INTEGRATED INFRASTRUCTURE CAPITAL PLAN (IICP)

Prioritized Water Capital Plan

Prepared for:

The City of Castlegar

July 2018

Submitted by:

URBAN systems

304-1353 Ellis Street
Kelowna, BC V1Y 1Z9
T: 250-762-2517
F: 250-763-5266
Contact: Scott Shepherd, BA, AScT.
E: sshepherd@urbansystems.ca

Report for

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Prioritized Water Capital Plan

Prepared for

City of Castlegar
460 Columbia Ave
Castlegar, BC V1N 1G7

Prepared by

Urban Systems Ltd.
304-1353 Ellis Street
Kelowna, BC V1Y 1Z9
T: 250-762-2517
www.urbansystems.ca

Scott Shepherd, BA, AScT
Asset Management Specialist/
Principal

Anthony Comazzetto, P.Eng.
Project Manager/Principal

July 2018

USL File No. 0841.0099.01

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1.0 INTRODUCTION

Climate change is an important issue for British Columbia. One of the most serious impacts of climate change is the increase of extreme events – warm days and precipitation. Forecasts suggest that the province will experience temperature increases by mid-century, relative to historical average, of between 2 to 4^{o}C. It is anticipated that the number of heavy precipitation events will increase in frequency and magnitude and there will be a shift in the seasonal pattern of occurrence. These changes will result in a longer growing season, and increased likelihood of floods and droughts. This change in climate will likely result in decreased infrastructure service-life. For example, an increased frequency of freeze/thaw events will degrade roads and increased frequency and magnitude of extreme precipitation events will result in floods and potential infrastructure damage due to undersized drainage capacity.

Incorporation of climate change into asset management and master plans has so far been limited, with the vast majority of new infrastructure continuing to be designed using established codes or history-based, asset-specific environmental criteria. The impacts of climate change will increase infrastructure costs as we move forward. The climate-related challenges that communities face are compounded by the maintenance, monitoring and replacement costs of aging infrastructure.

The objective of this report is to provide a risk based approach and an intuitive process to integrate climate change with asset management into the capital planning process for the City's water infrastructure.

1.1 Background

In 2010, a PIEVC Engineering Protocol for Climate Change Infrastructure Vulnerability Assessment was completed for the City of Castlegar's stormwater infrastructure. The intent of this PIEVC Protocol was to improve the community's understanding of the context for developing local climate change adaptation strategies. To date, the results of this assessment have not been incorporated in any City plan. The City of Castlegar recently received funding under the Strategic Priorities Fund for the development of an Asset Management and Climate Change Prioritization Framework that incorporates the PIEVC results for the City's linear infrastructure assets.

The primary outcomes from this assignment are:

- To establish a good understanding of the existing water distribution system by creating a reliable and accurate hydraulic model;
- To create a prioritized list of renewal (condition), capacity (growth) and regulatory (compliance) projects that embraces a triple bottom line approach and addresses all legislation/regulations, aging infrastructure and future growth (asset management plan);
- Conduct a climate change vulnerability assessment and create a scenario where these results are integrated with the asset management plan;

- Identify the funding requirements needed to meet the City's risk and service level requirements for infrastructure investment on an average annual basis,
- Utilize results to inform an integrated capital plan for roads, water, drainage and waste water; and
- To provide sufficient knowledge transfer to allow City staff to adopt and utilize the decision-making process for capital planning and infrastructure investment decision-making.

In parallel to this report, the City received funding to complete a Water Optimization Study that has the intended outcome of recommending upgrades and improvements to the water system to improve operations and optimize the amount of finished storage, pumping and number of pressure zones. The hydraulic modelling completed as part of this study for the risk assessment was completed in conjunction with the Optimization Study. The results of the hydraulic modelling in this report will refer to the Water Optimization Study.

The development of the Integrated Infrastructure Capital Plan (IICP) which combines the results of the water, sanitary, drainage and roads risk assessments will need to also consider the results of the Water Optimization Study.

1.2 Technical Memoranda

Four (4) technical memoranda were completed throughout this study to inform the overall strategy. Each section of the master plan is derived from previous analyses discussed in these memoranda. For readability, only summary information from each technical memorandum is provided in this report where required to support the strategy. However, for convenience a reference note is provided in key sections for the location of the related technical memorandum to allow the reader access to more information, if desired. Furthermore, some key findings from the technical memoranda are also included in order to support conclusions. **Table 1.1** below lists the technical memoranda; they are located within **Appendix A.**

Table 1.1 - List of Technical Memoranda

	Description
1	Design Criteria and Analysis
2	Hydraulic Modelling Results
3	Water Capacity Risk Assessment Methodology
4	Water Condition Risk Assessment Methodology

1.3 Infrastructure Hierarchy and Governance

Levels of service and policy, asset management, master planning, capital planning, and annual programs are all related; however, they should be evaluated and implemented separately for clarity and maximum effect. The infrastructure hierarchy is illustrated below:

- Includes all assets
- High level direction built on layers of detail
- Directed by Strategic Plans and Community Sustainability Plans
- Considers sustainable finance and achievable levels of service

- Planning to achieve a reliable level of service for current & future scenarios
- Focus on one asset, often in a defined area
- Analyze growth and demand trends
- Develop priorities and site specific projects

- Setting annual and 5-year budgets
- Selecting capital projects from Master Plans
- Confirm schedule (date) for capital project completion
- Annual operation and maintenance plans

Using this hierarchy for infrastructure planning, it is clear that establishing service levels and risk for the City's water utility are a priority in determining where to invest the City's limited infrastructure renewal budget.

1.4 Guiding Approach

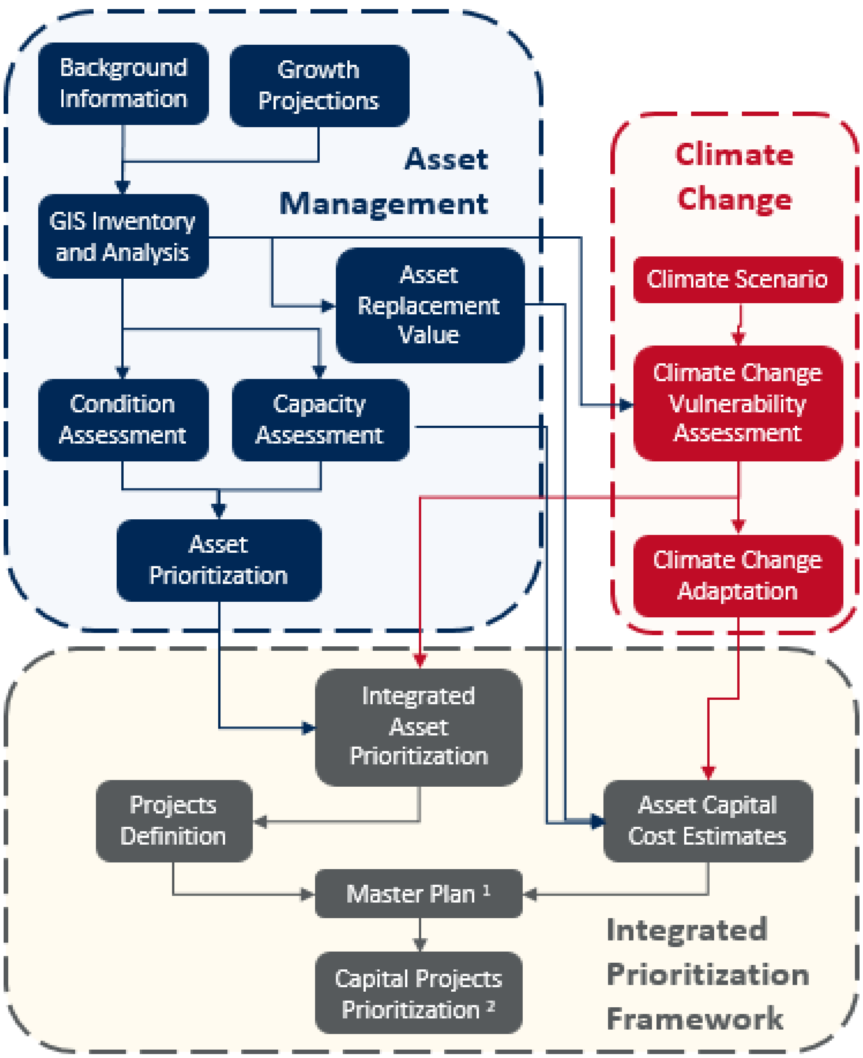
The approach to developing this plan was one that is holistic in nature. Master utility planning is currently undergoing a significant evolution as communities move from focusing solely on hydraulic servicing capacities and taking the perspective that "bigger is better", towards a more holistic and integrated risk-based approach that considers economic, social, environmental and climate change factors.

This approach looks to not only service future growth but to also help shape what future growth looks like as to capitalize on existing infrastructure capacity. Furthermore, this plan was developed in a collaborative fashion with City staff, building capacity within staff to fully understand the methodology utilized to develop the model and master plan; this is sure to support effective implementation of this plan over the long term.

Typically, identification of capital upgrades is completed based on an assessment of condition and/or capacity; however, the approach that guided this master plan includes *prioritization* of capital upgrades based on condition *and* capacity *and* risk with an additional scenario where changing climate conditions are considered.

Determining the list of capital priorities in Castlegar followed a scenario-based assessment of levels of service, which required two key analyses: network hydraulic modeling and a risk assessment with and without climate change. These analyses are summarized in **Section 3.0**.

The figure below illustrates the methodology and integration of climate change into the asset management planning process.



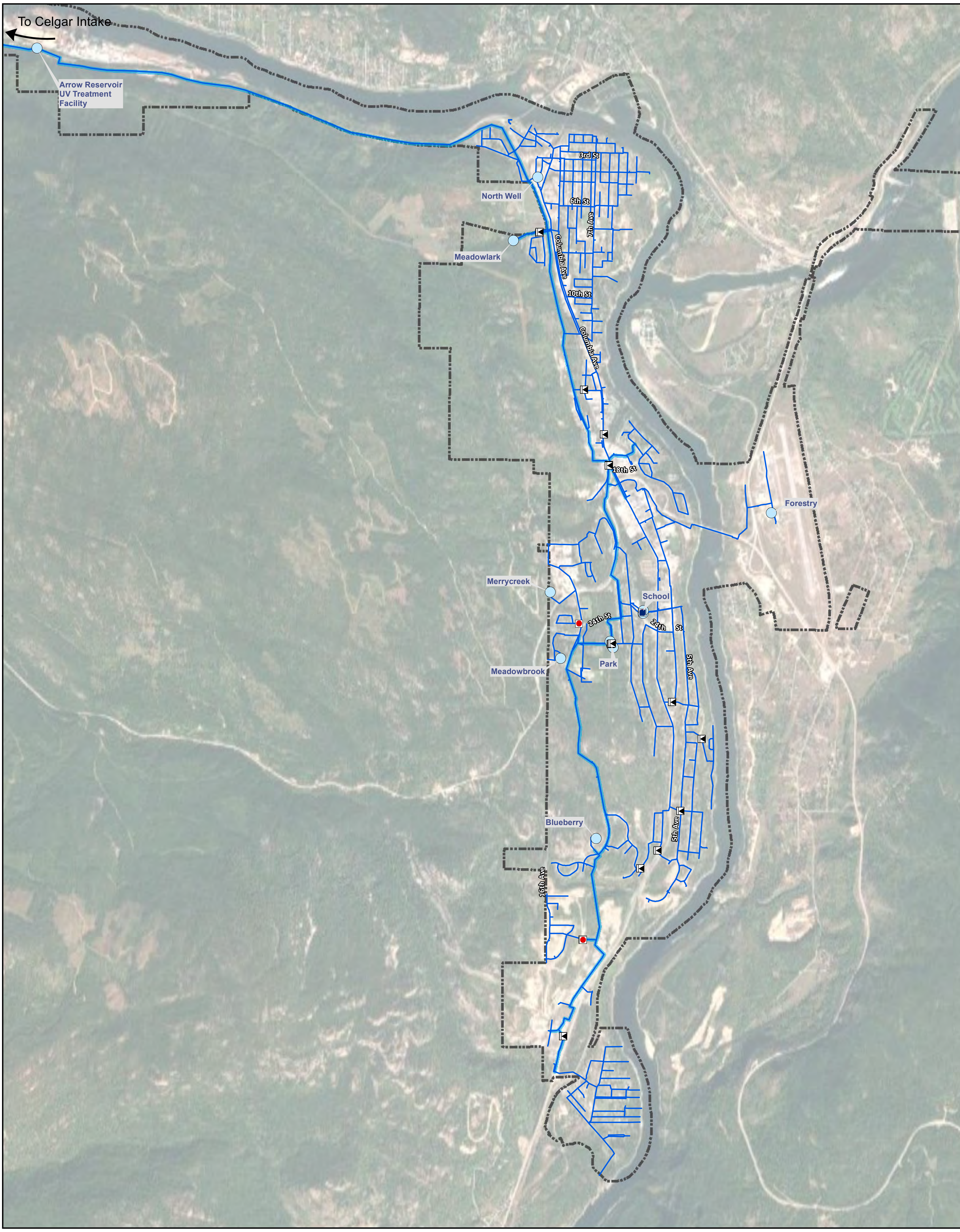
2.0 COMMUNITY CONTEXT

The City's vision for the community is to create a resilient, financially sustainable and healthy community through sound fiscal management, smart growth development, and wise asset reinvestment. The goal of this vision has been incorporated into this plan.

2.1 Current Water Infrastructure

The City's source water derives from the Arrow Lake; a source of historically high water quality and abundant supply. A supplementary groundwater source is available in the City core area, known as the North Well. It is used as a backup source for emergencies. A 1350 mm diameter watermain from the Arrow Lake intake delivers water to the City's Ultra-Violet (UV) treatment facility. A tee in the line delivers untreated water to the Zellstoff-Celgar pulp mill, with the remainder going to the City's treatment facility.

The existing water system is illustrated on **Figure A.** The City's water distribution system is made up of approximately 100 km of pipe, 5 pump stations, 13 PRV's and 8 reservoirs which distribute the treated water to the residents of Castlegar.



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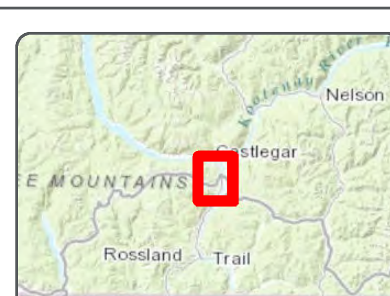
City of Castlegar

Integrated Infrastructure Capital Plan (IICP)

Existing Water System

Legend

- Altitude Valve
- Pressure Reducing Valve
- Pump
- Network Structure
- Water Main
- Supply / Trunk Mains



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Coordinate System: NAD 1983 UTM Zone 11N

Scale: 1:35,000

Data Sources:

Data provided by -
City of Castlegar
Urban Systems

Project #:	0841.0099.01
Author:	BP
Checked:	SS
Status:	~ DRAFT ~
Revision:	A
Date:	2017 / 10 / 5

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FIGURE A

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3.0 SYSTEM PERFORMANCE

This section presents summary results of the hydraulic analyses for an existing conditions scenario and the future conditions scenario.

3.1 Hydraulic Modelling Summary

The latest edition of the MMCD design guidelines provides the basis for the design criteria utilized in the hydraulic model analysis. The design criteria are outlined in the Water System Technical Memorandum #1.

EXISTING CONDITIONS MODEL

The model was calibrated for accuracy and completeness using flow records from the City. The previous model of the City's water system was based on old information and was using an outdated software model. Consequently, a new model was built from scratch in PCSWMM, based on the latest GIS information available for the City. This style of model allows for easy integration with the City's GIS data, using the Asset IDs as linkages between the two platforms.

For calibration purposes, the City provided flushing data from 2017 for the northern Castlegar water distribution system. As the exact flushing sequences and valving were not available, only the static pressure readings recorded at the hydrants were used for calibration. The City's water model was calibrated by adjusting pipe roughness coefficients, facility operations (PRV set-points, pump on/off, etc.), and network connectivity to ensure a good match with the City's static pressure readings provided for twenty-five locations. The calibrated roughnesses were applied throughout the system.

Existing Maximum Day Demands (MDD) based on the MMCD design criteria were added to the model, Technical Memorandum #1 lists the MDD applied to each node.

FUTURE CONDITIONS MODEL

Future Maximum Day Demands (MDD) were added to the model to create the future conditions model (2037). Technical Memorandum #1 lists the MDD applied to each node.

The growth projections and associated demands were overlaid on the water system network and each new demand was assigned to a node in the water model. After importation of all the infrastructure elements, each element was assigned a zone label to correspond with a pressure zone.

MODELLING RESULTS

Both the existing and future conditions models were analyzed under Peak Hour Demand (PHD) and Maximum Day Demand plus Fire Flow conditions to determine available fire flow and system pressures. The analysis identified areas of high and low pressure as well as areas with fire flow deficiencies.

Tech Memorandum #2 outlines those pipes that required upgrading to meet the design criteria requirements for fire flow, pressure and system demands. The results also identified 11 new pipe segments (1270m) required to improve fire protection and pressure, based on MMCD standards. These pipes can be seen on **Figures C** and **D**. The analysis identified several recommendations for optimizing finished storage, valving changes, hydrant lateral changes, and adjustments to the settings for the pressure reducing valves (PRV's).

An EPS (extended period simulation) model was not conducted as it was beyond the scope of this assignment. It is recommended that the City conduct further strategy work on chlorine management. This can be done through one or more of the following techniques:

- Information gathering (from operators and/or basic chlorine decay calculations, and a review of the last 5-10 years of water quality analysis)
- An EPS model
- Continuation and completion of the flushing plan

4.0 RISK ASSESSMENT AND CLIMATE CHANGE

The previous section detailed how pipe performance was assessed on flows in the existing conditions scenario and the future conditions scenario in an asset management capacity context.

The risk assessment typically tells us how to prioritize these capacity-related upgrades so that pipes that present the highest risk can be upgraded first. In addition, assessments were completed on the facilities to identify expected remaining life, compliance with regulations and identified the costs and timing of recommended upgrades.

In order to consider climate change, these two scenarios were analyzed again using the climate parameters discussed below in **Section 4.7.**

ASSET MANAGEMENT PIPE ASSESSMENT

4.1 Methodology

The risk assessment was completed with a focus on the two primary drivers of pipe failure: condition and capacity. For each of these drivers, the risk assessment was broken down into three parts:

- *Likelihood* of failure (i.e., probability)
- *Consequence* of failure (i.e., severity of environmental, social, and economic impacts)
- Assignment of total *risk scores* (after modification, if any, and combination of scores)

Once risk scores were assigned, *prioritization of asset replacement* could be completed according to which assets had the highest combined risk scores. Prioritized projects are described in **Section 4.8.**

Definitions of each of these parts and assignment of risk scores for use in the risk assessment are provided below.

4.2 Risk Due to Pipe Capacity

Likelihood of Failure: The likelihood of pipe failure due to capacity was assessed by analyzing the peak hour pressure and the available fire flow of the pipe under normal operating conditions. How criteria specifically correlate to likelihood of failure is described in **Technical Memorandum #3**.

Consequence of Failure: The consequence of failure is a function of the land use type and associated population. For example, the consequence of failure to single-family residential buildings is lower than that of multi-story apartment complexes or industrial, commercial, or institutional buildings. Risk scores assigned range from 1 to 5, with 1 indicating an insignificant consequence of failure and 5 indicating a severe consequence of failure. How criteria specifically correlate to likelihood of failure is described in **Technical Memorandum #3**.

4.3 Risk Due to Pipe Condition

Likelihood of Failure: The likelihood of condition-based failure is driven by actual condition information, including visual inspection, past breaks/leaks information, and materials testing. For non-pipe assets and if pipe condition data is not available, the asset was assigned a risk score based on its age. Asset age directly relates to the principles of asset management and tangible capital asset inventories. To exemplify the sensitivity of pipe age to the overall risk score, we provided two additional risk scenarios – one extended service lives by 25% and the other by 50%. These scenarios allow the City to easily observe the financial impact of choosing to take on more or less risk related to timing of asset replacement. Risk scores range from 1 to 5, with 1 indicating a low likelihood of failure and 5 indicating a high likelihood of failure. How criteria specifically correlate to likelihood of failure is described in **Technical Memorandum #4**.

Consequence of Failure: The consequence of failure is driven by two key factors: the cost to restore service and cover third-party liability (potential financial consequence) and the actual location of the infrastructure (potential traffic disruption consequence). How criteria specifically correlate to likelihood of failure is described in **Technical Memorandum #4.**

For this study we also considered a primary driver of failure consequence to be whether a pipe is located within a road and if so, what the associated road classification is, as this indicates the level of traffic disruption that may occur due to failure. The cost to repair a watermain break is closely linked to the type of road (and associated volume) that might be damaged as a result; for example, a failure within an arterial road presents greater traffic control and road reconstruction requirements than a failure within a local road. The City's GIS data set was used to analyze if a pipe is physically located within a road and if so, what the road classification is.

4.4 Modification of Consequence Risk Scores

Due to their larger size or nearby surroundings, some water mains present an increased level of consequence of failure. For this risk assessment, consequence risk scores were increased by one (with no score greater than five) for pipes that met certain requirements regarding:

- **Pipe diameter / primary transmission lines**: higher consequences for pipes carrying larger flows
- **Proximity to ICI land use**: greater disruption and higher costs for repairs and upgrades if servicing Industrial, Commercial, or Institutional land use
- **Proximity to an environmentally sensitive area:** higher environmental consequences if adjacent to, or crossing, a sensitive watercourse, within an OCP designated ESA, or within a steep slope area

4.5 Combining Risk Scores

The combined risk score incorporates the likelihood of failure score and consequence of failure score into a single score ranging from 1 to 5, with 1 indicating a low risk and 5 indicating a high risk. In cases where break history or manual investigation proves that a water main has already failed, the combined risk score will be automatically set to 5.

By combining risk scores, the social (land use), environmental (proximity to watercourses) and economic (cost to restore service) impacts of pipe failure are considered. This triple-bottom-line methodology is the basis of the infrastructure plan for the City.

To illustrate this methodology and for convenient reference, a pullout schematic **(Figure B)** is included on the following page. It shows how the methodology is applied to one example pipe; once familiar with the definitions, the schematic should be an effective tool for the City to use for visualizing the process.

CASTLEGAR ASSET RISK EVALUATION PROCESS - a combination of condition & capacity; consequence & likelihood

WATER

Priority	Project Trigger
1	((Existing Capacity >= 3 or Future Capacity >= 4) and Existing Condition >= 4) OR ((Existing Capacity >= 3 or Future Capacity >= 4) and Future Condition >= 4)
2	Condition or Capacity Combined Risk Score >= 4
3	Condition or Capacity Likelihood of Failure >= 4

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Figure B

4.6 Facility Assessments

The City operates a community water system that primarily sources water from the Arrow Lake. The system includes a UV treatment system, series of pump stations, pressure reducing stations, and reservoirs to deliver potable water throughout the City. Facilities

SOURCE WATER AND TREATMENT

The City's source water is drawn from behind the Hugh Keenlyside dam with an intake and primary pump system shared with Zellstoff-Celgar. Water levels at the dam are controlled by BC Hydro under the provisions of the Columbia River Treaty. A supplementary groundwater source is available in the City core area, known as the North Well. It is used as a backup source for emergencies.

The primary pump station has six high-lift pumps connected to a common header. One pump is dedicated to the City of Castlegar. However, all pumps are connected to a 1350 mm diameter watermain that leads from the pump station to the treatment facility. A tee in the line delivers untreated water to the Zellstoff-Celgar pulp mill, with the remainder going to the City's treatment facility. A further tee downstream of the treatment facility delivers treated water for domestic purposes to Zellstoff-Celgar. Replacement of the pump at the Celgar pump station is anticipated in or around the year 2027 at an estimated cost of $2.0 million.

The source water has had consistently low turbidity and meets the Interior Health criteria for filtration deferral. The treatment facility currently utilizes Ultra-Violet irradiation for 3-log inactivation of Giardia and Cryptosporidium and chlorination for secondary disinfection for bacteria and virus, and to maintain a system residual. The UV irradiation facilities were installed in 2011.

The UV reactors are from Trojan Industries Ltd. and consist of three medium pressure lamp reactors located in three parallel branches. Each reactor is rated at 150 L/s; two reactors are to provide 300 L/s, while the third reactor provides a 50% standby function. The UV dosage at the 150 L/s rate will achieve 3-log Giardia/Crypto inactivation with a water UVT (UV Transmittance) of 88%. If the UVT drops below 88%, the plant PLC will automatically restrict the flow rate in order to maintain the 3-log inactivation.

The flow control valves are messaged by both the water level in the Meadowlark reservoir and the water UVT sensor. It is noted that the flow restriction due to low UVT periodically impairs the system's ability to fill the reservoir in a timely fashion. Water exiting the UV reactors is dosed by means of a gas chlorination system before continuing to the Meadowlark Reservoir. The chlorine dosage rate is paced by the flowmeter signal.

The Zellstoff-Celgar raw water consumption rate is reported to have some effect on the pressure arriving at the treatment centre, but this has not been quantified.

The project completed in 2011 includes the UV reactor installation, upgrades to the chlorine injection system, improvements to the building and Electrical/PLC upgrades. No further work is anticipated within the 20-year time horizon (2037).

MEADOWLARK RESERVOIR AND PUMP STATION

The Meadowlark reservoir is the City's central distribution point and is located approximately 6 kilometers downstream of the treatment facility. The Celgar potable water service is located 730 m downstream of the treatment facility.

The Meadowlark reservoir is a 22m diameter concrete tank of 2.25 Megaliter (ML) liquid volume.

The top water level is 497 m. The treatment facility is at approximate elevation 452 with a typical exiting pressure of 90 psi when two trains are operating. The pressure shortfall to the Meadowlark reservoir is made up by a series of booster pumps (Stage 1) located at the Meadowlark pump station. The pumps were installed in 1980. These pumps are set to turn on sequentially in accordance with the level in the Meadowlark reservoir. Modulating valves control the flow rate into the reservoir.

A second set of booster pumps (Stage 2) is located in the Meadowlark pump station which boosts system pressure to the Park reservoir. They can draw from the reservoir or from the header. The Park reservoir level stops and starts the Stage 2 pumps.

The Meadowlark reservoir has a design life beyond the 2037 horizon. The replacement of the Meadowlark pump system is expected in or around the year 2022, at an estimated cost of approximately $1.4 million.

WATER BOOSTER STATIONS

The detailed field assessments of the water booster pump stations are provided on the facility data sheets (**Appendix B**) and include the following facilities and estimated costs of component replacements within the 20-year horizon. A summary of the anticipated replacement costs follows:

Table 4.1 – Anticipated Water Booster Replacement Costs

Identifier	Name	Estimated Cost	Estimated Timing
WPMP0001	Celgar-P1	$2,040,000	2027
WPMP0008-90025-26	PMP-Grandview-1-2-3-4	$1,114,000	2039
WPMP0010	PMP-Highland	$259,000	2039
WPMP0011-19	PMP-ML01-ML10	$2,710,000	2022
WPMP0020-23	PMP-PRK 11-14	$1,390,000	2029
WPMP0024	Airport Pump Station	$49,000	2023

Pressure Reducing Stations (PRV)

There are 11 pressure reducing valves or stations; the assessments are provided on the facility data sheets in **Appendix B**. A summary of the anticipated replacement costs within the 20-year time horizon follows:

Table 4.2 – Anticipated PRV Replacement Costs

PRV Identifier	Name	Estimated Cost	Estimated Timing
wCV0053	Blueberry PRV-9031 (a)	$210,000.00	2026
wCV0047	Southridge PRV	$210,000.00	2017
wCV0048	33rd St PRV-9003	$250,000.00	2017
wCV0049	27th St PRV-9005	$210,000.00	2026
wCV0050	Fireside (8th Ave) PRV-9007	$210,000.00	2021
wCV0051	17th St PRV-9009	$220,000.00	2042
wCV0052	15th St PRV-9019	$220,000.00	2036
wCV0054	Blueberry PRV-9031 (b)	$210,000.00	2026
wCV0055	2nd Ave PRV-9033	$260,000.00	2020
wCV0056	Twin Rivers PRV08	$240,000.00	2038
wCV0057	8th Ave PRV-9036	$200,000.00	2020

Additional recommendations from the hydraulic modelling for the Optimization Study have identified the need for six additional PRV's (these costs are not included in the above table).

Reservoirs

There are 8 reservoirs in addition to the Meadowlark reservoir and these are assessed on the facility data sheets in **Appendix B**. A summary of the upgrade costs within the 20-year time horizon follows:

Table 4.3 – Anticipated Reservoir Upgrade Costs

Reservoir Identifier	Name	Estimated Cost	Estimated Timing (non-structural)
WRES0002	Meadowbrook Res	$230,000	2026
WRES0003	Meadowlark Res	$101,200	2018
WRES0004	Merrycreek Res	$530,000	2025
WRES0007	Park 3 Res	$1,550,000	2045
WRES0006	Park 2 Res	$660,000	2025
WRES0005	Park 1 Res	$0	
WRES0011	Airport Res	$100,000	2025
WRES0009	School 2 Res	$640,000	2025
WRES0008	School 1 Res	$640,000	2025
WRES0001	Blueberry Res	$970,000	2025

Additional recommendations from the hydraulic modelling for the Optimization Study have identified the need for 3.5ML of additional finished storage in the Northern Upper Bench area (these costs are not included in the above table).

4.7 Integrating Climate Change

Two primary factors are considered within the context of asset management – condition, which is an indication of service life; and capacity, which can trigger replacement or upgrades before service life has been reached. Therefore, for the purposes of asset management, only climate changes that impact condition or capacity of an asset have been considered. While it's true that an asset can be affected by catastrophic events such as floods, landslides, stream bank erosion, and/or forest fires – all potentially impacted by climate change – the occurrence of such events is typically not a factor in determining when to replace or upgrade a capital asset. The exception is for drainage assets, which are designed to protect most other infrastructure from surface runoff, and which can be impacted by climate change.

Risk is defined as the product of likelihood and consequence of failure. Since the consequence of failure has already been determined as part of the asset management assessments, the climate change risk assessment focuses on developing the likelihood that a future change in climate variables will result in a material change in the processes that cause reduced capacity and/or reduced service life for each infrastructure asset. This approach has been taken since it is often the combination of climate variables, rather than a single climate variable, that contributes to the impact that each process has on an asset's capacity and/or longevity.

In keeping with the likelihood scoring method outlined for the asset management risk assessment (a 1-5 scale), weighted likelihood scores were also developed for the climate change risk assessment. This was done using the following methodology:

1. Identify processes that impact an asset's capacity and/or service life. These are called "failure processes" for the purposes of this assessment since, over time, these contribute to an asset's ultimate failure.
2. Determine the climate variables that impact each identified process.
3. Obtain the baseline value for each climate variable.
4. Obtain the projected values (or projected change in values) for each climate variable for applicable time periods. In this case, the time periods are:
    a. Baseline (1961-1990)
    b. 2020s (2010-2039)
    c. 2050s (2040-2069)
5. Assign a likelihood score to each climate variable change. Scoring is an integer from 1 to 5, with 1 being very unlikely and 5 being very likely.
6. Assign "climate contribution scores" to reflect the contribution that the projected change in each climate variable associated with each process has on that process. A scoring range of -2 to +2 was used, with the allowance of decimal fractions within that range. A score of -2 indicates that the projected change in the subject climate parameter significantly impacts the process but reduces or perhaps even reverses the reduction in capacity and/or service life. A score of +2 also significantly impacts the process but increases the reduction in capacity and/or service life. Note that this process relies heavily on engineering judgement based on experience.
7. Calculate the weighted likelihood for each failure process using the climate variable likelihood scores and weighting them by the absolute value of the corresponding contribution scores.

Note that the projected climate values are based on the PCIC ensemble of SRES AR4 - A1 runs. These represent the "business as usual" approach which means increasing concentrations of greenhouse gases at current rates.

Appendix C provides a more detailed explanation of the above methodology.

WATER DISTRIBUTION RESPONSE TO CLIMATE CHANGE

Most resources that address climate change impacts to potable water systems focus on water supply (quantity), flood damage, and water quality. However, from an asset management perspective, we are more interested in mechanisms that impact condition and/or capacity over the service life of the asset.

Based on this objective, the following potential responses to climate change have been identified:

- Pipe degradation due to increased soil acidity. This mostly affects the service life of ferrous metal pipes (cast iron, ductile iron, and steel). Soil acidification most commonly occurs by mineral leaching due to water infiltration. This process occurs more rapidly in warm, humid climates, and is dependent on soil type. Soils with high clay content and organic materials are less susceptible to acidification, while sandy soils with little organic content are more susceptible. Use of nitrogen and sulfur fertilizers can also lower pH (increase acidity) over time (NRCS).
- Pipe breakage due to soil movement caused by increased or decreased soil moisture (Wols et al). The potential for breakage by this process is dependent on soil type and pipe material. Asbestos cement pipe in clay or peat soils are most at risk under these conditions, while PVC in sandy soils are least at risk.
- Roughness growth due to water chemistry changes (steel and ductile iron pipes only). This response primarily impacts capacity, but to a lesser degree, also impacts condition and ultimately, service life. This is applicable to only the ferrous metal pipes in the system – ductile iron, steel, and galvanized iron pipe. The primary process for this response is increased water acidity. Freshwater lakes are subject to natural acidification over time due to mineral leaching from soils. Human causes (increased CO2, acid rain, pollutants) have also been shown to accelerate the acidification process. Research indicates that watershed characteristics have the largest impact on freshwater lake pH.

For context, the following table summarizes the length and percent of total system length of pipes by material class.

Table 4.4 - Pipes by Material Class

Material Class	Length (km)	% of System
Cement (AC, CONC)	61.7	56.6%
Copper (CUP)	0.3	0.3%
Ferrous (DIP, ST, GIP, CMP)	18.0	16.5%
Plastic (PVC, HDPE)	23.1	21.1%
Unknown	6.0	5.5%
Total	**109.1**	**100.0%**

Climate Change Risk Assessment

The identified failure processes can affect both capacity and condition of the potable water distribution system. The following climate variables were selected for the water distribution climate change risk assessment since each can impact one or more of the failure processes.

Climate Variable	***Rational***
Annual Precipitation	Precipitation contributes to the overall volume of water in the soil matrix, and contributes to water infiltration through the soil.
Average Annual Temperature	The processes that drive soil chemistry change function over a period of years. Average annual temperature will affect chemical reaction rates and soil moisture of this longer time period.
Soil Moisture – Average Annual	Average annual soil moisture contributes to potential soil acidification.
Soil Moisture – Annual Fluctuation	Annual soil moisture fluctuation contributes to potential soil movement.

The following sub-sections summarize the assessment of each failure process, and the rationale for the values summarized in Table 4.5.

Table 4.5 - Climate Change Risk Assessment (Weighted Likelihoods)

		Climate Parameters			
		Temperature - Average Annual	Precipitation - Average Annual	Soil Moisture - Average Annual	Soil Moisture Content - Annual Fluctuation
Baseline		1.8	898	568	94.1
Baseline Units		°C	mm	mm	mm
Projected Change (2050s) in Baseline Units		4.1	916	568.2	109.6
Projected Change (2050s) from Baseline (%)		127%	2%	0.1%	16.5%
Climate Variable Change Likelihood		5	5	3	3
Failure Process	**Weighted Likelihood**	**Climate Contribution to Failure Mechanism (-2 to +2)**			
Soil acidification	0.8	0.5	0.1		
Soil movement due to soil moisture change	0.8			0.1	1.0
Water supply acidification	0.4	0.2	0.1		

PIPE DEGRADATION DUE TO ACIDIC SOIL

The likelihood that ferrous pipes will degrade from increased soil acidification is represented by a weighted likelihood score of +0.8, which means that the likelihood is very low. Even though there is a high likelihood that the average annual temperature is projected to increase significantly, and that average annual precipitation has a high likelihood of increasing slightly, the overall weighted likelihood is still low because climate contributes only marginally to the failure process.

SOIL-MOVEMENT INDUCED PIPE BREAKAGE

The weighted likelihood score that pipes would break due to this mechanism was determined to be +0.8. This indicates a very low probability that pipe breakage due to soil movement will increase with climate change. It also reflects that most of the soils in Castlegar are well-drained sandy soils. Only cement-based pipes (asbestos-cement and concrete) were assessed for this risk.

INCREASED PIPE ROUGHNESS DUE TO SUPPLY WATER ACIDIFICATION

The weighted likelihood score that capacity will be reduced due to this process because of climate change was determined to be +0.4, which represents a very low likelihood. Natural acidification of a freshwater lake is typically a very slow process, and given the large volume of water in the Arrow Lakes system, will likely take a very long time to occur. The watershed also has few sources of pollutants that could contribute to acidification, and acid rain is not anticipated to be an issue.

ASSET MANAGEMENT RISK ASSESSMENT – CLIMATE CHANGE SCENARIO

The weighted likelihoods of the identified failure process contributing to decreased capacity and/or service life were evaluated to develop an asset management risk assessment scenario that includes climate change as outlined below:

Table 4.6 - Risk Assessment Methodology

Trigger	Modeled Parameters	Assets Impacted
Soil acidification caused by changes in soil moisture	Decrease service life by **3%**	Ferrous Water pressure mains
Weakening of pipes caused by increased soil moisture	Decrease service life by **3%**	Concrete Water pressure mains
Increased scouring of pipe due to higher sediment load from Inflow/Infiltration	Decrease in service life: • PVC/HDPE **3%** • Steel **5%** • Concrete **7%** • CMP **15%**	All Mains
High vulnerability risk assets as identified through PIEVC	Risk scores for 2037 scenario set to **5** (max)	Storm mains as identified through PIEVC as well as Water and water mains in immediate proximity to vulnerable storm infrastructure

4.8 Results and Prioritization

PRIORITIZATION METHODOLOGY

The risk analysis described above was applied to each pipe asset in the City's water system. The result was a database of over 1,200 assets with their own unique classification, including over 532 assets with a combined risk score of 4 or 5 for either Condition or Capacity, or both.

In order to prioritize the inventory of risks into a strategic list of assets, in sequence of importance, a three-step merging process was completed to yield a hierarchy of upgrades based on risk scores. This hierarchy relates directly to levels of service. This section describes the methodology; Section 4.6.2 translates level of service into tangible capital projects and associated costs.

METHODOLOGY

Step 1: **Level of Service 1:** Apply triple-bottom-line analyses to determine risk scores based on considerations for social (population/land use), economic (cost implications) and environment (water resources). This step combines multiple facets of risk, including conditions *and* capacity, likelihood *and* consequence of failure, and existing *and* future scenarios. The projects triggered here are considered **Priority 1 (highest priority)** because they are classified comprehensively.

Step 2: **Level of Service 2:** Determine which assets had a combined score of 4 or greater for *either* condition or capacity (still based on both likelihood and consequence of failure). Although this step does still incorporate the triple-bottom-line analyses of the previous step, it triggers projects that demonstrate sufficient risk for either condition *or* capacity. These projects are considered **Priority 2 (moderate priority)**. It is possible that a Priority 2 project could be prioritized above a Priority 1 project if it is deemed to have sufficient impact on the system due to capacity *or* condition issues. For example, a pipe with plenty of remaining life may have capacity issues due to recent development. Alternatively, a pipe may have excess capacity, but be experiencing frequent breaks.

Step 3: **Level of Service 3:** Determine which assets scored a 4 or greater under *likelihood of failure* for *either* condition or capacity. Therefore, projects arising from Step 3 are triggered by their probability of failure, but not by the impact of that failure. These projects are considered **Priority 3 (low priority)**.

This methodology results in a three-tiered prioritization of projects, which was used to create a list of capital priorities.

CAPITAL PRIORITIZATION: RESULTS – ASSET MANAGEMENT SCENARIO

The results of the prioritization process are categorized by priority rank (1, 2, or 3), and by priority trigger (condition or capacity). A list of capital upgrades under each category was compiled from the outputs of the risk assessment. The scope of upgrade depends on the primary trigger: for example, if a pipe was triggered for an upgrade due to capacity, the pipe will be replaced with one of greater diameter. Alternatively, if a pipe was triggered for an upgrade due to condition (with a capacity score of less than 3) the pipe will be replaced by one of equivalent diameter.

It should be noted that Priority 3 projects only relate to the *likelihood of failure for capacity* projects, whereas Priority 2 projects include those triggered by both *likelihood of failure* and *consequence of failure*.

The results of the prioritization of pipe assets are summarized in **Table 4.7.**

Table 4.7 -Capital Prioritization Results of Pipe Assets

Prioritization - Asset Management Scenario									
Asset Category	**# of Pipes**	**Length of Pipe (km)**	**0-5 Year**	**0-5 Year Replacement Cost**	**5-10 Year**	**5-10 Year Replacement Cost**	**10-20 Year**	**10-20 Year Replacement Cost**	**Total Replacement Cost**
Priority 1	261	21.1	76	$ 2,240,223	14	$ 320,123	171	$ 5,210,950	**$ 7,771,295**
Priority 2									
Condition	133	12.0	16	$ 534,043	0	$ -	117	$ 3,774,694	**$ 4,308,737**
Capacity	101	7.4	48	$ 1,502,186	41	$ 869,806	12	$ 420,733	**$ 2,792,725**
Priority 3									
Condition	3	0.1	0	$ -	0	$ -	3	$ 37,362	$ 37,362
Capacity	12	1.3	0	$ -	0	$ -	11	$ 374,820	$ 374,820
New Pipes	11	1.3	11	$ 542,573	-	-	-	-	**$ 542,573**
Total	**521**	**43.2**	**151**	**$ 4,819,025**	**55**	**$ 1,189,929**	**314**	**$ 9,818,558**	**$ 15,827,512**

URBAN systems

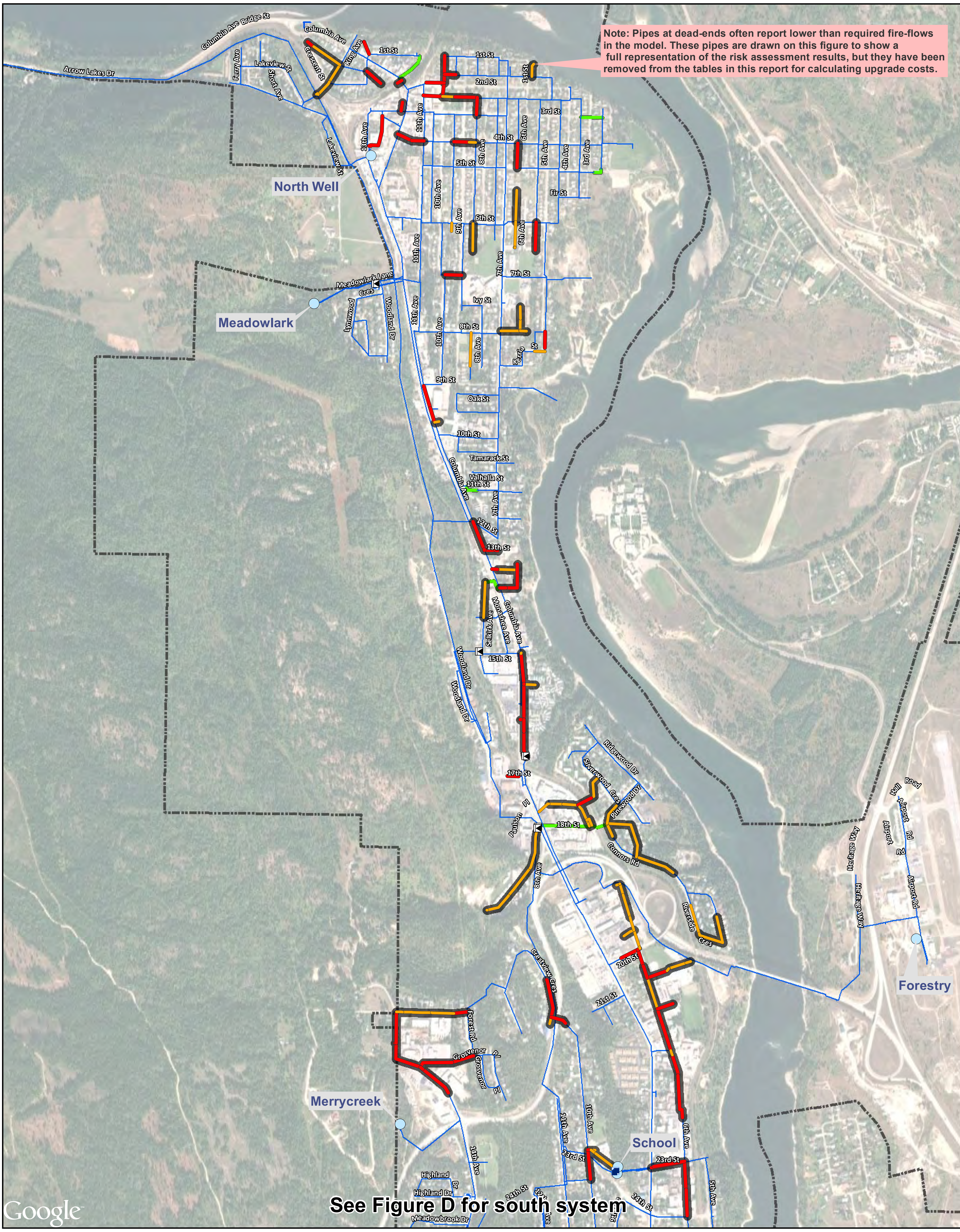
The average annual cost of for critical linear assets is **$791,000**. This amount includes:

- Priority 1 pipes,
- Priority 2 pipes,
- Priority 3 pipes, and
- New pipes required for improving fire flow and pressure.

It should be noted that nearly 30% of the annual cost is related to priority 2 condition triggered pipes. There are opportunities for costs related to this category to be significantly reduced, for several reasons:

1. These pipes are potential candidates for trenchless rehabilitation. A separate investigation can be undertaken to determine trenchless candidates, and to calculate the cost savings that this rehabilitation method can realize.
2. Condition-only triggers are highly dependent on the assumed service life of the pipe, since destructive testing was available for only a small portion of the system. It is very likely that many of these pipes will outlive their assumed service life and last well beyond the 20-year planning horizon. When possible, staff should document the quality of any water mains that are uncovered or removed from the ground. These observations can be compared to the assumed service lives and used to inform prioritization of the condition-only triggered pipes.

Figures C and D illustrates the locations of the Priority 1 and 2 pipes.

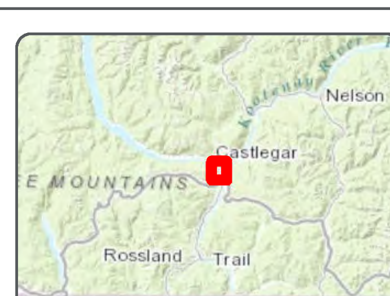


Legend

- Altitude Valve
- Pressure Reducing Valve
- Pump
- Network Structure
- Priority 1 Water Mains
- Priority 2 Water Mains
- Recommended New Watermains (0-5 years)

TIMING

- 0-5 Years (all other priorities shown are 5-10 years)



CASTLEGAR

City of Castlegar

Integrated Infrastructure Capital Plan (IICP)

Water Priority Pipes - North

The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

0 100 200 400 600

Metres

N

Coordinate System: NAD 1983 UTM Zone 11N

Scale: 1:15,000

Data Sources:

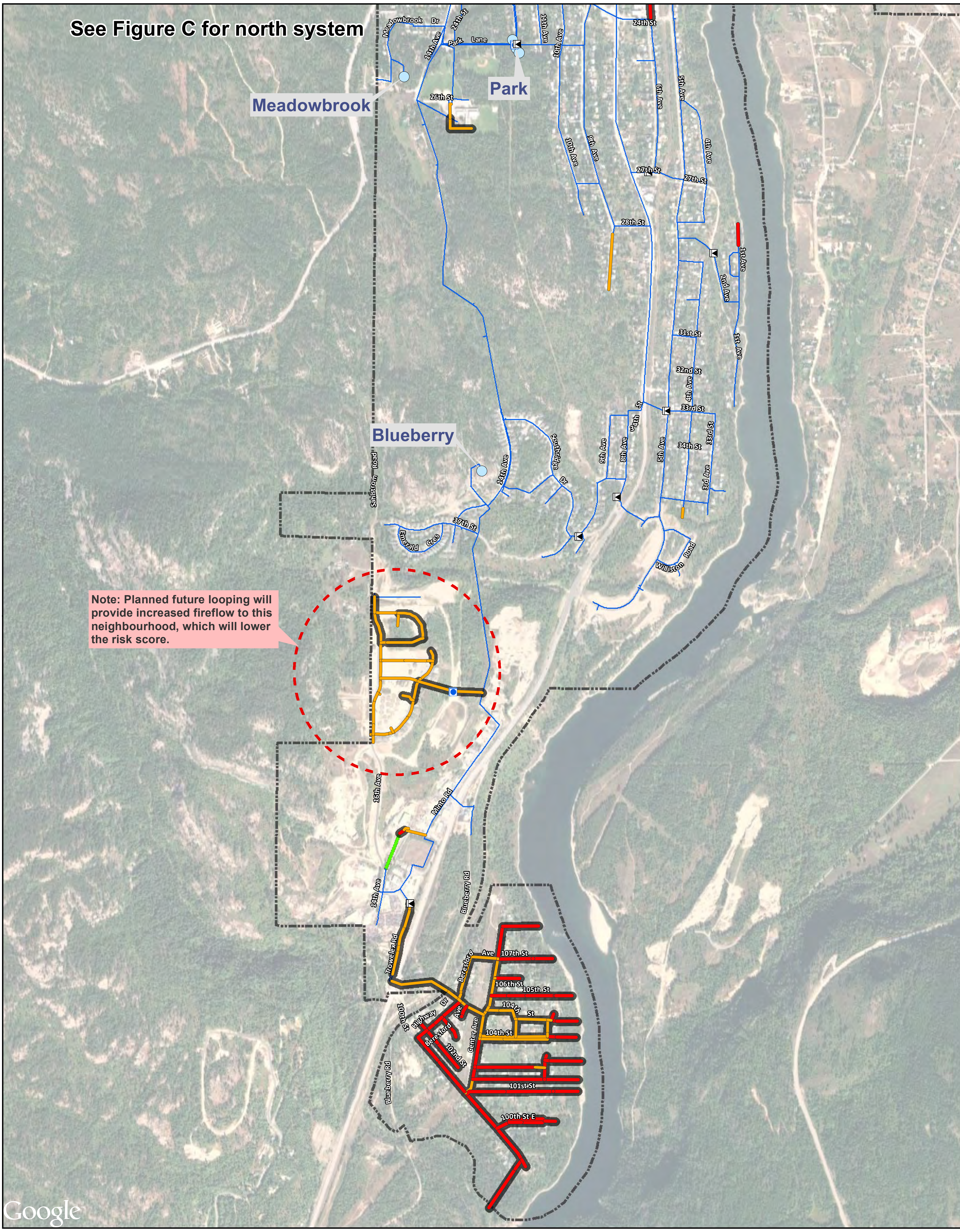
Data provided by -
City of Castlegar
Urban Systems

Project #:	0841.0099.01
Author:	BP
Checked:	SS
Status:	~ DRAFT ~
Revision:	A
Date:	2017 / 10 / 5

URBAN systems

FIGURE C

U:\Projects_KEL\0841\0099\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Figure C - Water Priority Pipes - North.mxd Last updated by bpauls on October 5, 2017 at 11:22:03 PM



Legend

- Altitude Valve
- Pressure Reducing Valve
- Pump
- Network Structure
- Priority 1 Water Mains
- Priority 2 Water Mains
- Recommended New Watermains (0-5 years)

TIMING

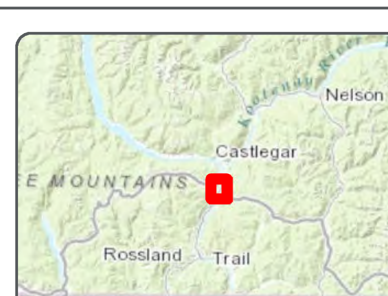
- 0-5 Years (all other priorities shown are 5-10 years)

CASTLEGAR

City of Castlegar

Integrated Infrastructure Capital Plan (IICP)

Water Priority Pipes - South



The accuracy & completeness of information shown on this drawing is not guaranteed. It will be the responsibility of the user of the information shown on this drawing to locate & establish the precise location of all existing information whether shown or not.

0 100 200 400 600
Metres

N

Coordinate System: NAD 1983 UTM Zone 11N

Scale: 1:16,000

Data Sources:
Data provided by -
City of Castlegar
Urban Systems

Project #:	0841.0099.01
Author:	BP
Checked:	SS
Status:	~ DRAFT ~
Revision:	A
Date:	2017 / 10 / 5

URBAN systems

FIGURE D

U:\Projects_KEL\0841\0099\01\D-Drafting-Design-Analysis\GIS\Projects\MXD\Current\Figure D - Water Priority Pipes - South.mxd Last updated by bpauls on October 5, 2017 at 11:34:45 PM

CAPITAL PRIORITIZATION: RESULTS – EXTENDED SERVICE LIFE SCENARIOS

As discussed in Section 4.3, two scenarios were run that extended infrastructure service lives using factors of 125% and 150%. These scenarios show how annual costs can be reduced if the City is willing to accept the risk of waiting to replace infrastructure. Some pipe materials can last well past their expected service lives depending on factors such as installation technique and soil chemistry. Other pipe materials are still relatively new (i.e. PVC), so the full extent of the service life has not been adequately tested. It is possible that these pipes could maintain good condition many years past industry expectations, saving the City the cost of early replacement.

On the flip side, some pipes fail much earlier than expected. Choosing to extend service lives may lead to increased pipe breaks or failures, making staff reactive rather than proactive. Either way, it is an informed, risk-based level of service decision that the City must make. The following two tables show the replacement costs of the 125% and 150% service life scenarios.

Table 4.8 – 125% Increased Service Life Prioritization Results of Pipe Assets

Prioritization – 125% Service Life Scenario									
Asset Category	**# of Pipes**	**Length of Pipe (km)**	**0-5 Year**	**0-5 Year Replacement Cost**	**5-10 Year**	**5-10 Year Replacement Cost**	**10-20 Year**	**10-20 Year Replacement Cost**	**Total Replacement Cost**
Priority 1	31	2.8	26	$ 690,441	0	$ -	5	$ 225,815	**$ 916,255**
Priority 2									
Condition	16	1.4	14	$ 498,635	0	$ -	2	$ 12,725	**$ 511,360**
Capacity	149	11.1	85	$ 2,690,553	50	$ 1,073,449	14	$ 437,753	**$ 4,201,755**
Priority 3									
Condition	1	0.0	0	$ -	0	$ -	1	$ 2,165	$ 2,165
Capacity	12	1.2	0	$ -	0	$ -	11	$ 360,383	$ 360,383
New Pipes	11	1.3	11	$ 542,573	-	-	-	-	**$ 542,573**
Total	**220**	**17.8**	**136**	**$ 4,422,202**	**50**	**$ 1,073,449**	**33**	**$ 1,038,840**	**$ 6,534,490**

Table 4.9 – 150% Increased Service Life Prioritization Results of Pipe Assets

Prioritization – 150% Service Life Scenario									
Asset Category	# of Pipes	Length of Pipe (km)	0-5 Year	0-5 Year Replacement Cost	5-10 Year	5-10 Year Replacement Cost	10-20 Year	10-20 Year Replacement Cost	Total Replacement Cost
Priority 1	23	2.0	23	$ 668,533	0	$ -	0	$ -	**$ 668,533**
Priority 2									
Condition	14	1.4	14	$ 498,635	0	$ -	0	$ -	**$ 498,635**
Capacity	153	11.1	88	$ 2,662,336	51	$ 1,102,870	14	$ 437,753	**$ 4,202,959**
Priority 3									
Condition	0	0.0	0	$ -	0	$ -	0	$ -	$ -
Capacity	12	1.2	0	$ -	0	$ -	11	$ 360,383	$ 360,383
New Pipes	11	1.3	11	$ 542,573	-	-	-	-	**$ 542,573**
Total	**213**	**16.9**	**136**	**$ 4,372,077**	**51**	**$ 1,102,870**	**25**	**$ 798,136**	**$ 6,273,082**

Significant differences in costs can be seen between Table 4.7 (baseline scenario) and the two extended service life scenario tables (4.8 and 4.9). There is a large group of assets that were installed in the same time period, which all come up for renewal in the next 20 years under the baseline scenario. Increasing service lives has deferred those assets past the 20-year horizon and lowered immediate costs significantly.

The difference between the 125% and 150% service life scenarios is minimal. If the City is willing to accept increased risk and chooses an extended service life scenario, the 125% scenario provides the greatest cost savings with the lowest amount of increased risk compared to the 150% scenario.

Based on the 125% scenario, the average annual cost for critical linear assets is **$327,000**, or $464,000 less than the standard service life scenario.

CAPITAL PRIORITIZATION: RESULTS – CLIMATE CHANGE SCENARIO

Using the methodology outlined in section 4.7.2 (where service lives of the existing pipes were reduced to incorporate climate change) climate change was integrated into the linear asset risk assessment and the model re-run. The baseline service life scenario was used as the input into the climate change scenario (no extension of service lives).

The results of the prioritization of pipe assets are summarized in **Table 4.8.**

Table 4.10 - Climate Change Prioritization Results of Pipe Assets

Prioritization - Climate Change Scenario									
Asset Category	# of Pipes	Length of Pipe (km)	0-5 Year	0-5 Year Replacement Cost	5-10 Year	5-10 Year Replacement Cost	10-20 Year	10-20 Year Replacement Cost	Total Replacement Cost
Priority 1	287	23.9	82	$ 3,675,948	192	$ 5,559,482	13	$ 299,535	**$ 9,534,965**
Priority 2									
Condition	128	11.5	2	$ 12,725	111	$ 3,724,000	15	$ 392,628	**$ 4,129,352**
Capacity	136	9.6	58	$ 2,356,235	59	$ 1,171,517	19	$ 453,270	**$ 3,981,022**
Priority 3									
Condition	4	0.1	0	$ -	0	$ -	4	$ 37,636	**$ 37,636**
Capacity	12	1.3	0	$ -	0	$ -	12	$ 379,854	**$ 379,854**
New Pipes	11	1.3	11	$ 542,573	-	-	-	-	**$ 542,573**
Total	**578**	**47.6**	**153**	**$ 6,587,480**	**362**	**$ 10,454,999**	**63**	**$ 1,562,923**	**$ 18,605,402**

Based on the modelled adjustments for climate change, total replacement cost has increased by $2,777,890 and the average annual cost for critical assets increased by $139,000 to **$930,000**. The increase is due to an increased number of pipes moving into the 20-year replacement timeframe (due to lower length of service life).

4.9 Levels of Service, Risk and Cost: Results

The benefit of the risk assessment is the connection between levels of service, risk, and priorities. This section advances the methodology described above to define which types of projects will be funded based on the priority level and affordability limits. The baseline service life scenario is used in this section.

URBAN systems

PRIORITY 1 – LEVEL OF SERVICE 1

- **Risk Level:** Asset replacements are selected when assets exhibit *both* condition and consequence of failure risk scores greater than or equal to 4.
- **What this means:** We will ensure that all pipes are maintained to a condition and capacity risk score of 3 or less. To do this, we will fund and construct projects that are of high risk (4 or 5) for both condition and capacity failures.
- **Cost Implications: $7,771,000** over 20 years.

PRIORITY 2 – LEVEL OF SERVICE 2

- **Risk Level:** Asset replacements are selected when assets exhibit risk scores greater than or equal to 4, for *either* condition or capacity.
- **What this means:** We will ensure that all pipes are maintained with a condition or capacity risk score of 3 or less. To do this, we will fund and construct projects that are high risk (4 or 5) for either condition or capacity.

  Note: Selecting this risk level would also trigger all the Priority 1 pipes.
- **Cost Implications:** Additional **$7,101,000** over 20 years.

PRIORITY 3 – LEVEL OF SERVICE 3

Selecting this risk level where assets scored a 4 or greater under *likelihood of failure* for *either* condition or capacity would trigger all Priority 1, 2 and 3 pipes which has a cost implication of **$15,285,000** over 20 years.

LEVEL OF SERVICE RECOMMENDATIONS

Selecting the preferred level of service to provide often comes down to community preferences and affordability. Willingness to pay for environmental protection or enhancement is also inherent in affordability. Based on discussions following the review of the preliminary results earlier in the study, it was determined that the following level of service and funding would be pursued, with confirmation occurring after the long term financial analysis is completed:

- Priority 1 – to be funded and implemented as quickly as possible
- Priority 2 and 3 – aim to gradually increase revenues over the 20-year time frame so that this level of service is achieved by 2036

ADDITIONAL INFORMATION IN APPENDICES

This Plan is submitted along with a GIS geodatabase (to be delivered with the final version of this report) which includes all the results of the modelling analysis. The geodatabase will be submitted in electronic form to allow GIS personnel to manipulate and present the information in a variety of ways, depending on the needs of City staff.

Lastly, each asset ID has a risk score for existing and future conditions. These risk scores are the basis of the prioritization (ranking) of the assets and all pipes in Priority 1/2/3 are listed in decreasing order of risk. This allows engineering staff to work with GIS staff to assemble projects based on risk, adjacent utility or roadworks projects (synergies), proximity and timing. Generally, however, the tables work like a check-list where each project completed results in less risk, thereby achieving the City's stated level of water servicing.

5.0 FUNDING AND IMPLEMENTATION STRATEGY

The assets identified in this study were prioritized and sequenced based on their level of risk, which was further categorized based on various rankings or risk scores and translated into levels of service. The identified Priority 1, Priority 2 and Priority 3 projects provide a high level of service for customers. The estimated costs for the critical assets is $15.8M (avg. $0.791M/year). Castlegar's water utility currently budgets approximately $0.743M per year in capital funding (see table 5.1) for water system projects. This equates to a deficit of approximately $48,000/year. Note that the required investment levels include linear infrastructure only, not water system facilities.

If the City were to adopt the climate change scenario, it would add $139,000/year, bringing the deficit to $187,000/year.

If the City were to adopt the 125% service life extension scenario, the estimated costs for the critical assets would be $6.5M (avg. $0.327M/year). This equates to a budgetary surplus of approximately $416,000.

The aim of the funding strategy for this study is to organize the costs and expenditures over 20 years and to inform the City's Water Rates Study. The refinement of timing, phasing and affordability of projects will be completed as part of the City's financial planning and integrated capital planning process.

Table 5.1 - Currently Funding Summary

Year	Own Source Revenues
2016	$ 800,000
2015	$ 364,000
2014	$ 195,000
2013	$ 1,399,629
2012	$ 1,562,559
2011	$ 134,237
Average Year	**$743,000**

5.1 Capacity Based Pipe Projects

Capacity-based pipe projects enable the water utility to meet hydraulic levels of service now and going forward as flows increase with an increase in population. Projects in the 0-5 and 5-10 year timeframe are typically required to address current service level deficiencies whereas 10-20 year capacity-based projects are required to deliver on growth plans. Each of these types of projects can be eligible for development cost-sharing.

There are several new pipes that were added to the results of the risk analysis in this table because they were identified as critical to improve fire flow and pressure levels of service.

5.2 Asset Renewal Needs

Based on the utility's current capital funding level of $0.75M, it appears that funding is inadequate to cover *linear* asset replacement over the 20-year horizon to meet pending condition renewal and backlog investments ($48,000 deficit). If the City chooses to take on more risk and increase service lives of linear assets, then the current capital funding level becomes adequate ($416,000 surplus). It is important to note that this report does not include costs for water system facilities renewal and replacement. Facilities will be addressed in a future facilities capital assessment. While these investment levels are based on macro-funding objectives, the results of the risk analysis work from the bottom up, to develop a list of asset-specific condition upgrades.

In summary, the proposed annual average level of renewal spending over the 20-year horizon is less than the current utility capital spending level but not by a significant margin.

5.3 Impacts to Water Utility Rates

Each year the water utility balances its financial position through incomes and revenues to cover the costs of operation, for capital expenditures and through reserve or development transfers which are part of longer-term financial operations. As costs for the utility rise due to escalation factors, changes in levels of service and through system expansion, the City decides how best to meet costs through various cost-recovery tools. Perhaps the most important cost-recovery tool is utility rates including metered rates, flat rates and other various charges from customers for the service they receive: rates generate over 80% of the incomes for the utility. A parallel exercise to the asset management plan and risk assessment is a water utility rate study. The primary drivers for that study are to implement a more equitable, consistent user-pay rate structure that encourages water conservation and allows for flat fees to cover fixed costs. An upcoming decision by Council on setting rates for 2018 is expected in December 2017.

The proposed changes to the water utility rate structure considered the gradual evolution towards sustainable utility financing in particular as it relates to covering capital costs year-over-year. The flat fee of the rate structure is designed to cover most of the expenditures that can be reliably predicted from one fiscal to the next. While some years show higher amounts for capital upgrades, others are lower. Over the last 6 years the water utility has expended about $700,000/yr toward capital projects with some years much higher and some years much lower. Moving forward, the proposed rates position the city to generate incomes to cover projected costs and to meet the $700,000 annual average for capitalization: in other words, the first year of applying the updated rates is anticipated to cover historic spending levels. Under this asset management study and by means of the risk assessment, the next 20 years of capital spending are estimated at $880,000/year.

These figures are projections and denote where the City would eventually like to get to in regard to annual recapitalization. There is an apparent gap in recapitalization however most communities in BC face a larger shortfall than the gap between current capital spending and the aspirational level identified in this study. That said, there is room to grow with incomes to meet the rising costs of the utility and to maintain the infrastructure in suitable condition to effectively deliver services.

Recommendations from this study in regard to water utility finance are to:

- Use the flat fees for each customer type to incrementally increase incomes to cover the gap in recapitalization; initial estimates suggest that 1% to 2% increases above inflation for the fleet fees for 5 years may generate sufficient incomes to meet these needs
- Continue to monitor actual conditions to prioritize investments
- Update the risk assessment model regularly to help prioritize annual capital plans and to adjust overall financing for the utility, and:
    - Spend first towards priority 1 pipes
    - Implement priority 2 pipes that are triggered by capacity or specific operator concern (either condition or capacity)
    - Renew existing facilities and expand carefully through grants and developer contributions

5.4 Implementation Plan and Recommendations

The pipe assets identified, through the risk assessment process, for renewal/replacement in this plan were prioritized based on their condition and function with a consideration of climate change.

The intent of the Prioritized Water Capital Plan is to organize the costs and expenditures over 20 years. The refinement of timing, phasing and affordability of projects will be completed as part of the financial planning and integrated capital planning process for the IICP (integrating with roads, water and drainage).

The Prioritized Water Capital Plan includes the following recommendations:

- To phase in capital projects based on their risk trigger; i.e., condition or capacity (**Figure C and D**). Existing condition and capacity is the primary driver for projects in the catchment and preparing for significant projects should start immediately.
- To budget for Priority 1 pipe replacement in the 5 year Capital and Financial Plans. Priority 1 pipes should generally be selected over Priority 2 pipes unless there are urgent condition or capacity issues occurring.

- Integrate these priorities with the results of the Water Optimization Study to inform the development of the Integrated Infrastructure Capital Plan (water, roads, drainage and sanitary).
- Determine funding requirements to address the municipal contribution gap in part, by potentially updating user fees/rates in 2017/18.
- To fund and replace the Priority 2 pipes by completing the highest order projects by capacity risk score first.
- To fund the recommendations identified in the Water Optimization Study which focuses on investment and efficiency improvements to the City's water facilities
- Consider increasing investment into asset renewal by $139,000 to account for the potential impacts of climate change on infrastructure.

Appendix A

Technical Memoranda

URBAN systems

This section presents a summary of the design criteria and hydraulic analyses for an existing conditions scenario and the future conditions scenario.

Design Criteria

The tables below include the design criteria and assumptions used in the analysis. The MMCD design guidelines form the basis of the criteria utilized. Existing demands were sourced from actual flow records at the Water Treatment Plant. It is recommended that future modeling and analysis confirm any changes to the BC Building Code that may affect the fire flow requirements. The MMCD requirements are conservative, and the BC Building Code may lower these requirements, triggering fewer pipes deficiencies in the model.

Fire Flow Requirements (MMCD)		
Zoning	**FF Req (L/s)**	**Hydrant Spacing (m)**
SF Residential	60	150
Duplex Residential	60	150
3/4 Plex Residential	90	150
Apartment/Row Housing	90	150
Commercial	150	150
Institutional	150	150
Industrial	225	150
Agricultural	-	300

Pressure Requirements (MMCD)		
Criterion	**Pressure (kPa)**	**Pressure (psi)**
Maximum Static	850	123
Minimum Static	300	44
Minimum PHD	300	44
Minimum MDD+FF	150	22

Demand Rates for Future Growth (MMCD)	
Demand Type	**Rate (L/c/d)**
ADD	600
MDD	1200
PHD	1800

Existing Demand Calculation (Source: 2016 WTP Flow Records)					
	Single Family (L/s)	**Multi-Family (L/s)**	**ICI (L/s)**	**Total (L/s)**	**Peaking Factor**
2016 ADD	88.3	8.1	2.2	98.5	
2016 MDD	174.2	15.9	4.3	194.4	2.0
2016 PHD	285.8	26.1	7.1	319.0	3.2

Future Demand Calculation						
	Single Family (L/s)	**Multi-Family (L/s)**	**ICI (L/s)**	**Residential Growth (L/s)**	**ICI Growth (L/s)**	**Total (L/s)**
2037 ADD	88.3	8.1	2.2	13.0	7.6	119.1
2037 MDD	174.2	15.9	4.3	26.0	15.1	235.5
2037 PHD	285.8	26.1	7.1	38.9	22.7	380.7

Population Density (Water Management Plan)		
Capita per Lot/Unit	2.4	people

2016 - 2037 Population Growth					
Zoning	**Land-Use Type**	**Units**		**P/u**	**Population Growth**
SF Residential	Single Family	32	Lots	2.4	77
Duplex or SF + Suite	Single Family	262	Lots	4.8*	1,258
Multi-Family	Multi-family	33	Units	2.4	79
Seniors	Multi-family	190	Units	2.4	456
Commercial	Commercial	10.60	Hectares	90	954
Industrial	Industrial	0.64	Hectares	50	32
Institutional	Institutional	1.16	Hectares	90	104
***Assumes each lot contains two "units"**					

URBAN systems

This memorandum presents a summary of the results from the hydraulic analyses for an existing conditions scenario and the future conditions scenario.

Overall Summary

		Existing System		With Upgrades
Deficiency Type	**Criteria**	**2016 Deficiencies**	**2037 Deficiencies**	**2037 Deficiencies**
High Static Pressure Junctions	P > 850 kPa (123 psi)	53 (4%)	52 (4%)	26 (2%)
ADD Low Pressure Junctions	P < 300 kPa (44 psi)	26 (2%)	26 (2%)	19 (2%)
PHD Low Pressure Junctions	P < 300 kPa (44 psi)	26 (2%)	26 (2%)	19 (2%)
	Deficient in excess of 10% of requirement	16 (1%)	18 (1%)	12 (1%)
Fire Flow Deficient Junctions	Available Flow @ 150 kPa (22 psi) < Required Flow	122 (10%)	126 (10%)	14 (1%)
	Deficient in excess of 10% of requirement	102 (8%)	105 (9%)	4 (1%)

Watermain Upgrade Recommendations

The tables below summarize the mains that require upgrades to improve fire flow and pressure.

Water Main ID	Existing Diameter (mm)	Upgrade Diameter (mm)	Length (m)
WMN0008	100	150	101
WMN0010	100	150	101
WMN0028	100	150	50
WMN0030	100	150	76
WMN0031	100	150	76
WMN0033	100	150	64
WMN0046	200	250	48
WMN0047	200	250	85
WMN0066	100	150	107
WMN0093	100	200	62
WMN0118	100	150	207
WMN0123	100	150	39
WMN0124	100	150	149
WMN0143	100	150	68
WMN0159	100	150	59
WMN0161	50	250	79
WMN0162	150	250	47
WMN0208	100	200	27

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WMN0211	200	250	53
WMN0212	200	250	15
WMN0218	150	200	33
WMN0222	200	250	70
WMN0223	150	200	52
WMN0224	150	200	54
WMN0225	150	200	22
WMN0228	150	250	76
WMN0229	150	200	82
WMN0232	100	200	77
WMN0233	150	200	74
WMN0236	100	150	153
WMN0243	200	250	98
WMN0244	150	200	132
WMN0245	150	250	131
WMN0249	100	150	70
WMN0252	150	250	7
WMN0253	150	250	48
WMN0267	150	250	134
WMN0284	200	250	77
WMN0285	100	150	71
WMN0300	150	200	123
WMN0301	150	200	84
WMN0309	100	150	146
WMN0311	150	200	94
WMN0350	150	200	133
WMN0351	150	200	55
WMN0364	150	200	143
WMN0371	150	250	77
WMN0372	200	250	74
WMN0373	150	250	71
WMN0374	150	250	86
WMN0379	150	250	74
WMN0387	150	200	134
WMN0388	150	200	179
WMN0389	150	200	87
WMN0391	150	200	80
WMN0400	150	250	121
WMN0401	150	200	233
WMN0403	150	250	196

WMN0404	150	250	144
WMN0406	200	250	229
WMN0407	200	300	55
WMN0408	200	250	141
WMN0409	200	250	93
WMN0410	200	250	140
WMN0417	200	300	120
WMN0419	250	300	170
WMN0420	250	350	146
WMN0421	250	350	120
WMN0440	150	200	260
WMN0441	150	200	184
WMN0442	150	200	108
WMN0444	150	200	183
WMN0456	200	250	151
WMN0458	150	200	183
WMN0470	100	150	244
WMN0473	150	200	159
WMN0474	200	250	160
WMN0476	150	250	142
WMN0477	200	250	66
WMN0478	200	250	28
WMN0492	100	150	176
WMN0493	100	150	164
WMN0560	100	150	176
WMN0561	100	200	123
WMN0562	100	200	76
WMN0563	100	200	50
WMN0564	100	250	108
WMN0565	100	200	59
WMN0566	100	150	104
WMN0569	100	150	212
WMN0570	150	200	72
WMN0571	150	200	54
WMN0572	150	200	124
WMN0573	150	200	86
WMN0577	100	150	12
WMN0581	100	150	32
WMN0586	100	150	43
WMN0587	100	150	108

WMN0588	100	150	202
WMN0590	100	150	41
WMN0597	100	150	127
WMN0598	100	150	25
WMN0601	100	150	25
WMN0602	100	150	43
WMN0603	100	150	77
WMN0604	100	150	86
WMN0605	100	150	73
WMN0609	100	150	153
WMN0611	100	150	143
WMN0617	200	250	65
WMN0618	200	250	253
WMN0621	100	250	70
WMN0622	100	150	38
WMN0623	100	150	46
WMN0624	100	150	140
WMN0636	300	350	132
WMN0637	300	350	271
WMN0642	200	300	105
WMN0645	300	350	79
WMN0648	150	300	96
WMN0650	150	300	4
WMN0651	150	250	2
WMN0652	200	250	97
WMN0664	50	300	25
WMN0677	150	200	117
WMN0678	150	250	17
WMN0683	150	200	3
WMN0773	100	150	55
WMN0774	100	200	9
WMN0775	100	150	170
WMN0779	150	200	12
WMN0780	150	200	8
WMN0782	100	150	4
WMN0783	100	150	14
WMN0784	50	150	5
WMN0786	100	150	2
WMN0789	200	250	14
WMN0791	300	350	2

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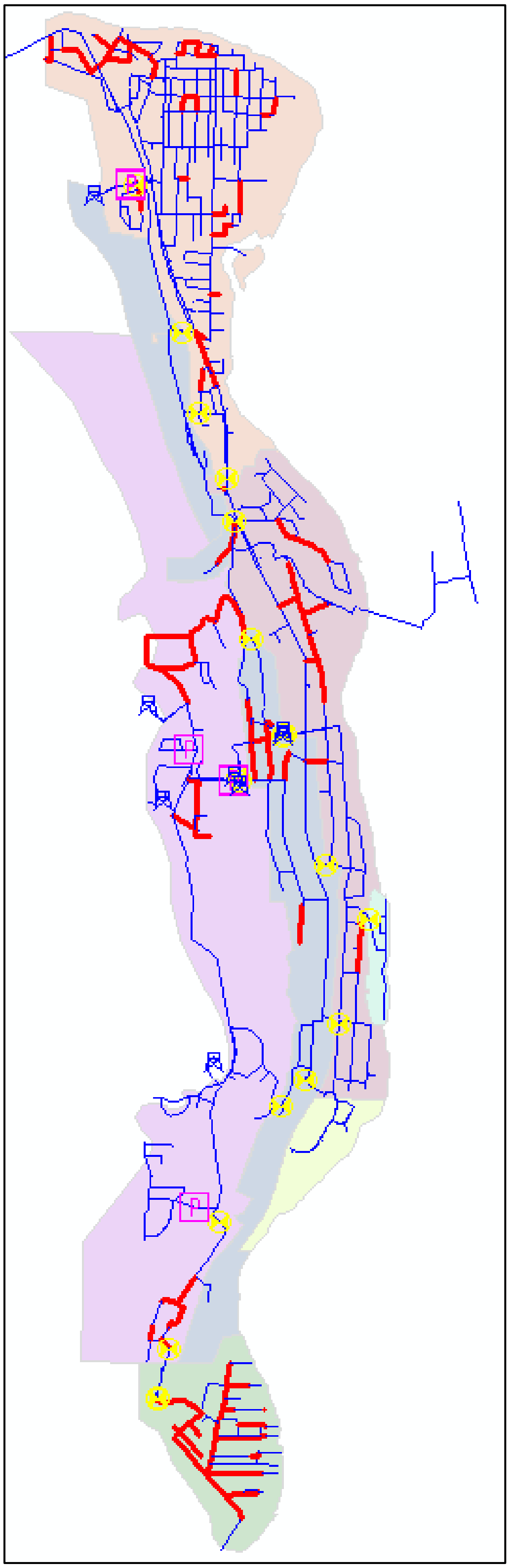
WMN0792	300	350	69
WMN0793	300	350	7
WMN0798	100	150	71
WMN0822	250	350	12
WMN0825	250	300	129
WMN0826	200	300	25
WMN0827	200	300	92
WMN0828	200	250	44
WMN0830	150	250	157
WMN0836	150	200	36
WMN0840	150	200	85
WMN0841	150	250	13
WMN0842	150	250	24
WMN0848	150	250	155
WMN0850	150	250	8
WMN0873	100	150	6
WMN0879	150	200	7
WMN0901	150	200	19
WMN0905	150	250	3
WMN0909	150	200	99
WMN0910	150	250	52
WMN0911	200	250	10
WMN0912	150	250	58
WMN0915	200	250	5
WMN0916	200	250	55
WMN0918	150	250	155
WMN0919	150	250	11
WMN0951	150	200	1
WMN0973	100	150	16
WMN0975	150	250	4
WMN0991	100	200	10
WMN1007	100	150	76
WMN1022	150	250	3
WMN1024	200	250	5
WMN1025	100	150	8
WMN1031	100	150	38
WMN1032	100	150	37
WMN1033	100	150	87
WMN1034	100	150	47
WMN1036	150	200	13

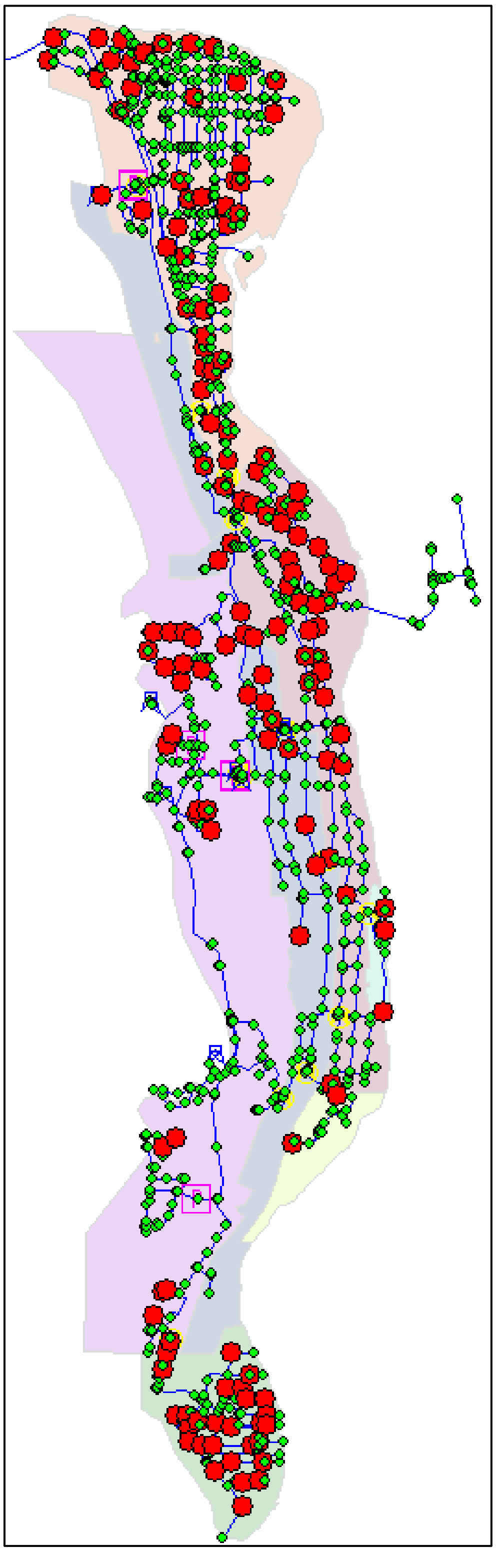
WMN1042	150	250	11
WMN1058	100	200	38
WMN1060	150	200	84
WMN1065	200	250	9
WMN1112	100	150	27
WMN1113	100	150	81
WMN1122	100	200	7
WMN1123	100	200	191
WMN1124	100	200	170
WMN1924	150	250	17
WMN1943	100	150	67
WMN1950	100	200	7
WMN2003	200	250	3

The schematic below illustrates the location of these upgrades.

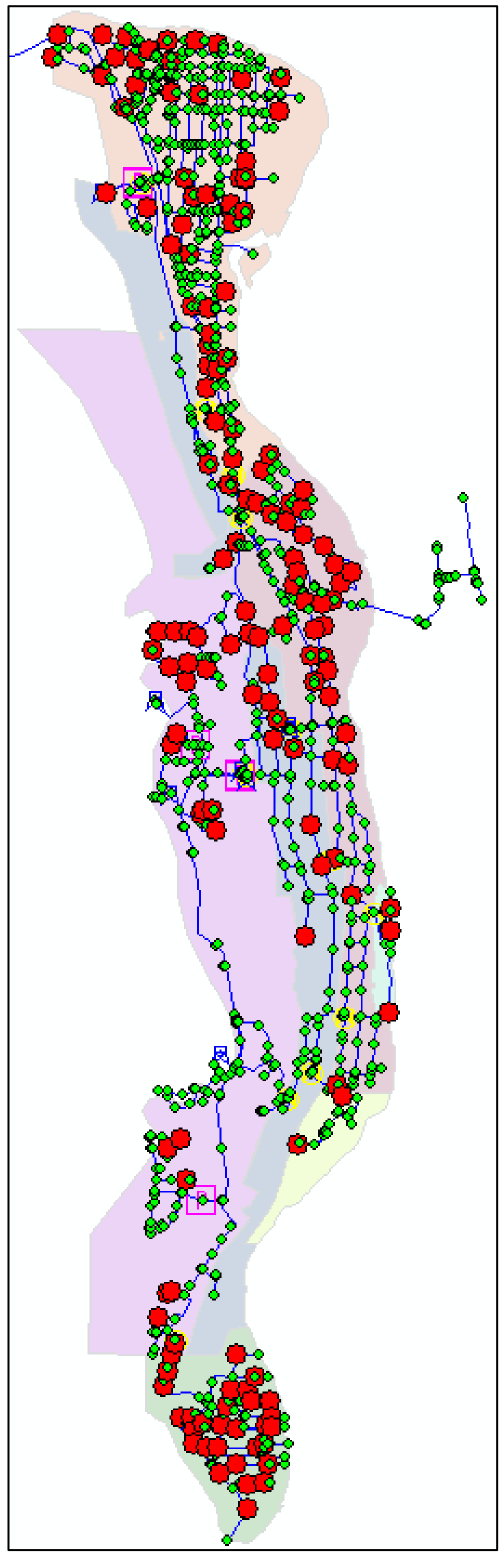


The schematics below illustrate the locations of high pressure, low pressure, and fire flow deficiency that were found in the model.

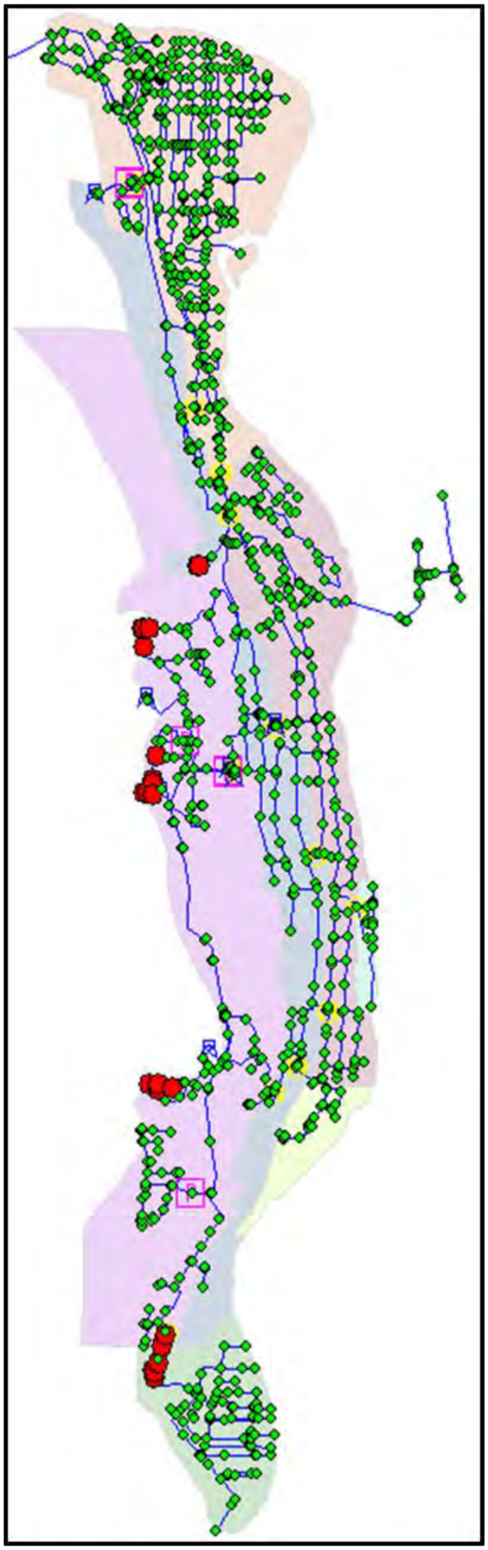
Existing System FF Deficiencies



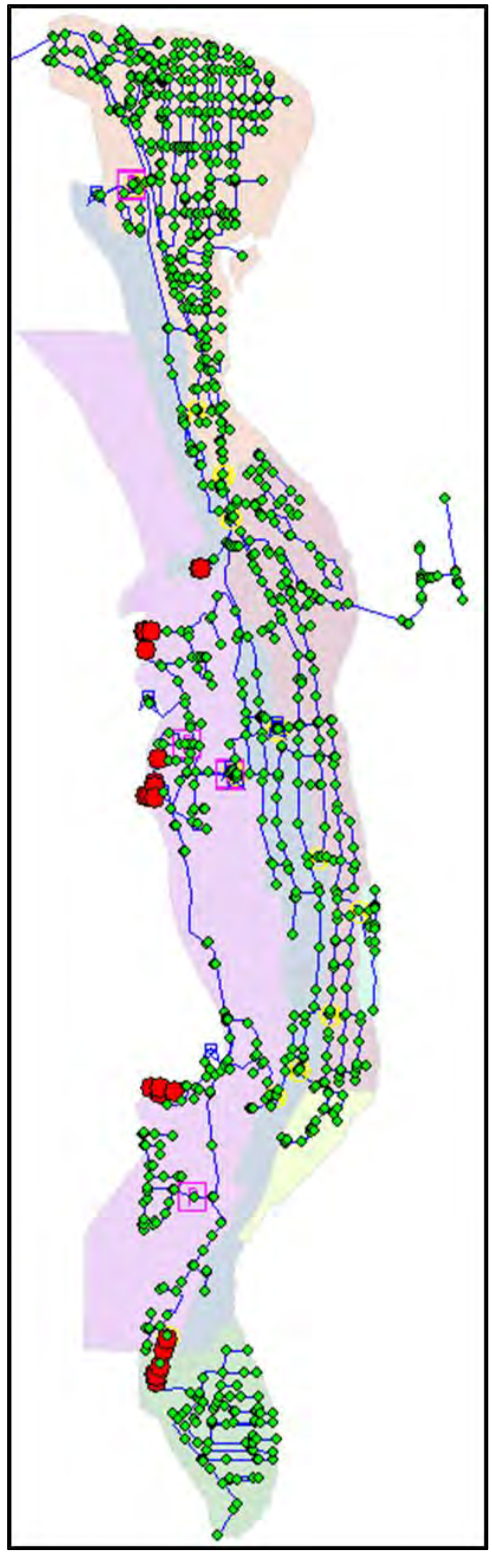
2037 FF Deficiencies



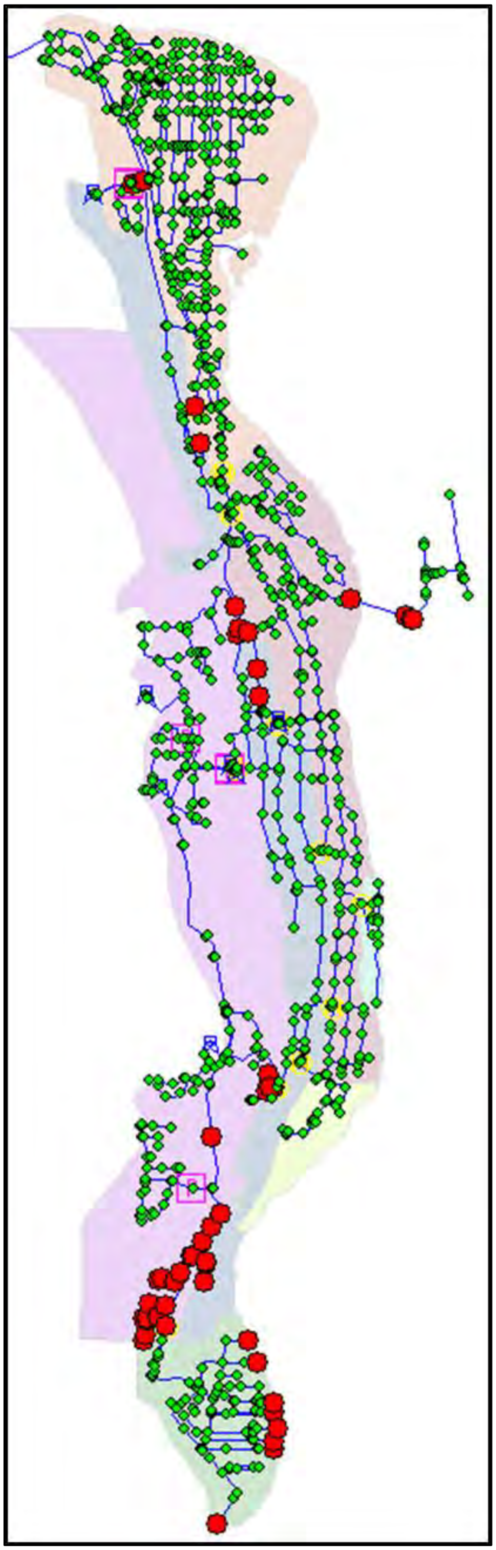
2016 ADD/PHD Low Pressure



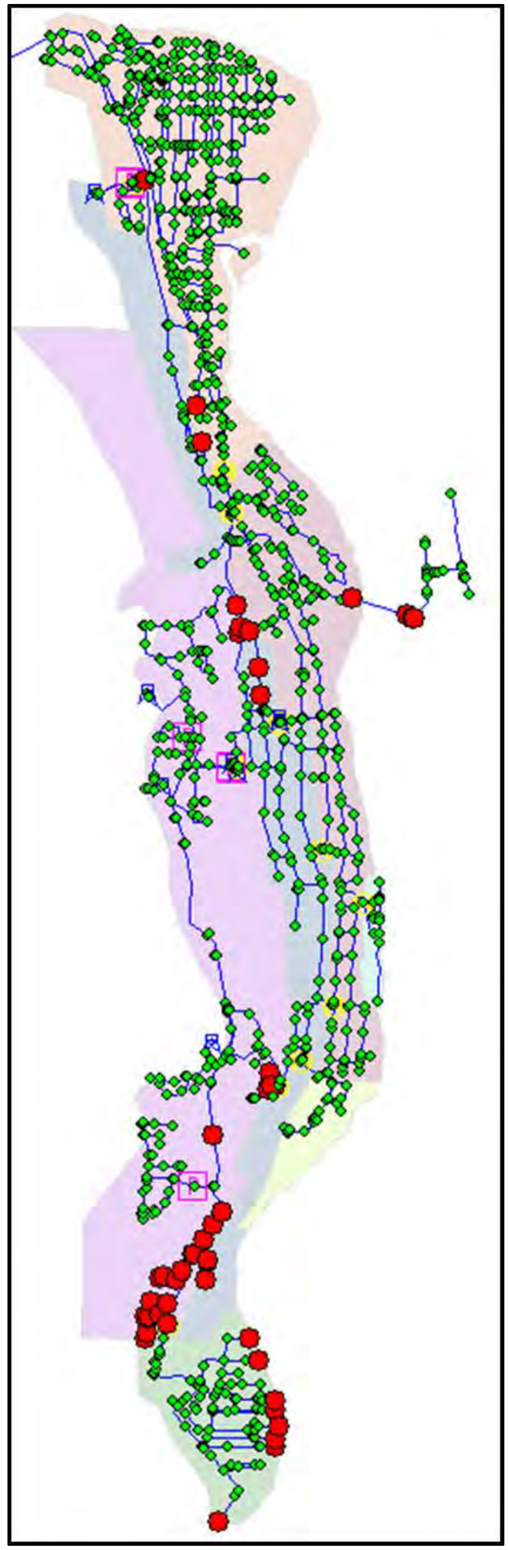
2037 ADD/PHD Low Pressure



2016 – High Pressure



2037 – High Pressure



New Watermain Recommendations

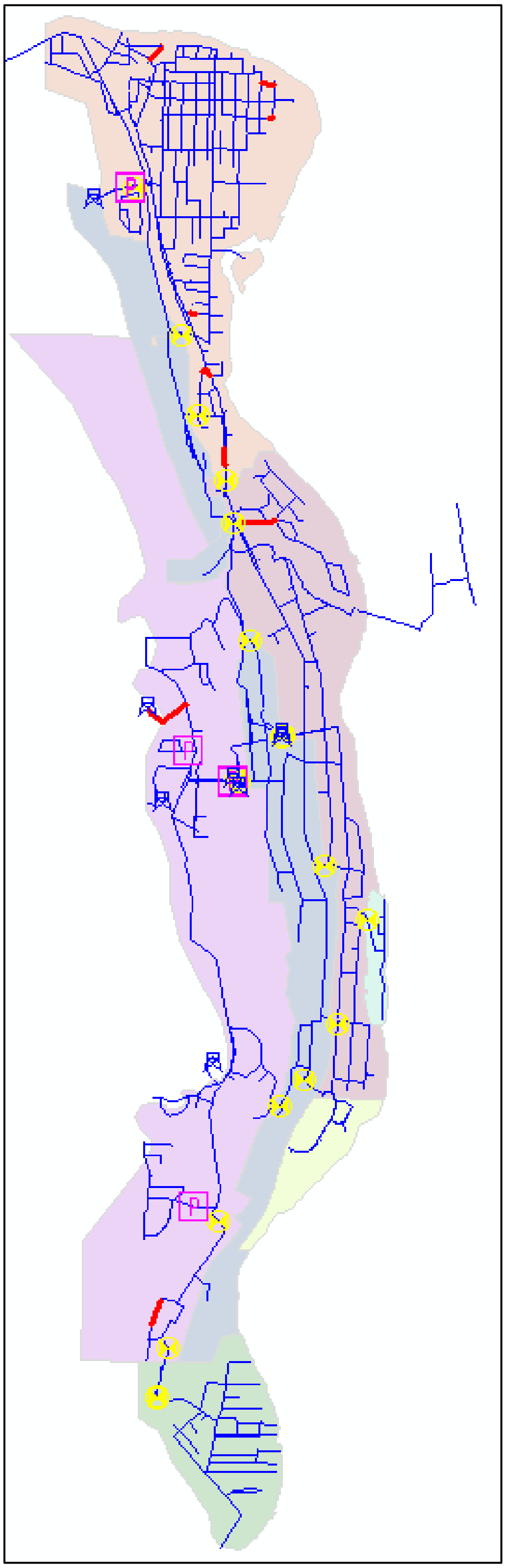
The tables below summarize the new mains required to improve fire flow and pressure deficiencies.

Water Main ID	Recommended Diameter (mm)	Length (m)
WMN3242	200	127
WMN3243	150	89
WMN3244	150	44
WMN3245	200	55
WMN3248	200	84
WMN3249	250	119
WMN3252	200	191
WMN3253	200	10
WMN3254	200	65
WMN3258	300	164
WMN3259	300	321

Other System Recommendations

The analysis also considered several operational efficiencies, the results of this modelling has been provided under separate cover.

The schematic below illustrates the location of these upgrades.



TECHNICAL MEMORANDUM

URBAN systems

Date:	June 01, 2016
To:	Chris Barlow, City of Castlegar
cc:	
From:	Scott Shepherd
File:	0841.0099.01
Subject:	**TECHNICAL MEMO – WATER CAPACITY RISK ASSESSMENT METHODOLOGY**

This memo outlines the proposed methodology on how capacity risks of pipes are identified, and how the risks will be applied in assessing pipes in the City of Castlegar. The methodology is broken down into three parts: an assessment of the likelihood of failure; an assessment of the consequence of failure; and, a risk score. These capacity risk scores will be used in conjunction with condition risk scores (methodology outlined under separate cover) to help guide the prioritized infrastructure capital replacement process.

PART 1 – LIKELIHOOD OF FAILURE

The likelihood of failure was assessed by two operating parameters: System Pressure and Available Fireflow. **Table 1** defines the water system levels of service correlated to the likelihood of failure.

Table 1 – Peak Operating Condition Likelihood of Failure

LIKELIHOOD OF FAILURE	SYSTEM PRESSURES		FIREFLOWS
5	Peak Hour Pressure < 15 psi	OR	Available Fire Flow <= 60% of Required Fire Flow
4	Peak Hour Pressure >=15 psi to < 20 psi	OR	Available Fire Flow >= 60% to <70% of Required Fire Flow
3	Peak Hour Pressure >=20 psi to < 30 psi	OR	Available Fire Flow >= 70% to <80% of Required Fire Flow
2	Peak Hour Pressure >=30 psi to < 35 psi	OR	Available Fire Flow >= 80% to <90% of Required Fire Flow
1	Peak Hour Pressure >= 35 psi	OR	Available Fire Flow >= 90% of Required Fire Flow

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PART 2 – CONSEQUENCE OF FAILURE

The consequence of failure is a function of the land use type and their associated populations. With single family residential dwellings, the consequence is lower than with multi-story apartment complexes or commercial, industrial or institutional buildings. **Table 2** and **Table 3** correlate the consequence of failure to the population and land use respectively. The populations in **Table 2** refer to total equivalent population, irrespective of land use.

Table 2 - Consequence of Failure Definitions

CONSEQUENCE				
1 INSIGNIFICANT	2 MINOR	3 MODERATE	4 MAJOR	5 SEVERE
n/a	< 10 people impacted or property loss < $0.5MM	10-50 people impacted or property loss 0.5MM-1.0MM	50-100 people impacted or property loss 1.0MM-5.0MM	>100 people impacted or property loss >5.0MM

Table 3 - Consequence of Failure by Land Use Designation

ADJACENT LAND USE DESIGNATION	CONSEQUENCE OF FAILURE
Open Space	1
Single Family Residential	3
Multi-Family Residential	4
Highway Commercial	4
Institutional	5
Industrial	5
Core Commercial	5

Modified Consequence Score

Due to their larger size or nearby surroundings, some watermains present an increased level of consequence should they fail. For the analysis, pipe size, stream crossings, and pipes in special community areas are treated differently so as to elevate their priority sequencing in capital projects. Three areas of modified consequence are:

- **Watermains 250 mm and larger** present greater failure consequences and a modified score is added to the normal risk rating (**Table 4** below).
- **Watermains located within environmentally sensitive areas** (as mapped in the OCP, or in steep slope areas) or **mains that are adjacent to or cross watercourses** present greater failure consequences and a modified score is added to the normal risk rating (**Table 4** below).
- **Watermains in ICI areas** (Industrial, Commercial, Institutional) demonstrate a greater consequence on community well-being. Therefore, water assets within these areas will be assigned a modified consequence score based on **Table 4**.

Table 4 – Modified Consequence Score

ORIGINAL SCORE		1	2	3	4	5
MODIFIED SCORE	>=250mm or adjacent to/cross sensitive watercourses, or located within either ICI or environmental areas	1	3	4	5	5

PART 3 – RISK SCORE

The risk score combines the likelihood of pipe failure and the consequence of failure to a single 1 to 5 rating. A risk score of 5 represents the highest risk and a score of 1 the least risk. **Table 4** correlates the consequence and the likelihood of failure to the risk score.

Table 5 – Risk Score

Consequence \ Likelihood of Failure	1	2	3	4	5
5	3	3	4	5	5
4	2	3	4	5	5
3	2	2	3	4	4
2	1	2	2	3	3
1	1	1	2	2	3

Likelihood of Failure

It is important to recognize that an asset that has a moderate or low risk attached to it may transition to having a higher risk over time due to changes in demand from growth or increased demands. Further, as more detailed data becomes available, the risk assessment could change. With this in mind, there must be emphasis on keeping the risk assessment a dynamic and living process.

Date:	June 01, 2016
To:	Chris Barlow, City of Castlegar
cc:	
From:	Scott Shepherd
File:	0841.0099.01
Subject:	**TECHNICAL MEMO – WATER CONDITION RISK ASSESSMENT METHODOLOGY**

This memo outlines the proposed methodology on how condition risks of water pipes are identified, and how the risks will be applied in assessing pipes in the City of Castlegar. The methodology is broken down into three parts: an assessment of the likelihood of failure; an assessment of the consequence of failure; and, a risk score. These condition risk scores will be used in conjunction with capacity risk scores (methodology outlined under separate cover) to help guide the prioritized infrastructure capital replacement process.

PART 1 – LIKELIHOOD OF FAILURE

The likelihood (probability) of asset failure will be based on the age of asset, since no actual physical condition data exists. A simple 1 to 5 scale will be applied whereby a condition rank of 5 would indicate that the likelihood of failure is very high and a score of 1 would indicate that the probability of failure is very low. Asset age based on approximate year of installation is used as a proxy to indicate the likelihood of failure, as defined in **Table 1**.

Table 1 - Condition Ranking

LIKELIHOOD OF FAILURE	CRITERIA
5	Asset age exceeds its SL* by 50%
4	Asset age exceeds its SL* by 25% - 50%
3	Asset age exceeds its SL* by 0% - 25%
2	75% of its SL* < Asset Age < 100% of its SL*
1	Asset age < 75% of its SL*

* **SL =** Service Life: Service life is the number of years that an asset is estimated to be able to fulfill its intended function to the community before it needs to be replaced.

Anecdotal evidence from operators was used in place of asset age, if this information was available. The break location history was incorporated as defined below:

- 1-2 breaks on or within 10m of a pipe = add 1 to LOF
- 3-5 breaks on or within 10m of a pipe = add 2 to LOF
- More than 5 breaks on or within 10m of a pipe = set LOF to 5 (max)

Estimated Service Lives

The following table summarizes the estimated service lives used in the analysis. The table is based on discussions with staff on their experience in the Castlegar area, destructive testing results within the City, and on the Province of BC's 2008 *Guide to the Amortization of Tangible Capital Assets.*

Table 2 – Estimated Service Lives

Material	Estimated Service Life
AC	70
CI	60
CON	60
HDPE	80
Steel	60
PVC	80

Part 2 – Consequence of Failure

The consequence of failure is based on the actual location of the infrastructure and the financial consequence that might occur, if the infrastructure failed. A simple 1 to 5 scale is used to classify the consequence of failure. **Table 3** details how each category is defined.

Table 3 - Consequence of Failure Definitions

CONSEQUENCE				
1 INSIGNIFICANT	2 MINOR	3 MODERATE	4 MAJOR	5 SEVERE
Total cost to restore service and 3rd party liability (< $500)	Total cost to restore service and 3rd party liability ($500 - $5,000)	Total cost to restore service and 3rd party liability ($5,000 - $15,000)	Total cost to restore service and 3rd party liability ($15,000 - $50,000)	Total cost to restore service and 3rd party liability (> $50,000)

For this study we consider the primary driver of failure consequence to be whether the pipe is located within a road, and if so what the road classification is. This is because the cost to repair a water main break is closely linked to the type of road that might be damaged. For example, a failure within an arterial road presents greater traffic control and road reconstruction requirements than would a failure within a local road. The City's GIS data set will be used to analyze if a pipe is physically located in a road, and if so what the road classification is. **Table 4** summarizes the consequence of failure ranking by road classification.

Table 4 - Consequence of Failure by Road Classification

ROAD CLASSIFICATION	CONSEQUENCE OF FAILURE
Arterial	5
Collector	5
Highway	5
Local	3
Strata	3
Lane	2
*SROW/Trail	1

**SROW - For pipe corridors in rights-of-way that are not overlaid by road networks.*

Modified Consequence Score

Due to their larger size or nearby surroundings, some watermains present an increased level of consequence should they fail. For the analysis, pipe size, stream crossings, and pipes in special community areas are treated differently so as to elevate their priority sequencing in capital projects. Three areas of modified consequence are:

- **Watermains 250 mm and larger** present greater failure consequences and a modified score is added to the normal risk rating (**Table 4** below).
- **Watermains located within environmentally sensitive areas** (as mapped in the OCP or in steep slope areas) or **mains that are adjacent to or cross watercourses** present greater failure consequences and a modified score is added to the normal risk rating (**Table 4** below).
- **Watermains in ICI areas** (Industrial, Commercial, Institutional) demonstrate a greater consequence on community wellbeing. Therefore, water assets within these areas will be assigned a modified consequence score based on **Table 5**.

Table 5 – Modified Consequence Score

ORIGINAL SCORE		1	2	3	4	5
MODIFIED SCORE	>=250mm or adjacent to/cross sensitive watercourse, or located within either ICI or environmental areas	1	3	4	5	5

Construction Cost Notes

There are scenarios in which a main will present a greater cost of construction due to its location. **Table 6** presents modifications that are to be incorporated into the estimated cost of construction for use in funding strategies.

Table 6 – Modified Construction Cost

POTENTIAL OBSTRUCTION	CONSTRUCTION COST MODIFICATION
Pipe crosses railway	Increase by 25%

PART 3 – RISK SCORE

The risk score combines the likelihood of asset failure and the consequence of failure into a single 1 to 5 rating. A risk score of 5 represents the highest risk and a score of 1 the least risk. **Table 7** correlates the consequence and the likelihood of failure to the risk score.

Table 7 – Risk Score

Consequence \ Likelihood of Failure	1	2	3	4	5
5	3	3	4	5	5
4	2	3	4	5	5
3	2	2	3	4	4
2	1	2	2	3	3
1	1	1	2	2	3

Likelihood of Failure

It is important to recognize that an asset that has a moderate or low risk attached to it may transition to having a higher risk over time due to the simple aging of the asset. Further, as more detailed data becomes available, the risk assessment could change. For example, if new condition assessment data suggests that an asset is in better condition than its age would indicate, the risk assessment would be altered. With this in mind, there must be emphasis on keeping the risk assessment a dynamic and living process.

Appendix B

Facility Assessment Sheet

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Celgar Pump Station

Asset ID: WPMP0001 P1-P6

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
900 HP VT Pump	2002	Good	10	2027	$1500000		$
					$		$
Minor Equipment							
Valves	1965	Fair	10	2027	$540000		$
					$		$
Structures							
	1965	Good	N/A		$		$
Electrical/Mechanical							
	1965	Fair	N/A		$		$

Comments:

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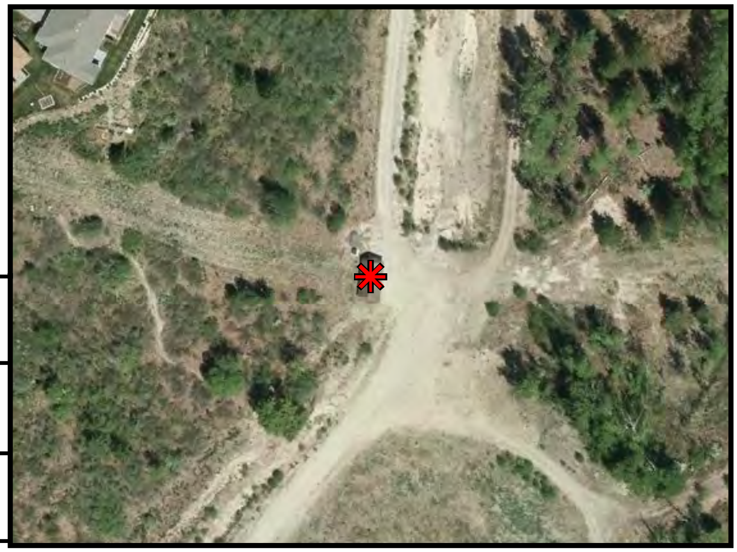
Project Title:	AMIP - Facilities Assessment
System Type:	Water System
Facility Name:	Grandview Pump Station
Asset ID:	WPMP0008-90025-26



Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
4 Pumps	2009	Good	22	2039	$240000		$
					$		$
Minor Equipment							
Valves/Fittings	2009	Good	22	2039	$144000		$
					$		$
Structures							
	2009	Good	42	2059	$130000		$
Electrical/Mechanical							
	2009	Good	22	2039	$600000		$

Comments:

Recent booster station for grandview;
No reservoir

URBAN systems

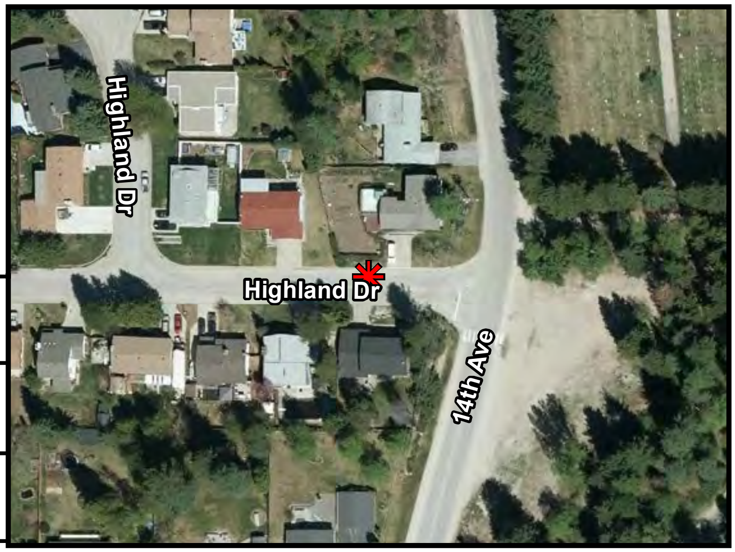
CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Highland Pump Station

Asset ID: WPMP0010

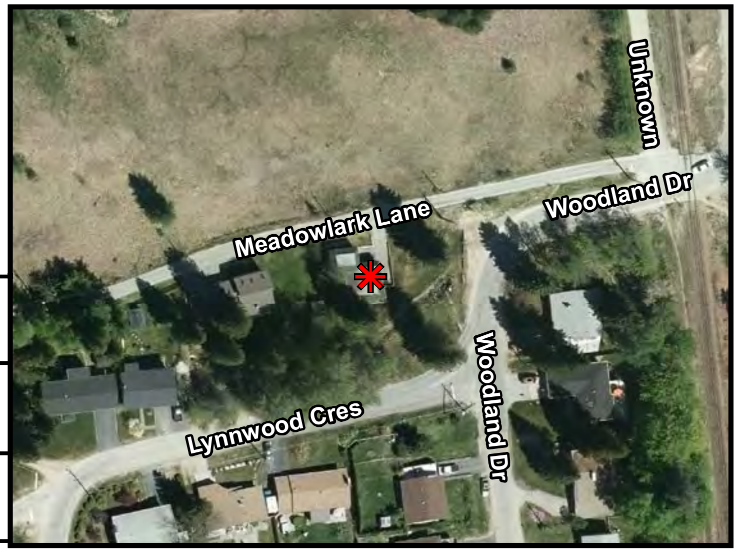


Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Booster Pump	2009	Good	22	2039	$75000		$
					$		$
Minor Equipment							
Valves/Fittings	2009	Good	22	2039	$30000		$
					$		$
Structures							
	2009	Good	42	2059	$54000		$
Electrical/Mechanical							
	2009	Good	22	2039	$100000		$

Comments:

URBAN systems

CASTLEGAR



Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Meadowlark Pump Station

Asset ID: WPMP0011-19

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
STG 1 Pump (4)	1980	Fair	5	2022	$500000		$
STG 2 Pump (4)	1980	Fair	5	2022	$500000		$
Minor Equipment							
Valves/Fittings	1980	Fair	5	2022	$360000		$
					$		$
Structures							
	1980	Good	30	2047	$350000		$
Electrical/Mechanical							
	1980	Fair	30	2047	$1500000		$

Comments:

Meadowlark reservoir pump station 3-75hp to reservoir, 2-50 hp to network, 3-150 hp boosters; 2 additional bases available; No standby power at the facility

URBAN systems

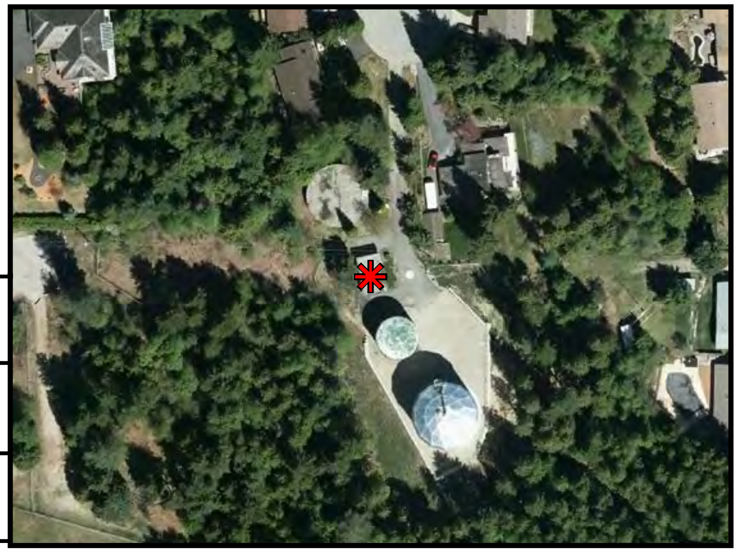
CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Park Pump Station

Asset ID: WPMP0020-23



Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
VT Pump (5)	1980	Good	12	2029	$400000		$
					$		$
Minor Equipment							
Valves/Fittings	1980	Good	12	2029	$150000		$
					$		$
Structures							
	1980	Good	12	2029	$220000		$
Electrical/Mechanical							
	1980	Good	12	2029	$620000		$

Comments:

Park reservoir: pumps re built in 2012

URBAN systems

CASTLEGAR

Project Title:	AMIP - Facilities Assessment
System Type:	Water System
Facility Name:	Airport Pump Station
Asset ID:	WPMP0024

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Small Well Pump	1960	Fair	6	2023	$15000		$
					$		$
Minor Equipment							
Valves/Fittings	1960	Fair	6	2023	$15000		$
					$		$
Structures							
	1960	Fair	6	2023	$12000		$
Electrical/Mechanical							
	1960	Fair	6	2023	$10000		$

Comments:

URBAN systems

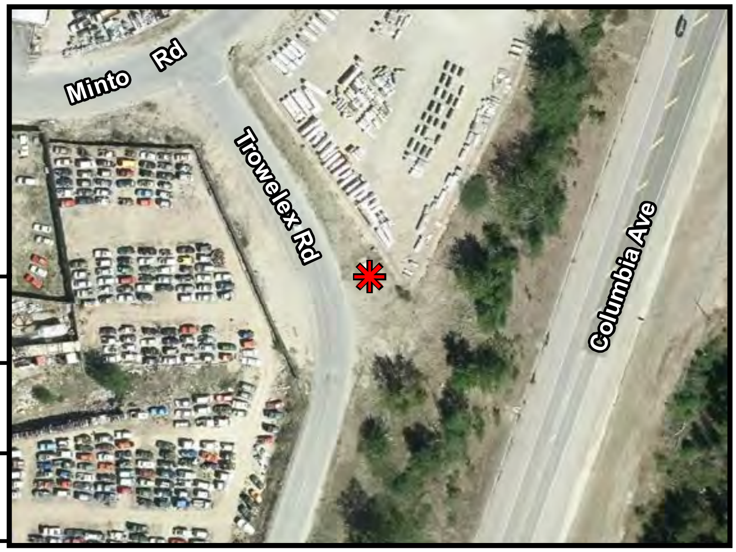
CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Blueberry PRV (a/b)

Asset ID: wCV0053-54



Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
BCA-Burried 2 Valves	1996	Fair	9	2026	$60000		$
					$		$
Minor Equipment							
Flowmeter	1996	Fair	9	2026	$20000		$
					$		$
Structures							
	1996	Good	19	2036	$90000		$
Electrical/Mechanical							
	1996	Good	19	2036	$40000		$

Comments:

Not tied to scada; Confined space entry

URBAN systems

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Southridge PRV

Asset ID: wCV0047

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Burried 2 Valves 150 Ø, 75 Ø	1983	Poor		2017	$60000		$
					$		$
Minor Equipment							
Insertion FM	1996	Good		2033	$20000		$
					$		$
Structures							
	1983	Poor	16	2033	$90000		$
Electrical/Mechanical							
	1983	Poor		2017	$40000		$

Comments:

Very deep chamber (5m); Confined space entry

URBAN systems

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: 33rd ST PRV-9003

Asset ID: wCV0048

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
CMP Culvert Chamber 2-150Ø	1970	Poor		2017	$80000		$
					$		$
Minor Equipment							
S/O Valves	1970	Poor		2017	$30000		$
					$		$
Structures							
	1970	Poor		2017	$90000		$
Electrical/Mechanical							
	1970	Poor		2017	$50000		$

Comments:

Extremely old station; CMP chamber ordered; To be replaced with above ground stations

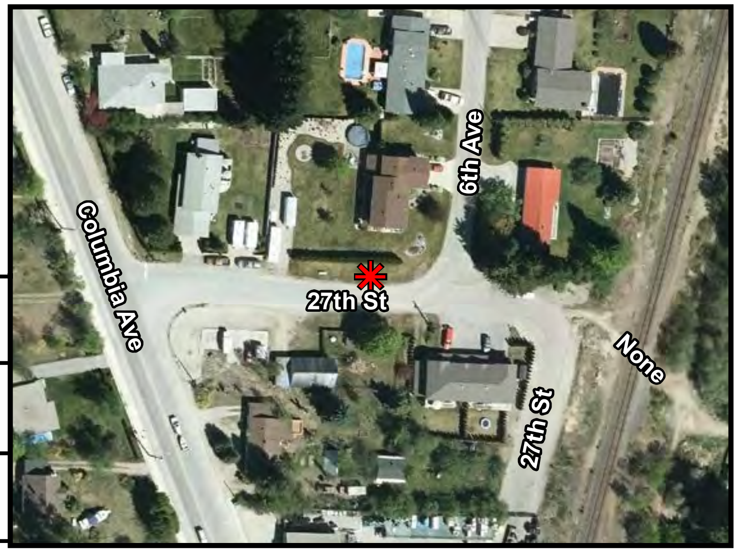
CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: 27th ST PRV-9005

Asset ID: wCV0049



Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Precast MH barrel chamber	1976	Good	9	2026	$60000		$
					$		$
Minor Equipment							
S/O Valves	1976	Good	9	2026	$20000		$
					$		$
Structures							
	1976	Fair	9	2026	$90000		$
Electrical/Mechanical							
	1976	Fair	9	2026	$40000		$

Comments:

Valves have been re-built; Confined space entry

URBAN systems

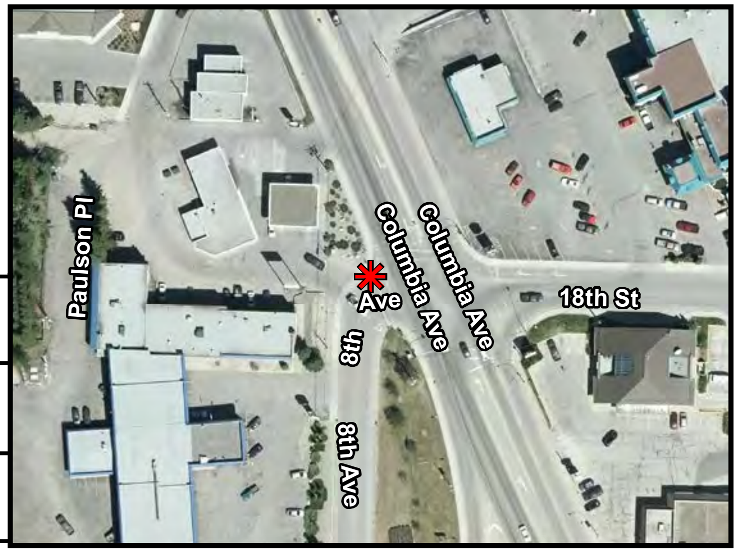
CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Fireside PRV-9007

Asset ID: wCV0050



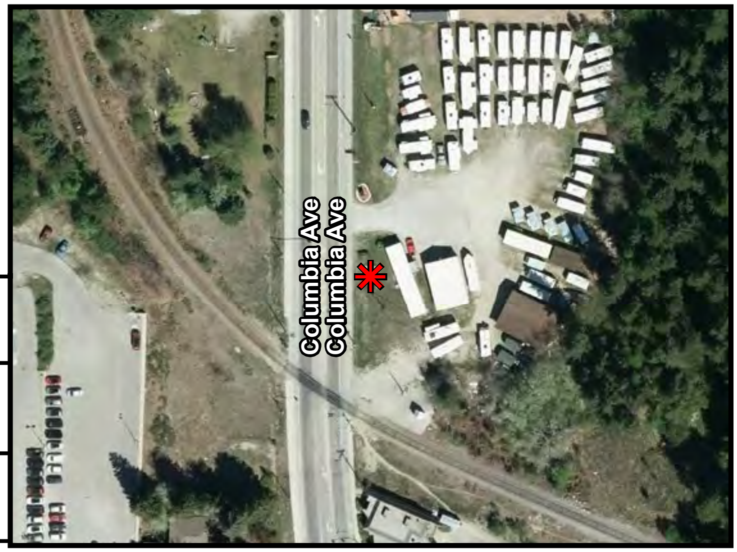
Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
PRV's	1991	Fair	4	2021	$60000		$
					$		$
Minor Equipment							
Valves/Fittings	1991	Fair	4	2021	$20000		$
					$		$
Structures							
	1991	Fair	4	2021	$90000		$
Electrical/Mechanical							
	1991	Fair	4	2021	$40000		$

Comments:

Difficult to maintan; Valves have been serviced; No flow meter; Confined space entry

URBAN systems

CASTLEGAR



Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: 17th ST PRV-9009

Asset ID: wCV0051

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Re-built	2012	Good	25	2042	$60000		$
					$		$
Minor Equipment							
S/O Valves	2012	Good	25	2042	$30000		$
					$		$
Structures							
	2012	Good	45	2062	$90000		$
Electrical/Mechanical							
	2012	Good	25	2042	$40000		$

Comments:

Station was re-built in 2012 to above ground building; 2-150 Ø prv's, flowmeter, scada

URBAN systems

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: 15th ST PRV-9019

Asset ID: wCV0052

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Burried Chamber Concrete	1996	Good	19	2036	$60000		$
					$		$
Minor Equipment							
S/O Valves Meters	1996	Good	19	2036	$30000		$
					$		$
Structures							
	1996	Fair	29	2046	$90000		$
Electrical/Mechanical							
	1996	Fair	19	2036	$40000		$

Comments:

BCA package station; Valves have been re-built; Insertion meters on valves

URBAN systems

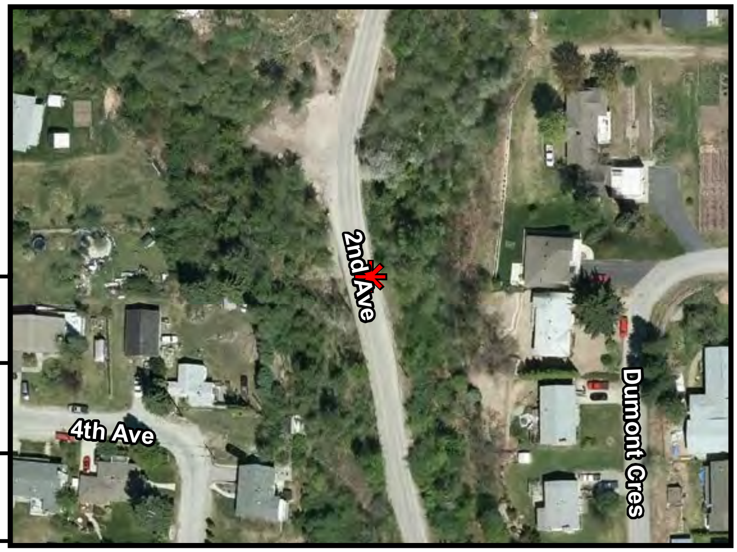
CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: 1st AVE PRV-9033

Asset ID: wCV0055



Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
BCA-Burried concrete 100-150Ø	1990	Fair	3	2020	$60000		$
					$		$
Minor Equipment							
S/O Valves	1990	Fair	3	2020	$20000		$
					$		$
Structures							
	1990	Good	23	2040	$90000		$
Electrical/Mechanical							
	1990	Fair	3	2020	$40000		$

Comments:

Valves have been serviced; Confined space entry

URBAN systems

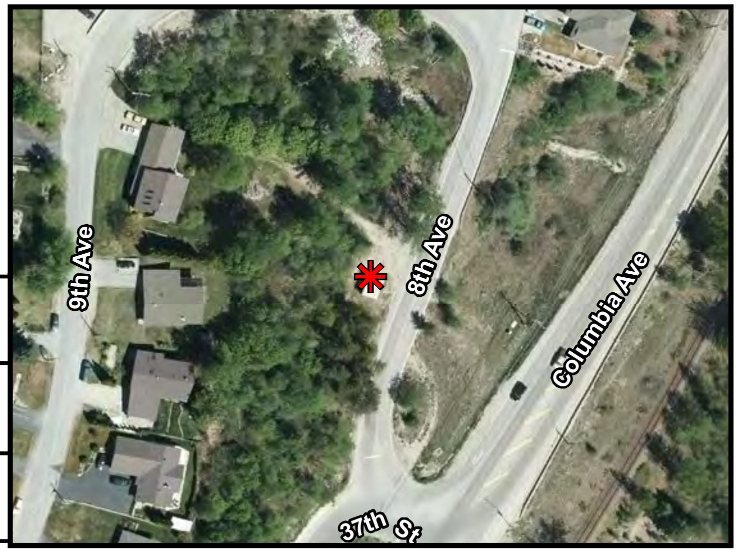
CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Twin Rivers PRV08

Asset ID: wCV0056



Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
75Ø & 150Ø above ground	2008	Good	21	2038	$80000		$
					$		$
Minor Equipment							
3/0 valves flowmeter	2008	Good	21	2038	$30000		$
					$		$
Structures							
	2008	Good	41	2058	$90000		$
Electrical/Mechanical							
	2008	Good	21	2038	$40000		$

Comments:

Above ground pre-cast concrete building

URBAN systems

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: 15th ST PRV-9036

Asset ID: wCV0057

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
BCA-Burried concrete	1990	Fair	3	2020	$60000		$
					$		$
Minor Equipment							
S/O Valves	1990	Fair	3	2020	$20000		$
					$		$
Structures							
	1990	Good	13	2030	$90000		$
Electrical/Mechanical							
	1990	Fair	3	2020	$30000		$

Comments:

Very close to private property; Confined space entry

URBAN systems

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Blueberry Res

Asset ID: wNS0010

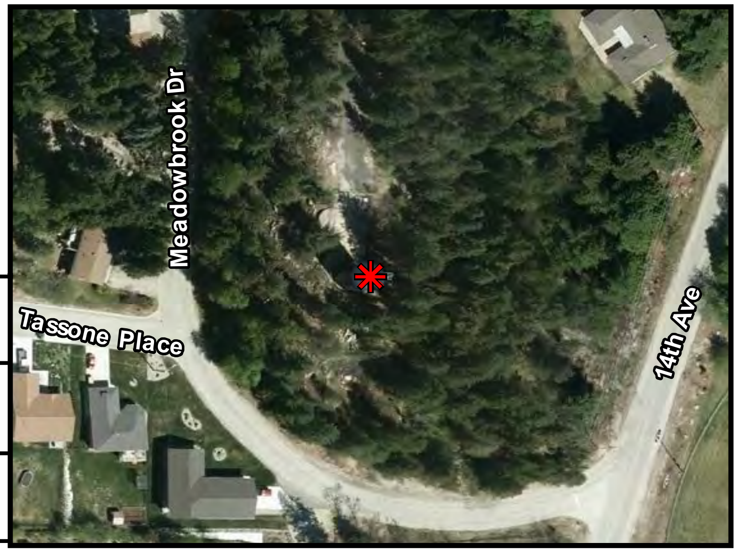
Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Concrete Tank	1980	Good	43	2060	$900000		$
					$		$
Minor Equipment							
Alt Valve	1980	Good	8	2025	$50000		$
					$		$
Structures							
	1980	Good	43	2060	$		$
Electrical/Mechanical							
	1995	Good	8	2025	$20000		$

Comments:

Concrete1.8 ml, 22m Ø, 4.8mH; Base el. 611.7 twl: 616.5 m; Poor water turnover; Fenced; Overflow to creek bed; On scada

URBAN systems

CASTLEGAR



Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Meadowbrook Res

Asset ID: wNS0011

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Bolted Steel	1996	Poor	9	2026	$150000		$
					$		$
Minor Equipment							
Alt Valve	1996	Fair	9	2026	$50000		$
					$		$
Structures							
	1996	Poor	9	2026	$		$
Electrical/Mechanical							
	1996	Fair	9	2026	$30000		$

Comments:

Steel 0.3ml 7.68 m Ø, 9.1m h base el. 609.5, twl 618.6 m

URBAN systems

CASTLEGAR

Project Title:	AMIP - Facilities Assessment
System Type:	Water System
Facility Name:	Meadowlark Res
Asset ID:	wNS0017

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Concrete Tank	1978	Good	41	2058	$1200000		$
					$		$
Minor Equipment							
					$		$
					$		$
Structures							
					$		$
Electrical/Mechanical							
					$		$

Comments:

Concrete tank 2.25 ml, 22 m Ø, 5.8m
base el 490.5m,twl 496.3m

URBAN systems

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Merrycreek Res

Asset ID: wNS0016

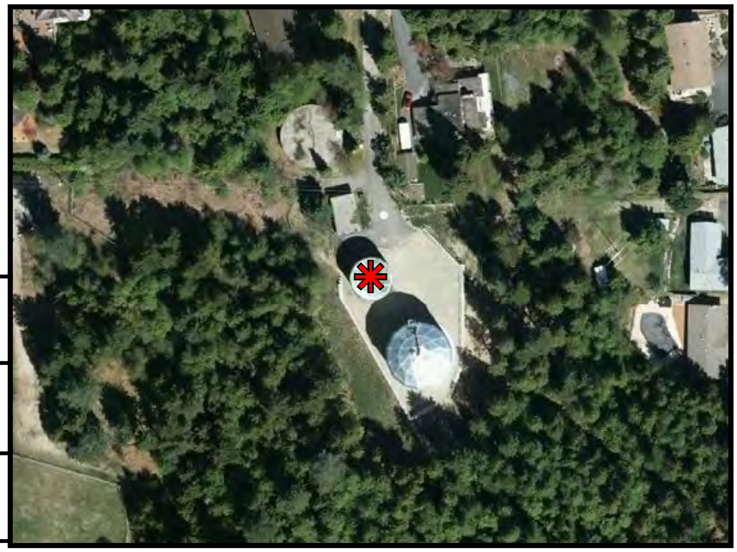
Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Concrete Tank	1978	Fair	41	2058	$450000		$
					$		$
Minor Equipment							
Alt Valve	1978	Poor	1	2018	$50000		$
					$		$
Structures							
	1978	Fair	41	2058	$		$
Electrical/Mechanical							
	1996	Fair	9	2026	$50000		$

Comments:

Concrete 0.9ml; Base el 613.95 m;
Overflow to highway (ditch)

URBAN systems

CASTLEGAR



Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Park 1 Res

Asset ID: wNS0014

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Steel Tank	1965				$		$
					$		$
Minor Equipment							
					$		$
					$		$
Structures							
					$		$
Electrical/Mechanical							
					$		$

Comments:

1.125ml, 11.5m Ø, 9.1 mh; Out of service - to be decomissioned & removed

URBAN systems

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Park 2 Res

Asset ID: wNS0015

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Concrete Tank	1985	Good	48	2065	$570000		$
					$		$
Minor Equipment							
Alt Valve	1995	Good	8	2025	$50000		$
					$		$
Structures							
	1985	Good	48	2065	$		$
Electrical/Mechanical							
	1995	Good	8	2025	$40000		$

Comments:

Concrete: 1.125ml, 15.8m Ø, 6m H;
Base el. 547.5; twl 553.5

URBAN systems

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Park 3 Res

Asset ID: wNS0018

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Steel Tank	1995	Good	28	2045	$1500000		$
					$		$
Minor Equipment							
ALT, Valve	1995	Good	8	2025	$80000		$
					$		$
Structures							
	1995	Good	28	2045	$		$
Electrical/Mechanical							
	1995	Good	8	2025	$50000		$

Comments:

Steel tank: 2.85ml, 18 m Ø, 11.2m h;
Base el. 547.7m, twl 558.9m

URBAN systems

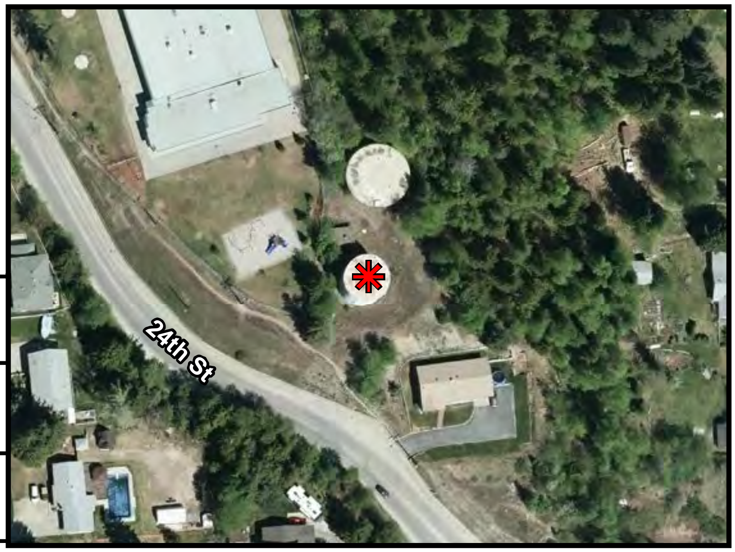
CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: School 1 Res

Asset ID: wNS0012



Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Concrete Tank	1995	Good	58	2075	$570000		$
					$		$
Minor Equipment							
Alt Valve	1995	Fair	8	2025	$50000		$
					$		$
Structures							
	1995	Good	58	2075	$		$
Electrical/Mechanical							
	1995	Fair	8	2025	$20000		$

Comments:

Concrete 1.125ml,15.84m Ø, 4.97m h;
Base el. 511.9m twl: 517.07m

URBAN systems

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: School 2 Res

Asset ID: wNS0013

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Steel Tank	1985	Poor	8	2025	$570000		$
					$		$
Minor Equipment							
Alt Valve	1985	Poor	8	2025	$50000		$
					$		$
Structures							
	1985	Poor	8	2025	$		$
Electrical/Mechanical							
	1985	Poor	8	2025	$20000		$

Comments:

Steel tank, 1.125ml, 12.6m Ø, 9.1m H; Base el. 512.2m twl: 522.0m; To be de-commisioned and replaced at park site

URBAN systems

CASTLEGAR

Project Title: AMIP - Facilities Assessment

System Type: Water System

Facility Name: Airport Res

Asset ID: wNS0019

Major Equipment	Install Year	Cond -ition	Remaining Life	Replace		Upgrade	
				Year	Cost	Year	Cost
Concrete Tank	1960	Fair	23	2040	$60000		$
					$		$
Minor Equipment							
Level Control	1995	Fair	8	2025	$20000		$
					$		$
Structures							
	1960	Fair	23	2040	$		$
Electrical/Mechanical							
	1995	Fair	8	2025	$20000		$

Comments:

URBAN systems