REPORT

Regional District of Central Kootenay

Creston Valley Alternative Water Supply Feasibility Study

APRIL 2025

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PAGE NO.

1 INTRODUCTION

Located in the territories of the **Yaqan Nuʔkiy People (Lower Kootenay Band)**, the Creston Valley is one of BC's most productive agricultural areas. The combination of productive soils, level terrain, and favourable climate has supported a vibrant agricultural sector since the late 1800's. Although the total area under agricultural use is relatively small compared to other key agricultural areas in BC, such as the Fraser Valley and Peace River, it accounts for a significant percentage of the total agricultural land in the **Regional District of Central Kootenay (RDCK)** and plays an outsized role in local food security. Like other parts of the BC Southern Interior, the Creston area experiences a significant summer soil moisture deficit, and irrigation is a critical component of agricultural production systems. Climate change predictions indicate that summer and early autumn will become progressively warmer and drier on average, increasing the need for robust water infrastructure and irrigation systems to support agriculture (Pacific Climate Impacts Consortium 2024).

Currently, agricultural demand in the Creston Valley is supplied by the Arrow Creek water treatment plant (WTP), the Goat River, and numerous private groundwater wells and surface water licences. In July and August of recent years, the demand from the Arrow Creek WTP reached its peak capacity of 320 L/s. As a result of water supply shortage and concerns from agricultural producers, the RDCK is looking for alternative feasible water sources that can potentially reduce water use pressure on the existing sources in the Creston Valley, focusing on Creston and to the south.

In February 2024, the RDCK issued a request for proposals to review and assess the feasibility of alternative long-term water supply for agriculture in the Creston Valley. This is a first step in securing a sustainable water supply for agriculture in the valley. The intent is to reduce pressure on the existing water systems, while looking for opportunities to increase water use efficiency and reduce system loss. The RDCK retained **Associated Engineering (B.C.) Ltd. (Associated)** to complete this work. In March 2024, Associated proposed a broad assessment of new potential water sources; however, based on preliminary meetings with the RDCK, it was understood that the RDCK and the Yaqan Nuʔkiy had identified the Kootenay River as the preferred alternative source and wanted to further explore the feasibility of using this source. A technical memorandum was issued to RDCK in September 2024 outlining a revised approach to meet the RDCK's goals of the study, which built upon the current state of knowledge on water supply in the Creston Valley and the interest in more reliance on the Kootenay River.

This report provides an assessment of using the Kootenay River as a water source to help improve water supply reliability and maintain environmental values in the watercourses of the Creston Valley. Also included are proposed locations for a new Kootenay River water supply system and suggested phasing and probable cost options that consider the expected infrastructure requirements.

1.1 Objectives

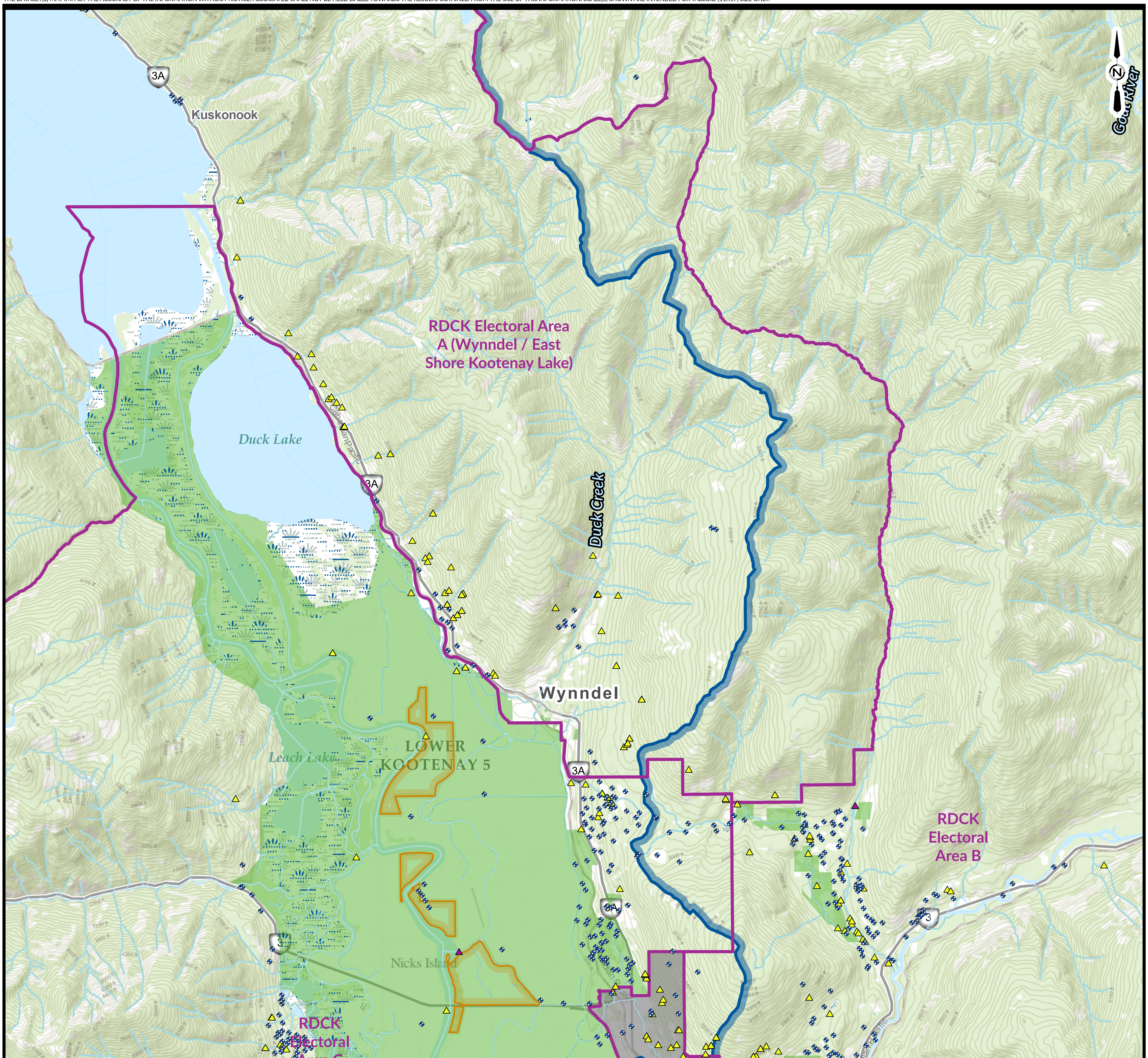
Using the Kootenay River as the alternative water source was identified early in the project. The intention is to take pressure away from the Goat River and Arrow Creek. The objectives of the study are as follows:

- Review background information to define water supply areas that are currently at risk and may require a new water supply in the near future.
- Identify and consult with the interested parties, water purveyors, and Yaqan Nuʔkiy representatives based on the interests and the rights in each area of interest.

- Summarize the current agricultural land uses and how agriculture in the areas of interest could change in response to climate change based on available information. Establish and define future climate and land use scenarios to form the basis of predictive water demand modelling.
- Explore options to centralize water supply on the Kootenay River that would reduce pressure from over-allocated waterbodies and at-risk supply areas.
- Identify the potential intake and water conveyance options for the proposed Kootenay River water supply system.

1.2 Study Area

The focus of the information review began in the Creston Valley from Duck Lake to the US border (**Figure 1-1**). This guided an understanding of the water demand and supply in the Goat River and Arrow Creek watersheds, the extent of agricultural land based on Agricultural Land Reserve (ALR) designation, and groundwater sources. Because of the history of water concerns and management in the study area, information is readily available and was used to help prioritize the areas with immediate concerns and that will be further stressed under future climate scenarios, and the corresponding need of a centralized supply.



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LEGEND

- Groundwater Wells
- Streams
- RDCK Administration Boundaries
- Goat River Watershed
- Yaqan Nukiy (Lower Kootany Band) Land
- Agricultural Land Reserve
- Town Of Creston

Active Irrigation Licenses (m3/year)

- 0 - 1,000,000
- 1,000,000 - 2,000,000
- 2,000,000 - 3,000,000
- 3,000,000 - 4,000,000

Associated Environmental

AE PROJECT NO.	2024-2027
SCALE	1:100,000
COORD. SYSTEM	NAD 1983 UTM ZONE 11N
DATE	2025-02-26
REV	00
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FIGURE 1-1
STUDY AREA

CRESTON AG-WATER DEMAND PROJECT

2 BACKGROUND REVIEW AND STAKEHOLDER ENGAGEMENT

To support the assessment, Associated completed a detailed background review of available information and conducted and attended several stakeholder meetings. This section summarizes the material reviewed and the meetings held.

2.1 Background Review

To gain an understanding of the historical and current water demand for agriculture, water supply systems, sources, and concerns in the Creston Valley, Associated reviewed background reports supplied by the RDCK and searched public databases for other sources. Associated reviewed municipal reports and historical records of water demand and uses. Licensing documents and spatial data layers, including the 2016 agricultural water demand model (AWDM) layers, were reviewed to delineate water use areas (purveyors) and estimate water allocation and use. The information reviewed includes:

- Alice Siding Water Society Water Source Feasibility Analysis (WSP 2018)
- Lister Water System Assessment Current Boundary (WSP 2019a)
- Lister Water System Long-Term Infrastructure Capacity Assessment (WSP 2019b)
- Creston Golf Club – Water Supply Assessment (Urban Systems 2017)
- Creston Valley Aquifer Vulnerability Assessment – Living Lakes (Paige, pers. comm. 2024)
- Creston Valley Drought Assessment – BC Ministry of Water, Lands, and Resource Stewardship
- Effectiveness Evaluation: Creston Valley, BC – BC Ministry of Environment Kootenay Region
- Aquifer Mapping in the Kootenay/Boundary Region of British Columbia: Creston, Rossland, Castlegar, and Salmo – Province of BC
- Drought Conditions in the West Kootenay 2015–2024
- Agriculture Water Demand Study Erickson Water Service Area
- Erickson Water Demand Presentation
- Working Together on Water Sustainability for Yaqan nuʔkiy ʔamakʔis – Creston Valley
- Water Conflicts and Risks in Yaqan Nuʔkiy ʔamakʔis – Creston Valley
- Regional District of Central Kootenay Regional Watershed Governance Initiative
- Arrow Creek Water Utility Capacity, Filtration, and Potential Improvements

While the background review provided context on the current water demand and concerns in the area, gaining an understanding of the current agricultural land use and agricultural water demand was through reviewing the agricultural land use inventory (ALUI), which provides data on crop type by parcel. Another resource is the AWDM in BC and for the Creston Valley, which involves calculating the water requirements for various agricultural activities, such as irrigation, livestock watering, frost protection, and crop cooling. The AWDM is a deterministic model that integrates data on crop types from the ALUI, irrigation systems, soil texture, and climatic conditions to estimate water need.

2.2 Stakeholder Engagement

Stakeholder input guided the understanding of agricultural water demand, issues with supply, and where from the Kootenay River to source water. This helped guide the modelling for agricultural water demand (AWDM) and the conceptual design for infrastructure. The RDCK has relationships with many stakeholder groups, which was leveraged to facilitate Associated's outreach to these groups. This was possible by reviewing a matrix provided by the RDCK that outlined the stakeholder groups that have been engaged on the project to date and their degree of involvement. With this support, Associated ensured that stakeholder concerns and input from the Yaqan Nuʔkiy was considered during analysis and design by the following methods:

- **Individual meetings** with the Yaqan Nuʔkiy, RDCK, and BC Ministry of Water, Land and Resource Stewardship (WLRS) to gather feedback on the current state of knowledge of the watershed, water availability concerns, and priorities.
- **Producer survey**, whereby a survey was distributed by the RDCK to agricultural producers to collect input on water usage and concerns. It was made available on the RDCK website, presented at the stakeholder meeting with farmers (below), and posted on the RDCK social media accounts.
- **Stakeholder meeting with farmers and water purveyors** entailed an in-person meeting in Creston on November 7, 2024, to present the background information about agriculture and water issues in the region and a preliminary water system concept with a water intake on the Kootenay River. The meeting was aimed at addressing producer-specific concerns and gathering insight to better inform the summary of water use issues and future water demand.
- **Follow-up meetings** were conducted with the BC Ministry of Agriculture and Food Regional Agrologist (Kootenay) Jeff Nimo, WLRS, and the Yaqan Nuʔkiy. Agricultural land use and trends and concerns were discussed with Mr. Nimo. Associated met with WLRS to discuss the preliminary design and concerns around licensing. The Yaqan Nuʔkiy engagement occurred at the kick-off meeting with the RDCK and on two other occasions:
  - On August 8, 2024, Associated (Drew Lejbak and Renée Larsen) met virtually with Isaac Dekker, watershed stewardship coordinator for the Yaqan Nuʔkiy and PhD candidate at the University of Victoria, to discuss the project, concerns about low streamflow in the Goat River, and the Band's perspective about the level of water use in the Goat River watershed.
  - On January 8, 2025, Associated (Matt Lozie, Drew Lejbak, and Renée Larsen) met virtually with three members of the Yaqan Nuʔkiy Band, Curtis Wallum, Director of Development, Norm Allard, Community Planner, and Isaac Dekker to discuss a focus on the Kootenay River as the alternative water source for the Creston Valley.

2.2.1 Meeting with Farmers and Water Purveyors

Numerous agricultural producers, water purveyor managers, RDCK, and the regional Ministry of Agriculture and Food attended the open house in Creson on November 7, 2024. The attendees provided input regarding issues with water supply, current agricultural land use, changes in land use, and a conceptual alternative supply presented by Associated. Some key concerns that were raised by the attendees included the capacity of the current water supply and infrastructure; the feasibility of irrigation and improvement districts in the future, considering current and future agricultural demand in infrastructure planning and projection; and the cost and implementation of new infrastructure. Some specific concerns that were voiced included observations of pressure drops in Erickson during the summer months and the current culture in the community that does not focus on water conservation. This led to a discussion about available water sources, including discourse about the sustainability of groundwater, specifically referencing a potential confined aquifer in east Creston.[1] Other individuals expressed concerns around the structure and future feasibility of improvement districts, such as the Duck Lake Dyking District, as the volunteers who run these districts are aging and funding is becoming increasingly difficult to secure. Lastly, there were discussions about whether the proposed infrastructure would consider changes to agricultural area and demands and if users in the proposed service areas would be obligated to connect and pay into the system even if they had a licensed irrigation source.

2.2.2 Meetings with Yaqan Nuʔkiy

Conversations with the Yaqan Nuʔkiy highlighted the cultural significance of the Goat River and Arrow Creek to their community members. Research conducted by Mr. Dekker around the historical flow in the Goat River and the results from the quantitative and qualitative ("One Heart" method) indicate that flow has been decreasing over time and has been affecting recreational, cultural, and ecological uses (Dekker et al. 2024). Additionally, there is concern from the Yaqan Nuʔkiy about the impact of groundwater use near the Goat River, as there is evidence of a potential hydrologic connection between the river and the underlying aquifer. Mr. Dekker has identified that groundwater input may act as a buffer for temperature in certain stretches of the Goat River, while under low-flow conditions, some reaches of the stream may experience loss to groundwater (i.e., a losing stream) (Dekker, pers. comm., 2024).

Based on discussions with the Yaqan Nuʔkiy about their perspective, it is clear that their preferred alternative source is the Kootenay River. They have concerns about risks to fish populations due to previous flow levels in the Goat River. Flow levels and flow needs for aquatic life are of great importance to the Yaqan Nuʔkiy. There are concerns around flow data showing low water levels at Canyon that indicate a losing stream with a deficit area of over 5 km. Flows of 2.7 m^3/s have historically been used as the environmental flow need value, but the water licence indicates that the shut-off must occur at a flow of 3.7 m3/s. Mr. Dekker also discussed that groundwater contributions may have previously provided a temperature buffer, but there are concerns that this has changed and that the lethal range for Kokanee is an important consideration. Discussions between the Yaqan Nuʔkiy and other users and interested parties so far have included raising awareness around water concerns in the Goat River. Despite this, the Yaqan Nuʔkiy are concerned about the lack of collaboration as they are aware of independent investigations from the provincial government during which they have not been consulted.

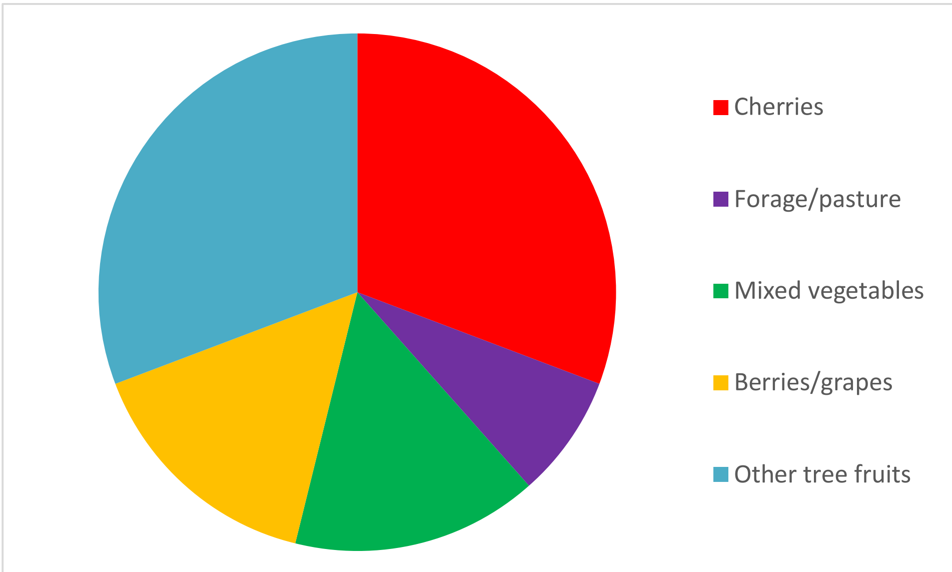
Further discussions during the 2025 meeting between the Yaqan Nuʔkiy and Associated focused on the proposed water system design, and the potential intake on Yaqan Nuʔkiy land and distribution system that would run through a section of their lands. The concept designs presented at that time placed the intake on culturally significant lands and would conflict with the community and health centre currently under construction. Additionally, concerns were raised about infrastructure crossing the Goat River, so a new design was proposed that would split the intake and supply area into two distinct areas. This design was seen as advantageous as the southern intake had already undergone community consultation and had power supply available. Associated discussed the target supply areas, and after discussing the water used in North and South Canyon and Lister, a consensus was reached that focusing on Erickson and Lister would help alleviate stress caused by groundwater interaction with the Goat River and would target a larger user base.

[1] This potential confined aquifer is the high-yielding part of the East Creston Bedrock Aquifer (0488). The ministry has indicated that further hydrogeological investigation and stress testing are required to confirm whether this part of the aquifer is a separate confined aquifer and its viability as a water source.

2.2.3 Survey Summary

The survey conducted by the RDCK included ten questions to understand the current and future agricultural use in the Creston Valley. Eleven responses were collected during the two-month survey window. Respondents were agricultural producers in the Creston Valley who produce various crops (**Figure 2-1**).

Figure 2-1 Types of Agricultural Production Reported by Survey Respondents



All respondents rely on irrigation for crops, and one respondent commented that they use drip irrigation for approximately 10 acres of their land, but they also have sections of their property that are not irrigated. Most respondents (6) believe that the current water supply is sufficient for their agricultural needs. Three respondents anticipate a change in the agricultural use of their property in the next five years and can foresee their water demand increasing over the next five to ten years. One respondent commented that their demand will increase with putting unused acres into production, and another commented that climate change will be responsible for the increased water demand on their property.

The cost of water is a common theme for producers, made apparent in the survey and during the stakeholder meeting. Comments were raised about the rising costs since the RDCK took over the Erickson Water System and the profitability of orchards in the Valley, especially during years with crop failure; concerns were also raised that insufficient water supply could lead people to believe that water would get even more expensive. Suggested solutions to this problem included reducing the maintenance and operational costs of the system or having the option to disconnect from the water system completely.

When asked whether a separate irrigation water source would improve their agricultural operations, some respondents (4) indicated No to this question and would also not be willing to support such a project if the associated costs exceeded $500 annually. The other respondents were more supportive of a separate system for irrigation, suggesting that it could solve capacity issues in the current system.

3 WATER SUPPLY, MANAGEMENT, AND FUTURE DEMAND

Water availability initiated this study and will continue to be an issue under future climate change scenarios, with warmer temperatures and droughts in the growing season, and changes to precipitation patterns (including reduced snowpack affecting water supply) (Mussell 2024). The current supply is from the Arrow Creek and Goat River watersheds and from groundwater, which is supplied and managed by different dyking and irrigation districts, described in more detail in this section.

3.1 Current Water Supply

The water sources used by the purveyors in the Creston Valley are predominantly creeks in the Goat River watershed or the Arrow Creek watershed. A smaller number of purveyors obtain water from groundwater sources and surface water points of diversion. The following subsections summarize the Goat River watershed, Arrow Creek watershed, and groundwater sources.

3.1.1 Goat River Watershed

The Goat River watershed has also been identified as a basin of concern by both the RDCK and Yaqan Nuʔkiy. While reports that detail the exact withdrawal within this watershed were not discovered during background review, the Yaqan Nuʔkiy has expressed concerns about current and future water availability within the Goat River watershed and Arrow Creek watershed, especially the risks to the aquatic ecosystem (Yaqan Nuʔkiy 2024).

In meeting with Isaac Dekker, Watershed Stewardship Coordinator for Yaqan Nuʔkiy, Associated was able to better understand concerns related to water availability within the Creston Valley. These conversations highlighted the cultural significance of the Goat River and Arrow Creek to Yaqan Nuʔkiy. The Goat River and downstream wetlands are a traditional hunting ground and are home to several culturally important species such as the Burbot (Lota lota). Yaqan Nuʔkiy is interested in restoring the southern branch of the Goat River to rehabilitate the aquatic ecosystem and restore fish habitat. The success of this work is dependent on the Goat River having sufficient flows in the future; Yaqan Nuʔkiy predicts the Goat River will experience no flows in the near future due to increasing demands and changing climatic conditions (i.e., warmer and drier summers). Isaac has also conducted research around historical flow in the Goat River and results from both the quantitative and qualitative (“One Heart” method) indicate that flows have been decreasing over time with impacts to recreational, cultural, and ecological uses (Dekker et al. 2024). Additionally, there is concern from Yaqan Nuʔkiy about the impact of groundwater use near the Goat River, as there is evidence of a potential hydrologic connection between the Goat River and the underlying aquifer. Isaac has identified that groundwater input may act as a buffer for temperature in certain stretches of the Goat River, while under low flow conditions, some reaches of the stream may experience losses to groundwater (i.e., a losing stream) (Dekker, pers. comm., 2024).

3.1.2 Arrow Creek Watershed

The Arrow Creek watershed is a critical water source within the study area providing 99% of the current potable water supply for the Town of Creston and Erickson (Town of Creston 2024). This includes residential, commercial and agricultural users (Metherall 2020). Over the past decade, there has been growing concerns about reduced flows in Arrow Creek, which, is in part, attributed to climatic changes such as reduced winter snowpack and higher summer temperatures. These issues are exacerbated by competing water demands within the watershed. The RDCK has recognized Arrow Creek's vulnerability to low flows during periods of drought, which can significantly impact water availability during times of high demand and adversely impact aquatic species. Since 2012 the majority of Arrow Creek has been designated as fully recorded by the Ministry of Water, Land and Resource Stewardship (WLRS), which means that no new diversions will be authorized due to insufficient water supply (WLRS 2025). There is a small the section of Arrow Creek that extends above east Creston that has not been noted as fully recorded, but it has been noted as possible water shortage since 1994, which means that while this section may experience water shortages and is close to being fully recorded.

Historically, there have been significant efforts to protect the Arrow Creek watershed. The watershed is primarily Crown land that is managed by the Creston Community Forest (Metherall 2020). Despite the careful management of the watershed, Arrow Creek continues to experience challenges related to water availability. As a result of the current water supply challenges in Arrow Creek, the RDCK has started to explore alternative water sources to reduce pressure on the water source over the long term.

3.1.3 Groundwater

Sedimentary rock types primarily underlay Creston, consisting of argillite, conglomerate turbidites, greywacke and wacke rocks, along with some intrusive granodiorite rocks. There are four main aquifers underlying the Creston Valley, namely the Creston-Kootenay River Overburden Aquifer (0487), the East Creston Bedrock Aquifer (0488), the Canyon Overburden Aquifer (0489), and the West Creston Bedrock Aquifer (1280). Recharge sources include precipitation, snowmelt, deep groundwater flow, hydraulic connections, tributaries and mountain block. The aquifers provide a water supply for a total of 40 artesian wells, with a [geometric] mean production capacity of between 0.97 – 2.1 L/s. There are no known water quality issues with these aquifers, except for iron found to be present in one well supplied by the Creston-Kootenay River Overburden Aquifer. An indication of vulnerability for these aquifers is either "Moderate" or "High."

It has been suggested that there is insufficient evidence in the Creston Valley to rule out groundwater and surface water interactions. The Yaqan Nuʔkiy do not support anything that affects the Goat River. If a creek has low water levels, this may be evidence of a losing stream.

3.2 Water Purveyors

Water purveyors are entities responsible for supplying water, including management of the systems that go to property lines. Water purveyors were identified within the Creston Valley, with boundaries delineated based on available mapping, water licences, and input at the stakeholder meeting (**Figures 3-1 and 3-2**). The purveyors and water sources are summarized in **Table 3-1**. Most water purveyors supply domestic connections with potable water, with some businesses like Kootenay Meadows Dairy and Creston Golf Clubhouse also served. Some small water systems have completed assessments and feasibility studies, but many have limited public information. The maintenance and associated efficiencies of these systems vary, based on input at the stakeholder meeting. To provide an alternative water supply in these areas will alleviate pressure on water purveyors, if a user decides to move to an alternative supply.

Table 3-1 Summary of Water Purveyors, Sources, and Concerns

Water Purveyor	Description	Water Source	Water Concerns	Information Source
Wynndel Irrigation District	Services 300 residential connections within Wynndel (located north of Creston)	Duck Creek	No water availability concerns identified; occasional boil water notices.	WSP 2018
Orde Creek Improvement District	Services 22 residential connections, with the remaining homes in the District drawing from private wells. Only domestic water supply (for property, not agricultural irrigation).	Orde Creek and Floyd Creek	High suspended solids and coliform levels. No treatment system, resulting in an ongoing boil water notice since 1994 with the reason listed as untreated drinking water at risk of containing pathogens.	WSP 2019a
South Canyon Improvement District	Services 36 residential connections, only domestic. Currently only "one artesian well" is listed as the source for South Canyon. The estimated water consumption is 22,800 m^3/year. A 2023 consultant study by Western Water Associates indicates that Floyd Creek ceased flowing completely for a portion of 2021.	Floyd Creek and groundwater	No flow or demand information available. Concerns that North Canyon Improvement District wells are reducing flows in Floyd Creek. No storage or treatment system, boil water notice has been in effect since 2003.	WSP 2019a, Interior Health Authority
North Canyon Improvement District	System is composed of two wells and a reservoir with chlorinator. Their website indicates they are trying to bring the Goat River Well back into the potable system. No information available on the number of connections. Connections include 170 residential and seven commercial. RDCK estimates annual water consumption to be 448,000 m^3.	Groundwater	Limited information online, but a flow management plan is in place.	North Canyon Improvement District 2024, RDCK
Rykerts Improvement District	Services 26 residential connections, only domestic.	South Rykerts Creek	Boils water notice in place since 1999 with reason listed as untreated drinking water at risk of containing pathogens (the system does not provide chlorination), aging infrastructure.	WSP 2019a, Interior Health Authority
Lister Water System	Supplies 196 connections. Primarily domestic water supply, except for a metered connection for Kootenay	Groundwater	Other water systems have indicated they would like to connect to the Lister system, along with 31 additional properties within the	WSP 2019a,b

Water Purveyor	Description	Water Source	Water Concerns	Information Source
	Meadows Dairy. Also provides domestic service to the Creston Golf Clubhouse.		area. Groundwater well reportedly has a safe yield that can accommodate this, but there is a potential hydraulic connection to adjacent creek. Additionally, expanding the service areas would require upgrades to the reservoir and pump that may not be possible due to topography and land acquisition.	
Erickson Arrow Creek Water System	Services the Town of Creston drinking water and domestic and agricultural for community of Erickson. Roughly 3,295 connections with a population of 5583 in the Town of Creston.	Arrow Creek supplemented by groundwater wells during peak intake.	Concern about the capacity of the Arrow Creek WTP with future water demand increases and climate change impacts (e.g., droughts). Agricultural water demand within Erickson is expected to increase and demand may exceed what is currently licensed for the region. Yaqan Nuʔkiy is concerned about impacts of low flows in Arrow Creek on the aquatic ecosystem health and with maintaining baseflows during summer months.	Yaqan Nuʔkiy 2024; WSP 2020; Holder & van der Gulik 2020; Town of Creston 2024
Duck Lake Dyking District	Unknown	Unknown	Unknown	Unknown
Creston Dyking District	Supplies 40 residential connections in the Creston Dyking District including a large agricultural area.	Duck Creek	No water availability concerns but concerns over inadequate infrastructure.	WSP 2018
Reclamation Dyking Distict	Unknown	Unknown	Unknown	Unknown
Nicks Island Dyking District	Unknown	Unknown	Boil water notice in effect since 1994 with reason listed as positive E. coli lab result.	Interior Health Authority
Bountiful Community Water System	Unknown	Unknown	Boil water notice in effect since 2000 with reason listed as untreated drinking water at risk of containing pathogens.	Interior Health Authority

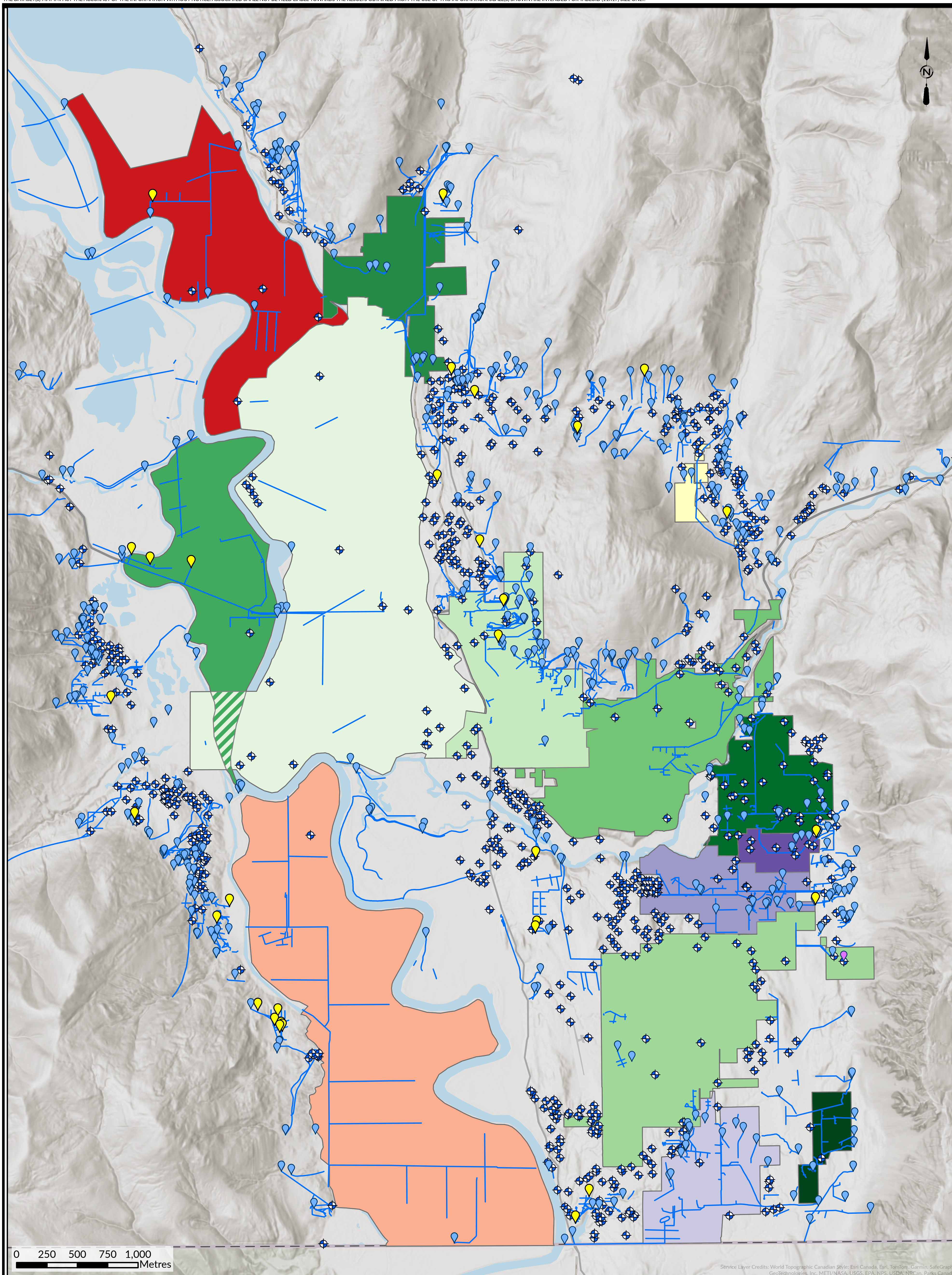
Based on information review and stakeholder input, Erickson and Lister face immediate water supply concerns, influencing the prioritization of the proposed water supply system.

Erickson:

- Large agricultural base with ongoing water supply issues, making it a priority for a new water supply system.
- Currently supplied by Arrow Creek WTP, which also serves the town of Creston.
- In summer, two groundwater wells supplement irrigation.
- Recent summers have seen demand nearly reach Arrow Creek WTP's peak capacity of 320 L/s, instigating sever water restrictions.
- Concerns about competing demands and low flows in the Arrow Creek watershed, especially with climate change and land use changes.
- Interest from other small water users to connect to Arrow Creek WTP also raises capacity concerns.

Lister:

- Faces future water demand concerns due to interest from adjacent water purveyors to tap into the same supply (Rykerts Irrigation District, Orde Creek, and South Canyon Improvement District).
- The neighbouring purveyors face pressures like aging infrastructure and boil water notices.
- Located south of Creston at a higher elevation within the ALR, with frost issues that limit crop types and agricultural growth or crop changes.
- Dominant crop is forage, largely not irrigated; irrigation is mostly supplied by private groundwater wells.
- Limited agricultural demand and urban growth expected due to ALR restrictions and climate limitations to agricultural capability.
- Lister Water System does not meet fire protection guidelines. Most of the distribution system is non-standard (intended for irrigation needs rather than for domestic and fire flows). The pipe materials include HDPE and PVC of inadequate size and pressure rating. There is a backlog in asset replacement needs.
- Lister's groundwater supply could meet additional demand, but infrastructure is inadequate, and there are concerns about the hydraulic connection of aquifer 489 to the Goat River. The Lister Water System production well is installed in Aquifer 489, a confined sand and gravel unit. Initial testing of the well indicated the aquifer is quite productive but is hydraulically connected to a nearby spring. During periods of intense pumping, water levels in the spring are known to decline.
- For the existing system, single family dwelling water accounts are for domestic use only, and includes irrigation allowance of up to one acre. No commercial or agricultural water usages are permitted for single family dwelling accounts. Any agricultural water usage applications are currently not being approved.



Associated Environmental

- Licensed Water Works Point (WAT code only)
- Well Diversion
- Surface Water Diversion
- Groundwater Well
- Licensed Water Works Linear

Water Supply System Boundaries and System Type

- Arrow Creek Water System - Domestic and Irrigation
- Creston Dyking District - Domestic and Irrigation
- Creston Water System - Domestic and Irrigation
- Lister Water System - Domestic and Irrigation
- Erickson Water System - Domestic and Irrigation
- Nicks Island Dyking District - Domestic and Irrigation
- Wyndell Irrigation District - Domestic and Irrigation
- North Canyon Improvement District - Domestic and Irrigation
- Bountiful Community Water System- Domestic and Irrigation
- Rykerts Irrigation District - Domestic Only
- Orde Creek Improvement District - Domestic Only
- South Canyon Improvement District - Domestic Only
- Reclamation Dyking District - Irrigation Only
- Duck Lake Dyking District - Irrigation Only

FIGURE 3-1 WATER SUPPLY SYSTEM AND WATER WORKING FEATURES

REGIONAL DISTRICT OF CENTRAL KOOTENAY

CRESTON VALLEY ALTERNATIVE WATER SUPPLY FEASIBILITY STUDY

AE PROJECT NO.	2024-2027-00
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COORD. SYSTEM	NAD 1983 UTM ZONE 11N
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REV	00
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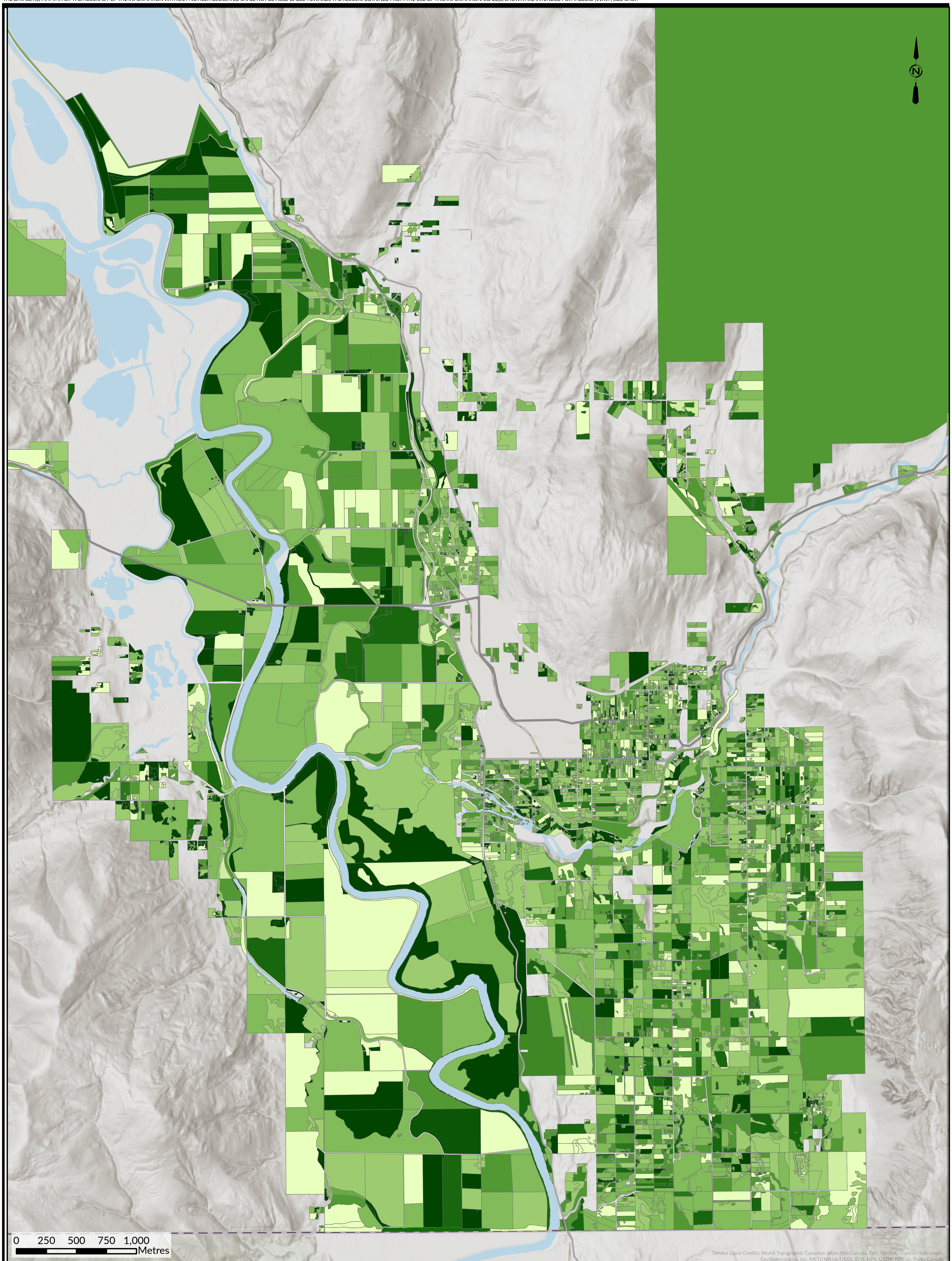

Associated Environmental

Agricultural Use - Irrigation Status

- Fruit Trees, Nuts, and Berries (High Irrigation)
- Vegetables (High Irrigation)
- Forage Crops (Moderate to High Irrigation)
- Cereal and Oil Crops (Moderate Irrigation)
- Ornamental / Landscaping (Moderate Irrigation)
- Grass/Turf (Moderate Irrigation)
- Cultivated Land (Variable Irrigation)
- Forestry / Trees (Low Irrigation)
- None (Unspecified)
- Other (Special Case / Undefined)
- Infrastructure / Buildings (No Irrigation Needed)
- Residential / Housing (No Irrigation Needed)

FIGURE 3-2 AGRICULTURAL USE AND IRRIGATION STATUS

REGIONAL DISTRICT OF CENTRAL KOOTENAY

CRESTON VALLEY ALTERNATIVE WATER SUPPLY FEASIBILITY STUDY

AE PROJECT NO.	2024-2027-00
SCALE	1:75,000
COORD. SYSTEM	NAD 1983 UTM ZONE 11N
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REV	00
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3.3 Crop Types by Purveyor Area

To further understand demand, the crop types from the ALUI are summarized by hectarage in **Table 3-2.** The ALUI as well as conversations with local producers indicate the dominant agricultural land covers/crops in the study area to be forage, cereal crops, pasture and cherries, which vary by purveyor often because of topographical or climatic limitations. Understanding the dominant agricultural land uses and how they are geographically distributed in this area enhance our understanding of current and future water demand. For example, the Erickson area contains roughly 50% of all cherry crops within the study area. During the summer months, cherry crops require more water than other dominant crops such as forage or cereal crops, resulting in areas such as Erickson relying more heavily on irrigation during the driest months of the year. Forage, while requiring relatively high water demands, is not always irrigated.

Table 3-2 Summary of Total Area of Agricultural Land Cover in Each Water Purveyor Area

Crop Type	Arrow Creek	Bountiful	Creston Diking District	Duck Lake	Erickson	Lister	Nick's Island	North Canyon	Orde Creek	Reclamation Diking	Rykerts	South Canyon	Wyndell	Private	Yaqan Nuʔkiy	Total
	Total Area (ha)															
Forage	17.54	21.68	1,569.17	655.04	101.26	797.98	533.65	145.45	247.63	1,669.87	321.93	70.68	36.71	969.28	775.01	7,932.88
Cereal	7.08	2.09	322.12	57.44	1.6	85.99	168.09	0.01	22.39	1,045.82	23.69	0.89	-	233.75	185.16	2,156.12
Pasture	14.16	24.07	201.39	62.09	48.49	129.33	77.68	73.33	21.4	26.69	96.61	10.77	15.53	402.65	361.13	1,565.32
Other[1]	3.79	7.49	72.22	11.53	84.94	60.23	1.79	42.89	35.85	0.84	12.69	10.23	8.95	151.37	48.43	553.24
Cherry	2.41	-	17.41	2.94	147.29	2.53	-	40.45	-	-	-	0.33	16.45	9.37	27.95	267.13
Nursery	-	-	87.3	94.92	1.78	0.31	-	0.22	0.09	-	-	6.85	2.22	3.24	4.62	201.55
Tree fruit[1]	0.53	0.05	4.76	0.85	20.41	13.85	0.31	9.13	0.81	0.16	3.56	1.11	5.62	84.47	-	145.62
Vegetable	0.07	1.47	42.77	2.78	14.85	3.24		3.7	-	0.31	0.08	0.15	1.57	6.39	-	77.38
Apple	3.74	-	-	0.11	28.00	-	-	5.81	-	-	-	-	0.28	0.28	-	38.22
Turf farm/park	-	-	-	32.08	-	1.55		1.62	-	-	-	-	-	-	-	35.25
Grape	0.21	-	-	-	17.51	-	-	0.26	-	-	-	-	0.94	1.43	-	20.35
Peach	-	-	-	-	9.24	-	-	1.21	-	-	-	-	-	0.07	-	10.52
Berry	-	-	-	6.04	0.36	-	-	-	-	-	0.1	-	-	3.27	-	9.77
Potato	-	-	-	-	1.99	-	-	1.67	-	-	-	-	-	-	-	3.66
Sweetcorn	-	-	-	-	2.44	-	-	0.21	-	-	-	-	-	0.2	-	2.85
Blueberry	-	-	-	-	0.75	1.38			-	-	-	-	-		-	2.13
Raspberry	-	0.08	0.31		0.43	-	-	0.21	-	-	-	-	-	1.05	-	2.08
Strawberry	-	-	-	0.15	1.51	-	-		-	-	-	-	-	-	-	1.66
Pear	0.18	-	-	-	0.37	-	-	0.53	-	-	-	-	-	-	-	1.08
	49.71	56.93	2,317.45	925.97	483.22	1,096.39	781.52	326.7	328.17	2,743.69	458.66	101.01	88.27	1,866.82	1,402.3	13,026.81

[1] Includes non-crop values (inactive, grass, golf course, interior greenhouse, and yard) and crops with a total area of <1 ha across all purveyors (apricot, floriculture, nuts, pea, plum, specialty, and tomato).

3.4 Water Demand by Purveyor Area

The initial water demand estimates are based on the ALUI from 2016. This inventory provided an initial understanding of the water demand in the Creston Valley and the corresponding peak irrigation demand (L/s) by hectarage based on total area of crop type in each purveyor area, including forage that could be irrigated. The current demand was further refined through the AWDM, done under contract by RHF Systems Ltd. (**Table 3-3**; detailed data provided in **Appendix A**). The baseline water demand model results are based on historical climate data for the 1995 climate period (1981–2010), the 2016 ALUI, and aerial imagery (Google Earth 2025).

Historically, the highest non-domestic water demand occurs in irrigation and diking districts. These include the Reclamation Dyking District, Creston Dyking District, Duck Lake Irrigation District, Rykerts Irrigation District, and Nick's Island Irrigation District, where a large proportion of crops are irrigated. Outside these districts, the community of Erickson has the highest non-domestic water use; it has used roughly 50% more water historically than other populated areas with historically high water demand (Orde Creek and Lister). Currently, non-domestic water in Erickson is supplied by the Arrow Creek WTP, supplemented by groundwater in the summer.

Table 3-3 Baseline (1981–2010) Maximum Annual Water Demand by Purveyor Area

Purveyor Area	Maximum Annual Water Demand (m^3)
Arrow Creek Water System	17,198
Bountiful Community Water System	9,756
Creston Dyking District	1,365,165
Duck Lake Dyking District	12,624
Erickson Water System	672,122
Lister Water System	466,051
Nick's Island Dyking District	211,148
North Canyon Improvement District	30
Orde Creek Improvement District	20,567
Reclamation Dyking Distict	78,015
Rykerts Improvement District	445,169
South Canyon Improvement District	162,478
Wyndell Irrigation District	283,183

3.5 Future Agricultural Water Demand

Understanding future demand under different climate scenarios helps to illustrate the future pressures on an already limited water supply. The AWDM was developed to estimate the current and future agricultural water demand based on a detailed ALUI, capturing water demand details to the individual field. These data are combined with soil and climate data to calculate water demand at the parcel level, which is then summarized for larger-scale water and land use planning. The AWDM helps in planning and managing water resources effectively, ensuring sustainable agricultural practices in the region. To determine future demand, RHF Systems Ltd. ran the AWDM for the study area under baseline conditions and two future climate scenarios, one with climate change and irrigation as is, and one with climate change and the addition of forage irrigation (**Appendix B**). The future climate period is 2020 to 2100 and uses predictive climate model datasets provided by the Pacific Climate Impacts Consortium (PCIC). The 2020 to 2100 climate period was assessed using rolling 30 mean year periods, which allowed for a more effective assessment of changes between decadal trends in water demand. The future climate AWDM scenarios are:

- Future climate scenario (2020 to 2100): This scenario used five climate models[2] to predict how much water that agriculture will need each month. It is based on two possible future situations, one in which moderate efforts are made to reduce greenhouse gas emissions (representative concentration pathway [RCP] 4.5) and one in which emissions continue to rise significantly (RCP 8.5). These models were selected to capture the changes in the extremes of those climate indices that are most significant to water supply (winter precipitation and maximum temperature) and agricultural water use (summer precipitation and maximum temperature), as represented by a subset of PCIC's upsampled Coupled Model Intercomparison Project simulations (Cannon 2015). None of the ten predictive models selected for this study are considered better or worse than another; combined, they encompass a selection of the available climate projections.
- Increased forage irrigation under future climate (2020 to 2100): This scenario represented and increase in irrigation of forage in the study area with future climate considerations to 2100. The forage irrigation type was selected as either travelling gun or sprinkler, based on the nearby irrigation types.

The modelling results were averaged to create a robust comparison of the current baseline and future water scenarios. The modelling outputs were used to estimate peak water demand based on the potential irrigatable land, *which includes forage that may not be irrigated now*, ALUI and irrigation codes (i.e., the type of irrigation system) and were summarized by purveyor area. The total hectarage (~2,200 ha total) was then multiplied by the estimated peak irrigation flow rate for Creston of 4.5 US gallons per minute per acre (0.702 L/s/ha) (BC MOE). By using the scenario that includes irrigated forage, it is a conservative of high estimate of water demand. The rates were developed using the peak evapotranspiration rate for typical deep-rooted crops for Creston growing in medium-textured soil and based on knowledge of the topography in the area. This rate also includes a 10% risk factor that is meant to represent a 1-in-10-year drought.

The summary of peak demand by area was used to inform the proposed water system design and phasing. Water demand results were grouped based on project phasing (**Section 4**) as follows:

- Phase 1: Erickson
- Phase 2: Lister
- Phase 3: North Canyon, South Canyon, and Orde Creek
- Phase 4: Rykerts Irrigation District and Bountiful Community Water System
- Other: Arrow Creek Water System, Creston Dyking District, Duck Lake Dyking District, Nicks Island Dyking District, Reclamation Dyking District, and Wyndell Irrigation District

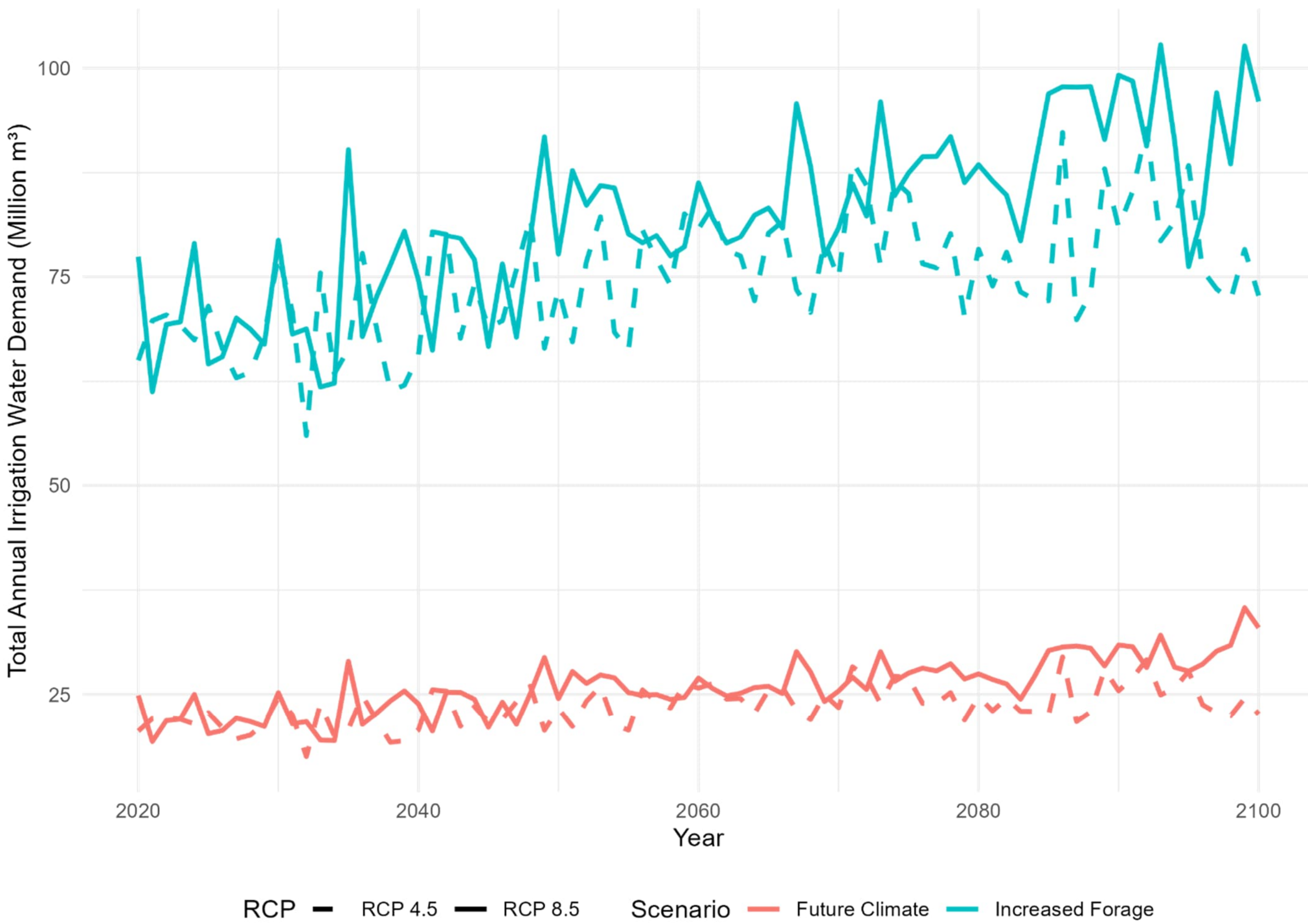
Future water demands increase across all areas under the RCP 4.5 and RCP 8.5 for the two future climate scenarios (**Figure 3-2**). In the increased forage scenario under RCP 8.5 (increased emissions), all phases experience an initial rise

[2] ACCESS 1-0, CanESM2, CNRM-CM5, inmcm4, CSIRO-Mk3-6-0

in demand through roughly 2050–2080, followed by a decline in later periods (2061–2100). The magnitude of this decline varies across different areas and the associated potential phases, reflecting differences in climate sensitivity, water use patterns, and irrigation demands. The areas allocated to Phase 3 experience the largest reduction (–2.17%), followed by the Arrow Creek system and the diking and irrigation districts (–2.10%) ("other" areas, not captured under a phase of expansion), Lister (–2.03%), and Erickson (–1.85%). The Phase 4 areas experience the smallest decline in water demand (–1.82%). Since neither scenario accounts for crop-type shifts, the late-century declines observed under RCP 8.5 are driven solely by climatic factors; the changes are likely driven by changes in temperature-driven evapotranspiration and precipitation patterns, and potential water supply constraints. Despite the overall decline, water demand is still substantially higher in late-century periods than in early-century periods.

In contrast, RCP 4.5 (efforts to reduce emissions) shows a more gradual but sustained increase without significant late-century reduction. Among the two future climate scenarios, the increased forage scenario consistently yields higher demand due to the high water demand for forage irrigation. In terms of the water purveyor areas, Erickson and Lister (Phases 1 and 2) showed moderate increase in demand that gradually increased throughout the century and displayed the mid-century decline that was experienced by the other water purveyor areas. When grouped by phase, Lister (Phase 2) and Rykerts and Bountiful (Phase 4) exhibit the greatest growth in demand under both RCPs. These areas experience a strong upward trend in demand throughout the century, with relatively smaller late-century reduction compared to other water purveyors. North Canyon, South Canyon, and Orde Creek also displayed one of the greatest increases in overall demand, particularly under the increased forage scenario, but this phase also experienced the largest decline in demand under RCP 8.5. Comparatively, Erickson and the other water purveyors exhibit a more moderate and consistent change in demand across both RCPs. This indicates that water demand in Erickson, Lister, Arrow Creek, and the diking and irrigation districts may have more consistent trends in the future.

Figure 3-2 Projected Future Irrigation Demand by Scenario Under RCP 4.5 and RCP 8.5



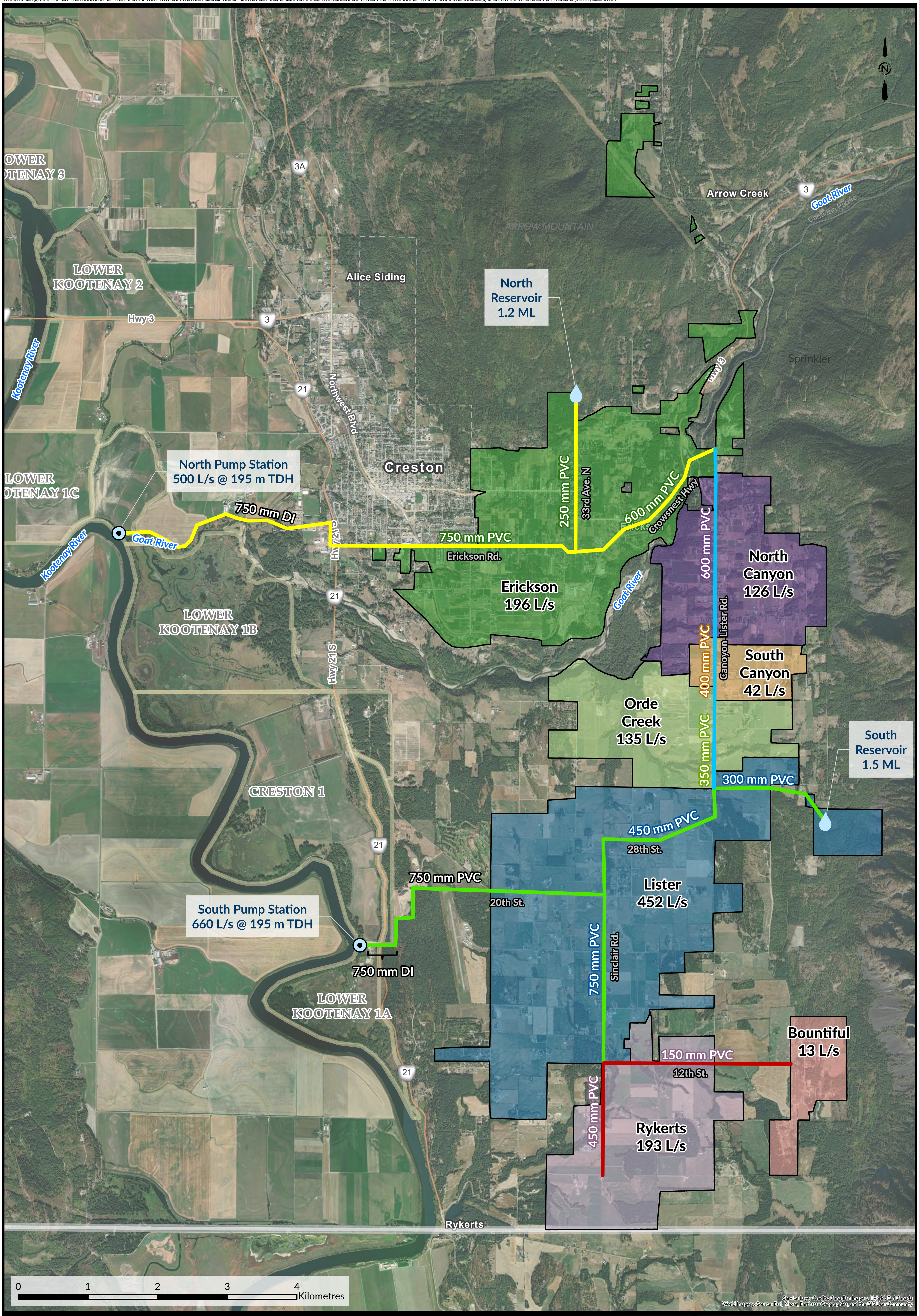
4 CENTRALIZED WATER SUPPLY

The Kootenay River is the proposed water source for a centralized water supply; the details about the hydrology of this system are provided in **Section 4.5**. **Figure 4-1** presents a water supply scheme that is based on a phased approach to implementing an ultimate buildout of the existing service areas. The RDCK prefers a phased approach to support future project funding and to focus the initial water supply of the Erickson service area in order to maximize the offset of water used for agriculture, which is currently being diverted from Arrow Creek.

4.1 Projection of Water Demand

The water demand calculations (**Section 3.4**) are based on a per-hectare demand and multiplied by the estimated peak irrigation flow rate for Creston of 4.5 US gallons per minute per acre (0.702 L/s/ha) (BC MOAg. Generally, most users do not use their full allotment on any given day, so the demand was scaled to 75% of the fully allotted demand, which is in line with the Agricultural Water Demand Study Erickson Water Service Area (Holder and Gulik 2019). As a reference to verify the accuracy of the 75% scaling factor, Associated compared this value to the scaling factor that was used for a similarly sized irrigation system for the South East Kelowna Irrigation District, now operated by the City of Kelowna. This service area has system metering and service metering and is therefore considered an accurate field representation. The scaling factor found by comparing the system metering data to the total hectares irrigated with the climate-specific irrigation allocation was found to be 74%. Associated therefore agrees with the proposed 75% scaling factor for sizing the area for future agricultural use.

Using this scaling factor and the per-hectare demand, as well as the service area metering data found for Southeast Kelowna (an area with similar climate and agricultural land base), the maximum day demand for each service area and the total flow requirements for each intake and pump station were projected (**Figure 4-1**).



LEGEND

- Pump Station
- Reservoir
- Water System Boundary
- Transmission Main - Phase 1
- Transmission Main - Phase 2
- Transmission Main - Phase 3
- Transmission Main - Phase 4

Associated Environmental

AE PROJECT NO.	2024-2027-00
SCALE	1:50,000
COORD. SYSTEM	NAD 1983 UTM ZONE 11N
DATE	2025-04-17
REV	00
DRAWN BY	MS
CHECKED BY	PC

FIGURE 4-1
PROPOSED AGRICULTURAL WATER SYSTEM

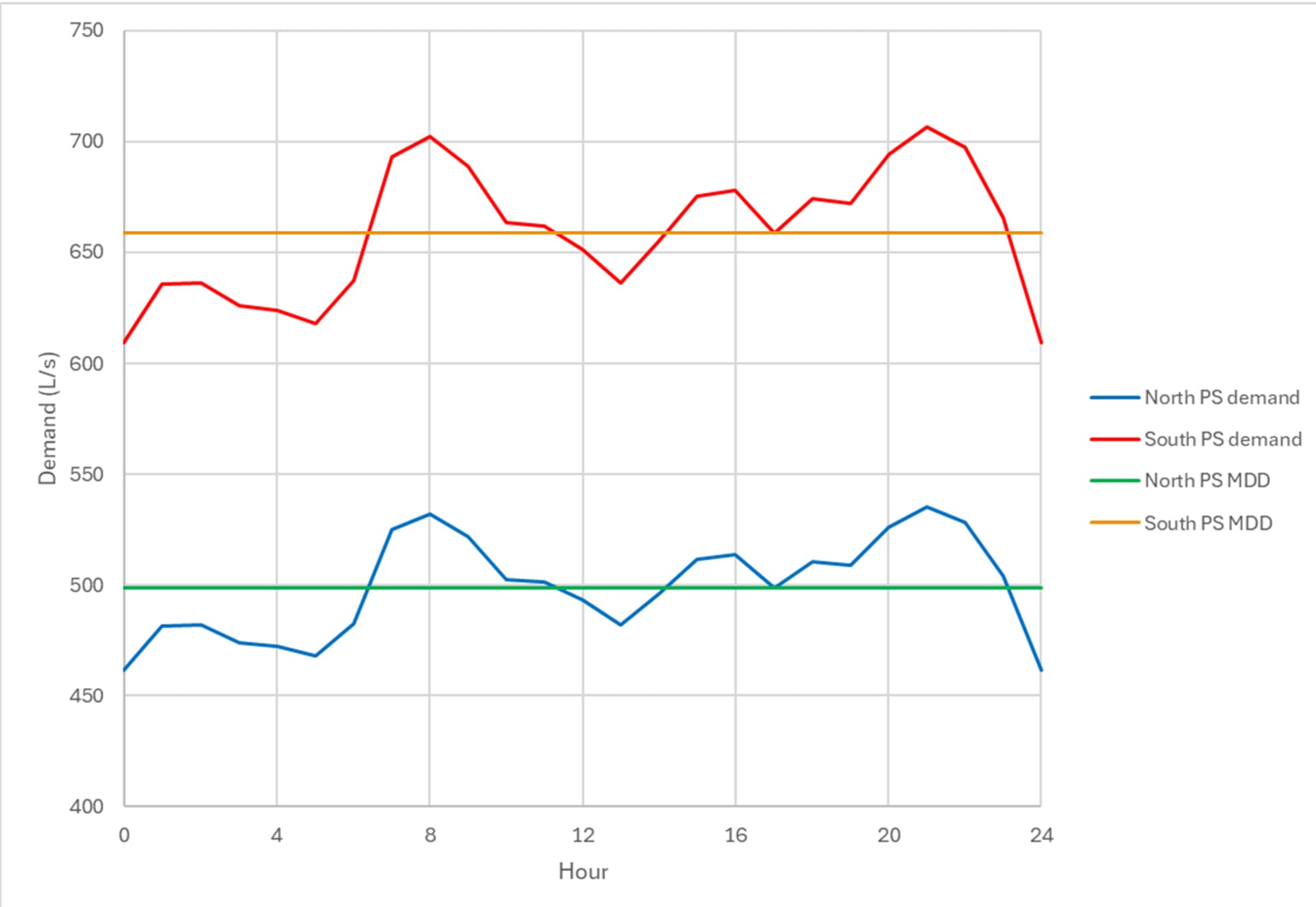
REGIONAL DISTRICT OF CENTRAL KOOTENAY

CRESTON AGRICULTURAL WATER DEMAND

4.2 Infrastructure Sizing

The proposed water supply system will be sized to meet the maximum day demand (MDD), which represents the maximum anticipated flow of water required on a hot, dry summer day, averaged over the full 24 hours of the day. The peak hourly flow in the distribution system would be attenuated by providing reservoir storage that allows the storage volume to be used during peak flow periods and recovers during lower flow periods. Generally, with agricultural systems, the variation of flow throughout the day is minimal as the users tend to rotate through irrigation zones throughout the day. **Figure 4-2** shows typical water use curves.

Figure 4-2 Projected Maximum Day Water Use Curves



Reservoir size includes a volume to provide rural fire flow, as outlined in Fire Underwriters Survey (2020). Associated has not included an overall analysis of fire flow because this would be a future discussion during the design stage for the RDCK to decide whether fire flow will be added to the services areas. There are obvious benefits to providing fire flow to a service area, but one significant drawback would be that the irrigation system would need to remain live during the winter months to provide fire flow, even when there is no irrigation demand. This poses stagnation and freezing challenges during the winter months. An emergency reservoir volume was provided per Master Municipal Construction Documents reservoir sizing guidelines.

Transmission mains were sized to allow a maximum velocity of 1.5 m/s, which is reasonable for minimizing head loss in the pipes without oversizing them, and therefore minimum energy consumption needed to convey water through the transmission mains. The power required for the intake pump stations would be based on the energy needed to lift the required volume of water from the Kootenay River (~535 m elevation) to the pressure zone on the agricultural bench, which would be balanced by reservoirs located at an elevation of ~720 m elevation.

4.3 Water Quality

The proposed water supply system separates agricultural water from the existing potable water supply systems in each water purveyor. The proposed system would therefore not need to meet the Health Canada Guidelines for Canadian Drinking Water Quality and would fall outside the jurisdiction of Interior Health, which regulates drinking water systems.

The guidance document used for agricultural water is the BC Working Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture (2024), developed by WLRS. This document outlines the parameters for agricultural use and is not as stringent as drinking water quality guidelines. It is expected that the water from the Kootenay River would meet these guidelines, although this would need to be confirmed by water sampling in future stages of design.

It is not anticipated that residents would use the agricultural system to fill swimming pools, so the BC Ministry of Environment's Recreational Water Quality Guidelines would not be required. However, Associated has included the required parameters and the irrigation and livestock watering requirements in **Appendix C**.

4.3.1 Disinfection Requirements

It is considered a best practice for irrigation systems to apply a small amount of disinfectant (0.2 mg/L residual) to the agricultural water to limit bacteriological regrowth in the pipes. Regrowth can adversely affect some crops, clog equipment, and cause odours. Spring flushing through hydrants or standpipes can accompany the disinfection.

The following identified risks can be mitigated by providing a minimal chlorine residual in the system:

- Human health risks
  - If raw water is not disinfected before entering the distribution system, an opportunity for biofilm regrowth in the pipes is created, which may involve bacteria and other pathogens colonizing the pipes. Other waterborne pathogens such as Escherichia coli, opportunistic pathogens, or pathogens that cause mosquito-borne diseases may be present in the raw water. The risk is that humans may be exposed to these pathogens through skin contact, direct or indirect ingestion, or inhalation of irrigation mist [3].
- Equipment degradation
  - Debris or particulates in the distribution system may lead to equipment blockage. Since the intake uses travelling screens, blockage is generally kept to a minimum, but biofilm growth in the pipes can cause blockage.
  - Organic matter in water can cause reduced dissolved oxygen levels through decomposition and can result in unwanted odours and release of pollutants from sediment[3].

[3] Environmental concerns for stormwater and rainwater harvest and use/reuse - Minnesota Stormwater Manual (state.mn.us)

- Crop quality and yields
  - Several sources indicate that biofilm is typically found in untreated irrigation systems and can negatively affect the quality of irrigation water and the health of some crops. These sources advise eradicating biofilm to improve crop quality and yields.[4] [5] [6]

To mitigate these risks, Associated recommends that the RDCK add a minimal chlorine residual to the distribution system throughout the year. Biofilms are typically less active in colder water, experienced throughout the winter, and will require minimal chlorine residual at that time. Associated also recommends a more robust spring flushing program that eliminates stagnant water in the distribution system. Ideally, the flushing should be done at the end of the lines and obtain a minimum flushing velocity.

All water containing a chlorine residual should be dechlorinated before being discharged to the receiving creek environment. Land application of chlorinated water is acceptable if the runoff from the application does not reach any natural waterbodies, such as creeks or ephemeral streams.

4.4 Phased Infrastructure Plan

The proposed conveyance infrastructure for agricultural water has been split into a phased approach. The infrastructure includes a new agricultural system that is separate from the existing combined potable and agricultural systems. This is the preferred approach so that the new agricultural system does not need to be treated to a level of potability, which would require a water filtration plant and would significantly increase capital and the ongoing costs of treating the water.

For the purposes of providing a high-level conceptual plan, Associated assumes that a new agricultural distribution system would need to convey water from the proposed transmission mains to the individual agricultural users. During future planning and design stages, this approach can be refined to reuse as many of the existing water mains as possible, which may reduce the scope of new infrastructure required. Since the Erickson area has the most established agricultural irrigation system, this system was used as the basis for the required distribution system network of pipes.

4.4.1 Phase 1: Erickson

Phase 1 consists of conveying water to the existing Erickson service area and includes a new river intake, pump station, transmission system, balancing reservoir, and distribution mains. The transmission main is sized to allow for the future connection to the North Canyon, South Canyon, and Orde Creek service areas (Phase 3).

A new river intake would be required and would include a concrete intake structure, fish screening, and low lift pumps to provide water up to the pump station. Alternative intake arrangements, such as infiltration galleries or Ranney wells, could be investigated to reduce costs in the future design stages, but a robust intake arrangement has been proposed as part of this study.

The location of the new intake on the Kootenay River conflicts with the Town of Creston's existing sewer outfall. The Municipal Wastewater Regulation does not permit locating agricultural intakes within 300 m downstream of a sewer

[4] https://watsonwell.com/removing-biofilm-agricultural-irrigation-systems/
[5] https://www.growertalks.com/Article/?articleID=20666
[6] https://sfamjournals.onlinelibrary.wiley.com/doi/pdf/10.1111/j.1472-765X.2011.03192.x

outfall as it could affect the water quality being applied to crops. The sewer outfall would likely need to be moved downstream (north) to accommodate the new agricultural intake. The new transmission main would use the outfall right-of-way and may therefore require twinning a new outfall pipe with the new agricultural transmission main near the Kootenay and Goat Rivers.

The pump station would be located on the banks of the Kootenay River, at an elevation above the 1:200-year flood line. Although many river intakes use settling ponds to remove the suspended solids in rivers with high levels of suspended solids, it is not anticipated that this would be required because the Kootenay River has relatively lower levels of this parameter. There is also an existing agricultural intake owned and operated by the Yaqan Nuʔkiy near the confluence of the Goat and Kootenay Rivers that does not use a settling pond. The requirement for a settling pond should be reviewed in future design stages based on a water quality sampling program for the Kootenay River.

The proposed reservoir would be set at an elevation of approximately 720 m to allow hydraulically supplying most of the Erickson system without additional pumping or reducing pressure. The reservoir is sized to provide peak hour attenuation for the service area.

4.4.2 Phase 2: Lister

Phase 2 consists of conveying water to the existing Lister service area and includes a new river intake, pump station, transmission system, balancing reservoir, and distribution mains. The transmission main is sized to allow for the future connection to the Orde Creek service area to the north and the Rykerts and Bountiful service areas to the south. The infrastructure assumptions listed in Phase 1 would apply.

The location of the new intake on Kootenay River was agreed to in concept with the Yaqan Nuʔkiy. This location was previously investigated and found to be acceptable to the Yaqan Nuʔkiy; it also provides a direct feed to the Lister service area. The proposed reservoir would be set at an elevation of approximately 720 m to allow feeding most of the Lister system and is sized to provide peak hour attenuation for the service areas.

4.4.3 Phase 3: North Canyon, South Canyon, and Orde Creek

Phase 3 consists of conveying water to the existing North and South Canyon and Orde Creek service areas and includes a transmission system, distribution mains, and a crossing of the Goat River from the Erickson service area. This area can be fed from the North or South pump stations and forms the connection between the Phase 1 and 2 infrastructure. Phase 3 increases the resiliency of the overall system so that in an emergency, if one of the pump stations is offline, the whole system could be fed from either pump station at a reduced flow rate.

This phase includes crossing the Goat River with a new piped connection from the Erickson service area. It is anticipated that the existing pipe will not have adequate capacity and could act only as a short-term connection before the full buildout of the agricultural distribution system in the Phase 3 service area. It is anticipated that a location for the pipe crossing could be found so that the pipe can form a bridge over the river between two new abutments. Alternatively, the possibility of hanging a new pipe off the existing Canyon Lister Rd. bridge could be reviewed in future design stages.

4.4.4 Phase 4: Rykerts Irrigation District and Bountiful Community Water System

Phase 4 consists of conveying water to the existing Rykerts and Bountiful service areas and includes a transmission system and distribution mains.

4.5 Kootenay River

The Kootenay River is a key water source for the Creston Valley. It is fed by the Goat River and Arrow Creek watersheds and currently supports various needs, including agriculture, domestic use, and ecological functions. This section summarizes the regulatory management, hydrologic, and future management changes as they pertain to using this waterbody as a centralized source.

4.5.1 Regulation and Management

The Kootenay River is the third-largest tributary to the Columbia River and includes a part of a large system of dams operated by different owners and for multiple purposes (IJC 2022). The river begins in British Columbia and flows into northwestern Montana and then Idaho, before returning to British Columbia near Creston.

The Kootenay River is included in the 1909 Boundary Waters Treaty (BWT), which provides the principles and mechanisms to help prevent and resolve disputes over the use of the waters shared by Canada and the United States and to settle other transboundary issues (IJC 2022). The International Joint Commission (IJC) was established through the Treaty and helps sets the conditions for projects through Orders of Approval, such as dams and diversions, which affect the natural level or streamflow of boundary waters, or dams on transboundary streams that would raise the level across the boundary in the upstream country (IJC 2022). The IJC and the International Kootenay Lake Board of Control established the 1938 Orders of Approval, which outlines the framework for the management of Kootenay Lake, which is driven by Kootenay River inflow from the United States (IJC 2022).

The Kootenay River is also included in the 1964 Columbia River Treaty. Under this Treaty, the construction of Duncan and Libby Dams was approved, and the operation of the dams largely influences Kootenay River inflow to Kootenay Lake (IJC 2022). Libby Dam was constructed in 1973 and is the last dam that manages Kootenay River flow before the river re-enters Canada. Since 2000, Libby Dam operations have followed the Libby Coordination Agreement under the Treaty (Government of BC 2024)[7]. Releases at Libby Dam have varied over time; however, in 2002, an interim alternative flood control procedure referred to as Variable Flow was adopted, which resulted in the dam discharging less water during the fall/winter period and more water during the spring/summer to benefit fish downstream (Government of BC 2024). The Variable Flow operation was permanently adopted in 2008 (Government of BC 2024).

4.5.2 Streamflow

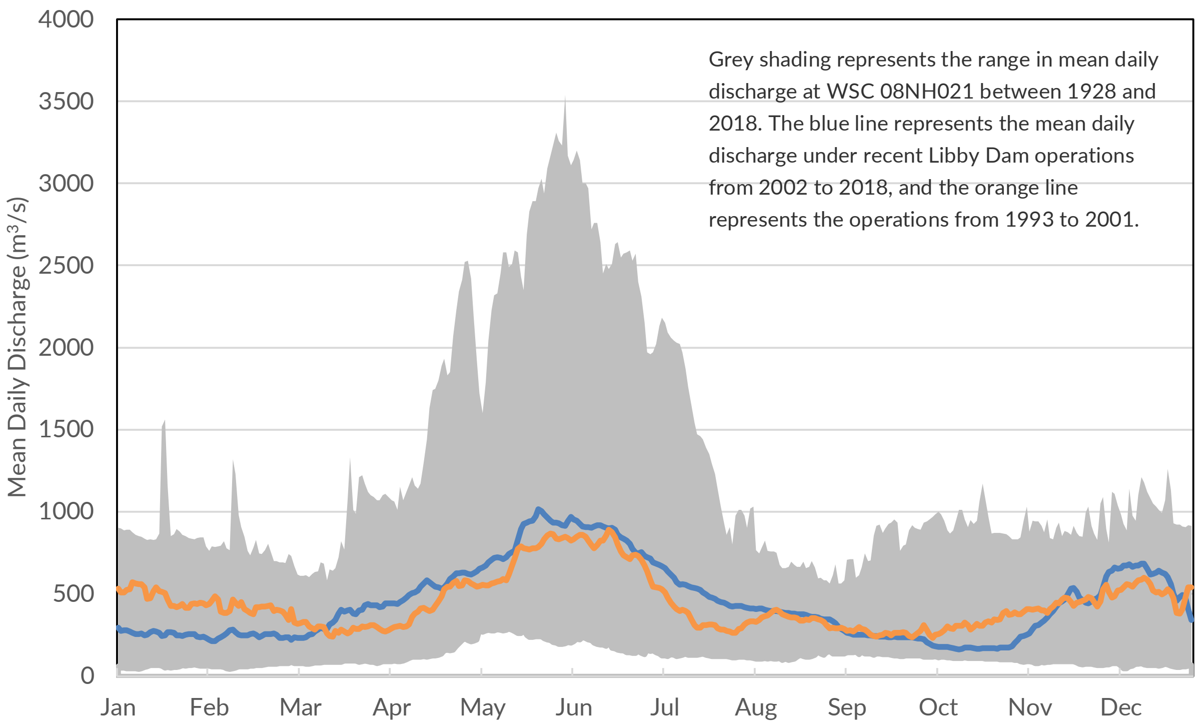
The Kootenay River streamflow that re-enters Canada in the Creston Valley is monitored by the United States Geological Survey (USGS) – Kootenai River at Porthill (08NH021). This hydrometric station is operated by the USGS, but data collected are presented by the Water Survey of Canada (WSC). The hydrometric station has been operated continuously since 1928 and is still active, but published records are available only to 2018.

WSC 08NH021 is located at the international border near Rykerts, BC; therefore, the Kootenay River streamflow recorded provides the expected magnitude and seasonality of the streamflow at the proposed water intake locations.

[7] BC Gov News

Figure 4-3 summarizes the mean daily discharge at the Kootenay River recorded since 1928 and the mean streamflow since 2002 (i.e., new Libby Dam operational regime) and for 1993–2001 (i.e., previous Libby Dam operational regime).

Figure 4-3 Mean Daily Discharge at Kootenay River (WSC 08NH021), 1928–2018



As outlined in **Section 4.2**, the design capacity is 0.500 m^3/s for the proposed north water intake, to support Phases 1 and 3, and 0.660 m^3/s for the south water intake, to support Phases 2 and 4. The maximum day demand is identified to occur during the summer months (July and August), so in comparison to Kootenay River streamflow in recent years, these maximum withdrawals would represent <0.5% of the streamflow during this period.

4.5.3 Future River Management Changes

Columbia River Treaty

In July 2024, Canada and the United States reached an agreement-in-principle (AIP) on the key elements of a modernized Columbia River Treaty (Government of BC 2025).

The AIP is a key step toward modernizing the Columbia River Treaty; however, the current Treaty remains in place until a new modernized Treaty is finalized (Government of BC 2025). Therefore, to bridge the gap between the AIP and the modernized Treaty, Canada and the United States have entered into interim arrangements under the existing Treaty to allow continued operation and implementation of some components of the AIP (Government of BC 2025).

In the future, changes to the Columbia River Treaty could influence Kootenay River streamflow downstream of Libby Dam; however, any changes would be considered in the Kootenay Lake Orders of Approval.

International Elk-Kootenai/y Watershed Study Board

In March 2024, the IJC appointed the International Elk-Kootenai/y Watershed Study Board, consisting of experts and Knowledge Holders from Canada, the United States, and the Ktunaxa Nation. The goal of the board is to explore the impacts of transboundary water pollution in the Elk-Kootenai/y watershed (IEKWSB 2025). Specifically, the board is to conduct transparent and coordinated transboundary data and knowledge sharing to support a common understanding of pollution in the Elk-Kootenai/y River watershed (IEKWSB 2025). The information gathered is intended to support further planning and decisions by the IJC.

The board's full review is not expected to be complete until 2026, but a draft plan of study was submitted to the IJC in January 2025. After this work is complete, any changes to Kootenay River streamflow downstream of Libby Dam would be reflected in the Libby Coordination Agreement and the Kootenay Lake Orders of Approval.

5 COST ESTIMATE

This section outlines the estimated capital and operational costs for the proposed upgrades. All costs discussed below are in 2025 Canadian dollars. No allowances have been included for fluctuations in currency exchange rates, general inflation, or market disruptions from the time these estimates were prepared to the time that the project will be constructed and operated.

5.1 Capital Costs

Table 5-1 shows a summary of costs for all phases. The class D cost estimates for each phase are shown in **Tables 5-2**, **5-3**, **5-4**, and **5-5**.

Table 5-1 Summary Costs by Phase

Description	Cost
Phase 1 – Erickson	$94,300,000
Phase 2 – Lister	$105,800,000
Phase 3 – North Canyon, South Canyon, and Orde Creek	$26,000,000
Phase 4 – Rykerts and Bountiful	$14,700,000
Subtotal	**$240,800,000**
Engineering (15%)	$36,120,000
Contingency (40%)	$96,320,000
Total	**$375,000,000**

Table 5-2 Phase 1 Capital Cost Estimate

Description	Unit	Quantity	Unit Price	Total Amount
400 mm Sanitary Outfall Pipe	lin.m	2,600	$ 1,360.00	$ 3,600,000.00
Sanitary Outfall	LS	1	$ 1,000,000.00	$ 1,000,000.00
Distribution Pipe - Erickson	ha	1,101	$ 16,410.00	$ 18,100,000.00
Phase 1 750 mm DI - Erickson - Unpaved	lin.m	4,287	$ 2,490.00	$ 10,700,000.00
Phase 1 750 mm PVC - Erickson - Paved	lin.m	2,950	$ 2,640.00	$ 7,800,000.00
Phase 1 600 mm PVC - Erickson - Half Paved	lin.m	2,657	$ 1,970.00	$ 5,300,000.00
Phase 1 250 mm PVC - Erickson - Paved	lin.m	2,276	$ 930.00	$ 2,200,000.00
Highway 21S Crossing	lin.m	40	$ 10,000.00	$ 400,000.00
Northwest Blvd Crossing	lin.m	40	$ 10,000.00	$ 400,000.00
North Reservoir	cu.m	1,203	$ 940.00	$ 1,200,000.00
North Pump Station Intake	LS	1	$ 13,409,100.00	$ 13,500,000.00
North Pump Station	LS	1	$ 7,669,200.00	$ 7,700,000.00
Subtotal				**$ 94,300,000.00**
Engineering (15%)				$ 14,145,000.00
Contingency (40%)				$ 37,720,000.00
Total				**$ 147,000,000.00**

Table 5-3 Phase 2 Capital Cost Estimate

Description	Unit	Quantity	Unit Price	Total Amount
Distribution Pipe - Lister	ha	1,376	$ 16,410.00	$ 22,600,000.00
Phase 2 750 mm DI - Lister - Unpaved	lin.m	514	$ 2,490.00	$ 1,300,000.00
Phase 2 750 mm PVC - Lister - Paved	lin.m	2,424	$ 2,640.00	$ 6,400,000.00
Phase 2 750 mm PVC - Lister - Half Paved	lin.m	3,798	$ 2,360.00	$ 9,000,000.00
Phase 2 450 mm PVC - Lister - Paved	lin.m	2,879	$ 1,500.00	$ 4,300,000.00
Phase 2 300 mm PVC - Lister - Half Paved	lin.m	1,807	$ 890.00	$ 1,600,000.00
Highway 21S Crossing	lin.m	40	$ 10,000.00	$ 400,000.00
South Reservoir	cu.m	1,540	$ 940.00	$ 1,500,000.00
South Pump Station Intake	LS	1	$ 17,700,000.00	$ 17,700,000.00
South Pump Station	LS	1	$ 10,867,420.00	$ 10,900,000.00
Subtotal				**$ 105,800,000.00**
Engineering (15%)				$ 15,870,000.00
Contingency (40%)				$ 42,320,000.00
Total				**$ 164,000,000.00**

Table 5-4 Phase 3 Capital Cost Estimate

Description	Unit	Quantity	Unit Price	Total Amount
Distribution Pipe - North Canyon	ha	476	$ 16,410.00	$ 7,800,000.00
Distribution Pipe - South Canyon	ha	121	$ 16,410.00	$ 2,000,000.00
Distribution Pipe - Orde Creek	ha	422	$ 16,410.00	$ 7,000,000.00
Phase 3 600 mm PVC - Erickson - Unpaved	lin.m	407	$ 1,690.00	$ 700,000.00
Phase 3 600 mm PVC - North Canyon - Paved	lin.m	2,303	$ 2,260.00	$ 5,200,000.00
Phase 3 400 mm PVC - South Canyon - Paved	lin.m	905	$ 1,510.00	$ 1,400,000.00
Phase 3 350 mm PVC - Orde Creek - Paved	lin.m	1,257	$ 1,080.00	$ 1,400,000.00
Pipe Bridge Crossing	LS	1	$ 500,000.00	$ 500,000.00
Subtotal				**$ 26,000,000.00**
Engineering (15%)				$ 3,900,000.00
Contingency (40%)				$ 10,400,000.00
Total				**$ 41,000,000.00**

Table 5-5 Phase 4 Capital Cost Estimate

Description	Unit	Quantity	Unit Price	Total Amount
Distribution Pipe - Rykerts	ha	524	$ 16,410.00	$ 8,600,000.00
Distribution Pipe - Bountiful	ha	138	$ 16,410.00	$ 2,300,000.00
Phase 4 450 mm PVC - Rykerts - Paved	lin.m	1,606	$ 1,500.00	$ 2,400,000.00
Phase 4 150 mm PVC - Bountiful - Paved	lin.m	2,687	$ 490.00	$ 1,400,000.00
Subtotal				**$ 14,700,000.00**
Engineering (15%)				$ 2,205,000.00
Contingency (40%)				$ 5,880,000.00
Total				**$ 23,000,000.00**

These estimates were developed using costs from similar projects completed recently and engineering judgment based on prior experience. The following assumptions were made for this estimate:

- PST and GST are not included.
- Amount of paving required was estimated based on the location of pipes. The cost of pavement restoration required for pipe installation was included in pipe costs and are expected to be borne by RDCK, not the Ministry of Transportation and Transit, per Section 62 of the Transportation Act.
- Piping that cross rails and highways will be installed via trenchless technologies, per the ministry's requirements. Length of each crossing was assumed to be 40 m.
- No costs for obtaining new right-of-way agreements are included in this estimate. Generally transmission mains were placed under existing roads where possible. Existing rights-of-way would be used where possible to share potable and agricultural pipes within the same right-of-way. Further investigation required during subsequent design phases.
- The replacement costs of the sanitary sewer overflow pipe and outfall were based on the assumed pipe length from the treatment plant to discharge location and a pipe size of 400 mm.
- The costs for transmission mains and distribution mains assume the material to be PVC, with the exception of ductile iron pipes when the system pressure exceeds 235 psi.
- No archaeologically significant discoveries will be made during construction (note that no archaeologic surveys have been done to date).
- No unforeseen geotechnical conditions will be encountered during construction.
- Three phase power is currently available near the North pump station location. We have assumed that adequate power available for the future pump station requirement. The cost of a customer/primary metered service was added.
- Assumed a single-phase power line along Creston Rykers Hwy would require upgrading to three phase power and extended to the South pump station from the Mallory Rd intersection at a distance of 3.4 km. This needs to be confirmed with Fortis at subsequent design stages. The cost of a customer/primary metered service was added.

The following sections describe the approach for estimating costs of distribution mains, transmission mains, and facilities.

5.1.1 Water Distribution

To develop the cost of the water distribution system in each district, Associated used existing water system data, which was only available for Erickson (Associated 2015). Associated assumed the new water distribution network for irrigation flow would be similar to the existing system; therefore, Associated analyzed the Erickson data and used them to estimate the distribution system costs in each district. The following steps were taken to determine these:

1. Associated considered all pipes smaller than 450 mm to be distribution.
2. Using the pipe sizes and lengths, Associated estimated the total replacement value for distribution mains in Erickson. The unit rates used were based on costs from similar projects, adjusted for inflation and market fluctuations.
3. This value was divided by the total area in Erickson, in hectares, to determine a cost per hectare.
4. To estimate the cost of distribution piping in each district, Associated multiplied the cost per hectare from step 3 by the area of each of the other districts (Lister, North Canyon, South Canyon, Orde Creek, Rykerts, and Bountiful).

5.1.2 Transmission Mains

The cost of transmission mains is based on the pipe sizing discussed in **Section 4.2**. The unit rates used were based on costs from similar projects, with adjustments for inflation and market fluctuations.

5.1.3 Facilities

All of the required vertical infrastructure is proposed to be constructed in Phases 1 and 2. They include:

- Phase 1:
  - River intake structure;
  - Pump station capable of 500 L/s at 195 m total dynamic head;
  - 1.2 ML balancing reservoir; and
  - Sanitary sewer outfall relocation.
- Phase 2:
  - River intake structure;
  - Pump station capable of 660 L/s at 195 m total dynamic head; and
  - 1.5 ML balancing reservoir.

The costs of the intake structures, pump stations, and reservoirs were estimated using recent projects that are similar in concept, scaled for size/capacity, and adjusted for inflation and market fluctuations. The intake structure cost includes environmental permitting. The cost of the sanitary sewer outfall is an estimated allowance including construction and required environmental permitting.

5.2 Operational Costs

We estimated the peak monthly operational costs for the North and South Pump Stations, as the duration of irrigation season and shoulder season will vary from year to year. These were calculated based on the proposed pump station capacities and FortisBC's rates current at the time of this report and are summarized in **Table 5-6**.

Table 5-6 Estimated Monthly Operational Costs

	North Pump Station	South Pump Station
Customer Charge	$70	$70
Daily Energy Charge	$2,880	$3,600
Monthly Energy Charge	$87,600	$109,500
Demand Charge	$17,920	$23,840
Monthly Total	**$105,600**	**$133,500**

This estimate was developed using the following assumptions:

- The required flow will be constant at maximum day demand (discussed in **Section 4**) for 24 hours daily for one month.
- The pumps will be operating at 75% efficiency.
- The following charges from FortisBC commercial electricity rates were used:
  - Customer charge of $69.06 per 30-day billing period.
  - Demand charge of $14.53 per kW over 40 kW.
  - Energy charge of $0.08827 per kWh.
- FortisBC commercial service rate used is for customers with demand between 40 kW and 500 kW. Both pump station demands would exceed 500 kW; however, no rates were available for higher demand.
- Only energy costs were included.

6 ADDITIONAL CONSIDERATIONS

There will be provincial regulatory approvals in the event of going to a centralized supply from the Kootenay River. Foremost is the need for a water licence to withdraw water from the Kootenay River. An environmental assessment would be triggered if there is >10 million m^3/year withdrawn, or an increase of >35% of the maximum rate on an existing licence. Even if all phases went forward at once, the maximum volume would be below 10 million m^3/year. However, there is a need for continual consultation with the Yaqan Nuʔkiy, particularly for a pump on their land. At a minimum any disturbance would require archaeological review. Also, any work proposed in the ALR would need to be approved by the Agricultural Land Commission. This would include the pipeline, pumphouse and any fill transfer, if required. Regulatory requirements continually evolve and can be revisited as the project moves forward.

CLOSURE

This report was prepared for the Regional District of Central Kootenay to review a centralized water supply to agricultural land in the Creston Valley.

The services provided by Associated Engineering (B.C.) Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practising under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,

Associated Engineering (B.C.) Ltd.
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APPENDIX A - MAXIMUM ANNUAL WATER DEMAND BY PURVEYOR AREA

Table A-6-1 Maximum Annual Water Demand by Purveyor Area (m3)

Max of demand_m3	Column Labels								
Row Labels	0*	April	May	June	July	August	September	October	Grand Total
ARROW CREEK	2,896	8	4,854	11,916	17,198	14,709	9,485	2,473	17,198
BOUNTIFUL	843	391	2,091	5,834	9,756	8,398	3,263	147	9,756
CRESTON DYKING	595,027	2,826	181,398	904,542	1,365,165	1,114,207	707,033	206,161	1,365,165
CRESTON NO. 1	3,522		1,150	7,396	12,624	12,165	8,855	2,811	12,624
DUCK LAKE	299,111	29,576	104,312	434,268	672,122	585,752	387,976	114,820	672,122
ERICKSON	107,006	807	78,546	286,797	466,051	404,436	227,797	47,767	466,051
LISTER	19,470	1,564	98,482	149,748	211,148	178,378	115,555	28,605	211,148
LOWER KOOTENAY 3	16		4	21	30	26	17	5	30
LOWER KOOTENAY 4	8,855		3,068	14,437	20,567	17,417	11,344	3,363	20,567
LOWER KOOTENAY 5	14,837		22,097	50,459	78,015	65,474	36,958	10,119	78,015
NICKS ISLAND	200,275		68,815	311,020	445,169	376,216	245,930	73,025	445,169
NORTH CANYON	28,145	1,155	38,889	103,976	162,478	141,492	80,924	17,626	162,478
ORDE CREEK	25,156	3	136,833	202,948	283,183	241,831	161,860	40,770	283,183
PRIVATE	61,153	27,886	250,377	393,167	543,697	457,096	302,896	75,117	543,697
RECLAM DYKING	1,387,138	14	417,445	2,017,143	2,927,886	2,326,989	1,357,807	401,356	2,927,886
RYKERTS	42,284	12	237,468	344,428	476,205	406,026	272,088	67,162	476,205
SOUTH CANYON	4,348	264	12,595	24,388	35,753	32,353	22,375	5,508	35,753
WYNDELL	8,124	113	11,551	32,915	49,745	41,211	24,088	6,618	49,745
Grand Total	**1,387,138**	**29,576**	**417,445**	**2,017,143**	**2,927,886**	**2,326,989**	**1,357,807**	**401,356**	**2,927,886**

*0 represents the annual soil moisture deficit. The Annual Soil Moisture Deficit is the amount of water that the farmer adds into the soil to bring it back to field capacity to prevent it from freezing. This is only applied in dry/cold climates; wet climates are assumed to have sufficient precipitation and warm enough temperatures to avoid the risk of freezing without this extra application of water.

There is no fixed date associated with irrigation to compensate for the annual soil moisture deficit - the farmer may choose to do it any time after the end of the growing season and before the freeze up. In the agriculture water demand model's summary reports, the demand associated with the annual soil moisture deficit shows as occurring at time 0 (week 0, month 0, etc.) simply to differentiate it from other demands that do have a date of occurrence during the crop's growing season.

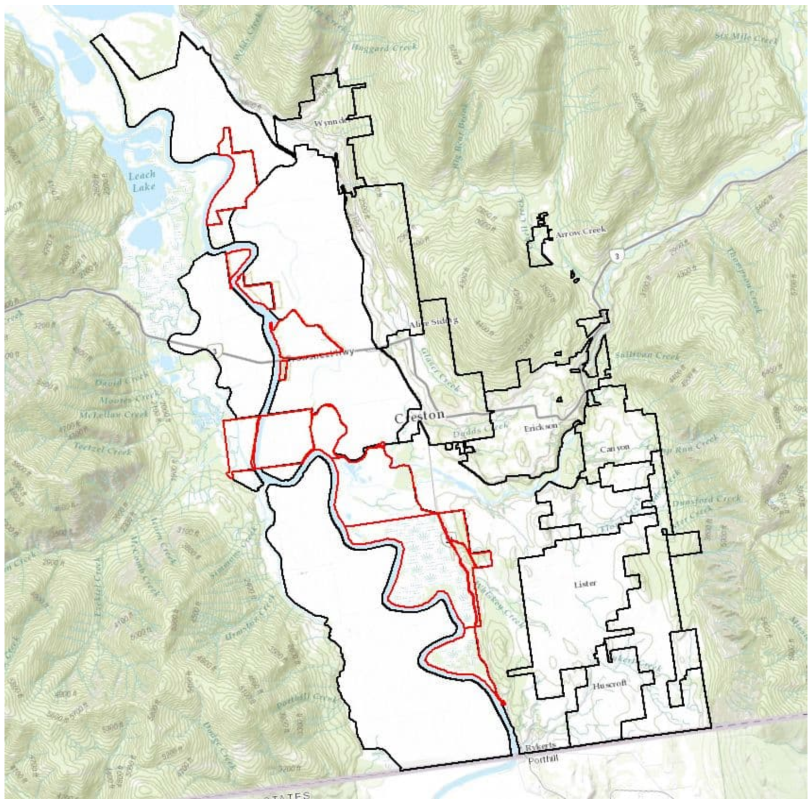
APPENDIX B – MODELLING OF AGRICULTURAL WATER DEMAND (RHF SYSTEMS LTD.)

Agriculture Water Demand Model
Creston Valley Modeling
February 2, 2025

This document describes the water demand modeling performed for Associated Environmental for their Creston Valley Water Sources project. It does not provide details on the actual calculations used by the model; refer to separate documents (AWDM Fact Sheets, AWDM Technical Description) for those descriptions.

Area of Interest and Summary Areas

AE provided two covers containing water distribution and water use area polygons: one outlining the city's water systems and a second for the Lower Kootenay Band. These polygons were used to summarize the demand results.



Water distribution/use area polygons: city systems in black, LKB polygons in red

Landbases

Associated provided two covers representing the cropping and irrigation systems:

Updated LUI
- expanded version of the AWDM's current Land Use Inventory for the area

All Forage
- cover representing an increased agriculture scenario

These covers were used as complete replacements for the land use information in the model. For the Updated LUI, only polygons with an irrigation use code of "Y" were selected; for the All Forage landbase, irrigation use codes of Y, N and P were used.

Climate Data
The Updated LUI cover was run under the historic climate dataset for the 30 year period 1981 – 2010.

Both the Updated LUI and All Forage scenarios were modeled under two representative concentration pathways (rcps 4.5 and 8.5) of each of the five predictive climate models listed below for the period 2020 – 2100:

ACCESS 1-0
CanESM2
CNRM-CM5
inmcm4
CSIRO-Mk3-6-0

Water Demand Types
Along with irrigation demands, the Agriculture Water Demand Model can produce demand results for animals using property-based animal counts and fixed daily per-animal allotments. Replacing the standard LUII cover with the two AE-supplied land use covers meant losing the representations of cadastral properties and associated animal counts. The results produced for this modeling exclude animal water uses.

Annual Soil Moisture Deficit
The Annual Soil Moisture Deficit is the amount of water that the farmer adds into the soil to bring it back to field capacity to prevent it from freezing. This is only applied in dry/cold climates; wet climates are assumed to have sufficient precipitation and warm enough temperatures to avoid the risk of freezing without this extra application of water.

There is no fixed date associated with irrigation to compensate for the annual soil moisture deficit - the farmer may choose to do it any time after the end of the growing season and before the freeze up. In the agriculture water demand model's summary reports, the demand associated with the annual soil moisture deficit shows as occurring at time 0 (week 0, month 0, etc.) simply to differentiate it from other demands that do have a date of occurrence during the crop's growing season.

Irrigation Management Practices
Through the use of an Irrigation Management Practices setting, the model increases or decreases the amount of water assumed lost to deep percolation from over-watering. There are 3 sets of multipliers (good, average, poor) driving percolation loss calculations based on characteristics such as soil textures, crop rooting depths and water extraction coefficients, and irrigation system types.

An *average* irrigation management practices setting was used for this modeling.

Growing Season and Irrigation Season Overrides
The water demand model determines the start and end of each crop's growing season according to the climate data; warmer temperatures early or late in the year translate into longer growing seasons and, potentially, into increased theoretical water demand. The model supports use of override tables which can limit the extents of either the growing seasons or irrigation seasons (in some areas, water purveyors provide water for irrigation only during certain times of the year regardless of the climate). These overrides are often used when modeling the current time frame but turned off when modeling future years under the assumption that future climate may well allow for extended growing seasons. For these scenarios, the overrides have been turned off for all time periods including the historic period. This would seem to provide a better basis for comparison than having the overrides in play for one time period but not another.

Data Summaries and Tables

The water demand data is being delivered as comma-delimited text files (.csv) carrying monthly breakdowns of the total demands by water distribution area:

district

- value from the DISTRICT column in the Updated LUI cover and from the NGLSHNM attribute in the LKB_land cover
- blank for a small amount of area falling outside of the two distribution area covers

district2

- DISTRICT2 value from the Updated LUI cover
- blank for the LKB polygons

year

- 1981 – 2010 for the historic period, 2020 – 2100 for the predictive models

monthNumber

- month of year 1-12
- 0 for the annual moisture deficit

demand_m3

- water demand in cubic metres

APPENDIX C – WATER QUALITY GUIDELINES

Parameter	Units	Recreational Guideline Regulation	Agricultural Guideline Regulation (Irrigation)	Agricultural Guideline Regulation (Livestock)
Alkalinity (bicarbonate, as CaCO3)	mg/L			
Aluminum Extractable	mg/L		5	5
Antimony Extractable	mg/L			
Arsenic Extractable	mg/L		0.1	0.025
Barium Extractable	mg/L			
Boron Extractable	mg/L		0.5-15	5
Cadmium Extractable	mg/L		0.25	0.25
Calcium	mg/L			
Chloride	mg/L		100	600
Chlorine	mg/L		1*	
Chlorophenols				
MCPs	mg/L	AO=0.0001		185
DCPs	mg/L	AO=0.0003		46
TCPs	mg/L	AO=0.002		21
TTCPs	mg/L	AO=0.001		41
PCPs	mg/L	AO=0.03		17.5
Chromium Extractable	mg/L			
Colour	TCU	AO=15		
Conductivity	umhos/cm			
Copper Extractable	mg/L		200	300
Cyanide	mg/L			
Cyanobacterial Toxins (as Total Microcystins)	mg/L	0.02		
Diisopropanolamine (DIPA)	mg/L		0.0039	0.038
Fluoride	mg/L		2	1.5-4
Hardness	mg/L			
Iron Extractable	mg/L			
Lead Extractable	mg/L		0.2-0.4	0.1
Magnesium	mg/L			
Manganese Extractable	mg/L		1	1
Mercury	mg/L		0.002	0.003
MTBE	mg/L	0.02		
Molybdenum	mg/L		0.05	0.05-0.08
Nitrate (as N)	mg/L	10		100
Nitrite (as N)	mg/L	1		10
pH		5.0-9.0		
PCBs	mg/L		0.0005	
Selenium	mg/L		0.01	0.03
Sodium Extractable	mg/L			
Sulfolane	mg/L		8.4	14
Sulphate	mg/L			1000
Total dissolved solids / TDS	mg/L			
Total Trihalomethanes / TTHM	mg/L			
UV Transmittance @ 254nm	%			
Turbidity	NTU	AO=50		
Uranium Extractable	mg/L			
Zinc Extractable	mg/L		1.0-5.0	2
E. coli				
mean concentration of min. 5 samples	#/100mL	200		
max. concentration of single sample	#/100mL	400		
Enterococci				
mean concentration of min. 5 samples	#/100mL	35		
max. concentration of single sample	#/100mL	70		
Coliforms (Fecal)	#/100mL			
Coliforms (Total)	#/100mL			
Cryptosporidium spp. (total confirmed)	#/100L			
Giardia spp. (total confirmed)	#/100L			