Does the Option align with CMRB members plans and policies? (Collaboration?)	1.75	1.25	0	0	Option 1 = increased collaboration & efficiencies - Option 2 = status quo + less efficient solution	Options 1 and 1B entails collaboration with more parties	
Does the Option support Federal objectives?	1	0.75	0	-0.25	All proposed systems havel imited impact on federal objectives	Options 2 and 2B may have impacts to aquatic life by discharging treated effluent to the Bow	
Does the Option support the Local objectives?	1.75	1	0	0.75	More expensive for Option 2B - Option 1 = increased collaboration & efficiencies	Additonal infrastruture to tie in Cochrane to Harmony is counter to current objectives of Cochrane; no significant value to Cochrane communties.	
Does the Option align with Provincial approvals and/or policy objectives?	1.25	1	0	0.25	All will require provinical approvals - AEP wants to minimize WWTP discharging in rivers	Options 2 and 2B may have impacts to aquatic life by discharging treated effluent to the Bow; potential issue with Calgary on these options	All neutral because provincial policy is quiet on source water protection
Economic							
Does the Option have opportunity for grant funding?	1.75	1.5	0	-0.5		Options 1 and 1B entails collaboration with more parties thus have better ability to attract grants	
Does the Option have opportunity for cost sharing?	1.75	1.5	0	-0.75		Options 1 and 1B entails collaboration with more parties thus have better ability for cost sharing	
Does the Option provide the abiltiy to phase to balance cash flow and reduce impact to debt limits?	0.67	0.33	0	-0.75	Only 1B offers phasing solution - but 1-2 years may not provide signfiicant advantage	Option 1B is worst as it will entail Cochrane to pay for additional pipeline and and to use Harmomy's WWTP capacity and for a temporary basis, impacting Cochrane's debt limit and potentially demand from growth	
Does the Option consider the best value for the taxpayer?	1.25	-0.5	0	-0.75	Option 1B may not be the best option if interim solution only lasts 1 year	Option 1 is best option; provides servicing by optimizing existing infrastructure and land	
Social							
Does the Option minimize impacts to public during construction and operation?	0.75	-0.25	0	-1	Mostly the same - Option 1B may duplicate efforts and disrupt public twice	Options 1B and 2B entail construction on new land and crossings	
Does the Option have timely implementation for growth?	0.5	0.25	0	-0.75	Options 1 & 1B may be quicker than AEP approval processe for new outfalls	Options 1B and 2B entail negotiations for land easements etc, which may cause significant delay	
Is the Option reliable & does it minimize risk of service interruptions?	0.75	0.5	0	-0.25	Status quo - but Harmony option may offer future redundancy for emergency pipeline break	Options 1B and 2B would require additonal system components (lift stations, upgrade to Harmony's WWTP) that could entail more risks	
Does the Option minimize the potential for regional and social conflict?	0.75	0.25	0	-0.75	Depends on future governance model - each solution may or may not increase conflict	Option 2 B also discharges treated effluent in the Bow similar to the base option, plus the additional potential conflict with the new land/crossings for the new pipe alignment	
Technological							
Does the Option minimize the degree of operational responsibility and safety? (is the option less risky)	1.00	-0.25	0.00	-0.50	Pipelines more secure / less complex than WWTP	Option 1B is worst as it will entail Cochrane to negotiate new agreement, new processes with a new partner that provides WW treatment servicing that is currenrly not existing	
Is the Option energy efficient? (pumps vs. gravity)	0.67	0.33	0.00	-0.33		Options 1B and 2B would require additional system components (lift stations, upgrade to Harmony's WWTP) that could have more energy demand	
Does the option effectively use existing infrastructure?	0.75	-0.75	0.00	-1.75	Option 1 and 1B would be least efficient use of existing WWTP facility, but Option 2B requires building longer outfall	Option 1 is best option; provides servicing by optimizing existing infrastructure and land	
Does the Option accommodate variability with growth patterns?	1.00	0.00	0.00	-0.75	Option 1B may offer additional flexibility for variable growth	Option 2B entails a signifcant investment for a new pipeline which coul have challenges for land agreements; plus if economy slows down, this investment could be at risk	
Does the Option have simple overall asset renewal?	0.67	0.00	0.00	0.00	Option 2 require additional maintenance - Options 1 & 1B require upgrades to City WWTP	Options 1B and 2B would require additonal system components (lift stations, upgrade to Harmony's WWTP) that could entail more issues with asset renewal.	
Legal & Administrative							
Does the Option require additional lands?	0.5	0	0	-1.5	Fairly minimal - 2B may require longer ROW	Option 2B requires the most in new land	
Does the Option require additional staffing or complex administration? (Higher level operators, etc.)	-0.25	-0.75	0	-0.5	Depends on governance structure - Options 1 & 1B may require creation of 3rd party system operator	Options 1B and 2B would require additional system components (lift stations, upgrade to Harmony's WWTP) that could entail more issues with staffing and operations	
Does the Option require additional agreements and approvals?	-1	-1.25	0	-1	Option 2 require more stringent AEP approvals while Option 1 require additional agreements	Options 1B and 2B would require more and agreements in both land, agreements due to the new land required and more system components required in the system	
Does the Option have complex governance?	-1	-1.25	0	-0.5		Option 1B is worst; new governance required for a temporarray solution. Both Option 1 and 2B require new governance structures that currently not existing	
Environmental							
Does the Option require environmental approvals?	1	0.75	0	0	Option 1 still requires approvals but easier to obtain?	Base options is worst with environmental approval potentially being more difficult with teated water being discharged upstream of Calgary	
Does the option effectively manage the water resources in the region?	1.75	1.25	0	0.75	All slgihtly better sourcewater protection than baseline	Option 1 and 2 best in minimizing potential impact to aquatic life and water river quality	
Does the Option have Environmental impacts during and post construction (Land, Rivers, Seasonal)?	0.25	0	0	-1		Both options 1B and 2B could require disruptions around water bodies or environmentally sensitive areas, with 2B potentially having more issues.	
Does the Option offer resiliency to long term climate change?	-0.25	-0.25	0	-0.25	Water balancing may present long-term challenges in drought situations	Option 2 and Option 2B use treated wastewater for irrigation mitigating risks around drought and water supply.	
Final PESTLE Score (Y -Axis)	**3.17**	**0.23**	**0.00**	**-0.48**			

APPENDIX B: FLOW SUMMARY TABLE

PHF:MDF **1.38** ***Based on diurnal curve peaking***

MDF:AADF	2.00	
PHF:AADF	2.76	
I&I Rate	0	L/s/hectare

MDF:AADF	1.99	
PHF:AADF	2.75	
I&I Rate	0	L/s/hectare

Year	Cochrane						Cochrane Lakes						
	Per capita	200				L/ca/day	Per capita	312			L/ca/day		
	Population	Population Growth (Annual)	AADF (L/s)	MDF (L/s)	PHF (L/s)	PWWF (L/s)	Population	Population Growth (Annual)	AADF (L/s)	MDF (L/s)	PHF (L/s)	PWWF (L/s)	% of Calgary Flow
2016	25,853		59.8	119.7	165.2	165.2	330		1.19	2.37	3.27	3.27	2%
2017	26,887	4%	62.2	124.5	171.8	171.8	369	12%	1.33	2.66	3.66	3.66	2%
2018	27,963	4%	64.7	129.5	178.6	178.6	413	12%	1.49	2.97	4.10	4.10	2%
2019	29,081	4%	67.3	134.6	185.8	185.8	462	12%	1.67	3.33	4.59	4.59	2%
2020	30,244	4%	70.0	140.0	193.2	193.2	462	0%	1.67	3.33	4.59	4.59	2%
2021	32,199	6%	74.5	149.1	205.7	205.7	468	1%	1.69	3.37	4.65	4.65	2%
2022	33,487	4%	77.5	155.0	213.9	213.9	760	62%	2.75	5.47	7.54	7.54	3%
2023	34,826	4%	80.6	161.2	222.5	222.5	1,051	38%	3.80	7.56	10.44	10.44	4%
2024	36,219	4%	83.8	167.7	231.4	231.4	1,343	28%	4.86	9.66	13.34	13.34	5%
2025	37,668	4%	87.2	174.4	240.7	240.7	1,635	22%	5.91	11.76	16.23	16.23	6%
2026	39,175	4%	90.7	181.4	250.3	250.3	1,926	18%	6.96	13.86	19.13	19.13	7%
2027	40,742	4%	94.3	188.6	260.3	260.3	2,057	7%	7.44	14.80	20.42	20.42	7%
2028	42,372	4%	98.1	196.2	270.7	270.7	2,188	6%	7.91	15.74	21.72	21.72	7%
2029	44,067	4%	102.0	204.0	281.5	281.5	2,318	6%	8.38	16.68	23.02	23.02	7%
2030	45,829	4%	106.1	212.2	292.8	292.8	2,449	6%	8.85	17.62	24.31	24.31	7%
2031	47,662	4%	110.3	220.7	304.5	304.5	2,579	5%	9.33	18.56	25.61	25.61	7%
2032	49,569	4%	114.7	229.5	316.7	316.7	2,729	6%	9.87	19.63	27.09	27.09	7%
2033	51,552	4%	119.3	238.7	329.4	329.4	2,878	5%	10.41	20.71	28.57	28.57	7%
2034	53,614	4%	124.1	248.2	342.5	342.5	3,027	5%	10.95	21.78	30.06	30.06	7%
2035	55,758	4%	129.1	258.1	356.2	356.2	3,177	5%	11.49	22.86	31.54	31.54	7%
2036	57,989	4%	134.2	268.5	370.5	370.5	3,326	5%	12.03	23.93	33.02	33.02	7%
2037	60,308	4%	139.6	279.2	385.3	385.3	3,554	7%	12.85	25.57	35.29	35.29	7%
2038	62,720	4%	145.2	290.4	400.7	400.7	3,782	6%	13.67	27.21	37.55	37.55	7%
2039	65,229	4%	151.0	302.0	416.7	416.7	4,010	6%	14.50	28.85	39.82	39.82	7%
2040	67,838	4%	157.0	314.1	433.4	433.4	4,239	6%	15.32	30.50	42.08	42.08	8%
2041	70,552	4%	163.3	326.6	450.7	450.7	4,467	5%	16.15	32.14	44.35	44.35	8%
2042	73,374	4%	169.8	339.7	468.8	468.8	4,819	8%	17.42	34.67	47.85	47.85	8%
2043	76,309	4%	176.6	353.3	487.5	487.5	5,171	7%	18.70	37.21	51.35	51.35	8%
2044	79,361	4%	183.7	367.4	507.0	507.0	5,524	7%	19.97	39.74	54.84	54.84	8%
2045	82,536	4%	191.1	382.1	527.3	527.3	5,876	6%	21.24	42.28	58.34	58.34	8%
2046	85,837	4%	198.7	397.4	548.4	548.4	6,228	6%	22.52	44.81	61.84	61.84	9%
2047	89,271	4%	206.6	413.3	570.3	570.3	6,967	12%	25.19	50.13	69.17	69.17	9%
2048	92,842	4%	214.9	429.8	593.2	593.2	7,706	11%	27.86	55.44	76.51	76.51	10%
2049	96,555	4%	223.5	447.0	616.9	616.9	8,444	10%	30.53	60.76	83.84	83.84	10%
2050	100,417	4%	232.4	464.9	641.6	641.6	9,183	9%	33.20	66.07	91.18	91.18	11%
2051	104,434	4%	241.7	483.5	667.2	667.2	9,922	8%	35.87	71.39	98.51	98.51	11%
2052	108,612	4%	251.4	502.8	693.9	693.9	10,661	7%	38.54	76.70	105.85	105.85	12%
2053	112,956	4%	261.5	522.9	721.7	721.7	11,399	7%	41.21	82.02	113.18	113.18	12%
2054	117,474	4%	271.9	543.9	750.5	750.5	12,138	6%	43.88	87.33	120.52	120.52	12%
2055	122,173	4%	282.8	565.6	780.6	780.6	12,877	6%	46.56	92.65	127.85	127.85	13%
2056	127,060	4%	294.1	588.2	811.8	811.8	13,616	6%	49.23	97.96	135.19	135.19	13%
2057	132,143	4%	305.9	611.8	844.2	844.2	14,354	5%	51.90	103.28	142.52	142.52	13%
2058	137,428	4%	318.1	636.2	878.0	878.0	15,093	5%	54.57	108.59	149.86	149.86	13.2%

MDF:AADF	1.80	
PHF:AADF	2.48	
I&I Rate	0.0	L/s/hectare

MDF:AADF	1.99	*CL peaking factors*
PHF:AADF	2.75	
I&I Rate	0	L/s/hectare

Year	**Harmony**						**Springbank Homes**				
	Per capita	**244**				**L/ca/day**	**Per capita**	**312**			
	Population	**Population Growth (Annual)**	**AADF (L/s)**	**MDF (L/s)**	**PHF (L/s)**	**PWWF (L/s)**	**Population, Equivalent (Estimated)**	**AADF (L/s)**	**MDF (L/s)**	**PHF (L/s)**	**PWWF (L/s)**
2016	15		0	0.1	0.1	0.1	0	0.0	0.0	0.0	0.0
2017	192	1140%	1	1.0	1.3	1.3	0	0.0	0.0	0.0	0.0
2018	446	132%	1	2.3	3.1	3.1	0	0.0	0.0	0.0	0.0
2019	577	29%	2	2.9	4.0	4.0	0	0.0	0.0	0.0	0.0
2020	681	18%	2	3.5	4.8	4.8	0	0.0	0.0	0.0	0.0
2021	911	34%	3	4.6	6.4	6.4	0	0.0	0.0	0.0	0.0
2022	1,238	36%	3	6.3	8.7	8.7	0	0.0	0.0	0.0	0.0
2023	1,581	28%	4	8.0	11.1	11.1	0	0.0	0.0	0.0	0.0
2024	2,037	29%	6	10.4	14.3	14.3	308	1.1	2.2	3.1	3.1
2025	2,471	21%	7	12.6	17.3	17.3	308	1.1	2.2	3.1	3.1
2026	3,262	32%	9	16.6	22.9	22.9	308	1.1	2.2	3.1	3.1
2027	4,205	29%	12	21.4	29.5	29.5	308	1.1	2.2	3.1	3.1
2028	5,236	25%	15	26.6	36.8	36.8	308	1.1	2.2	3.1	3.1
2029	6,482	24%	18	33.0	45.5	45.5	308	1.1	2.2	3.1	3.1
2030	6,658	3%	19	33.9	46.7	46.7	308	1.1	2.2	3.1	3.1
2031	8,154	22%	23	41.5	57.2	57.2	308	1.1	2.2	3.1	3.1
2032	9,562	17%	27	48.6	67.1	67.1	308	1.1	2.2	3.1	3.1
2033	10,516	10%	30	53.5	73.8	73.8	308	1.1	2.2	3.1	3.1
2034	11,687	11%	33	59.4	82.0	82.0	308	1.1	2.2	3.1	3.1
2035	12,446	6%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2036	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2037	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2038	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2039	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2040	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2041	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2042	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2043	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2044	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2045	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2046	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2047	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2048	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2049	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2050	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2051	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2052	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2053	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2054	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2055	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2056	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2057	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1
2058	12,446	0%	35	63.3	87.4	87.4	308	1.1	2.2	3.1	3.1

MDF:AADF	1	
PHF:AADF	1	
I&I Rate	0	L/s/hectare

MDF:AADF	1.33	*Provided by HAWSCO*
PHF:AADF	1.83	
I&I Rate	0.0	L/s/hectare

Year	**Springbank Airport**						**Bingham**					
	Per capita		**244**				**Percapita**	**244**				**L/ca/day**
	Population, Equivalent (Estimated)	**Population Growth (Annual)**	**AADF (L/s)**	**MDF (L/s)**	**PHF (L/s)**	**PWWF (L/s)**	**Population**	**Population Growth (Annual)**	**AADF (L/s)**	**MDF (L/s)**	**PHF (L/s)**	**PWWF (L/s)**
2016	0		0	0	0	0	0		0	0	0	0
2017	0	0%	0	0	0	0	0	0%	0	0	0	0
2018	0	0%	0	0	0	0	0	0%	0	0	0	0
2019	0	0%	0	0	0	0	0	0%	0	0	0	0
2020	0	0%	0	0	0	0	0	0%	0	0	0	0
2021	0	0%	0	0	0	0	0	0%	0	0	0	0
2022	0	0%	0	0	0	0	0	0%	0	0	0	0
2023	0	0%	0	0	0	0	0	0%	0	0	0	0
2024	1,426	0%	10	10	10	10	1001	0%	3	3.8	5.2	5.2
2025	1,682	18%	11.8	11.8	11.8	11.8	1668	67%	5	6.3	8.6	8.6
2026	1,939	15%	13.6	13.6	13.6	13.6	2508	50%	7	9.4	13.0	13.0
2027	2,196	13%	15.4	15.4	15.4	15.4	3348	33%	9	12.6	17.3	17.3
2028	2,452	12%	17.2	17.2	17.2	17.2	4188	25%	12	15.7	21.7	21.7
2029	2,709	10%	19	19	19	19	4188	0%	12	15.7	21.7	21.7
2030	2,965	9%	20.8	20.8	20.8	20.8	4188	0%	12	15.7	21.7	21.7
2031	3,222	9%	22.6	22.6	22.6	22.6	4188	0%	12	15.7	21.7	21.7
2032	3,479	8%	24.4	24.4	24.4	24.4	4188	0%	12	15.7	21.7	21.7
2033	3,735	7%	26.2	26.2	26.2	26.2	4188	0%	12	15.7	21.7	21.7
2034	3,992	7%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2035	3,992	0%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2036	3,992	0%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2037	3,992	0%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2038	3,992	0%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2039	3,992	0%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2040	3,992	0%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2041	3,992	0%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2042	3,992	0%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2043	3,992	0%	28	28	28	28	4188	0%	12	15.7	21.7	21.7
2044	7,984	100%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2045	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2046	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2047	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2048	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2049	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2050	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2051	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2052	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2053	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2054	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2055	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2056	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2057	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7
2058	7,984	0%	56	56	56	56	4188	0%	12	15.7	21.7	21.7

Year	HAWSCO											Total Contributing Flowrate				
	Total			Surplus to Calgary												
	ADD (L/s)	MDF (L/s)	PWWF (L/s)	Effluent Disposal Cap (L/s)	Treatment Capacity - Stage 1 - Max Day (L/s)	Treatment Capacity - Stage 1 - Peak Hour (L/s)	AADF (L/s)	MDF (L/s)	PHF (L/s)	PWWF (L/s)	% of Calgary Flow	Population	AADF (L/s)	MDF (L/s)	PHF (L/s)	PWWF (L/s)
2016	0.0	0.1	0.1	21.5	32.6	64.0	0.00	0.00	0.00	0.00	0%	26,198	61.04	122.06	168.45	168.45
2017	0.5	1.0	1.3	21.5	32.6	64.0	0.00	0.00	0.00	0.00	0%	27,448	63.57	127.13	175.44	175.44
2018	1.3	2.3	3.1	21.5	32.6	64.0	0.00	0.00	0.00	0.00	0%	28,822	66.22	132.43	182.75	182.75
2019	1.6	2.9	4.0	21.5	32.6	64.0	0.00	0.00	0.00	0.00	0%	30,120	68.99	137.96	190.39	190.39
2020	1.9	3.5	4.8	21.5	32.6	64.0	0.00	0.00	0.00	0.00	0%	31,388	71.68	143.35	197.82	197.82
2021	2.6	4.6	6.4	21.5	32.6	64.0	0.00	0.00	0.00	0.00	0%	33,578	76.23	152.44	210.36	210.36
2022	3.5	6.3	8.7	21.5	32.6	64.0	0.00	0.00	0.00	0.00	0%	35,484	80.26	160.50	221.49	221.49
2023	4.5	8.0	11.1	21.5	32.6	64.0	0.00	0.00	0.00	0.00	0%	37,459	84.42	168.80	232.94	232.94
2024	19.7	26.3	32.5	21.5	32.6	64.0	0.00	0.00	0.00	0.00	0%	42,333	88.70	177.35	244.74	244.74
2025	24.6	32.8	40.8	21.5	32.6	64.0	3.13	0.19	0.00	0.00	0%	45,431	96.23	186.35	256.89	256.89
2026	31.0	41.8	52.5	21.5	32.6	64.0	9.53	9.17	0.00	0.00	0%	49,118	107.18	204.39	269.41	269.41
2027	37.9	51.6	65.3	21.5	32.6	64.0	16.37	18.92	1.29	1.29	0%	52,855	118.12	222.34	282.02	282.02
2028	44.9	61.7	78.7	21.5	32.6	64.0	23.46	29.11	14.68	14.68	5%	56,743	129.45	241.01	307.11	307.11
2029	50.3	69.9	89.2	21.5	32.6	64.0	28.78	37.24	25.22	25.22	8%	60,071	139.17	257.93	329.77	329.77
2030	52.6	72.6	92.3	21.5	32.6	64.0	31.08	39.94	28.26	28.26	8%	62,397	146.02	269.73	345.37	345.37
2031	58.6	82.0	104.6	21.5	32.6	64.0	37.11	49.35	40.56	40.56	11%	66,114	156.76	288.57	370.68	370.68
2032	64.4	91.0	116.2	21.5	32.6	64.0	42.88	58.31	52.24	52.24	13%	69,834	167.49	307.43	396.02	396.02
2033	68.9	97.6	124.7	21.5	32.6	64.0	47.38	64.96	60.74	60.74	15%	73,176	177.12	324.34	418.67	418.67
2034	74.0	105.4	134.8	21.5	32.6	64.0	52.49	72.72	70.76	70.76	16%	76,815	187.54	342.71	443.35	443.35
2035	76.1	109.2	140.1	21.5	32.6	64.0	54.64	76.58	76.09	76.09	16%	79,869	195.19	357.58	463.86	463.86
2036	76.1	109.2	140.1	21.5	32.6	64.0	54.64	76.58	76.09	76.09	16%	82,248	200.89	368.98	479.59	479.59
2037	76.1	109.2	140.1	21.5	32.6	64.0	54.64	76.58	76.09	76.09	15%	84,796	207.09	381.36	496.68	496.68
2038	76.1	109.2	140.1	21.5	32.6	64.0	54.64	76.58	76.09	76.09	15%	87,436	213.50	394.17	514.36	514.36
2039	76.1	109.2	140.1	21.5	32.6	64.0	54.64	76.58	76.09	76.09	14%	90,173	220.13	407.43	532.65	532.65
2040	76.1	109.2	140.1	21.5	32.6	64.0	54.64	76.58	76.09	76.09	14%	93,011	226.99	421.15	551.59	551.59
2041	76.1	109.2	140.1	21.5	32.6	64.0	54.64	76.58	76.09	76.09	13%	95,952	234.10	435.35	571.19	571.19
2042	76.1	109.2	140.1	21.5	32.6	64.0	54.64	76.58	76.09	76.09	13%	99,127	241.91	450.95	592.71	592.71
2043	76.1	109.2	140.1	21.5	32.6	64.0	54.64	76.58	76.09	76.09	12%	102,414	249.97	467.07	614.96	614.96
2044	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	16%	109,811	286.31	511.74	665.96	665.96
2045	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	15%	113,337	294.93	528.97	689.74	689.74
2046	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	15%	116,991	303.85	546.79	714.33	714.33
2047	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	14%	121,163	314.47	568.00	743.60	743.60
2048	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	13%	125,473	325.41	589.85	773.75	773.75
2049	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	13%	129,925	336.67	612.35	804.81	804.81
2050	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	12%	134,526	348.28	635.55	836.82	836.82
2051	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	12%	139,282	360.25	659.46	869.82	869.82
2052	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	12%	144,198	372.59	684.12	903.84	903.84
2053	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	11%	149,281	385.32	709.55	938.94	938.94
2054	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	11%	154,538	398.45	735.78	975.14	975.14
2055	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	10%	159,976	412.00	762.85	1012.49	1012.49
2056	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	10%	165,601	425.98	790.79	1051.05	1051.05
2057	104.1	137.2	168.1	21.5	32.6	64.0	82.64	104.58	104.09	104.09	10%	171,423	440.42	819.63	1090.86	1090.86
2058	104.1	137.2	168.1	21.5	32.6	64.0	82.64	**104.58**	104.09	104.09	9%	177,447	455.33	849.42	1131.96	1131.96