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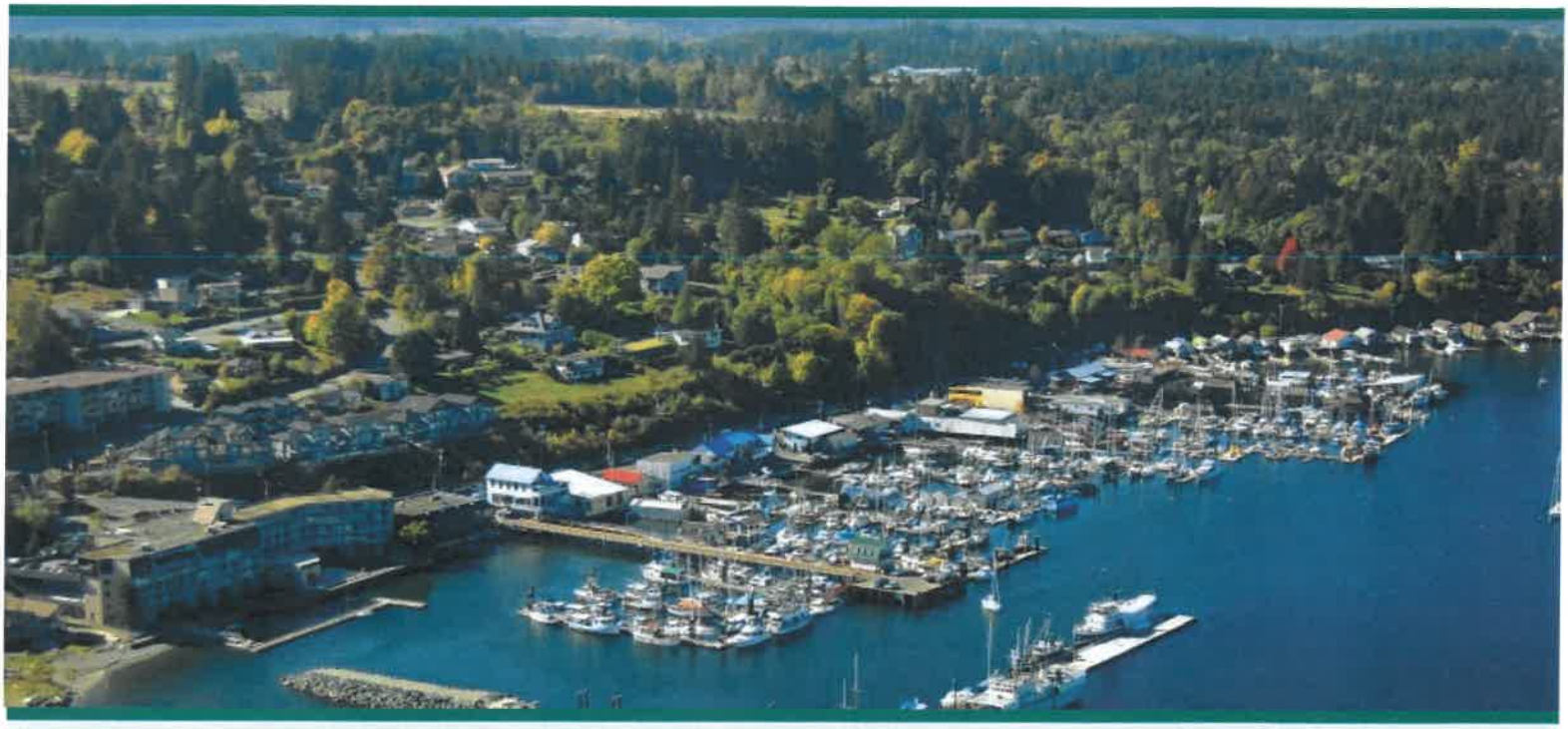

Cowichan Bay Waterworks District

2024 Water Model Update

October 9, 2024

Submitted to: Cowichan Bay Waterworks District
Prepared by McElhanney

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Executive Summary

Cowichan Bay Waterworks District (the District) engaged McElhanney Ltd. (McElhanney) to review and update the hydraulic model of its water distribution system, aiming to assess current conditions, confirm past recommendations, and anticipate future requirements. This summary encapsulates the key findings and strategic recommendations from the comprehensive analysis.

Model Review and Update

The District's existing hydraulic model was updated using Bentley OpenFlows WaterCAD CONNECT Edition. The process included:

- Reviewing the existing utility mapping of the water network against the model.
- Reviewing the specifications for the water facilities, including reservoirs, pressure reducing valve (PRV) stations, and pump stations.
- Incorporating network upgrades that have been completed since the model was last updated in 2021.

Key Findings

Fire Flow Capacity: The updated hydraulic model indicates that fire flows in certain residential areas, particularly those with smaller-diameter mains and dead-end segments, do not meet the required fire flow standards. Many of these areas rely on older asbestos cement pipes, which are undersized for current fire flow requirements, and minimal looping of mains, contributing to the deficiencies.

Reservoir Storage: The reservoir capacities for Pressure Zone 1 (PZ1) and Pressure Zone 2 (PZ2) are each sufficient to meet both existing and future demands through 2044.

Well Capacity: The system's well capacity is adequate for both existing and future demands through 2044. However, there is a risk of insufficient supply if Valleyview Well #1 is offline. The system's ability to meet Maximum Day Demands (MDD) in such a scenario would fall short, indicating vulnerability during emergency or maintenance events.

Pressure Issues: Pressure across the network generally remains within acceptable limits, but some areas, especially those near the Ordano Road Reservoir and at higher elevations along Cowichan Bay Road and Hillbank Road, experience lower pressures, occasionally falling below the minimum requirement of 40 psi. High-pressure zones remain within acceptable limits, but some areas are nearing the upper threshold of 100 psi.

Bench Elementary School: Fire flow for Bench Elementary School remains below the 200 L/s requirement outlined in the District's bylaw. In general, schools are equipped with additional on-site fire protection, such as building sprinklers, which reduces the need for higher external fire flows. Additionally, the school's isolated location, with no buildings within 30m and most structures more than 80m away, helps minimize fire risk. The combined external and on-site fire protection should be reviewed to determine if additional upgrades are required to further increase the fire flow available in this area.

1. Introduction

McElhanney was retained by the Cowichan Bay Waterworks District (CBWD/ the District) to update the hydraulic model of their existing water distribution network. The hydraulic model enables detailed analysis and simulation of the water distribution system's performance under various operating conditions. It is designed to help identify the impact of different demand scenarios, including Average Day Demand (ADD), Peak Hour Demand (PHD), and Maximum Day Demand (MDD). Additionally, the model facilitates the visualization of potential problem areas within the network, such as locations susceptible to low pressures or high watermain velocities and can be used to test the efficacy of proposed network expansions or modifications.

By predicting how the system behaves under different conditions, the model provides a valuable tool for proactive maintenance planning and emergency response preparation. This ensures that CBWD can continue to manage its water resources effectively and maintain a reliable supply to all users.

1.1. WATER NETWORK OVERVIEW

The District manages a water supply and distribution system serving Cowichan Bay and Electoral Areas C and D of the Cowichan Valley Regional District (CVRD). A recent extension now includes water provision to the Tommy Road area within the Cowichan Tribes' Est-Patrolas 4 Reserve. The distribution network comprises approximately 26km of watermains, 90 fire hydrants, and 1100 service connections. The water sources for the system are two groundwater wells located at the Valleyview Center at the south end of the service area.

There is one groundwater well at the District office, known as the Pavenham Road/Office Well that has more recently been taken out of service due to capacity issues. Additionally, there is the Kidd Well, situated northwest of the main service area, which has been out of use for several years.

Three above-ground storage reservoirs supply two pressure zones, regulated by pressure reducing valve stations. A booster pump station is situated near the Office Reservoir, with a newly constructed booster pump station near the Ordano Reservoir. A map of the existing water system is provided as **Figure A1** in **Appendix A**.

Figure 1 following provides a schematic overview of the system operation.

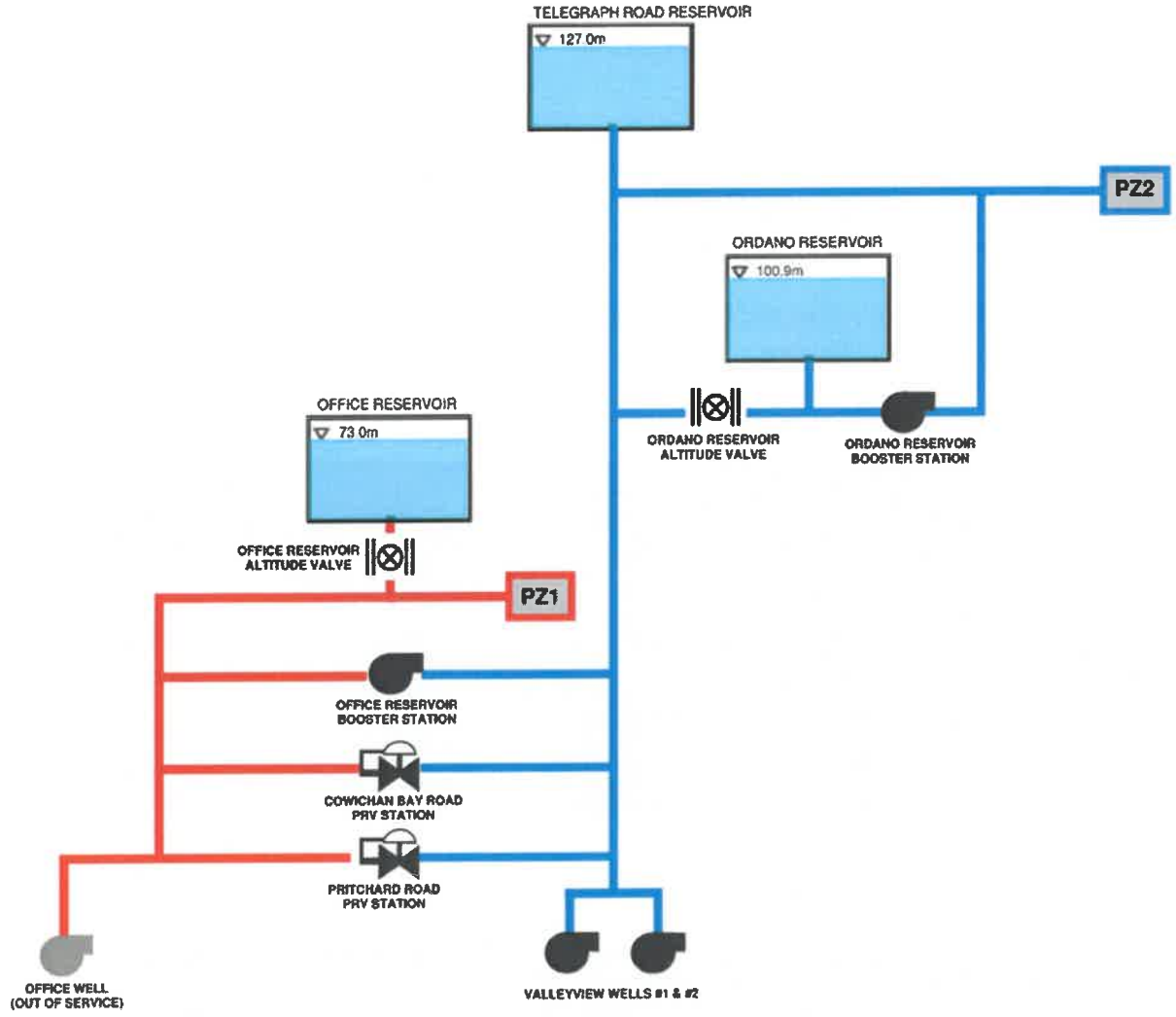

Figure 1: Cowichan Bay Water District Water System Overview

1.2. SOFTWARE DETAILS

The hydraulic model for CBWD was updated using Bentley OpenFlows WaterCAD CONNECT Edition Update 3, Version 10.03.03.72. This software supports detailed hydraulic analysis and simulation capabilities. For geospatial analysis and map creation, Esri Inc. ArcGIS Pro Version 3.1.3 was used.

1.3. BACKGROUND DOCUMENTS

The District provided McElhanney with the water model, which was updated by Associated Engineering (AE) as part of the 2021 Water System Master Plan Update, along with a copy of the associated report. The primary data source for reviewing and updating the hydraulic water model was the existing AutoCAD database of the network, provided by the District. Additional record drawings were also supplied by CBWD.

The District also provided the Cowichan Bay Water Works Hydrant Flow Testing – 2023 Report, which contains hydrant test data for all the District's hydrants.

1.4. DESIGN CRITERIA

The following general design criteria, within **Table 1** through **Table 5** are based on the Cowichan Bay Waterworks District Subdivision Water Regulation Bylaw No. 323 – 2020 (the Bylaw). These design criteria were used in the update and analysis of the water model.

It was assumed that all well pumps and booster pumps were off during all ADD scenarios, and all were on during MDD + FF and PHD scenarios.

Table 1: Cowichan Bay Waterworks District Fire Flow Requirements

Property Type	Fire Flow Required (L/s)	Duration (Hours)
Single-Family Housing	60	1.50
Churches, Apartments, Townhouses	90	2.00
Commercial (> 1,500 m^2)	150	2.00
Institutional (> 1,500 m^2)	200	2.00
Light Industrial (> 4,500 m^2)	225	3.00

Table 2: Cowichan Bay Waterworks District Watermain Maximum Velocities

Operational Condition	Maximum Allowable Velocity (m/s)
Fire Flow Conditions	3.5

Table 3: Cowichan Bay Waterworks District Water Network Pressure Requirements

Design Pressures	Pressure (kPa [psi])
Maximum Desirable	700 [100]
Minimum, MDD	275 [40]
Minimum, PHD	240 [35]
Minimum, MDD + Fire at Hydrant	140 [20]
Minimum, Static at Building Site	275 [40]

Table 4: Cowichan Bay Waterworks District Bylaw Per Capita Demands

Residential Demands	Per Capita (L/capita/day)
Average Day Demand (ADD)	500
Maximum Day Demand (MDD) [2.2 x ADD]	1,100
Peak Hour Demand (PHD) [4 x ADD]	2,000

Table 5: Cowichan Bay Waterworks Bylaw Population Density

Land Use	Description	Average Occupancy (Persons per Unit)
Low Density Residential	< 20 units per hectare	2.6
Medium Density Residential	20 – 50 units per hectare	2.0
High Density Residential	> 50 units per hectare	1.4

2. Existing Condition (2024) Physical Model Update

2.1. PRESSURE ZONE CONFIGURATION

The District distributes treated water into two pressure zones:

- Pressure Zone 1 (PZ1): Lower pressure zone with a hydraulic grade line (HGL) of approximately 73.0m, set by the top water level (TWL) of the Pavenham Road/Office Reservoir
- Pressure Zone 2 (PZ2): Upper pressure zone with an HGL of approximately 127.0m set by the TWL of the Telegraph Road Reservoir

Water can flow from PZ2 to PZ1 via two pressure reducing valve (PRV) stations, both set to 73.0m HGL. One PRV station is located on Wilmot Road at the intersection of Pritchard Road, and the other on Cowichan Bay Road near Austin Place.

A booster station at the Office Reservoir site on Pavenham Road also enables pumping from PZ1 to PZ2.

2.2. WATERMAIN DETAILS

McElhanney reviewed the provided 2021 water model against the District's water network CAD database and updated the model details where discrepancies were identified. McElhanney incorporated updates to the physical attributes of the model to reflect network upgrades completed since the model was last updated by AE in 2021.

The existing distribution network consists of approximately 25.8km of watermain, with the vast majority being Asbestos Cement (AC) or Polyvinyl Chloride (PVC). Based on available records, the AC mains were generally installed from the late 1950s to the late 1980s, while the PVC mains were mostly installed from the mid-1980s to the present day. However, some PVC mains in the provided water model are labeled with installation years as far back as 1958.

Table 6 and **Table 7** outline the percentage of each material and the percentage of each pipe diameter within the District's water network. **Figure A1** included in **Appendix A** provides a map of the pipe diameters and pipe materials for the entire water network.

Table 6: Cowichan Bay Waterworks District Network Pipe Material Breakdown

Material	Total Length (km)	Percentage of Total Pipe Length
Asbestos Cement (AC)	5.5	21.2%
SCH 40 Steel (ST)	0.6	2.6%
Polyethylene (PE)	0.2	0.6%
Polyvinyl Chloride (PVC)	19.5	75.6%

Table 7: Cowichan Bay Waterworks District Network Pipe Diameter Breakdown

Diameter (mm)	Total Length (km)	Percentage of Total Pipe Length
<100	0.9	0%
100	4.2	17.3%
150	13.0	34.1%
200	4.8	29.2%
250	2.9	6.6%

2.3. GROUNDWATER WELLS AND WATER TREATMENT

The District supplies water to customers through three operational groundwater wells, with two additional wells currently not in use.

- **Two Valleyview Wells (#1 and #2) – In Service**
    - The Valleyview Wells are the main water source for the District and supply PZ2 directly.

  - Well #1 has an original capacity of 31 L/s but is currently providing 23 L/s due to the size of the existing pump.
  - Well #2 is designed for 38 L/s but is pumping at 6 L/s due to sand production issues.
  - The disinfection system for these wells was upgraded in 2021.

- **The Office Well – Out of Service**
  - The Office Well was occasionally used to supply the system under high demand scenarios and pumps to PZ1.
  - This well is having supply issues and CBWD is currently looking into decommissioning it.

- **The Kidd Well – Out of Service**
  - The Kidd Well has not been used for several years due to aesthetic complaints from customers. It is capable of pumping to PZ1.

2.4. TREATED WATER STORAGE

Treated water storage for the District's water system is provided by three above-ground steel reservoirs. Their capacities and TWLs are detailed in the following table.

Table 8: CBWD Existing Potable Water Reservoir Details

Reservoir	Volume (m^3)	Top Water Level (m)
Pavenham Road/ Office (PZ1)	545	73.0
Ordano Road (PZ2)	1,568	100.9
Telegraph Road (PZ2)	734	127.0
Total	2,847	

The Ordano Reservoir has a TWL below the HGL of PZ2. It is filled via an altitude valve. A booster station at the reservoir site is able to pump the water up to the HGL of PZ2.

The Telegraph Road reservoir is very tall and narrow (29.6m in height and 5.6m in diameter), which can result in significant drops in water levels during periods of high demand, causing fluctuations in system supply pressures.

3. Existing (2024) Demand Scenario Creation

The following three demand scenarios were created for the District's updated hydraulic water model to reflect the current (2024) demands:

- Average Day Demand (ADD)
- Peak Hour Demand (PHD)
- Maximum Day Demand + Fire Flow (MDD + FF)

3.1. DEMAND ALLOCATION

The CVRD updated their Official Community Plan (OCP) in 2023, which included an estimated annual population growth rate of 1% for Electoral Area D, where the majority of the CBWD is located. The 2021 AE report provided an estimate for the service population in 2021, which was used as the baseline for the population projections for this water model update. Starting with an estimated 2021 population of 2,279 for the area serviced by CBWD, the projected population for 2024 is 2,348.

As described in the 2021 AE Report these ADD demands are based on the measured water use from 2018 to 2021 rather than the Bylaw per capita demands. For assigning the MDD and PHD demands the MDD:ADD ratio of 2.2:1 and PHD:ADD ratio of 4:1 from the CBWD Bylaw were used. Hourly water use data is not available but based on records of 2018 to 2021 the MDD:ADD ratio ranged from 1.5:1 to 1.8:1, so the 2.2:1 ratio used is more conservative than the measured values.

Table 9: Existing (2024) Water Demands for 2024 Population of 2,348

Demand Scenario	2024 Total Demand (L/s)	Equivalent Per Capita Demand (L/capita/day)
ADD	8.45	311
MDD	18.59	684
PHD	33.79	1,243

3.2. FIRE FLOW REQUIREMENTS

Fire flow requirements were maintained from the original AE model, with required fire flows split based on the following categories:

- Single-family residential: 60 L/s
- Multi-family residential/commercial: 150 L/s

There is one existing school, Bench Elementary, which, based on the District's Bylaw, requires a minimum fire flow of 200 L/s.

3.3. MISCELLANEOUS MODEL ADDITIONS

In addition to the previously mentioned model updates, the following enhancements were made to increase the model's accuracy and usability:

- Pressure zones were assigned to the nodes within the model.
- Pump definitions were updated based on our best estimates of the pumps installed at the existing wells and booster stations.
    - Generally, the Total Dynamic Head (TDH) of the existing pumps was not available, only flow rates. The TDH was estimated based on the intended use of the pump. For instance, the Ordano Booster Station is intended to pump water from Ordano Reservoir up to a HGL to service PZ2.
- Addition of the Ordano fire pump to the model.
- Update of the fire flow alternative to include a maximum velocity of 3.5 m/s and a minimum residual pressure of 20 psi as per the CBWD Bylaw.
- Addition of various annotations and color coding for model analysis.
- Creation of ADD, MDD + FF, and PHD scenarios for 2024, 2029, and 2044 to align with the 5-year and 20-year scenarios created in the 2021 Cowichan Bay Water Master Plan.
- Update of pump operations with pumps running for PHD and MDD + FF and off for ADD scenarios.

3.3.1. Reservoir and Wells Selection Set

A selection set for nodes to be excluded from the minimum pressure requirements in the fire flow scenario was created. This setup ensures proper operation of the fire flow scenario, as "removed" model assessment nodes include those near reservoirs, pump stations, and PRV stations, which can typically be less than 20 psi. Including these nodes can prevent the fire flow scenario from running properly. The fire flow module is configured such that a value of 20 psi is the minimum residual pressure allowed in the model within each specific pressure zone during the fire flow run. Generally, the following nodes have been excluded from the fire flow selection set and should continue to be excluded as further updates are made to the model:

- Nodes at reservoirs – static pressure is too low here and will usually prevent the fire flow scenario from providing any results.

- Nodes along reservoir distribution mains, prior to any fire hydrants – these locations likely have low static pressure due to their proximity to the reservoir, which can prevent the model from providing any results.

Importantly, it has been confirmed that none of the above nodes are connected to residential connections, for which the minimum 20 psi pressure requirement would apply during fire flows.

4. 5-Year (2029) and 20-Year (2044) Horizon Water Model Scenario Creation

This section outlines the creation of water model scenarios for the 5-year (2029) and 20-year (2044) horizons. These scenarios are essential for planning and ensuring that CBWD can meet future water demands based on projected growth rates.

4.1. POPULATION GROWTH AND DEMAND ESTIMATES

The CVRD updated their Official Community Plan (OCP) in 2023, which included an estimated annual population growth rate of 1% for Electoral Area D, where the majority of the CBWD is located. The 2021 AE report provided an estimate for the service population in 2021, which was used as the baseline for the population projections for this water model update.

Table 10 includes the estimated demands for the 5-year horizon (2029) and the 20-year horizon (2044) based on this annual population growth rate. Starting with an estimated 2024 population of 2,348 this results in a population of 2,468 for 2029, and 2,865 for 2044.

Table 10: Estimated 5-Year (2029 – Population of 2,468) and 20-Year (2044 – Population of 2,865) Horizon Demands

Demand Scenario	Per Capita Demand (L/capita/day)	2029 Total Demand (L/s)	2044 Total Demand (L/s)
ADD	311	8.88	10.31
MDD	684	19.53	22.68
PHD	1,243	35.52	41.23

4.2. DEMAND ALLOCATION AND DISTRIBUTION

4.2.1. Future Demand Distribution

Since dramatic population growth or large developments that would significantly impact overall demand distribution are not expected, the future demands for the 2029 and 2044 scenarios were increased universally based on the 1% growth rate. This approach maintains the same water network demand distribution as provided in the model initially created by AE.

4.2.2. Note on Methodological Limitations

While the methodology employed for the demand distribution model does not guarantee perfect accuracy, it is a reasonable approach given the scope and constraints of this assignment. The assumptions and estimates are based on the best available data and are intended to provide a reasonable framework for understanding future water demands. This approach allows for informed planning and decision-making, acknowledging that the precision of the model is aligned with the level of detail currently available.

It is important to recognize that water models are 'living files' that should be continually updated as new data becomes available and as conditions evolve. Regular updates will ensure that the model remains relevant and effective in guiding future infrastructure decisions and water management strategies.

5. Reservoir Capacity Review

The storage requirements for the CBWD pressure zones are based on existing land uses within the area. The formula used for calculating these requirements is:

$$Total\ Required\ Storage\ Volume = A + B + C$$

Where:

$$A = Fire\ Storage\ (Bylaw\ requirement\ of\ 200\ L/s\ for\ the\ FUS\ required\ duration\ of\ 2.5\ hours)$$

$$B = Equalization\ Storage\ (25\%\ of\ MDD)$$

$$C = Emergency\ Storage\ (25\%\ of\ A + B)$$

5.1. SUMMARY OF TOTAL AVAILABLE POTABLE WATER STORAGE

The following table provides a summary of the total potable water storage within the CBWD water system. There is a total capacity of just over 2.8 ML (2,847 m³). As PZ2 operates at a HGL higher than the Office Reservoir, the Office Reservoir has been excluded from the reliable water storage for PZ2. The Office Reservoir site has an existing booster pump that is able to pump between PZ1 to PZ2, but this booster station capacity is only 9.5 L/s.

While the FUS allows offsetting fire storage requirements with pumped water sources, given that the base water source is reliable and the pump system has emergency power, standard practice often still favors ensuring all storage is provided through direct gravity feed, which is what has been presented in **Table 11. Appendix B** provides the detailed calculations for the reservoir storage requirements.

Table 11: Existing Reservoir Capacities in m^3

	Treated Water Storage Capacity
Office Reservoir	545
Ordano Road Reservoir	1,568
Telegraph Road Reservoir	734
PZ1 Total Reservoir Capacity	2,847
PZ2 Total Reservoir Capacity	2,302

5.2. PRESSURE ZONE 1 RESERVOIR CAPACITY REQUIREMENTS

Table 12 presents the reservoir storage requirements for PZ1 for 2024, 2029, and 2044, along with the existing available storage. Based on these calculations, there is sufficient treated water storage for PZ1 up to and including 2044. Detailed calculations can be found in **Appendix B**.

For fire storage *(A)*, a maximum requirement of 150 L/s for 2.0 hours has been used for PZ1, which is the Bylaw requirement for commercial areas. This was based on a review of the aerial imagery available and the CVRD OCP Land Use Designation Maps LD1.3 and LD1.4 (2023-06-28)

Table 12: Pressure Zone 1 Reservoir Capacity Requirements in m^3

	2024	2029	2044
Fire Storage (A)	1,080	1,080	1,080
Equalization Storage (B)	134	141	163
Emergency Storage (C)	303	305	311
Total (A + B + C)	1,517	1,526	1,554
Existing Reservoir Capacity	2,847	2,847	2,847
Storage Surplus (+ve) or Deficiency (-ve)	**+1,330**	**+1,321**	**+1,293**

5.3. PRESSURE ZONE 2 RESERVOIR CAPACITY REQUIREMENTS

For fire storage *(A)*, a maximum requirement of 200 L/s for 2.0 hours has been used for PZ2, which is the Bylaw requirement for institutional areas. Based on a review of the aerial imagery available and the

CVRD OCP Land Use Designation Maps LD1.3 and LD1.4 (2023-06-28), PZ 2 includes one school (Bench Elementary at 1501 Cowichan Bay Road). There is one industrial property at 1455 Cowichan Bay Road that is within CVRD, but it has been confirmed by the District that this property is not within the CBWD service area.

Table 13 presents the reservoir storage requirements for PZ2 for 2024, 2029, and 2044, along with the existing available storage, illustrating that based on the estimated population growth PZ2 has sufficient storage capacity for up to and including the 20-year horizon (2044).

Table 13: Pressure Zone 2 Reservoir Capacity Requirements in m^3

	2024	2029	2044
Fire Storage (A)	1,440	1,440	1,440
Equalization Storage (B)	268	281	326
Emergency Storage (C)	427	430	442
Total (A + B + C)	2,135	2,151	2,208
Existing Reservoir Capacity	2,302	2,302	2,302
Storage Surplus (+ve) or Deficiency (-ve)	**+167**	**+151**	**+94**

6. Well Capacity Review

The following table shows reported well capacities for the existing wells and the capacities of the existing pumps installed at each of the wells.

Table 14: Existing Well Capacity and Well Pump Capacity Overview

	Reported Well Capacity (L/s)	Existing Well Pump Capacity (L/s)
Valleyview Well #1	38	23
Valleyview Well #2	6	6
Total Capacity	44	29
2044 MDD	22.7	22.7

Based on a total MDD for 2044 of 22.7 L/s for CBWD, the existing pumps appear to be of adequate size. However, if the largest well is offline, the capacity would drop to 6 L/s, which is insufficient to meet the 2044 MDD or even the 2024 MDD of 18.6 L/s.

7. Existing Conditions (2024) Model Results

The following sections provide a brief analysis of the model results for the Existing (2024) Conditions scenarios. This analysis focuses on how closely the existing water network meets CBWD's level of service targets, as outlined in the Subdivision Water Regulation Bylaw. **Figures A3** through **A5** in **Appendix A** provide visual representations of the following results.

7.1. EXISTING (2024) AVERAGE DAY DEMAND

The 2024 ADD results, illustrated in **Figure A3** within **Appendix A**, identify areas with pressures exceeding the maximum static pressure limit of 100 psi specified in the Subdivision Water Regulation Bylaw. In these areas, the highest pressure modeled is 102 psi. High pressures are generally avoided as they can increase the risk of leaks and bursts, accelerate wear and tear on the mains and associated infrastructure, and may lead to appliance failures and leaks within homes and businesses. As this is an existing condition, and these pressures are nearly within the District's maximum pressure limit, no changes will be recommended to specifically address these areas.

The District operates as just two pressure zones, which offers significant benefits, including simplified infrastructure management with fewer pumps, pressure reducing stations, and reduced complexity in pipe network design. Unless the District has a significant history of pipe network failures in these high-pressure areas, introducing additional pressure zones is not recommended.

A few areas within the District fall below the minimum static pressure requirement of 40 psi. These include the following areas:

- Immediately downstream of both of the existing PRVs
- Immediately downstream of the Ordano Road Reservoir and Booster Station
- The high point at the south end of the watermain on Hillbank Road
- Along Cowichan Bay Road, south of Koksilah Road
- Along Koksilah Road
- The far eastern portion of the service area, east of the Telegraph Road Reservoir which services Wood Road, Nelson Road, Sears Road, and Mindy Road.

Recommendations to address low system pressure issues are included in **Table 15** following in **Section 8.2**.

7.2. EXISTING (2024) PEAK HOUR DEMAND

The 2024 PHD results, illustrated in **Figure A4** within **Appendix A**, generally align with the 2024 ADD results. However, as the model was run assuming that the existing booster pumps would be running during the PHD scenario, the overall pressure is slightly increased. The highest pressure throughout the

network ranges increases from 102 psi to 114 psi. This is based on assumed pump design points as pump TDHs were generally not available at the time of this assessment. The model should be updated and these should be confirmed if additional pump details are made available.

Figure A4 also illustrates the velocities through the mains during the 2024 PHD scenario. The District's Bylaw only specifies a maximum allowable velocity during MDD + FF scenarios, but it is common practice to also have a maximum allowable velocity during PHD. A common target for this is 2.0 m/s, so we have included this as an additional level of assessment for the District's network. As shown in **Figure A4**, none of the mains reach velocities above this 2.0 m/s during the 2024 PHD scenario.

7.3. EXISTING (2024) MAXIMUM DAY DEMAND PLUS FIRE FLOW

Figure A5 in **Appendix A** provides an overview of the available fire flows throughout the District under the 2024 MDD scenario.

In general, the following types of areas stand out as not meeting the assigned fire flow targets when reviewing **Figure A5**:

- **Residential areas with small diameter mains:** These include dead ends and loops with small diameter mains. For example, the 100mm AC watermain on Bicks Road, the 100mm AC watermain on Glen Road, and the 100mm AC watermain on Fenwick Road.
- **Long dead-end mains:** This is particularly in relation to the 150mm PVC 3.5km dead-end watermain on Cowichan Bay Road from Wessex Road to the out-of-service Kidd Well.
- **Residential areas with low static pressures:** The far eastern portion of the service area, east of the Telegraph Road Reservoir which services Wood Road, Nelson Road, Sears Road, and Mindy Road has low static pressure and, as a result, has low available fire flows.
- **Non-residential/commercial areas with inadequately sized mains:** For example, the 100mm AC watermain within the commercial area along the water on Cowichan Bay Road. This main is twinned with a 150mm PVC watermain, but neither are able to provide the District's required fire flow of 150 L/s for commercial areas.

It has been assumed that areas that do not have existing fire hydrants are not included in the fire service area, including Koksilah Road and the watermain from Koksilah Road to Ordano Road Reservoir, and the west end of Wilmot Road. Consequently, watermain upgrades to increase fire flow and the addition of hydrants to these areas have not been included in the proposed upgrades for this reason.

8. Recommended Infrastructure Upgrades

This section outlines the recommended infrastructure upgrades for CBWD. The recommendations are prioritized based on several key factors to ensure efficiency, safety, and long-term reliability.

8.1. UPGRADE CRITERIA

The following criteria and recommendations were used to prioritize the recommended infrastructure upgrades:

- **Avoid Upgrading Recently Installed Pipes:** Focus on older infrastructure and exclude pipes installed in 2000 or later from upgrade recommendations.

- **Target High Impact/High Population Density Areas:** Target upgrades in areas with high population density and significant impact, particularly for 2029 upgrades that would be completed within a relatively short timeframe.

- **Safety and Fire Flow Improvements**: Prioritize areas where fire flows are significantly below the required levels or where very low fire flows are available, enhancing safety.

- **Consider Age and Condition:** Base recommendations on the age of the infrastructure, with the understanding that upgrades can be adjusted based on actual conditions and CBWD needs. Pipes with no issues may remain in service longer. AC pipes installed between the 1950s and 1970s will be 70 to 90 years old by 2044 and have all been recommended for replacement.

8.2. GENERAL CONSIDERATIONS

In addition to the upgrade criteria, the following general considerations are provided:

- **Flexible Upgrade Options (A and B):** Presented as alternative upgrade paths to accommodate District preferences/budgets for upgrades that are intended to fulfill the same general goal.

- **New Source Water Integration**: The 2021 AE Report recommended investigation into a new water source. If a new source is added to the network this could change which distribution system upgrades are required and/or change the prioritization of the upgrades.

- **Minimum Pipe Size:** Upgraded pipes are recommended to be a minimum of 200mm in diameter to provide more flexibility for future potential land uses. Generally, a 200mm main fed from one direction is able to provide the multi-family residential minimum of 90 L/s without going over the 3.5 m/s velocity requirement, and a looped 200mm fed from two directions is generally able to convey the minimum commercial requirement of 150 L/s without exceeding this velocity target. However, increasing pipe size to improve fire flows can also lead to increased stagnation issues.

- **Water stagnation and Flushing Program:** Areas with long dead-end mains, which are present in the CBWD water network, are prone to water stagnation, which can lead to poor water quality. Implementing a regular flushing program is essential to maintain water quality. This program should focus on areas with low water turnover to prevent sediment buildup and biofilm formation. Regular flushing helps ensure that residents receive clean and safe water and reduces the risk of taste and odor issues. Additionally, increasing pipe size helps with fire flows but can exacerbate stagnation issues, making regular flushing even more critical.

- **Maintain Original Fire Flow Distribution:** The same fire flow requirement distribution as the original AE report/water model has been maintained for our analysis. The OCP Land Use mapping and aerial imagery from Google Maps was reviewed to ensure general accuracy but this distribution was not reviewed in detail.

- **Fire Flow Constraints:** Fire flows in the model are restricted based on maximum velocity and minimum residual pressures from the Bylaw's design criteria. Hydrant test results in the field may have more flow as this test method only measures residual pressure at one nearby hydrant and extrapolates for maximum available flow.

Error! Reference source not found. following provides a summary of the recommended distribution system upgrades. The Upgrade ID numbers correspond to **Figures A6** and **A10** within **Appendix A**. The first two digits (i.e. 29 or 44) correspond to the scenario in which the upgrade has been recommended, and the second two digits provide the prioritization of the upgrades.

Table 15: Proposed 5-Year (2029) and 20-Year (2044) Distribution Network Upgrades

Upgrade ID	Location	From	To	Length (m)	Existing Size (mm) and Material	Existing Pipe Installation Year	Proposed Size (mm) and Material	Description & Rationale
2029 Proposed Upgrades								
29-01	Cowichan Bay Road	Hydrant North of Existing Twinned Mains	Wilmot Road	520	150mm PVC	1958	200 mm PVC & 250 mm PVC	Upgrade of existing main along Cowichan Bay Road commercial strip to provide adequate fire flows – minimum 150 L/s.
29-02	McGill Road	Ordano Reservoir	Rondeault Road	70	150mm PVC	1974	200 mm PVC & 250 mm PVC	Upsize of watermain from Ordano Reservoir to where network looping begins to increase fire flows in the central area of the network.
29-03	Telegraph Road Reservoir	N/A	N/A	N/A	N/A	N/A	N/A	Addition of booster pump station to increase fire flows to the neighbourhood east of Telegraph Road Reservoir.
2044 Proposed Upgrades								
44-01A	Cowichan Bay Road	Pritchard Road	Kidd Well	2,800	2,500 m of 150 mm PVC 300 m of 200mm PVC	1985 (150mm) 2018 (200mm)	300 mm PVC	Option A: Upgrade of existing 150mm diameter dead end main to increase fire flow availability in this area.
44-01B	Cowichan Bay Road	N/A	N/A	N/A	N/A		N/A	Option B: Addition of a fire pump to provide a minimum 60 L/s to this area of Cowichan Bay Road and Hillbank Road.
44-02	McGill Road	Pavenham Road	Rondeault Road	360	150 mm AC	1974	200 mm PVC	Replacement of aging AC watermain, significant main that supplies water to a large area of the network.
44-03	Cowichan Bay Road	Wilmot Road	Pritchard Road	160	150 mm AC	1958	200 mm PVC	Upsizing of existing watermain to provide multi-family residential fire flow requirements to this area.
44-04	Valleyview Well	N/A	N/A	N/A	N/A	N/A	N/A	Addition of a new well at the Valleyview Well Location to increase reliable well capacity and also increase available fire flows in southern section of distribution network including the southern commercial area.
44-05	Hillbank Road	Cowichan Bay Road	South End of Watermain	520	150 mm PVC	1985	300 mm PVC	Upsize of watermain to increase fire flow to a minimum of 60 L/s.
44-06	Pritchard Road	Wilmot Road	Cowichan Bay Road	360	150 mm PVC	1980	200 mm PVC	Upsizing of existing watermain to provide multi-family residential fire flow requirements to this area.
44-07	George Road	Wilmot Road	Ordano Road	335	100 mm AC	1965	200 mm PVC	Replacement of aging small diameter AC watermain to provide required single-family residential fire flows.
44-08	Glen Road	McGill Road	Cowichan Bay Road	360	100 mm AC	1964	200 mm PVC	Replacement of aging small diameter AC watermain to provide required single-family residential fire flows.
44-09	Wilmot Road	Falcon Crescent	George Road	275	105m of 100 mm AC 170m of 50mm PE	1968 (100mm) 1972 (50mm)	200 mm PVC	Replacement of aging small diameter watermain to provide required single-family residential fire flows.

Upgrade ID	Location	From	To	Length (m)	Existing Size (mm) and Material	Existing Pipe Installation Year	Proposed Size (mm) and Material	Description & Rationale
44-10	Nelson Road	Wood Road	Sears Road	130	100 mm AC	1971	200 mm PVC	Replacement of aging small diameter watermain to provide required single-family residential fire flows.
44-11	Mindy Road	Sears Road	East Extents	385	100 mm AC	1971	200 mm PVC	Replacement of aging small diameter watermain to provide required single-family residential fire flows.
44-12	Wood Road	Telegraph Road	Nelson Road	325	100 mm AC	1971	200 mm PVC	Replacement of aging small diameter watermain to provide required single-family residential fire flows.
44-13	Sears Road	Telegraph Road	Nelson Road	330	100 mm AC	1971	200 mm PVC	Replacement of aging small diameter watermain to provide required single-family residential fire flows.
44-14	Fenwick Road	Pritchard Road	Pritchard Road	205	100 mm AC	1972	200 mm PVC	Upgrade of small diameter aging AC main to increase available fire flows in this single-family residential area.
44-15	Bicks Road	Longwood Road	Northern extents	190	100 mm AC	1986	200 mm PVC	Replacement of aging small diameter AC watermain to provide required single-family residential fire flows.
44-16	Wilmot Road	Wilmot Road	Pritchard Road	175	100 mm AC	1958	200 mm PVC	Replacement of aging small diameter AC watermain.
44-17	Cowichan Bay Road	Longwood Road	Wadham Road	50	100 mm AC	1964	200 mm PVC	Replacement of aging small diameter AC watermain.
44-18	Cowichan Bay Road	Joseph Road	Southern Commercial Area	45	150 mm PVC	1998	250 mm PVC	Increase in watermain diameter to provide increased fire flows to southern commercial area.
44-19	Southern Commercial Area	Valleyview Well	Southern Commercial Area	150	150 mm PVC	1998	200 mm PVC	Increase in watermain diameter to provide increased fire flows to southern commercial area.
44-20	Southern Commercial Area Loop	N/A	N/A	510	150 mm PVC	1998	200 mm PVC	Increase in watermain diameter to provide increased fire flows to southern commercial area.
44-21	Austin Place	McGill Road	Cowichan Bay Road	205	100 mm AC	1972	200 mm PVC	Replacement of aging AC watermain.
44-22	Pavenham Road/ McGill Road	Pritchard Road	McGill Road	420	150 mm AC	1974	200 mm PVC	Replacement of aging AC watermain.
44-23	Alder Glen Place	Ordano Road	Glen Road	305	150 mm AC	1974	200 mm PVC	Replacement of aging AC watermain.
44-24	Maple Glen Place	N/A	Alder Glen Place	120	150 mm AC	1974	200 mm PVC	Replacement of aging AC watermain.
44-25	Ordano Road	George Road	Alder Glen Place	190	150 mm AC	1974	200 mm PVC	Replacement of aging AC watermain.
44-26	Willow Glen	West Extents	McGill Road	120	150 mm AC	1974	200 mm PVC	Replacement of aging AC watermain.
44-27	Glen Road	West Extents	McGill Road	310	150 mm AC	1974	200 mm PVC	Replacement of aging AC watermain.
44-28	Gordon Place	West End	Bicks Road	90	100 mm AC	1986	200 mm PVC	Replacement of aging AC watermain.

8.3. IMPACTS OF HOUSING STATUTES (RESIDENTIAL DEVELOPMENT) AMENDMENT ACT

Bill 44, the Housing Statutes (Residential Development) Amendment Act 2023, introduced by the British Columbia government, allows for the construction of up to six units per lot in designated areas with frequent bus service, with a baseline of four units on lots previously zoned exclusively for single-family homes. This legislative change permits higher residential density in parts of CBWD that were not initially intended for such development. The potential increase in residential density in traditionally single-family areas introduces the possibility of greater demands on local infrastructure, including the water system, which may need evaluation and potential upgrades to meet increased consumption and fire protection needs.

With the allowance for higher-density constructions like fourplexes or sixplexes in previously single-family zones, the required fire flow rates, as outlined in the CBWD Subdivision Water Regulation Bylaw, would increase, thus affecting the CBWD's utility planning. For example, whereas the fire flow required for a single-family lot is 60 L/s, townhouse development requires 90 L/s based on the Bylaw standard. This adjustment might elevate the priority for infrastructure upgrades in areas that previously might have only needed moderate improvements.

Additionally, Fire Underwriters Survey (FUS) calculations, which determine necessary fire flows based on factors such as building size, construction materials, and proximity to other buildings, are likely to indicate higher requirements in these newly densified areas. This is due to generally larger building footprints and reduced setbacks compared to standard single-family homes. If FUS calculations exceed the bylaw-prescribed fire flows, these higher requirements must be met.

As a result of Bill 44, in areas where upgrades were already recommended, the target fire flow rate was generally increased to 90 L/s, rather than 60 L/s. This approach strikes a balance between realistic infrastructure upgrades and the potential for increased density, ensuring that the CBWD's water system can accommodate future demands while being mindful of current development trends. However, it is not necessary to upgrade the entire network to this standard, as there is a very low likelihood of extensive redevelopment in areas with relatively new single-family homes.

8.4. ADDITIONAL UPGRADE CONSIDERATIONS

8.4.1. Review of 2021 Water Master Plan Update Recommended Upgrades

The 2021 Water System Master Plan Update completed by AE recommended several upgrades related to source water, water treatment, and treated water storage upgrades.

The following table is a summary of the additional recommendations provided in the 2021 Water System Master Plan Update.

Table 16: Summary of Additional 2021 Water Master Plan Recommendations

Recommendations Not Addressed by This Report
Engineering Studies Including: - Collect data and update the Cowichan Bay Waterworks District Subdivision Water Regulation Bylaw to reflect changing demographics, water usage, and approach to water supply capacity - Monitor non-revenue water usage to identify system issues and reduce overall system costs - Evaluate the existing system at Pavenham to determine if the old reservoir has been properly abandoned - Complete a water quality review for the distribution system, including an evaluation of chlorine contact time for the existing sources - Complete a model calibration exercise to increase confidence in the model results and continue use of the model as a design tool
Demolish Abandoned Structures: - George Road well building - Ordano Road old valve building - Old Valleyview site
Decommission Kidd Well: - Kidd Well produces water that does not meet drinking water objectives, is aesthetically unpleasing, and would require significant upgrades to operate as designed. Once it has been confirmed that future flows can be provided by the Valleyview and Office sources, the Kidd Well should be decommissioned. Decommissioning should include the groundwater well, the building, and the portion of watermain between the well connection and last service connection. Consideration for ongoing flushing of this line should be included in the decommissioning design.
Recommendations Confirmed by This Report
New Water Source: - The system does not currently have adequate water supply to provide maximum day demand with the largest well out of service (i.e., firm capacity). It is recommended that CBWD investigate and complete another groundwater well, potentially in the Valleyview area (due to the reported aquifer capacity and production rates of existing wells).
Recommendations Already Complete
Source Water Protection Plan: - The Valleyview source provides high-quality water requiring minimal treatment to the CBWD system; however, this could change if the aquifer became contaminated. It was recommended that CBWD complete a source water protection plan to identify potential source contamination. This has been completed since the production of the 2021 Water Master Plan Update.

These items should still be considered when the CBWD is planning for capital works, but the specific prioritization and review of requirements of these items have not been included within the scope of this specific modeling exercise.

8.4.2.Recommendations for Well Capacity Improvements

To ensure reliability and adequate capacity, the following improvements are recommended:

- **Upgrade 44-04 - Increase Pumping Capacity at Valleyview Well #1:** Enhancing the pumping capacity at Valleyview Well #1 would provide additional fire protection flow to the Southern Commercial Area. Currently, this area relies on water traveling a long distance down a singular main from the existing reservoirs, resulting in significant head loss and therefore fire flows that are much lower than the commercial requirement of 150 L/s, in the range of 62 to 95 L/s.

These improvements will help CBWD maintain an adequate water supply and fire protection capacity, ensuring the system's resilience and reliability.

8.4.3. Treated Water Reservoir Storage Capacity

As discussed in **Section 5,** the existing reservoir storage capacity is likely sufficient for the existing land use within the CBWD. However, if industrial land use is proposed in the future, these requirements will need to be re-evaluated, and the existing reservoir storage capacity is likely no longer sufficient.

8.4.4. Hydrant Coverage

The existing hydrant coverage based on the CBWD Bylaw has been illustrated in **Figure A14** of **Appendix A**.

- **Koksilah Road:** This area has been assumed to not be included in the fire protection service area based on there being no existing fire hydrants.
- **General Central Service Area Fire Hydrant Density:** Fire hydrant density should be increased as aging mains are replaced to meet the following Bylaw requirements for maximum spacing:
    - Single family residential areas with more than 3 m separation between houses: 150m
    - Single family residential areas with less than 3 m separation between houses: 90m
    - Townhouses or multi-family and other medium-density areas: 90m
    - Institutional, commercial, industrial, apartments, and other high-density areas: 90m
- **Low Population Density Areas:** In general, low population density areas lack comprehensive hydrant coverage. For example, the watermain on Cowichan Bay Road from Telegraph Road to the southern commercial area near Highway 1 was likely not designed to provide full hydrant coverage. Similarly, the north end of Cowichan Bay Road from Wessex Road to the existing Kidd Well site has minimal hydrants. Following are some considerations/recommendations.

- Install additional hydrants when development occurs in these areas.
- Review what existing subdivisions/developments have on-site fire hydrants, as these may not be shown in the water model.
- Identify locations that are outside of the fire protection area or have fire protection from another system, such as St. Catherines Drive, Judge Drive, and Shearing Road areas which are directly adjacent the CBWD network but are not provided fire protection via the CBWD network.

9. 5-Year Horizon (2029) Model Results

The following sections provide a brief analysis of the results of the model for the 5-Year Horizon (2029) scenarios for the hydraulic model, focusing on how closely the existing water network meets the CBWD's level of service targets as outlined within the CBWD Subdivision Water Regulation Bylaw. The results include the recommended infrastructure upgrades as outlined in **Section 8**. The 2029 results are illustrated in **Figures A7** to **A9** in **Appendix A.**

9.1. 5-YEAR (2029) AVERAGE DAY DEMAND

The 2029 ADD results are illustrated in **Figure A6** within **Appendix A** of this report. The results are very similar to the 2024 ADD results, this is to be expected as the overall 1% demand growth over 5-years is not very significant, and there were no significant changes made to the overall network operations in the 2029 recommended upgrades.

9.2. 5-YEAR (2029) PEAK HOUR DEMAND

The 2029 PHD results are illustrated in **Figure A7** within **Appendix A** of this report. The results for 2029 PHD generally align with the results for 2024 PHD, for the same reasons as noted for 2029 ADD. It was assumed that all pumps were running during PHD, resulting in areas east of the Telegraph Road Reservoir experiencing pressures of 40 to 46 psi with the proposed booster pump running.

Figure A7 also illustrates the velocities through the mains during the 2024 PHD scenario. CBWD does not have a maximum allowable velocity during PHD, so an industry standard maximum 2.0 m/s has been used for this analysis, and as shown in this figure, none of the mains are reaching velocities over 2.0 m/s.

9.3. 5-YEAR (2029) MAXIMUM DAY DEMAND PLUS FIRE FLOW

Figure A8 in **Appendix A** provides an overview of the available fire flows throughout the CBWD with the estimated 2029 MDD. The upgrades for this year were focused on higher-density areas, areas with fire flows significantly below the requirement, and upgrades that would impact a more significant area. Key upgrades include:

- **Upgrade 29-01 - Commercial Area Along Cowichan Bay Road:** Increase in fire flows.

- **Upgrade 29-02 - Watermain Diameter Increase from Ordano Reservoir:** Increase the available fire flows in the most densely populated central area of the CBWD.

- **Upgrade 29-03 - Fire Flows East of Telegraph Road Reservoir:** Addition of the booster pump station is recommended based on the relatively short timeline, but upsizing the watermain in this area is recommended in the 2044 upgrades scenario, with a high priority to be completed soon after the booster station to reap the full benefits.

As mentioned in **Section 0** regarding the modelling results for the 2024 MDD + FF scenario, the lack of available fire flow is generally a result of small diameter mains, areas with minimal looping, as well as long dead-end mains.

10. 20-Year Horizon (2044) Model Results

The following sections provide a brief analysis of the results of the model for the 20-Year Horizon (2044) scenarios for the hydraulic model, focusing on how closely the existing water network meets the CWBD's level of service targets as outlined within the Subdivision Water Regulation Bylaw.

10.1. 20-YEAR (2044) AVERAGE DAY DEMAND

The 2044 ADD results are illustrated in **Figure A11** within **Appendix A** of this report. The results are very similar to the 2024 and 2029 ADD results due to the relatively low annual demand growth rate of 1%.

10.2. 20-YEAR (2044) PEAK HOUR DEMAND

The 2044 PHD results are illustrated in **Figure A7** within **Appendix A** of this report. The results for 2044 PHD generally align with the results for 2024 and 2029 PHD.

Figure A7 also illustrates the velocities through the watermains during the 2024 PHD scenario. As shown in this figure, none of the watermains are reaching velocities over 2.0 m/s.

10.3. 20-YEAR (2044) MAXIMUM DAY DEMAND PLUS FIRE FLOW

Figure A8 in **Appendix A** provides an overview of the available fire flows throughout the CBWD with the estimated 2044 MDD, including the recommended upgrades for 2044.

The network has limitations due to the long stretches of non-looping mains, for example, Cowichan Bay Road north and south of the central service area. As mentioned in **Section 0** regarding the modeling results for the 2024 MDD + FF scenario, the lack of available fire flow is generally a result of small diameter mains, areas with minimal looping, as well as long dead-end mains. The following sections discuss the remaining fire flow deficiencies following the implementation of the proposed 2029 and 2044 upgrades.

10.3.1. Remaining Deficiencies

When reviewing **Figure A5 – 2024 MDD + FF** against **Figure A13 – 2044 MDD + FF** it can be seen that there is a significant increase in the available fire flow throughout the network with the proposed upgrades. In general, the network upgrades increase the fire flows to meet the CBWD's targets based on the existing land use. There are a couple of locations that still don't meet the land use fire flow requirement target following the implementation of the proposed 2029 and 2044 upgrades. Following is a summary and discussion of those areas:

Bench Elementary School Property:

- The property is located at the southern end of Cowichan Bay Road. The recommended 2044 upgrades scenario improves the fire flow to approximately 130 to 155 L/s, compared to 100 to 130 L/s in 2024.
- The property is serviced by a 250mm diameter PVC main, installed in 2009, which extends approximately 1.7km along Cowichan Bay Road. Replacing the main with a larger-diameter pipe would be expensive and not recommended from a sustainability perspective due to the recent installation of the existing pipe.
- Bench Elementary School likely has on-site fire protection measures, such as building sprinklers, reducing the reliance on external fire flows. The school presents a lower fire risk due to its relatively isolated location, with no buildings within 30m and most surrounding structures more than 80m away.
- Since the fire flow deficiencies are specific to the school property, it is more practical to ensure that there are adequate on-site fire protection measures. This approach ensures that the available fire flow at the watermain is sufficient for the school's needs, given the absence of other industrial or institutional land use areas within the CBWD service area.

South Commercial Area Near Trans-Canada Highway on Cowichan Bay Road:

- This area is relatively new, with the watermains installed in 1998.
- The available fire flow increases from 90 L/s in the Existing (2024) MDD to 135 L/s in the 2044 MDD scenario with the proposed upgrades.
- Future source water wells, such as an additional well developed at the Valleyview Well site, could supplement the fire flow in this area.
- This area is located at the end of the same 1.7km long 250mm diameter PVC watermain installed in 2009.

- The extent of upgrades required to increase the fire flow in this area from 135 L/s to 150 L/s is not recommended due to diminishing returns. A very significant level of upgrades would be necessary for a minimal increase in the level of service.

10.3.2. Discussion on Fire Flow Requirements

The Bylaw requirements for fire flow are typically provided as a guideline based on standard building types and uses, but the actual requirements can vary significantly depending on the specifics of individual buildings and developments.

Several factors influence the required fire flow for a given area, including building construction materials, size, and occupancy type. For example, an older single-family home on a lot with dense vegetation may present a greater fire risk compared to a new fourplex that has been constructed with modern fire-resistant materials and equipped with additional fire protection measures such as fire walls and fire-resistant cladding. The older home, surrounded by flammable vegetation and potentially built with less fire-resistant materials, would require a higher fire flow to ensure adequate fire protection. In contrast, the new fourplex, despite housing more occupants, may require a lower fire flow due to its enhanced fire safety features.

It is important to recognize that the current fire flow requirements based on projected land use may not immediately translate into a critical issue. While planning for adequate fire flow to meet future land use is important, the immediate concern should be tempered with an understanding of the flexibility in building design and the actual timeline for development. Continuous monitoring and reassessment of fire flow requirements in line with development progress and building specifics will ensure that fire protection needs are appropriately met without unnecessary alarm over current shortfalls.

11. Conclusions and Recommendations

The 2024 Water Model Update for Cowichan Bay Waterworks District highlights key areas for improvement in fire flow capacity, reservoir storage, well capacity, and pressure management across the distribution network. The following recommendations address these issues to help the system meet both current and future demands through 2044.

Targeted Fire Flow Upgrades:

- Residential Zones: Focus on upgrading watermains in older residential areas where fire flow is significantly below required levels. Prioritize areas with small-diameter mains, such as Bicks Road and Glen Road, where fire flow is insufficient.

- Bench Elementary School: Although the available fire flow at the school is lower than the 200 L/s requirement, the combination of on-site fire protection measures and the school's isolation reduces the immediate need for upgrades. On-site protection measures, such as sprinklers, should be reviewed for adequacy to meet fire safety standards.

Reservoir and Well Capacity:

- PZ1 Reservoir: The existing storage capacity in PZ1 is sufficient through 2044. No immediate action is required, but regular monitoring of infrastructure will help address future demands.

- PZ2 Storage: Storage in PZ2 is currently adequate for the school property, and no additional storage is necessary under current and future scenarios.

- Well Capacity: Increasing the pumping capacity at the Valleyview Wells and/or adding a new water source would improve system reliability during emergencies. This would provide additional capacity for both regular demand and fire protection, particularly in the southern service areas.

Pressure Management:

- Low Pressure: Address low-pressure issues in areas like Cowichan Bay Road and Hillbank Road by considering the installation of booster pumps or adjustments to existing PRVs. This will help bring pressures up to minimum standards during peak demand periods.

- High Pressure: Continue monitoring high-pressure zones, but no immediate action is necessary unless pressures exceed the 100 psi limit.

Long-Term Planning:

- Water Distribution Upgrades: Focus on replacing outdated asbestos cement mains and upgrading infrastructure in areas expected to experience growth. The network should be designed to handle future demand without sacrificing service quality.

- On-Site Fire Protection: Properties like Bench Elementary School should maintain or enhance on-site fire protection measures, such as sprinkler systems, to reduce reliance on the municipal fire flow during emergencies.

By adopting these recommendations, the waterworks district will improve its water distribution network and strengthen overall system resilience. These measures will provide adequate fire protection, maintain pressure requirements, and allow the system to meet future water demands with reliability for residents and critical facilities. If you have any questions, please contact the undersigned.

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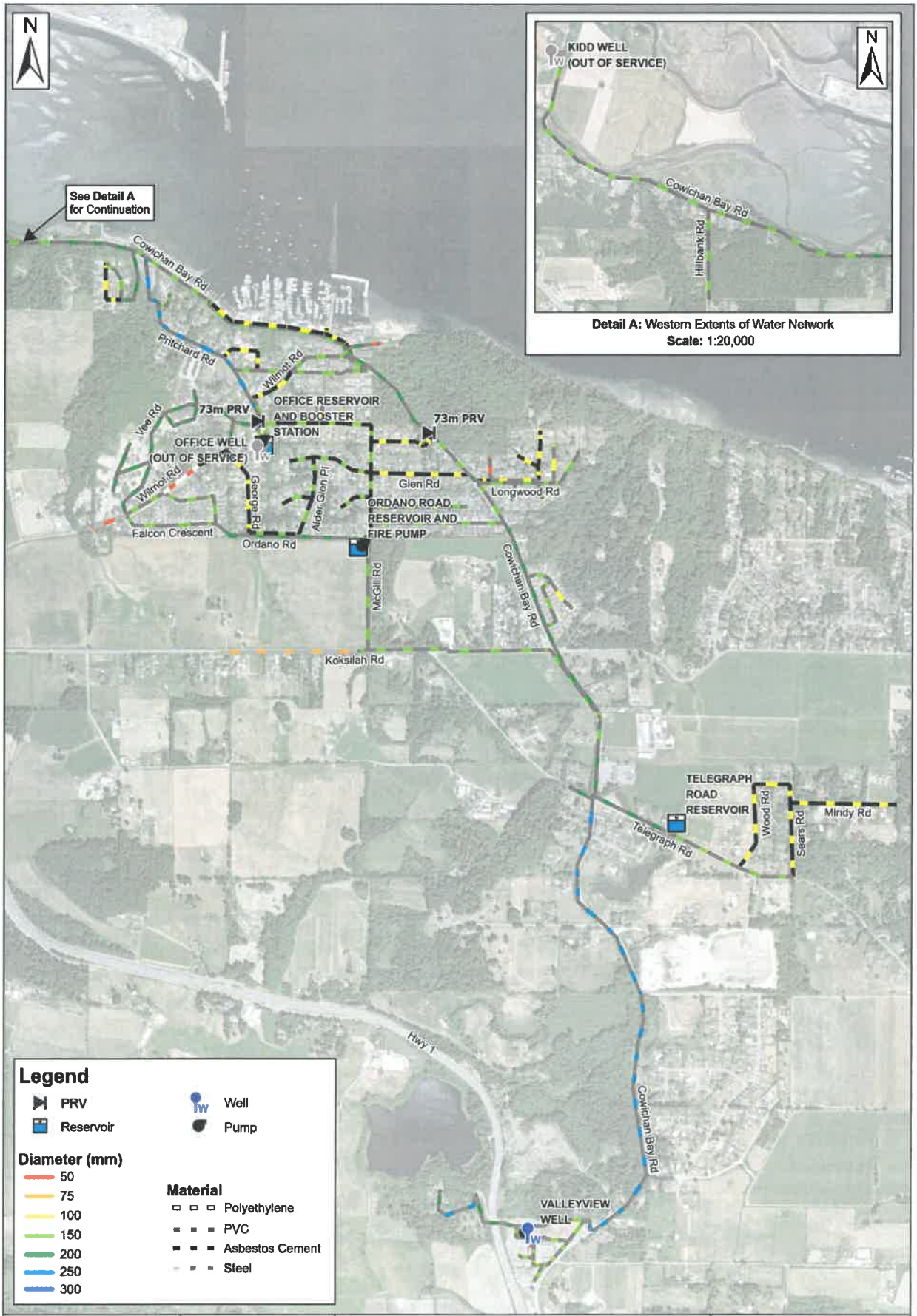
Senior Reviewer

APPENDIX A

Model Results Mapping



McElhanney

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Client: Cowichan Bay Waterworks

Figure A1
Cowichan Bay Waterworks District
Existing Infrastructure Summary

Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

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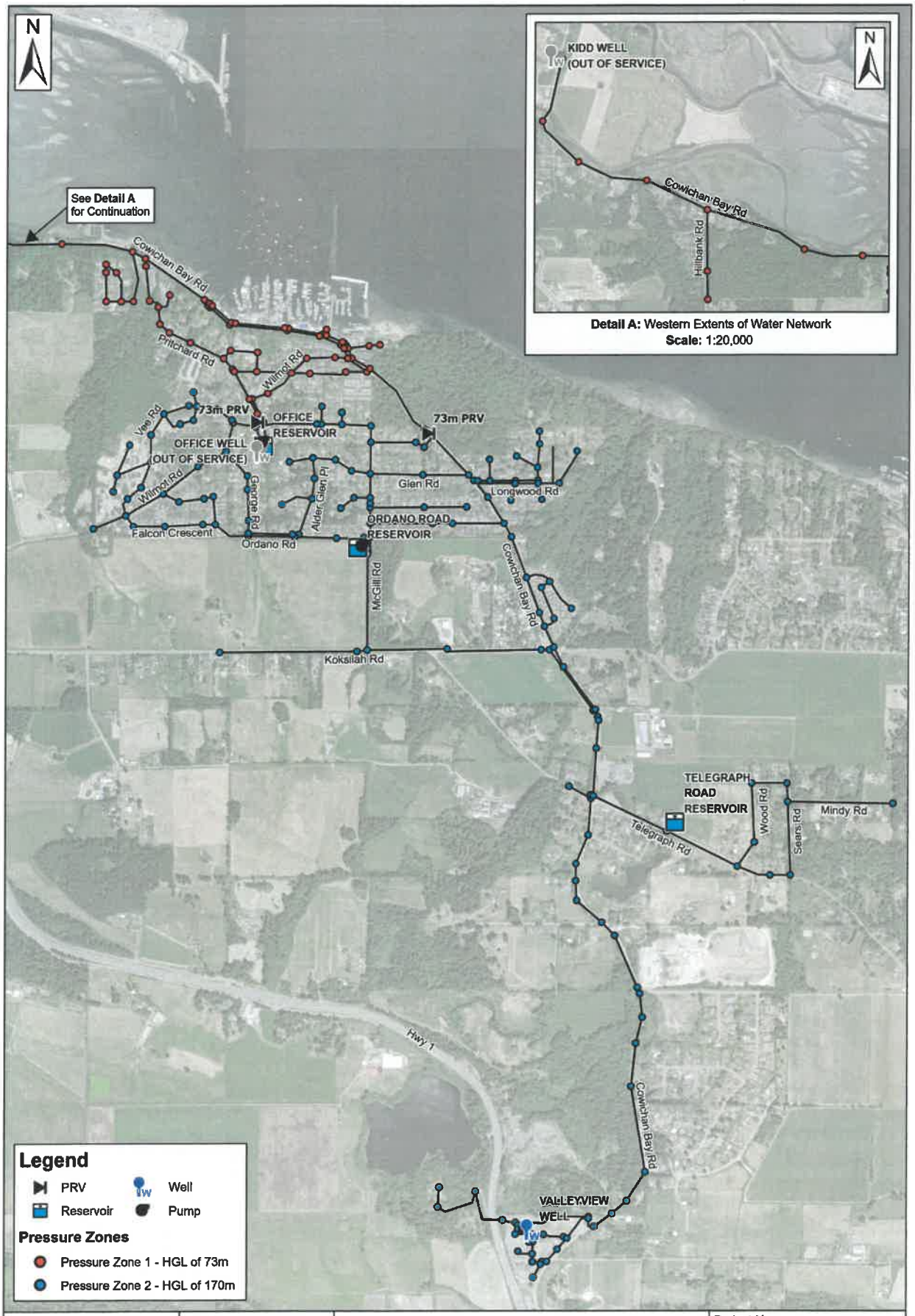

Detail A: Western Extents of Water Network
Scale: 1:20,000

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Figure A2
Cowichan Bay Waterworks District
Existing Pressure Zones

Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

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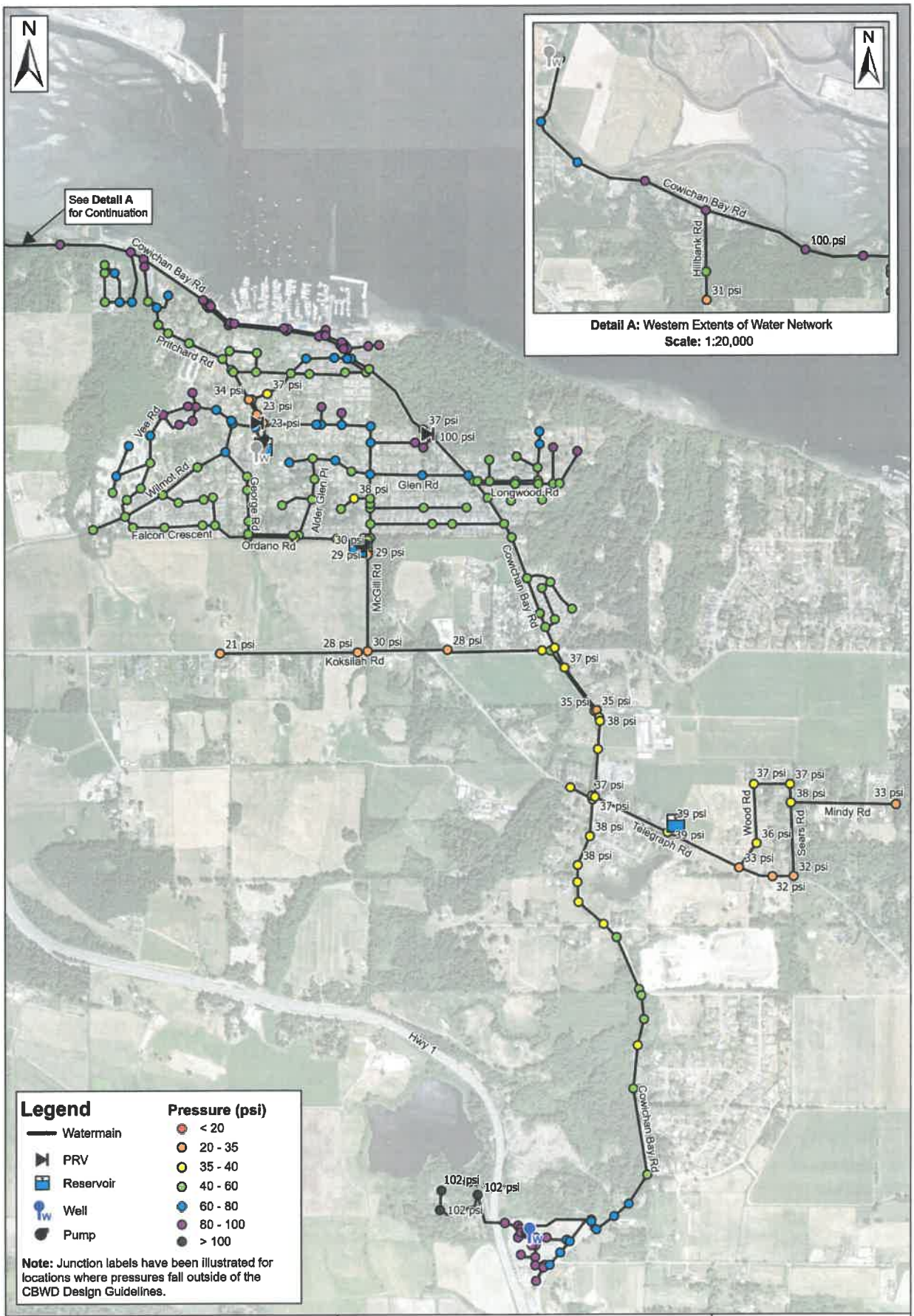

Detail A: Western Extents of Water Network
Scale: 1:20,000

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Figure A3
Cowichan Bay Waterworks District
2024 Average Daily Demands (ADD)

Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

0 100 200 400 Meters

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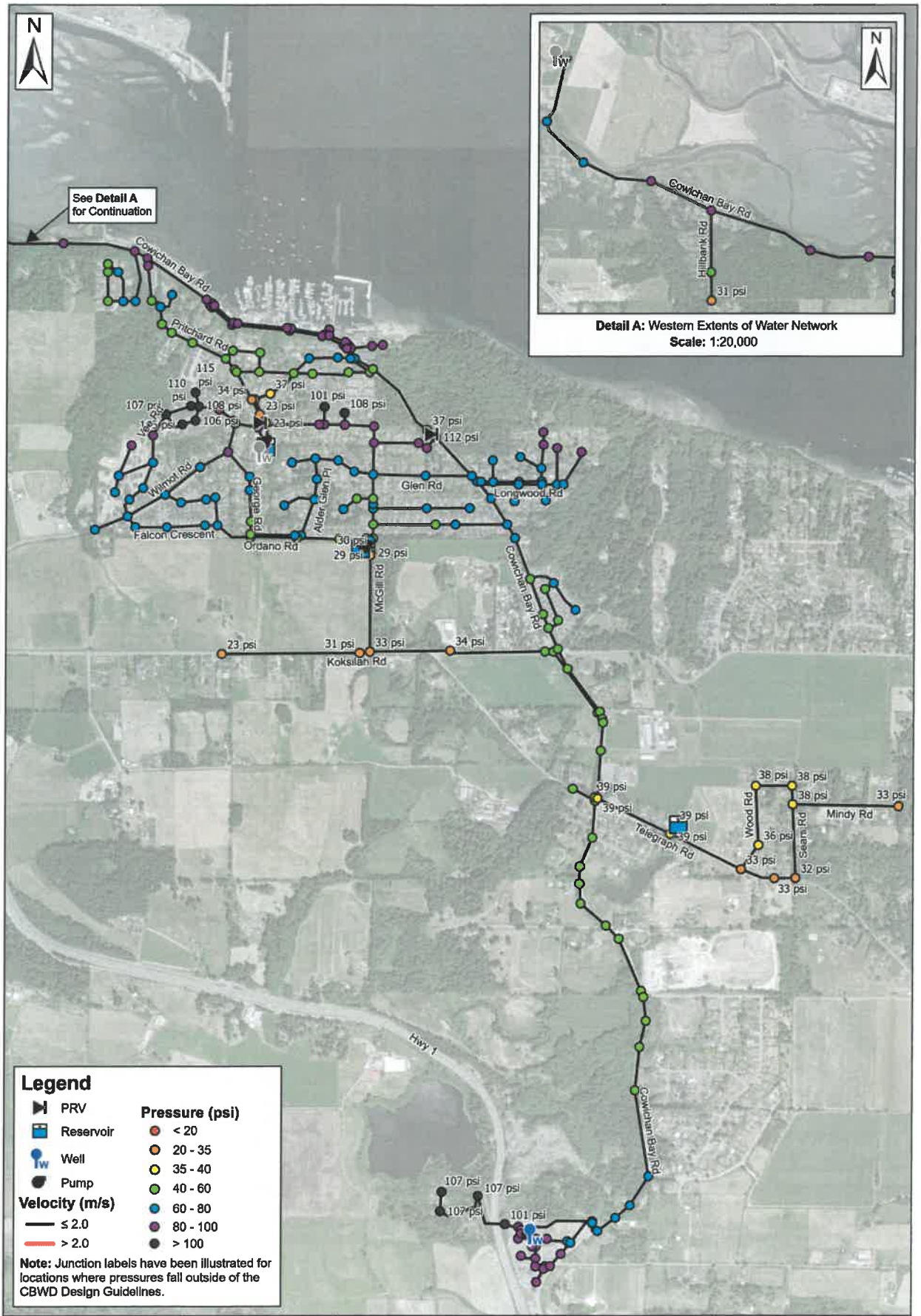

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Figure A4
Cowichan Bay Waterworks District
2024 Peak Hour Demands (PHD)

Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

0 100 200 400 Meters

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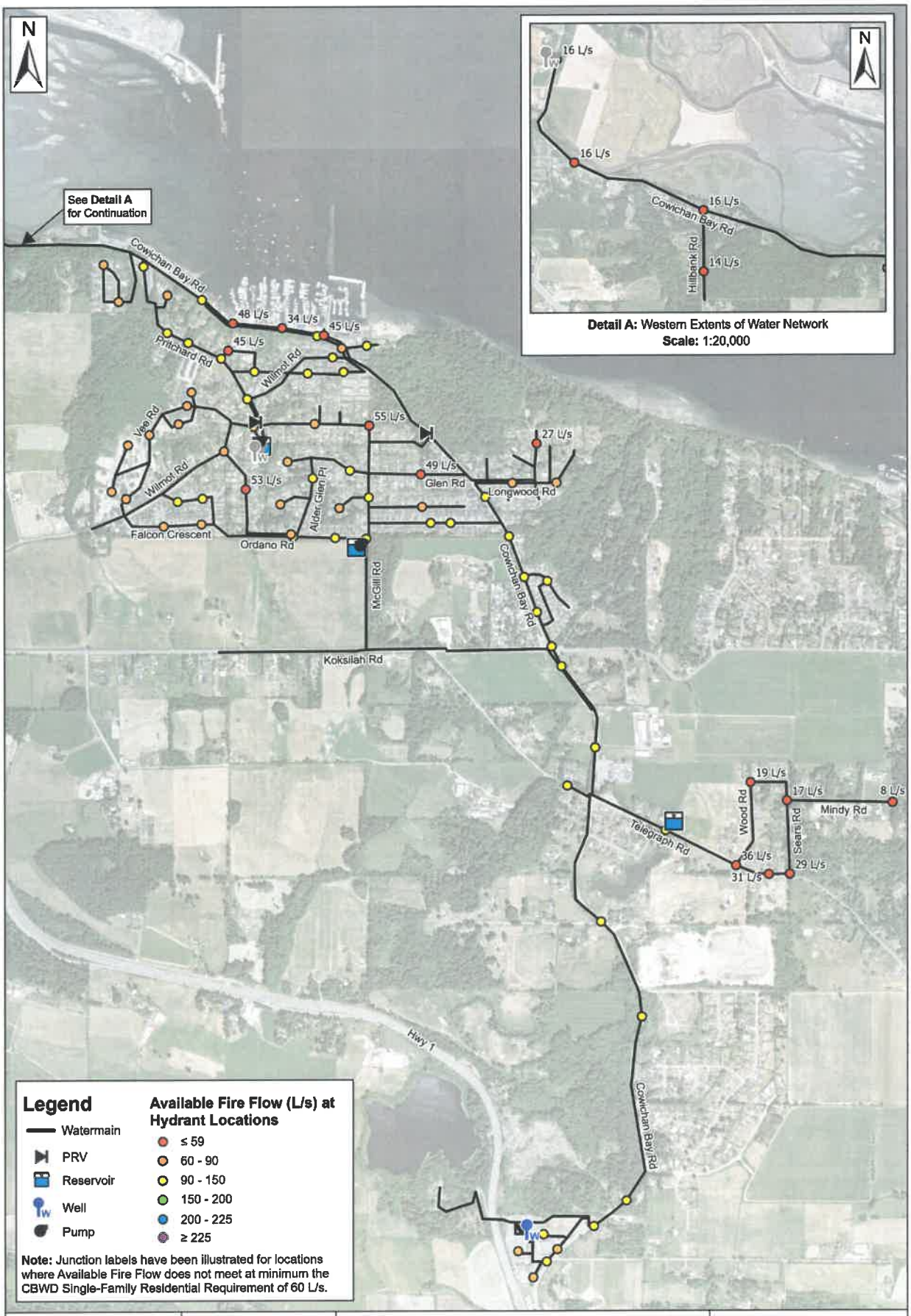

Detail A: Western Extents of Water Network
Scale: 1:20,000

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Figure A5
Cowichan Bay Waterworks District
2024 Maximum Day + Fire Flow Demands (MDD + FF)

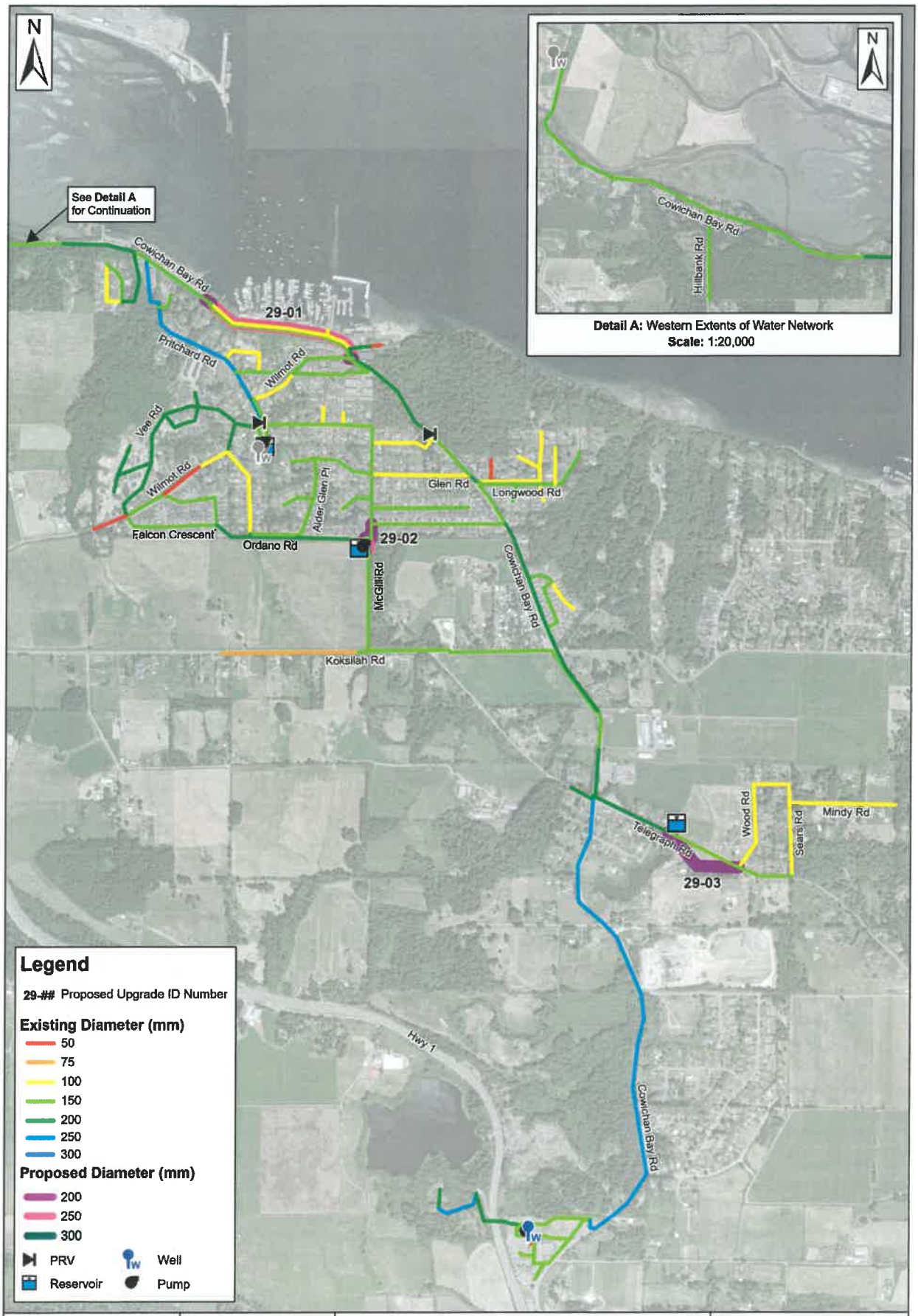
Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

0 100 200 400 Meters

Path: X:\2233\Projects\22330211004 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-08-02 CBWD GIS Base.aprx



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Client:

Figure A6
Cowichan Bay Waterworks District
Proposed 2029 Upgrades

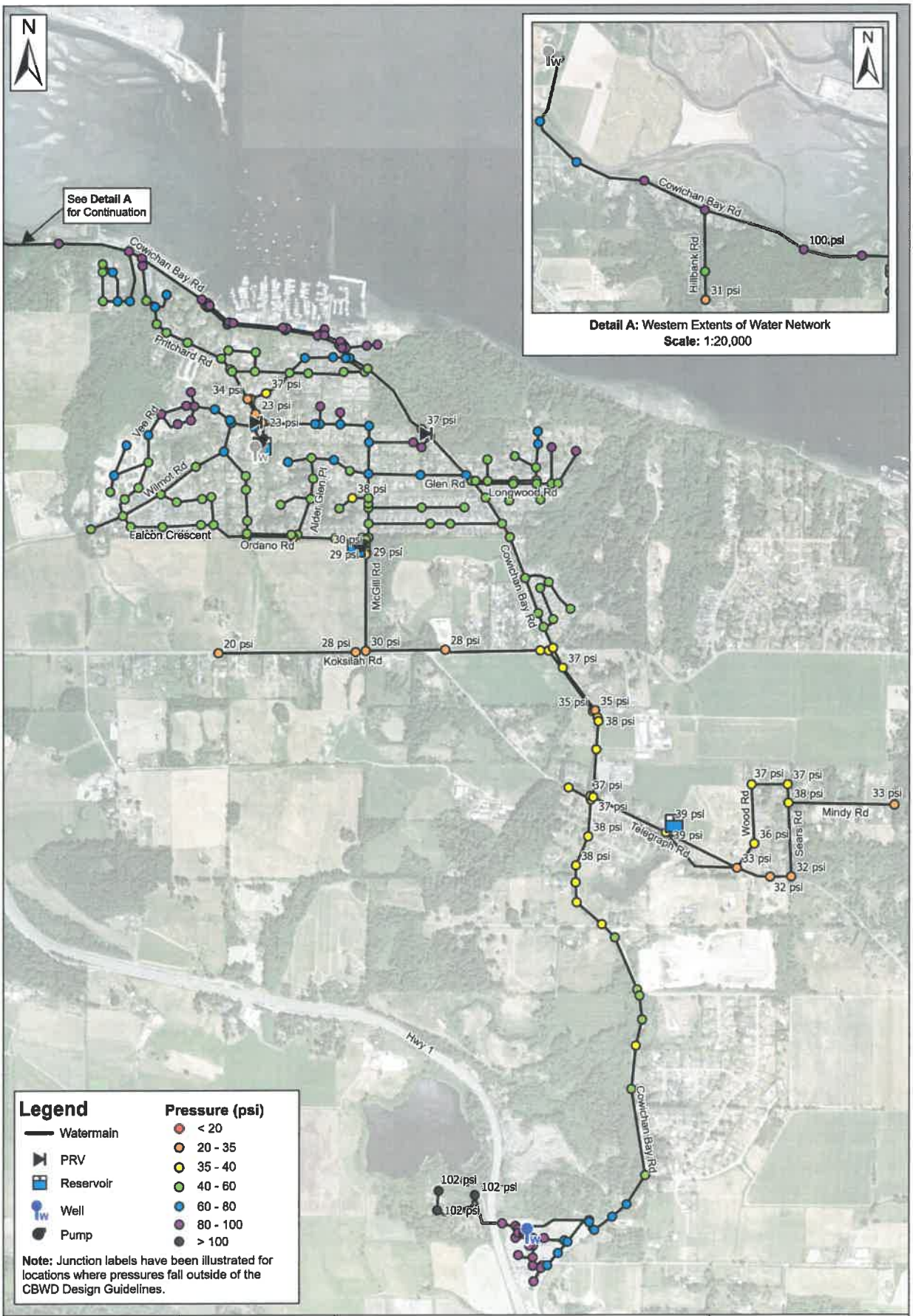
Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

0 100 200 400 Meters

Path: X:\2233\Projects\2233021004 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-08-02 CBWD GIS Base.aprx



Detail A: Western Extents of Water Network
Scale: 1:20,000

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Tel 250-746-3335

Client: COWICHAN BAY WATERWORKS

Figure A7
Cowichan Bay Waterworks District
2029 Average Daily Demands (ADD)

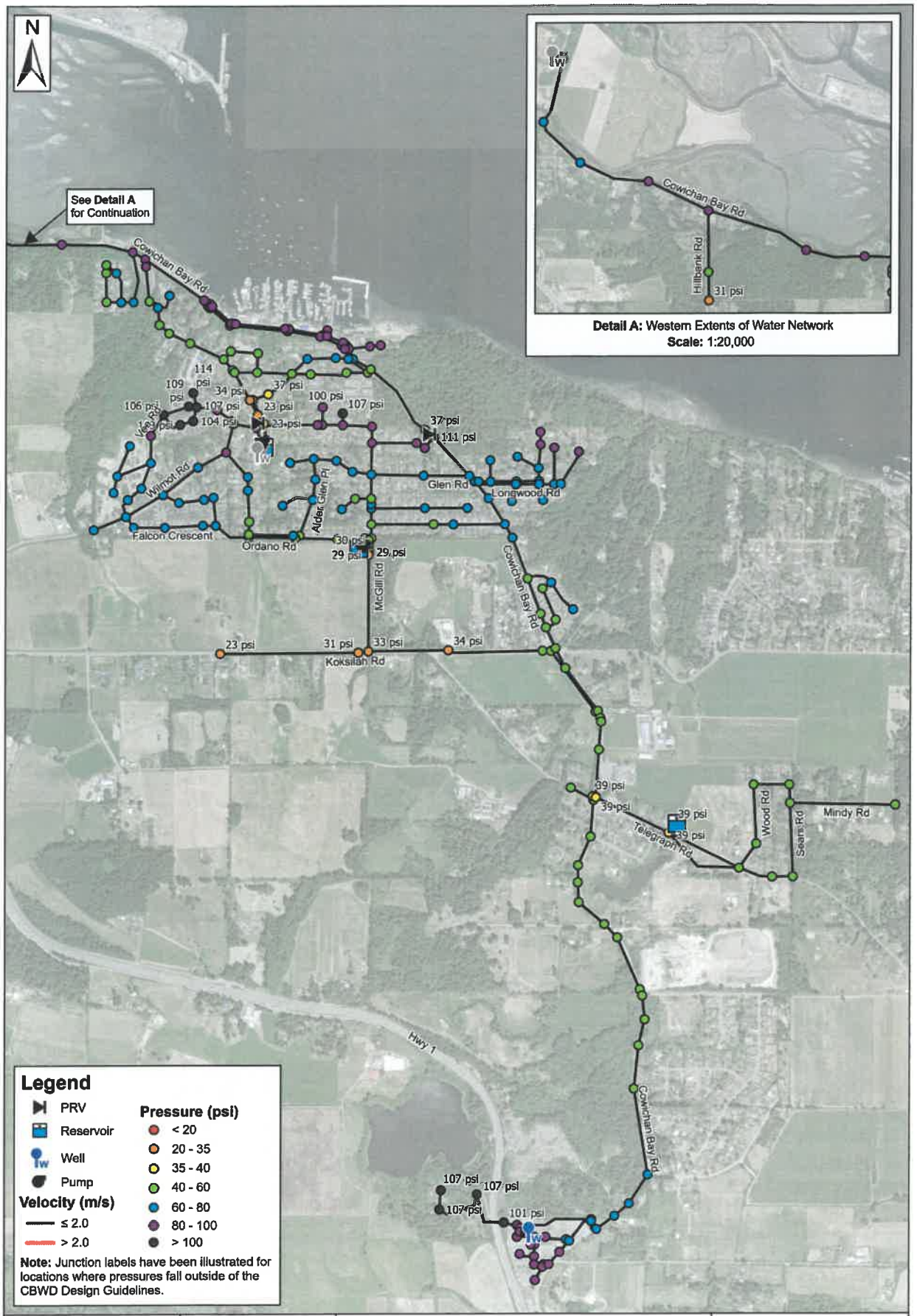
Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

0 100 200 400 Meters

Path: X:\2233\Projects\22330211004 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-08-02 CBWD GIS Base.aprx



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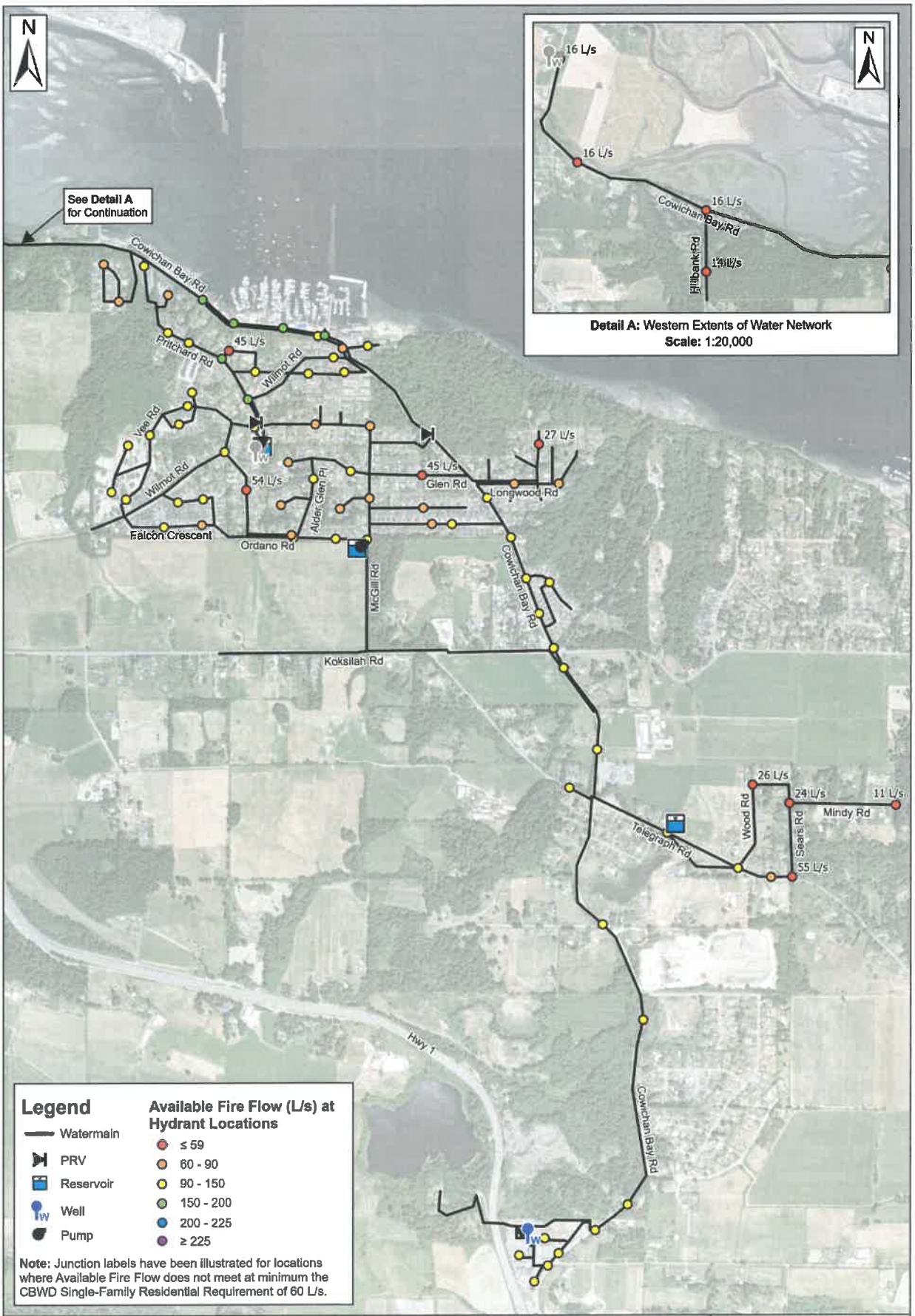
Client: Cowichan Bay Waterworks

Figure A8
Cowichan Bay Waterworks District
2029 Peak Hour Demands (PHD)

Project No.:	2233-02110-04
Date:	10/3/2024
Scale:	1:12,500

0 100 200 400 Meters

Path: X:\2233\Projects\22330211004 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-08-02 CBWD GIS Base.aprx



Detail A: Western Extents of Water Network
Scale: 1:20,000

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Client: Cowichan Bay Waterworks

Figure A9
Cowichan Bay Waterworks District
2029 Maximum Day + Fire Flow Demands (MDD + FF)

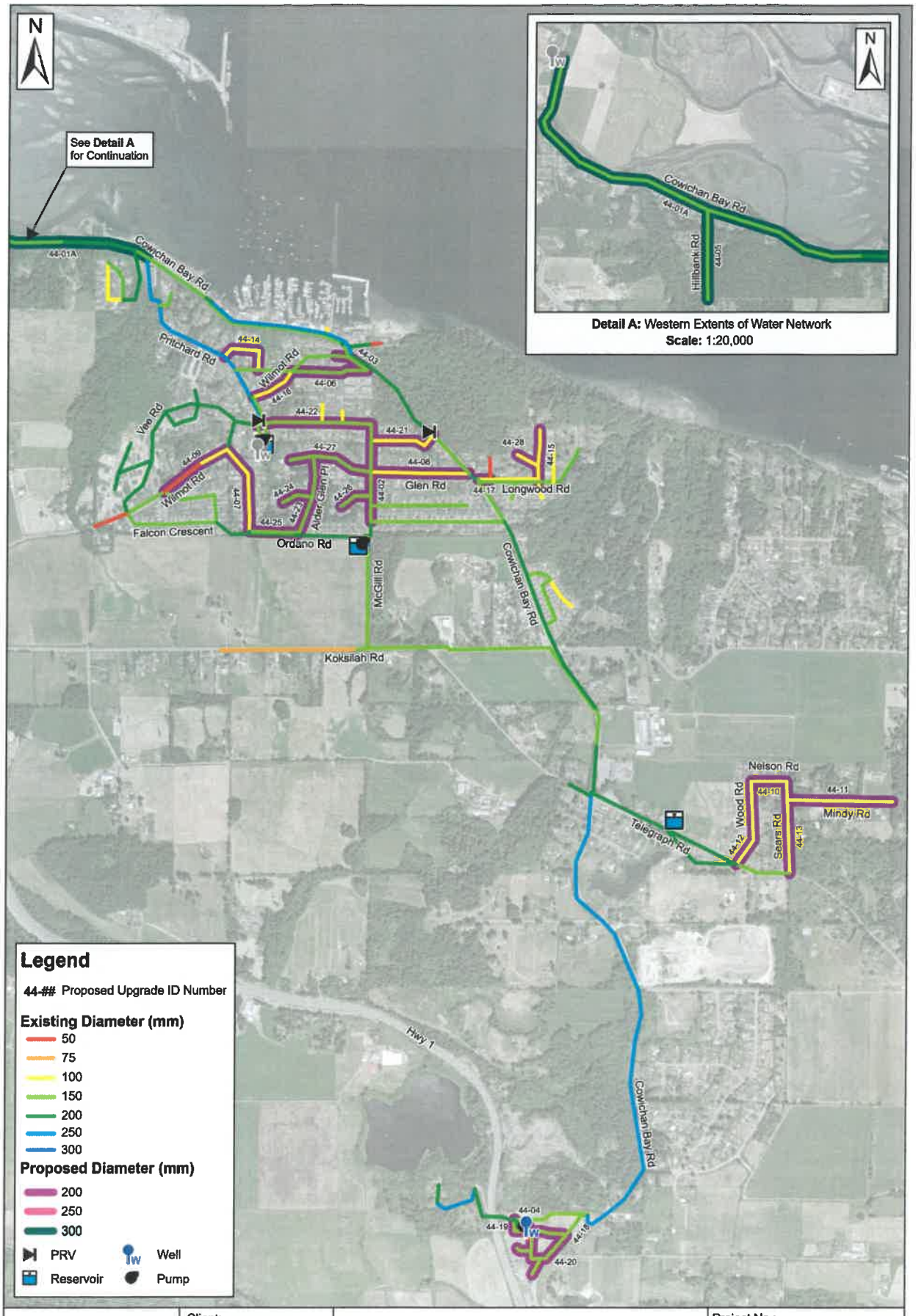
Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

0 100 200 400 Meters

Path: X:\2233\Projects\23330211004 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-08-02 CBWD GIS Base.aprx



Detail A: Western Extents of Water Network
Scale: 1:20,000

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Figure A10
Cowichan Bay Waterworks District
Proposed 2044 Upgrades

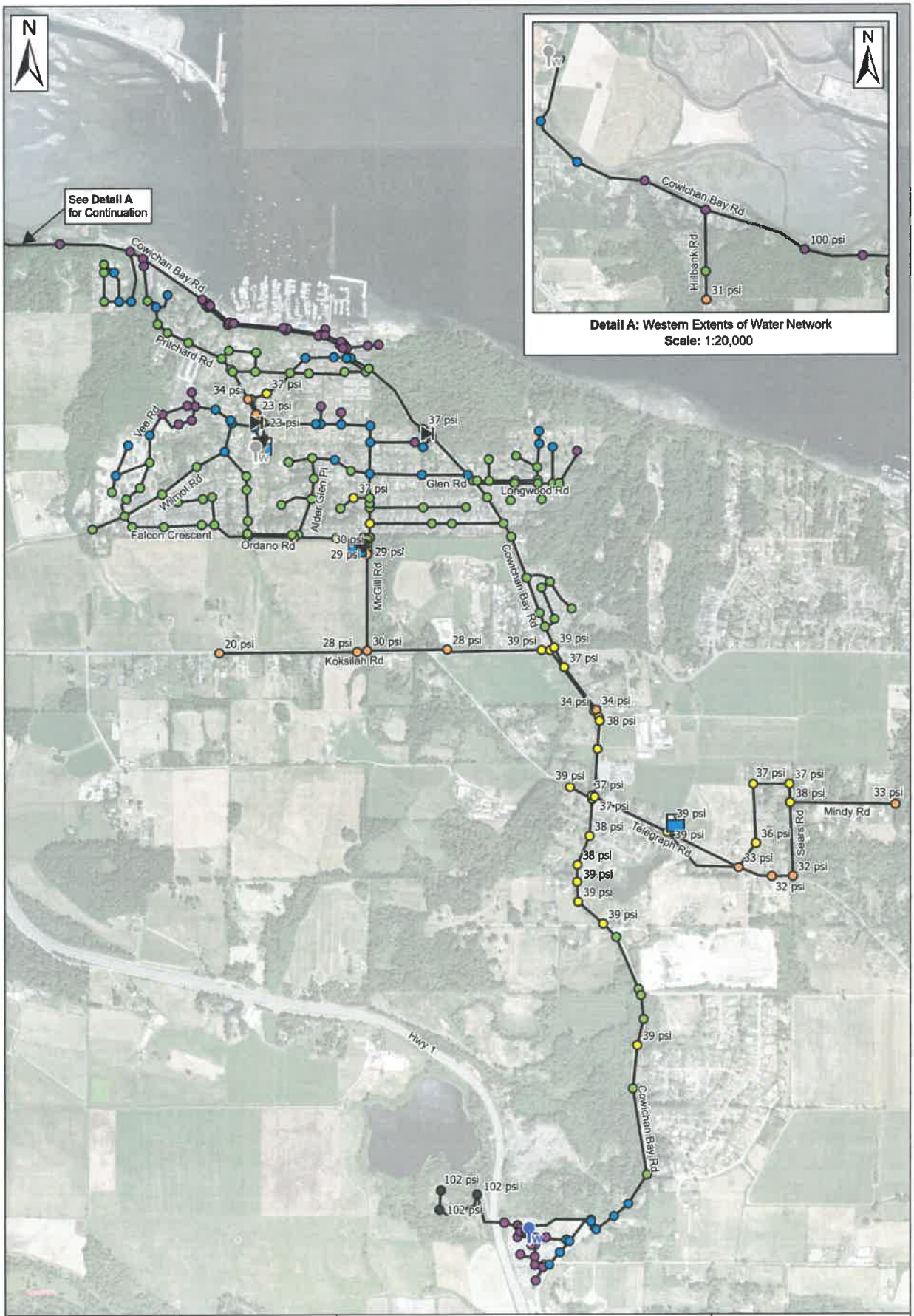
Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

0 100 200 400 Meters

Path: X:\2233\Projects\223302110\04 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-08-02 CBWD GIS Base.aprx



Detail A: Western Extents of Water Network
Scale: 1:20,000

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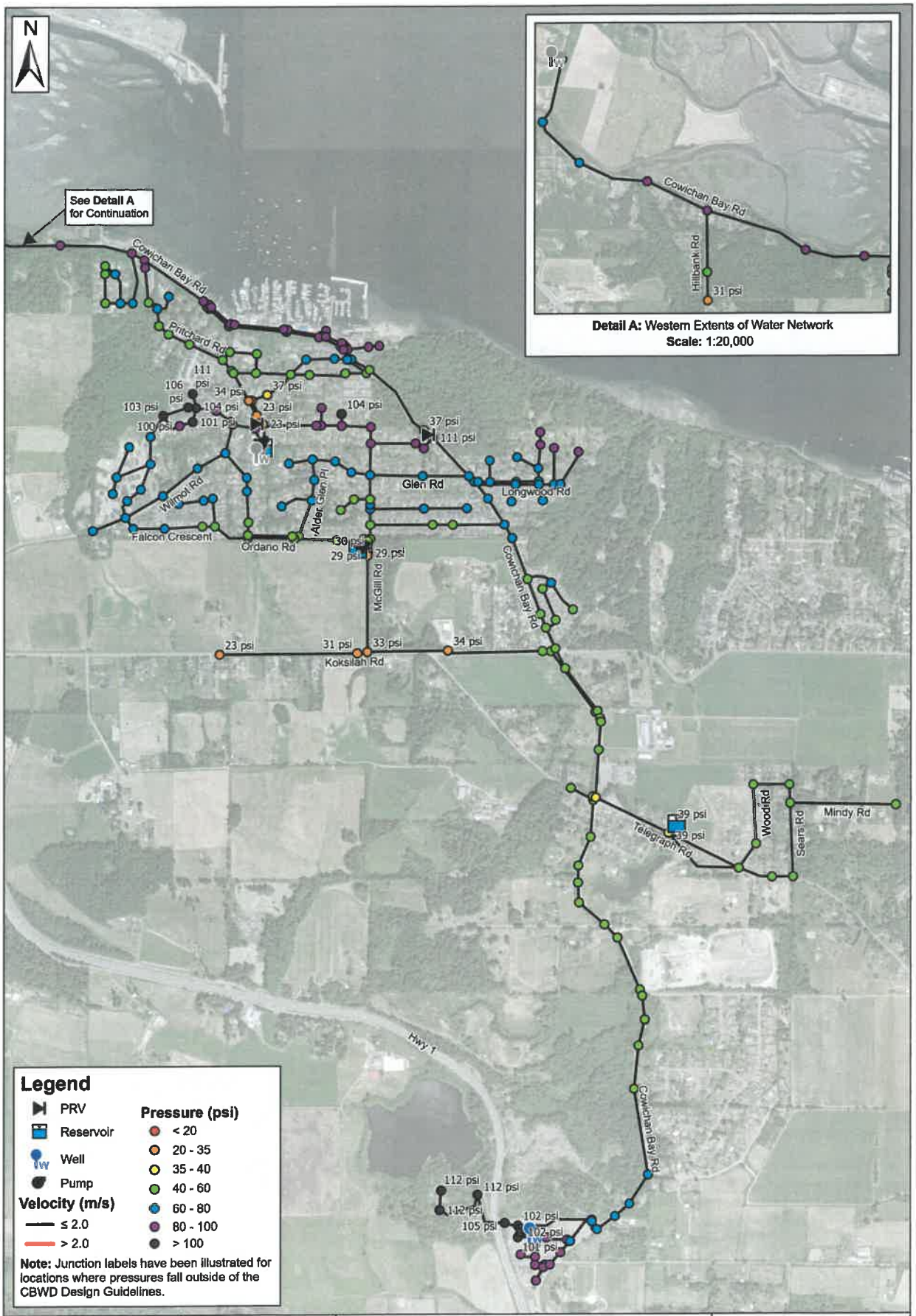
Client:

Figure A11
Cowichan Bay Waterworks District
2044 Average Daily Demands (ADD)

Project No.:	2233-02110-04
Date:	10/3/2024
Scale:	1:12,500

0 100 200 400 Meters

Path: X:\2233\Projects\23330211004 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-08-02 CBWD GIS Base.aprx



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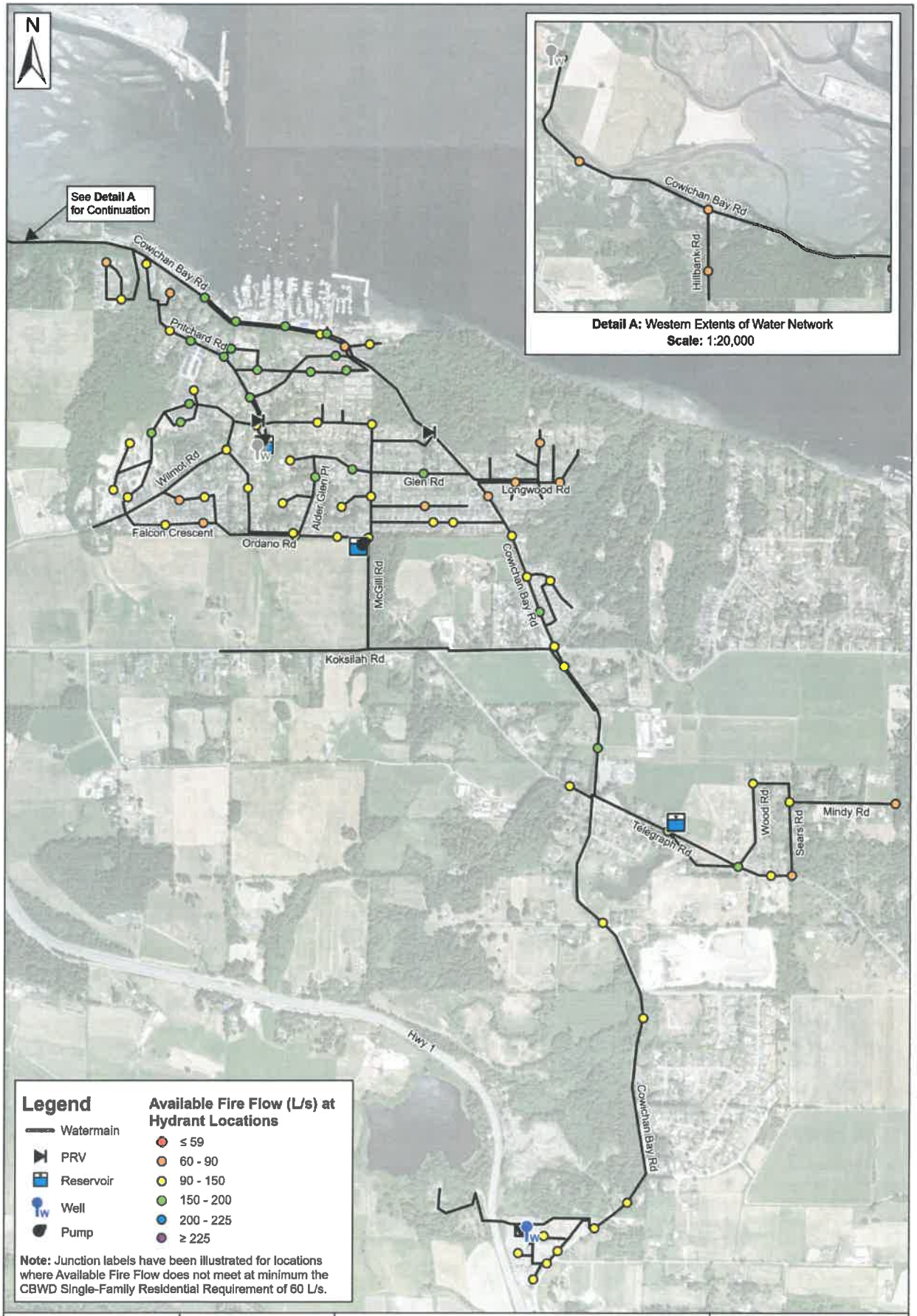
Client: COWICHAN BAY WATERWORKS

Figure A12
Cowichan Bay Waterworks District
2044 Peak Hour Demands (PHD)

Project No.: 2233-02110-04
Date: 10/3/2024
Scale: 1:12,500
0 100 200 400 Meters

Path: X:\2233\Projects\23330211004 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-06-02 CBWD GIS Base.aprx



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Client: COWICHAN BAY WATERWORKS

Figure A13
Cowichan Bay Waterworks District
2044 Maximum Day + Fire Flow Demands (MDD + FF)

Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

0 100 200 400 Meters

Path: X:\2233\Projects\23330211004 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-08-02 CBWD GIS Base.aprx

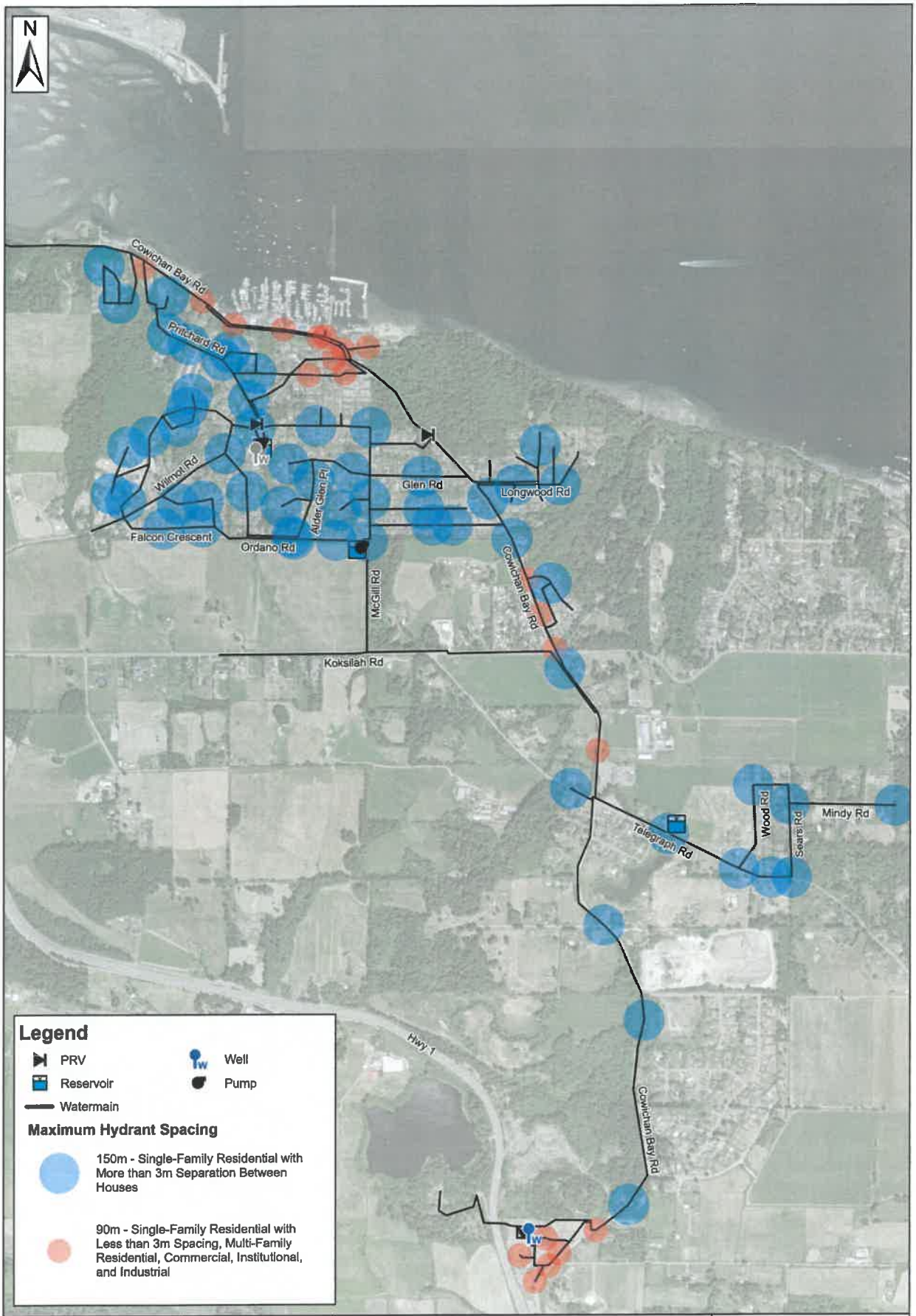

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Figure A14
Cowichan Bay Waterworks District
Existing Hydrant Coverage

Project No.: 2233-02110-04

Date: 10/3/2024

Scale: 1:12,500

0 100 200 400 Meters

Path: X:\2233\Projects\2233021104 CBWD Water Model Update\07_DRAWINGS\04_Models\GIS Files\2024-08-02 CBWD GIS Base.aprx

APPENDIX B

Reservoir Capacity Calculations

Project Name:	CBWD 2024 Water Model Update
Project Number:	2233-02110-04
Document Title	Appendix B: Reservoir Capacity Review
Prepared By:	W. Roe
Date:	2024-09-23

McElhanney

Reservoir Calculation			Office Reservoir	Ordano Reservoir	Telegraph Road Reservoir
Total Storage Volume	=	A + B + C	0.545 ML	1.568 ML	0.734
A	=	Fire Storage	545000 L	1568000 L	734000 L
B	=	Equalization Storage (25% of MDD)	**Total Existing (PZ1)**		**Total Existing (PZ2)**
C	=	Emergency Storage (25% of A + B)	2847000 L		2302000 L
			2847 m^3		2302 m^3
			2.847 ML		2.302 ML

Pressure Zone 1 (PZ1)

	PZ1 MDD	
MDD (Current - 2024)	6.20 L/s	535,766
MDD (2029)	6.53 L/s	564,019
MDD (2044)	7.57 L/s	653,962

Commercial

Fire Storage	150 L/s	
Fire Flow Required	9,000 L/min	
Duration	2 hours	120 min

Existing (2024)	Volume (L)	Volume (m3)	Volume (ML)
Fire Storage (A)	1,080,000	1,080	1.08
Equalization Storage (B)	133,942	134	0.13
Emergency Storage (C)	303,485	303	0.30
Total Storage Volume Required	1,517,427	1,517	1.52
Total Storage Volume Available	2,847,000	2,847	2.85
Total Surplus/Deficit	1,329,573	1,330	1.33

2029	Volume (L)	Volume (m3)	Volume (ML)
Fire Storage (A)	1,080,000	1,080	1.08
Equalization Storage (B)	141,005	141	0.14
Emergency Storage (C)	305,251	305	0.31
Total Storage Volume Required	1,526,256	1,526	1.53
Total Storage Volume Available	2,847,000	2,847	2.85
Total Surplus/Deficit	1,320,744	1,321	1.32

2044	Volume (L)	Volume (m3)	Volume (ML)
Fire Storage (A)	1,080,000	1,080	1.08
Equalization Storage (B)	163,490	163	0.16
Emergency Storage (C)	310,873	311	0.31
Total Storage Volume Required	1,554,363	1,554	1.55
Total Storage Volume Available	2,847,000	2,847	2.85
Total Surplus/Deficit	1,292,637	1,293	1.29

Pressure Zone 2 (PZ2)

	PZ2 MDD	
MDD (Current - 2024)	12.39 L/s	1,070,410
MDD (2029)	13.00 L/s	1,123,373
MDD (2044)	15.11 L/s	1,305,590

Institutional

Fire Storage	200 L/s	
Fire Flow Required	12,000 L/min	
Duration	2 hours	120 min

Existing (2024)	Volume (L)	Volume (m3)	Volume (ML)
Fire Storage (A)	1,440,000	1,440	1.44
Equalization Storage (B)	267,602	268	0.27
Emergency Storage (C)	426,901	427	0.43
Total Storage Volume Required	2,134,503	2,135	2.13
Total Storage Volume Available	2,302,000	2,302	2.30
Total Surplus/Deficit	167,497	167	0.17

2029	Volume (L)	Volume (m3)	Volume (ML)
Fire Storage (A)	1,440,000	1,440	1.44
Equalization Storage (B)	280,843	281	0.28
Emergency Storage (C)	430,211	430	0.43
Total Storage Volume Required	2,151,054	2,151	2.15
Total Storage Volume Available	2,302,000	2,302	2.30
Total Surplus/Deficit	150,946	151	0.15

2044	Volume (L)	Volume (m3)	Volume (ML)
Fire Storage (A)	1,440,000	1,440	1.44
Equalization Storage (B)	326,398	326	0.33
Emergency Storage (C)	441,599	442	0.44
Total Storage Volume Required	2,207,997	2,208	2.21
Total Storage Volume Available	2,302,000	2,302	2.30
Total Surplus/Deficit	94,003	94	0.09

APPENDIX C

Statement of Limitations

Statement of Limitations

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