



PARSONS



DRAINAGE MASTER PLAN

January 2023

District of North Saanich



Metrotower I, 2300 – 4710 Kingsway
Burnaby, British Columbia V5H 4M2
Direct: +1 604.438.5300
parsons.com

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Executive Summary

The District of North Saanich (District) is updating its stormwater management planning. This includes a Drainage Master Plan (DMP) to address overall drainage asset management throughout North Saanich, and an Integrated Stormwater Management Plan (ISMP) that focuses on the Tseycum Creek and McDonald Park Road Drain watershed.

The Drainage Master Plan is intended to be a guiding document for the District's drainage infrastructure that provides an overview of the system, identifies deficiencies, and makes recommendations to resolve them. The following tasks were performed for this Drainage Master Plan:

- Review of the District's existing drainage GIS database and discussion with District staff to identify areas of concern.
- Analysis of the total drainage asset value based on available GIS information.
- A sample visual condition assessment to validate available GIS condition information.
- Development of a comprehensive district-wide hydrological and 1-D hydraulic model using PCSWMM software, including the most current available GIS information.
- Installation of flow monitoring stations within the Tseycum Creek and McDonald Park Road Drain watershed for PCSWMM model calibration and validation.
- Calibration and validation of the PCSWMM model using monitored flow rates and flow depths.
- Model simulations for 5-year and 25-year rainfall events, with allowance for climate change and sea level rise, to identify hydraulic deficiencies in the drainage system.
- Review of ARSDA criteria and modeling of the agricultural drainage performance.
- Identification of drainage infrastructure that requires condition replacement, using available GIS information.
- Evaluation of hydraulic upgrades required to improve system flow capacity.
- Prioritization of hydraulic upgrades and condition replacements into a long-term phased implementation plan with cost estimates.

The total number of pipes in the District's drainage system is 5,062, covering a length of 98.6 km.

The total value of the District's drainage assets is estimated at \$103.46 million (CAD 2022).

The hydrological and hydraulic analysis identified 284 pipes and culverts (6.28 km) that require hydraulic upgrade. The condition assessment identified 500 pipes and culverts (4.45 km) in need of condition replacement, as well as the need for approximately 49% of the piped lateral drainage infrastructure to be assessed to determine condition. The condition assessment further identified 13 point-drainage infrastructure (such as manholes) in need of a replacement. Based on the results of the analyses, and the information gathered, the recommendations for the District are:

- The District should establish annual budgets for drainage infrastructure replacements and upgrades. The total cost for these replacements and upgrades is estimated to be \$12.01 million (CAD 2022), which can be realized within a 20-year capital replacement program with an annual budget of approximately \$600,000.
- The District should perform a comprehensive district-wide condition assessment of the currently unassessed 49% of its storm sewer and culvert pipes, as well as point-drainage infrastructure.
- The District should consider the use of concrete or plastic pipes for upgrades and replacements due to their longer service life and limit the use of new metal pipes such as ACMP and CSP.
- The District should conduct a district-wide flood risk assessment to assess the flood risks and flood hazards from extreme storm events. Flood risk management plans should be developed to minimize and mitigate these risks.
- The District should obtain appropriate land encumbrances to maintain significant municipal drainage features which extend onto private property.
- The District should revisit the Drainage Master Plan every five years to reflect the capital program progress, update the design storms based on current information, and update the hydrological and hydraulic PCSWMM model.

1. Introduction

The District of North Saanich (the District) retained Parsons Inc. (Parsons) to develop a Drainage Master Plan (DMP) for all District watersheds and an Integrated Stormwater Management Plan (ISMP) for the Tseycum Creek and McDonald Park Road Drain watershed in particular. The ISMP is a separate document from this Drainage Master Plan.

1.1 Background

The District of North Saanich is located on Vancouver Island in British Columbia, at the northern end of the Saanich Peninsula. The District has a population of approximately 11,000 residents and covers an area of approximately 4,015 hectares. The District has four major watercourses: Tseycum (WSIKEM) Creek, Ten-Ten Creek, Reay Creek (KELSET) and Chalet (Tatlow) Creek, as well as smaller creeks and piped outfalls that drain directly into the ocean around the peninsula. The District is surrounded on three sides by ocean shoreline, on its southern border by the District of Central Saanich and shares a 4.5 km long border to the east with the Town of Sidney. The District has a diverse range of land uses, including large tracts of Agricultural Land Reserve (ALR), residential areas with variable density, as well as commercial harbours. The four major watercourses and the associated catchment areas also include the following jurisdictions: the Victoria International Airport (YYJ), Tseycum First Nation, Pauquachin First Nation, and the BC Ministry of Transportation.

Stormwater drainage within the District is mostly conveyed through open ditches, driveway culverts, and road crossing culverts. These discharge into creeks or piped outfalls into the ocean. Denser residential areas, such as Dean Park, are drained via storm sewer systems. The area within and surrounding the airport lands mostly consists of low-lying agricultural areas and grasslands with gentle slopes. The northern and southern parts of the District are hilly and mostly consist of forested and residential land uses. The three major watersheds, Tseycum (WSIKEM) Creek, Ten-Ten Creek, and Reay (KELSET) Creek are mostly located within the low-lying areas of the District. The Chalet (Tatlow) Creek watershed is in the northern hilly part of the District. Some areas of the stormwater system are influenced by tides and potentially impacted by sea level rise. In addition to District infrastructure, stormwater in this region is conveyed through infrastructure within the Victoria Airport Authority, Town of Sidney, District of Central Saanich, BC Ministry of Transportation (Highway 17 and sections of West Saanich Road and McTavish Road), Tseycum First Nation, and Pauquachin First Nation lands, as well as private properties.

The District of North Saanich manages in total about 25.5 km of culverts and 73.1 km of pipes as enclosed stormwater infrastructure, as well as 168.8 km of drainage ditches and 14.1 km of swales as open stormwater infrastructure.

The study areas of the Drainage Master Plan (DMP) and the Integrated Stormwater Management Plan (ISMP) are shown in **Figure 1**, which also shows the major watersheds and creeks within the District.



FIGURE 1 - OVERVIEW MAP

1.2 Objectives

The overall objective of the DMP is to assess the capacity of the existing drainage system, to recommend replacement of infrastructure that is hydraulically undersized or in poor condition, and to develop a prioritized capital replacement plan. The specific objectives of the DMP are to:

1. Review existing stormwater system information, discuss with District staff, and identify infrastructure data gaps.
2. Assess the total drainage asset value based on the available information.
3. Conduct a visual field condition assessment on a representative sample of drainage pipe infrastructure to compare to District GIS condition information.
4. Provide flow monitoring at different locations within the Tseycum Creek and McDonald Park Road Drain watershed to calibrate and validate the hydrologic and hydraulic model.
5. Develop a hydrologic and hydraulic model of the existing drainage system to identify infrastructure that is hydraulically undersized.
6. Determine level of service, future servicing requirements, and design storm criteria.
7. Run the developed hydrological and hydraulic model to identify areas and infrastructure in need of hydraulic upgrades based on future condition storm scenarios.
8. Review ARSDA criteria and model agricultural drainage performance.
9. Outline the objectives of the DMP as part of the ISMP public engagement process.
10. Identify and prioritize recommended hydraulic upgrades and condition replacements.
11. Develop a 20-year capital replacement program with a schedule and a cost estimate.

Areas of Drainage Concern

Key areas of known drainage issues were evaluated from previous reports including “*Hydrological Assessment of Tseycum Creek (2009)*”, through discussion with District’s staff, and from the public engagement process. They were compiled into an overview map “Areas of Drainage Concern” in **Appendix D**. These areas are further used as described in **Section 4.2**, to prioritize hydraulic upgrades and condition replacements to resolve these issues quickly.

Public Engagement

Public engagement for the DMP and the ISMP began with Phase 1 from May to October 2021. Public engagement included online meetings with stakeholders like environmental stakeholders, Tseycum First Nation, Pauquachin First Nation, WSÁNEĆ technical advisory committee and the Victoria Airport Authority. Furthermore, the District conducted several site visits along various properties in the Tseycum Creek watershed. Phase 1 of the public engagement provided information about the DMP and ISMP objectives and solicited feedback from participants on drainage concerns or comments. This information was used to further define the ‘Areas of Concern’ and to update model information. A full summary of the public engagement led by Lanarc Consultants can be found in **Appendix C**. Phase 2 of the public engagement focused on the ISMP and was conducted in July 2022.

1.3 Abbreviations

The following abbreviations are used in the Drainage Master Plan:

AC	Asbestos Cement
ACMP	Aluminium Corrugated Metal Pipe
ALR	Agricultural Land Reserve
ARSDA	Agricultural and Rural Development Subsidiary Agreement
CC	Climate Change
CGVD28	Canadian Geodetic Vertical Datum of 1928

CONC	Concrete
CRD	Capital Regional District
CSP	Corrugated Steel Pipe
DMP	Drainage Master Plan
DNS	District of North Saanich
FB	Freeboard
GCM	Global Circulation Models
GIS	Geographic Information System
HDPE	High-Density Polyethylene
HGL	Hydraulic Grade Line
HHWLT	Higher High-Water Large Tide
IDF	Intensity-Duration Frequency
ISMP	Integrated Stormwater Management Plan
LIDAR	Light Detection and Ranging
MoTI	Ministry of Transportation and Infrastructure British Columbia
OCP	Official Community Plan
PLA	Preliminary Layout Acceptance
PVC	Polyvinylchloride
RA	Rural Agricultural
RCP	Representative Concentration Pathway
SCS	Soil Conservation Service
UV	Ultraviolet
VAA	Victoria Airport Authority
VISN	Vancouver Island School Based Weather Station Network

1.4 Total Drainage Asset Value

The total drainage asset value for the District was evaluated. It represents the estimated replacement value of significant drainage infrastructure within the District and helps to establish a context for the recommended capital asset replacement program (**Section 4.5**). It also shows the annual upgrade and replacement costs in relation with the overall drainage asset value. Drainage assets are piped infrastructure such as culverts and storm sewers, open-channel drainage infrastructure (ditches and swales), smaller lateral stormwater pipes such as catch basin leads, as well as manholes, outfalls, inspection chambers, catch basins, cleanouts, silt traps and trash racks.

Table 1 below shows the total assessed drainage asset value, including the total asset length if applicable and the estimated replacement costs.

Drainage Assets	Size Class (mm)	Number of Assets	Total Asset Length (m)	Estimated Replacement Cost	Total Replacement Value
Pipes					
	Unknown	400	4,680	-	-
	< 300	920	35,401	\$650 /m	\$23,010,650
	300 - 399	529	16,933	\$850 /m	\$14,393,050
	400 - 499	195	6,525	\$1,000 /m	\$6,525,000
	500 - 599	89	3,425	\$1,200 /m	\$4,110,000
	600 - 699	124	3,959	\$1,400 /m	\$5,542,600
	700 - 799	5	261	\$1,600 /m	\$417,600
	800 - 899	8	271	\$1,700 /m	\$460,700
	900 - 1199	16	943	\$1,800 /m	\$1,697,400
	1200 - 1399	15	679	\$2,300 /m	\$1,561,700
	1400 - 1599	0	-	\$2,500 /m	-
	1600 - 2000	0	-	\$2,700 /m	-
	Total	2,301	73,077	-	\$57,718,700
Culverts					
	Unknown	605	7,050	-	-
	< 300	139	944	\$650 /m	\$613,600
	300 - 399	1,428	11,433	\$850 /m	\$9,718,050
	400 - 499	335	3,254	\$1,000 /m	\$3,254,000
	500 - 599	135	1,352	\$1,200 /m	\$1,622,400
	600 - 699	94	1,099	\$1,400 /m	\$1,538,600
	700 - 799	11	154	\$1,600 /m	\$246,400
	800 - 899	12	153	\$1,700 /m	\$260,100
	900 - 1199	1	6	\$1,800 /m	\$10,800
	1200 - 1399	1	24	\$2,300 /m	\$55,200
	1400 - 1599	0	-	\$2,500 /m	-
	1600 - 2000	0	-	\$2,700 /m	-
	Total	2,761	25,469	-	\$17,319,150
Lateral Lines					
	Unknown	1,681	15,978	-	-
	< 300	200	1,723	\$650 /m	\$1,119,950
	300 - 399	4	29	\$850 /m	\$24,650
	Total	1,885	17,730	-	\$1,144,600
Catch Basin Leads					
	< 300	634	4,265	\$650 /m	\$2,772,250
Outfalls					
		139	-	\$15,000	\$2,085,000
Catch Basins					
		794	-	\$3,000	\$2,382,000
Manholes					
		917	-	\$12,000	\$11,004,000

Drainage Assets	Size Class (mm)	Number of Assets	Total Asset Length (m)	Estimated Replacement Cost	Total Replacement Value
Inspection Chambers					
		404	-	\$10,000	\$4,040,000
Cleanouts					
		324	-	\$3,000	\$972,000
Trash Racks					
		35	-	\$3,000	\$105,000
Silt Traps					
		175	-	\$15,000	\$2,625,000
Ditches					
		3,584	168,763	\$350/m	\$1,254,400
Swales					
		363	14,067	\$100/m	\$36,300
Totals		14,316			\$103,422,100

TABLE 1 – TOTAL DRAINAGE ASSET VALUE OF THE DISTRICT OF NORTH SAANICH

The total drainage asset value for the District of North Saanich is estimated to be approximately \$103.46 million (CAD 2022). The drainage infrastructure is further categorized into piped infrastructure, open-channel infrastructure, and point infrastructure to show how the value is distributed:

Piped Infrastructure:

- Includes storm sewers, culverts, lateral lines, catch basin leads.
- Estimated total value is \$78.95 million or 76.3% of the total drainage asset value.
- Estimated value of culverts and storm sewers is \$75.04 million or 72.5% of the total drainage asset value.

Open-Channel Infrastructure:

- Includes ditches and swales.
- Estimated total value is \$1.29 million or 1.3% of the total drainage asset value.

Point Infrastructure:

- Includes outfalls, catch basins, manholes, inspection chambers, cleanouts, trash racks and silt traps.
- Estimated total value is \$23.21 million or 22.4% of the total drainage asset value.

A comparison of drainage asset values for these categories reveals that most of the value for the District is contained within piped infrastructure, primarily in storm sewer pipes and culverts that comprise 72.5% of the total estimated value.

2. Hydraulic Modeling

A hydrological and hydraulic PCSWMM model was developed for stormwater infrastructure within the District. The model incorporated existing PCSWMM models of the District. Stormwater infrastructure included pipes (culverts and storm sewers) of 300 mm diameter or greater, with some pipes smaller than 300 mm in diameter from already in existing models. The model was used to assess the capacity of the existing stormwater infrastructure, for both existing and future conditions, and to identify where additional system capacity is required to mitigate flooding due to surcharging. The model was built and run on the SWMM 5.1.013 version of PCSWMM developed by CHI Water.

2.1 Existing Condition

2.1.1 INFRASTRUCTURE

The PCSWMM model was built based on existing PCSWMM models and from GIS data received from the District. The GIS data includes ditches, culverts, storm sewers, outfalls, and manholes. Storm sewer data (including elevation, material, and geometry) within Reay Creek and residential areas such as Dean Park were included in the GIS data. A comparison between pipes used in the model and pipes within the District's GIS inventory is presented in **Table 2** below.

Pipe Size Category (mm)	PCSWMM Pipe Number	GIS Pipe Number ²⁾
< 300	64 ¹⁾	1,059
300 - 399	595	1,957
400 - 499	263	530
500 - 599	129	224
600 - 699	152	218
700 - 799	19	16
800 - 899	23	20
900 - 1199	39	17
1200 - 1399	19	16
1400 - 1599	3	0
1600 - 2000	3	0
Total	1,309	5,062
¹⁾ Pipes < 300 mm in the model were only incorporated from existing models.		
²⁾ Only incorporates pipes owned by District of North Saanich in use.		

TABLE 2 – TOTAL NUMBER OF PIPES IN HYDRAULIC MODEL AND GIS

The District conducted GPS point surveys of sections of culverts and ditches along the roadways within the District in 2017 and 2018. Data collected included the material, headwall, diameter, and condition information for culverts. Along roadside ditches, the bottom and top elevations were recorded. The combined data within the GIS and the survey were used to input junction, conduit, and outfall data into the model.

The PCSWMM model also incorporated record data for newer ditches and culvert infrastructure on Victoria Airport Authority lands along Willingdon Road within the Ten-Ten Creek watershed and along McDonald Park Road. This was in

addition to record data for the McTavish Interchange on Patricia Bay Highway, provided by the BC Ministry of Transportation and Infrastructure (MoTI) and from the Sandown development, provided by the District.

The District of North Saanich provided several PCSWMM models for areas within the District. Data from the “Tseycum Creek and McDonald Park Road Drain with Sandown” (September 2019), and “Dean Park North” models were reviewed and imported into the model. The imported model included outdated data from 2016 before major drainage improvements along McDonald Park Road between the Patricia Bay Highway and Blue Heron Road, as well as between Glamorgan Road and John Road, which were revised based on record drawing information provided by the District. The section of the existing model covering the Tseycum Creek watershed was reviewed and adjusted based on existing GIS information.

Most roadside ditches were input to the model as a simple triangular channel cross-section. Survey data was typically not available for creeks and ditches on private property. A reasonable assumption of a trapezoidal channel cross-section was used for creeks, with geometric data estimated from aerial photographs and LiDAR data. It should be noted that the existing PCSWMM model “Tseycum Creek and McDonald Park Road Drain with Sandown” (September 2019) had more detailed cross-sectional data for some sections of Tseycum Creek, and these were incorporated into this PCSWMM model. Ditches that connect culverts through private properties were input as trapezoidal channels with a typical bottom width of 1 m.

An overview for the assumed roughness and loss coefficient parameters for the model are given in **Table 3** below and are considered conservative to account for the age of the infrastructure. The “Dynamic Wave” routing method was used to route flows through the conveyance system in the model, with time steps being set as low as 5 minutes during rainfall. Overall, the PCSWMM model contains 2,362 conduits, 2,357 junctions, 68 outfalls and 1 storage node.

Pipe Material/Ditch Cover	Manning’s Roughness Coefficient
Asbestos Cement (AC)	0.013
Aluminium Corrugated Metal Pipe (ACMP)	0.025
Corrugated Steel Pipe (CSP)	0.025
Concrete (Conc)	0.013
High Density Polyethylene (HDPE)	0.013
Polyvinylchloride (PVC)	0.013
Unknown Pipe Material (UNK)	0.025
Vegetative Linings (Ditch & Swale)	0.500

Culvert Model Parameters	Loss Coefficient
Flow Entry	0.5
Flow Exit	1.0

TABLE 3 - MODELLING PARAMETERS FOR ROUGHNESS AND LOSS-COEFFICIENTS

2.1.2 CATCHMENTS AND LAND USE

LiDAR data provided by the District as well as aerial photographs were used to define subcatchment boundaries, land use (including pervious/impervious coverage), and catchment slope and width. The model includes catchment areas with an outlet capacity greater than 100 L/s or equivalent to a pipe diameter of 300 mm or greater. A typical catchment with an area less than 2 hectares is not expected to generate more than 100 L/s of runoff during design storm events. The model contains 845 subcatchments.

The PCSWMM model uses the Horton method to estimate the infiltration capacity on pervious land. According to the “Soils of Southern Vancouver Island” (1985) report, the low-lying agricultural lands and grasslands within the District mostly consist of silty clay loam or clay loams, shaded as dark brown in **Figure 2**. Due to the underlying clay soils, significant infiltration is not expected and there is a higher runoff potential in the low-lying areas for the peak flows events that this model is focussed on. The poor infiltration is supported by local landowners, as noted in the “Hydrological Assessment of Tseycum Creek” by Parsons (as Delcan) in 2009. The more hilly and forested parts of the District within the north and south boundaries consist of gravelly loamy sand, shaded in yellow, pink, and green below. Higher infiltration of rainfall runoff is expected as a result.

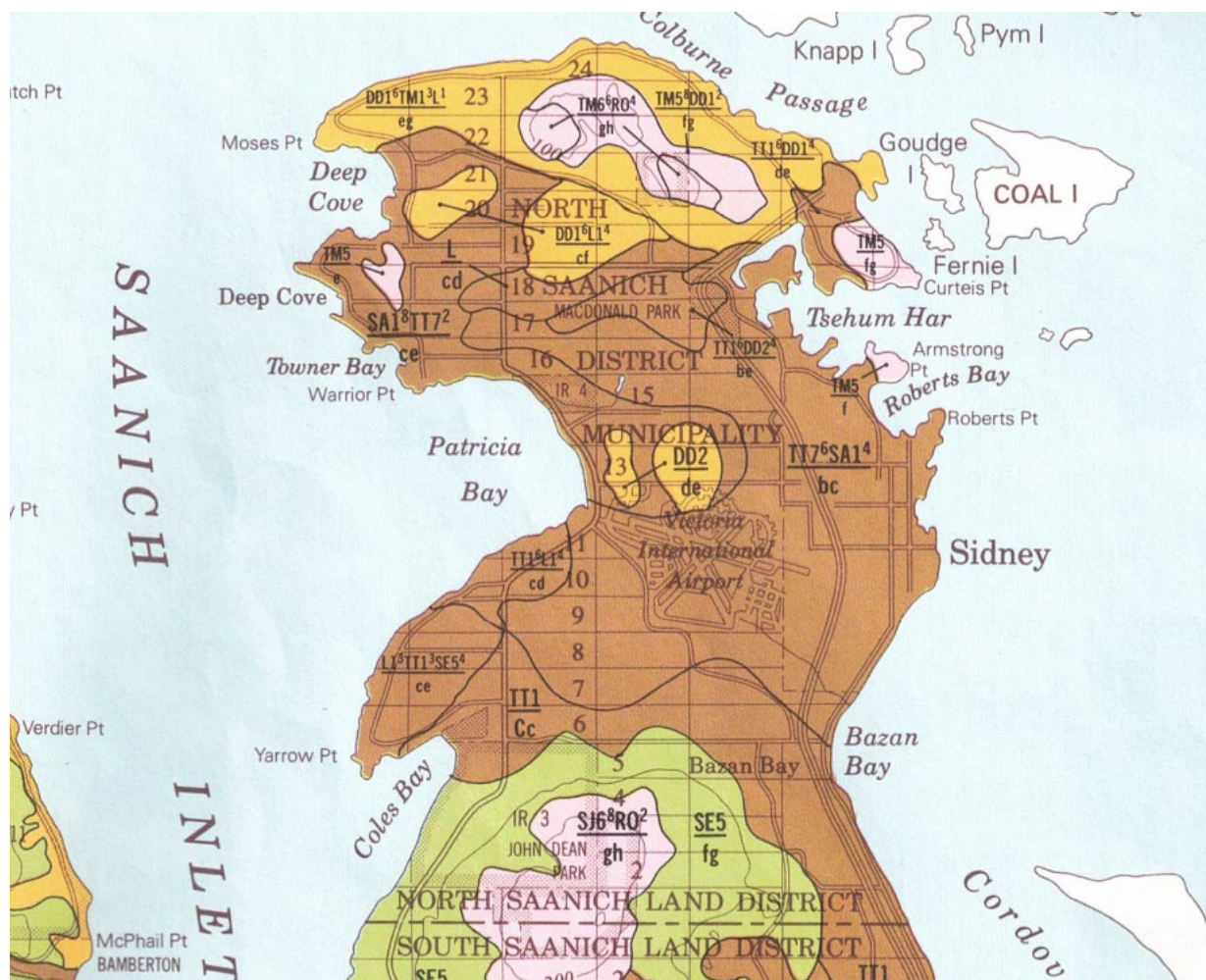


FIGURE 2 - NORTH SAANICH SOIL MAP, SOIL OF SOUTHERN VANCOUVER ISLAND REPORT (1985)

Table 4 below summarizes the Horton method infiltration parameters as input into each subcatchment based on the underlying soils of the region. Previous PCSWMM models of regions in the District used the same parameters.

Horton Method Parameters	Silty Clay Loam/Clay Loam Soils	Gravelly Loamy Sands
Max. Infiltration Rate	10 mm/hr	25 mm/hr
Min. Infiltration Rate	0.5 mm/hr	2 mm/hr
Decay Constant	4 hr ⁻¹	4 hr ⁻¹
Drying Time	7 days	7 days

TABLE 4 - SUMMARY OF HORTON METHOD PARAMETERS, UNCALIBRATED MODEL

Most of the District consists of Agricultural Land Reserve (ALR), grasslands, and single-family residential areas per the District's Official Community Plan (OCP). Subcatchments in these areas typically have a high pervious-to-impervious ratio. The District's overall mean imperviousness in the model is about 20% for the existing condition.

2.1.3 BOUNDARY CONDITIONS

Most of the District drains directly into the ocean through 66 outfalls. Two further outfalls were used in the model to drain into the municipal storm system of Central Saanich to the south. At low-lying foreshore areas, tide levels have an impact on the capacity of stormwater infrastructure immediately upstream of the outfalls. Tidal information obtained from Canadian Hydrographic Services (CHS) indicates that the Higher High-Water Large Tide (HHWLT) on the east side of the peninsula, based on the Sidney tide gauge, is 1.35 m above geodetic datum (CGVD28). On the west side of the peninsula the HHWLT is 1.49 m above geodetic datum (CGVD28) based on the Patricia Bay tide gauge. The slightly higher elevation on the west side of the peninsula is due to restrictions in Satellite Channel. The fixed tidal level of 2 m was set as the boundary condition for the outfalls in the model. This assumes a storm surge induced increase of 0.5 m over the HHWLT of 1.5 m and should be seen as the worst-case scenario during a major storm event.

2.1.4 DESIGN STORMS

The District of North Saanich has referenced the District of Saanich Engineering Specifications "Schedule H to Bylaw 7452" from 2004 which state that storm drains up to 900 mm diameter in size should be designed for the 10-year design storm and larger storm drains designed for the 25-year design storm. The storm drainage system was therefore separated into a Major System that represents culverts and pipes larger than 900 mm and a Minor System for pipes and culverts smaller or equal to 900 mm.

A design storm in this report is represented by its statistical recurrence period (such as 5 years), through its rainfall duration, (such as 24 hours) and the resulting total rainfall amount in millimetres. Intensity-Duration-Frequency (IDF) data which describes this relationship, were used in from the Victoria International Airport climate station (ID: 1018621). The design storm distribution was based on the "SCS Type IA" rainfall distribution which is considered representative for the Pacific coast with wet winters. Due to its rural character with significant coverage by agricultural fields and green spaces, a 24-hour rainfall duration was anticipated to result in the highest runoff, rather than a storm of shorter concentration time, due to the reduction in rainfall infiltration after saturation of the soils and the slow concentration times within the District.

Future rainfall of increased frequency and intensity can be expected due to climate change. The design storms for this report were developed in coordination with the District. A 5-Year return period with a 24-Hour rainfall duration, including an allowance for climate change was selected for the Minor design storm (refer to **Table 5**). This design storm has a rainfall depth of 78.2 mm and is nearly identical with the current design storm of 10-Years and 24-Hour of 79.3 mm. It was agreed that this would give similar hydraulic results and level of service for the minor system. The Major system's design storm was selected as a 25-Year 24-Hour design storm plus allowance for climate change. The rainfall depth for this design storm is 113.4 mm compared to the current design storm without climate change of 95.6 mm to give more conservative results preparing for an increase in future rainfall intensities for the major system.

System	Drainage Pipe Size (mm)	Design Storm	Total Rainfall Depth (mm)	Climate Change
Standard Design Storms used by District of North Saanich				
Minor System	Diameter ≤ 900 mm	10-year return period, 24-hour duration	79.3 mm	None
Major System	Diameter > 900 mm	25-year return period, 24-hour duration	95.6 mm	None
Design Storm used for Drainage Master Plan				
Minor System	Diameter ≤ 900 mm	5-year return period, 24-hour duration	78.2 mm	RCP 8.5 ¹ , projected year 2071
Major System	Diameter > 900 mm	25-year return period, 24-hour duration	113.4 mm	RCP 8.5 ¹ , projected year 2071

¹ RCP: Representative Concentration Pathway 8.5 Watts per sq. metre for the year 2100.

TABLE 5 – DISTRICT OF NORTH SAANICH DESIGN STORMS

The “IDF_CC tool 4.5” (Simonovic et. al., 2021) developed by Western University was used to generate IDF curve extrapolations for the year 2071 as new drainage infrastructure is expected to have a design life of at least 50 years. A ‘Representative Concentration Pathway’ (RCP) of 8.5 (Watts per square metre) was assumed for the 5-year and 25-year design storms. The extrapolated rainfall amounts were derived from the results of 24 Global Circulation Models (GCMs) and 9 downscaled GCMs that simulate various climate conditions for local rainfall data and specific rain gauges. This location-sensitive approach based on scientific climate models is believed to provide reasonable conservative predictions.

Extreme Rainfall Event November 14/15, 2021

An extreme rainfall event occurred across southwestern British Columbia between November 14th and 15th, 2021, during the preparation of this DMP, with impacts felt throughout the region, including the District of North Saanich. The District received numerous reports from residents of flooding and drainage issues during and after the event, affecting public and private properties. An analysis of the rainfall data from the rain gauge “Saanichton CFIA” (ID: 1016943) from Environment and Climate Change Canada showed that the storm had a rainfall duration of 24 hours and a total rainfall depth of 126.4 mm, with preceding saturating rainfalls. Compared to the 100-Year 24-Hour IDF storm for the closest rain gauge “Victoria International Airport” (ID: 1018621) this rainfall event exceeded the 100-Year storm by 2.2% and can therefore be considered an extreme rainfall event. The “Climate Projections for the Capital Region” (Murdock, et al, 2017) projects that the Capital Region on Vancouver Island will see an increase of precipitation of 12% to 68% over the next 30 years and 26% to 126% over the next 50 years, increasing the need to address extreme rainfall events.

Extreme rainfall events like the November 2021 storm overwhelm drainage pathways such as culverts, storm sewers and ditches and flow mostly as overland sheet flow, following the local topography, including across streets. The hydrological and hydraulic PCSWMM model used for this DMP does not have the capability to model these 2D/3D flow conditions, Modelling and analysis of this storm is beyond the scope of this DMP.

A district-wide Flood Risk Assessment as a next step would help to identify areas, infrastructure, and properties at risk. The resulting flood risk and flood hazard maps provide an overview of those risks in the District. At this point a Flood Management Plan could be developed, and used to inform and educate residents, and help them to address those risks.

2.2 Existing Condition - Model Calibration and Validation

2.2.1 COLLECTED DATA

To calibrate and validate the hydraulic model various data samples were collected, including rainfall data, flow monitoring data and field observation data during a heavy rainfall event in December 2020.

Flow Monitoring Data

Five monitoring stations were installed to record flow data at different locations within the Tseycum Creek and McDonald Park watershed in coordination with the District. The first was Monitoring Location 1 at the Tseycum Creek footbridge on January 16th, 2020, north of Munro Road by Current Environmental (refer to **Figure 3**). This monitoring station was equipped with an automatic flow depth datalogger recording hourly flow depth in Tseycum Creek. Additionally, for this location and at four other locations (Locations 2, 3, 4 and 5), flow data was measured by on-site personnel during or shortly after rainfall events on January 13th, January 31st, and March 31st, 2020. The measured flows and constantly logged flow depths were used to calculate a stage-discharge relationship for Location 1 to determine hourly flows for the model calibration.

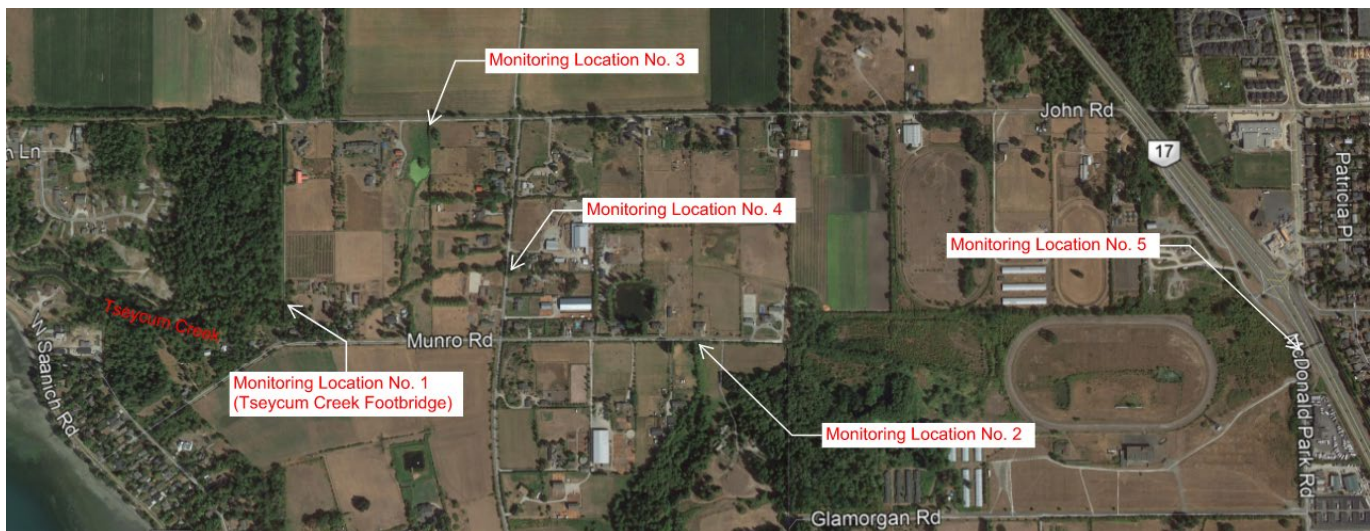


FIGURE 3 - FLOW MONITORING LOCATIONS

After conversation with the District three additional continuous flow depth dataloggers were installed at flow Monitoring Locations 2, 3 and 5 on November 19th, 2020 by Colquitz Engineering (refer to **Figure 3**). These additional continuous monitoring stations recorded flow depths in 15-minute intervals and were installed for a broader picture of the Tseycum Creek Watershed. These monitoring stations were uninstalled on February 5th, 2021. Stage-discharge relationships were calculated for each station with manually measured flows during or shortly after rainfall events.

The measured flow monitoring data of the five different locations was used for the calibration of the model.

Monitoring Location 1 - Tseycum Creek Footbridge:

- Longitude: 48° 39'44.18"N, Latitude: 123° 25'2.55"W
- Flow depth datalogger, hourly intervals (January 16th, 2020 – March 19, 2021)

Monitoring Location 2 - Munro Road -Ditch:

- Longitude: 48 ° 39'44.00"N, Latitude: 123 ° 25'59.94"W
- Manually flow measuring station (January 13th, January 31st and March 31st, 2020)
- Flow depth datalogger, 15-minute intervals (November 19th, 2020 – February 8th, 2021)

Monitoring Location 3 - John Road – Culvert Crossing:

- Longitude: 48 ° 39'58.42"N, Latitude: 123 ° 26'24.23"W
- Manually flow measuring station (January 13th, January 31st, and March 31st, 2020)
- Flow depth datalogger, 15-minute intervals (November 19th, 2020 – February 8th, 2021)

Monitoring Location 4 – Wilson Road – Culvert Crossing:

- Manually flow measuring station (January 13th, January 31st and March 31st, 2020)

Monitoring Location 5 - McDonald Park Road – Culvert Crossing:

- Longitude: 48 ° 39'44.18"N, Latitude: 123 ° 25'2.55"W
- Manually flow measuring station (January 13th, January 31st and March 31st, 2020)
- Flow depth datalogger, 15-minute intervals (November 19th, 2020 – February 8th, 2021)

Rainfall Data

Rainfall data as described below was input to the model and its calibration to produce results comparable to the measured flow data from the dataloggers and manually recorded flow depth data.

For the first calibration, rainfall data was used from the Vancouver Island School-Based Weather Station Network (VISN), developed at the University of Victoria, as the data was logged every 10 minutes rather than the hourly logged data from the Victoria International Airport. Rainfall data from North Saanich Middle School was collected from January 2020 to March 2020. During that period two large rainfall events occurred, with the first starting on January 30th with a total rainfall of 58.4 mm over a 37-hour period. The second event started on March 26th with a total rainfall of 22.86 mm over a 103-hour period.

The second calibration was also conducted with rainfall data from the VISN North Saanich Middle School. Rainfall data from December 2020 and January 2021 were collected with two significant rainfall events during this period. The most significant rainfall event was on December 21st with a total rainfall amount of 65.2 mm over a 16-hour period with occasional snow.

Field Observations December 2020

A field observation was conducted by Colquitz Engineering during the snow and rainfall event on December 21st, 2020. The crew collected flow depth data and site photos at various sites showing water levels or flooding throughout the District. The field observation report can be found in **Appendix G**.

2.2.2 CALIBRATION AND VALIDATION

Calibration #1

The first calibration was performed in September 2020 using the January 30th, 2020 rainfall event flow data from Monitoring Location 1. **Figure 4** compares the hourly measured flows to the flows calculated by the model. The flow

hydrograph generated by the model correlates well with the hydrograph generated from measured depths. The model predicts peak flows to be 1.77 m³/s compared to a peak measured flow of 1.76 m³/s.

It should be noted that the modelled flows tend to drop to zero between rainfall runoff periods and at the end of rainfall events. This occurs because the model was developed to predict peak flows during rainfall events and groundwater to create interflows and baseflows are not included in the model.

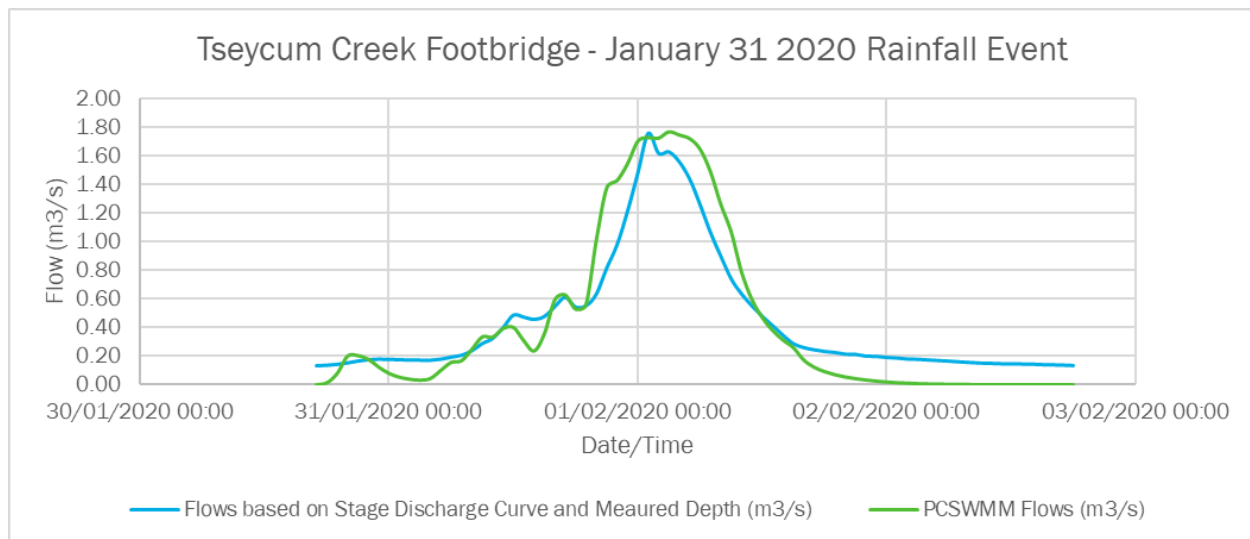


FIGURE 4 – FLOW COMPARISON AT TSEYCUM CREEK FOOTBRIDGE – JANUARY 30TH EVENT

In addition to the comparison with Monitoring Location 1, the flows for the other monitoring stations have been compared with flows measured manually by on-site personnel on January 30th. The comparison is summarized in **Table 6**, showing that the model predicts flows conservatively but with reasonable correlation.

Flow Monitoring Location	Approximate Time of Measurement	Measured Flows	PCSWMM Flows
Monitoring Location 2	13:00	0.036 m ³ /s	0.067 m ³ /s
Monitoring Location 3	15:00	0.33 m ³ /s	0.27 m ³ /s
Monitoring Location 4	14:00	0.008 m ³ /s	0.017 m ³ /s
Monitoring Location 5	15:00	0.13 m ³ /s	0.19 m ³ /s

TABLE 6 – COMPARISON OF MEASURED FLOWS AND MODELLED FLOWS FOR JANUARY 30TH, 2020

The model flow hydrographs for Monitoring Locations 3 and 5 predict flows of 0.27 m³/s and 0.15 m³/s respectively approximately 1 hour after the measured flows were taken. These flows are closer to the measured flows than to the PCSWMM flows predicted below. It should also be noted that the model may overestimate low flows as discussed above. This is shown at Monitoring Locations 2 and 4.

Calibration #2

The second calibration was performed in March 2021 using the December 21st, 2020 rainfall event, with over 65 mm within a short period of 16 hours during the period of flow measurement. The measured flow data from four Monitoring Locations 1, 2, 3 and 5 was compared with the model results. As described above, the flow measurement for the monitoring stations is based on the measured flow depth which is then converted into flow values by a stage-discharge relationship, which was calculated based on manual on-site flow measurements. Due to the location of Monitoring Stations 2, 3 and 5 these flow measurements were not taken in the centre of the ditches, as the risk to on-site personnel was too high during

high flows. Therefore, for the high flows of the stage-discharge curve an extrapolation assumption was made which introduces some uncertainty.

Since Monitoring Station 1 has the largest connected catchment area and the highest confidence from its measured flows it was chosen to be the primary comparison point for calibration, as with Calibration #1. **Figure 5** shows the comparison of the measured flow at the Tseycum Creek footbridge with the predicted flows from the model before and after the second calibration. The model before the calibration predicts the flows accurately. It shows approximately the same time for the highest peak flow although it overpredicts the maximum flow at $1.50 \text{ m}^3/\text{s}$ compared to the measured flow at $1.43 \text{ m}^3/\text{s}$. This slight overprediction can also be seen for flow Monitoring Station 2 with a predicted flow of $0.40 \text{ m}^3/\text{s}$ compared to a measured flow of $0.36 \text{ m}^3/\text{s}$ (**Figure 6**) and flow Monitoring Station 3 with a predicted flow of $0.69 \text{ m}^3/\text{s}$ compared to a measured flow of $0.60 \text{ m}^3/\text{s}$ (**Figure 7**). The model matches measured flows at Monitoring Station 5, with the peak flow of $0.27 \text{ m}^3/\text{s}$ comparing closely with $0.28 \text{ m}^3/\text{s}$ (**Figure 8**).

Due to the small over-prediction for Monitoring Locations 1, 2 and 3, it was decided to increase the minimum infiltration rate after saturation (Horton Method parameters) for all sub-catchments by 34%:

- Silty Clay Loam/ Clay Loam Soils:
 - Calibration #1: 0.50 mm/hr
 - Calibration #2: 0.67 mm/hr
- Gravelly Loamy Sands:
 - Calibration #1: 2.00 mm/hr
 - Calibration #2: 2.68 mm/hr

The revised calibrated flows are shown in **Figure 5**, **Figure 6**, **Figure 7** and **Figure 8** as the green lines. The new calibration fits well for Monitoring Locations 1, 2 and 3, but less well for Monitoring Location 5.

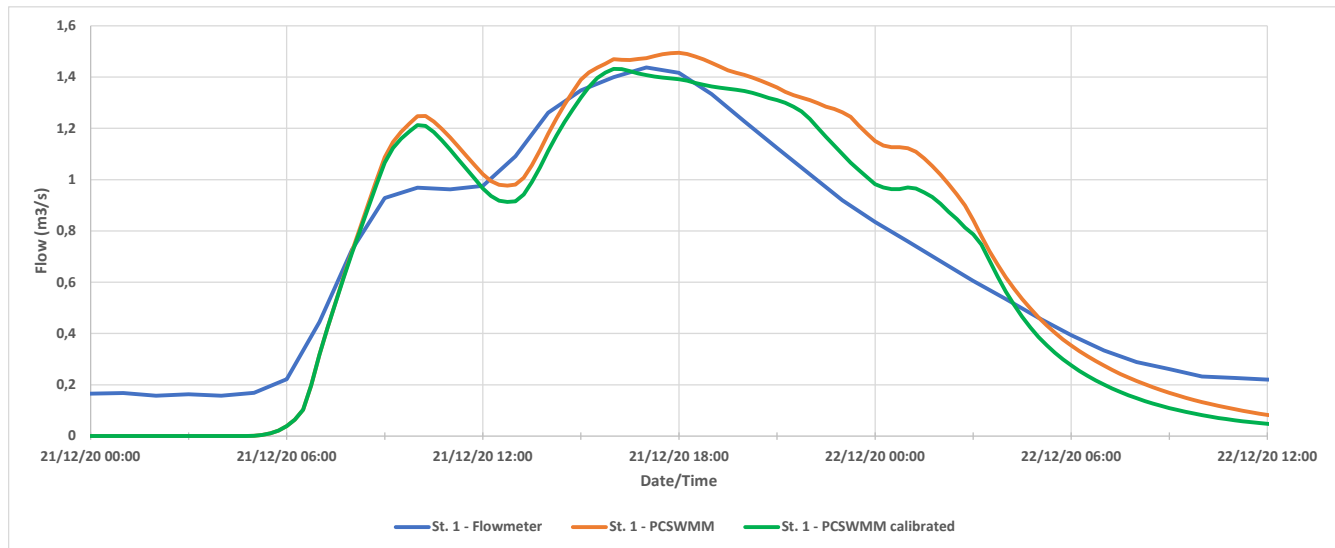


FIGURE 5 – COMPARISON GRAPH FOR FLOW MONITORING STATION 1

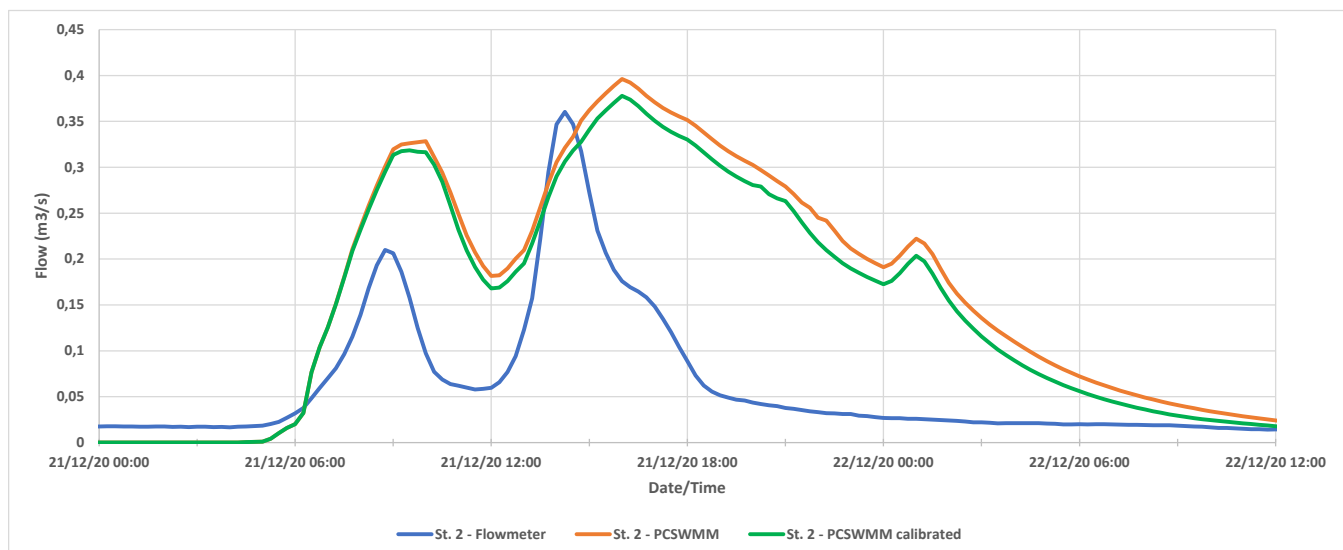


FIGURE 6 – COMPARISON GRAPH FOR FLOW MONITORING STATION 2

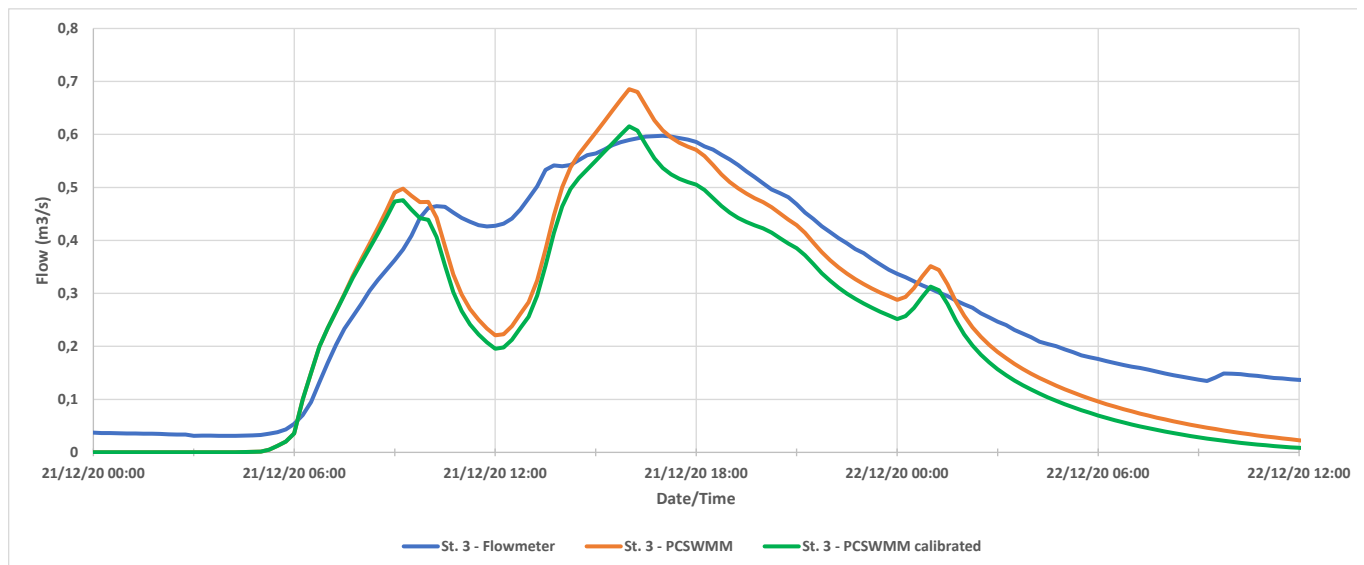


FIGURE 7 - COMPARISON GRAPH FOR FLOW MONITORING STATION 3

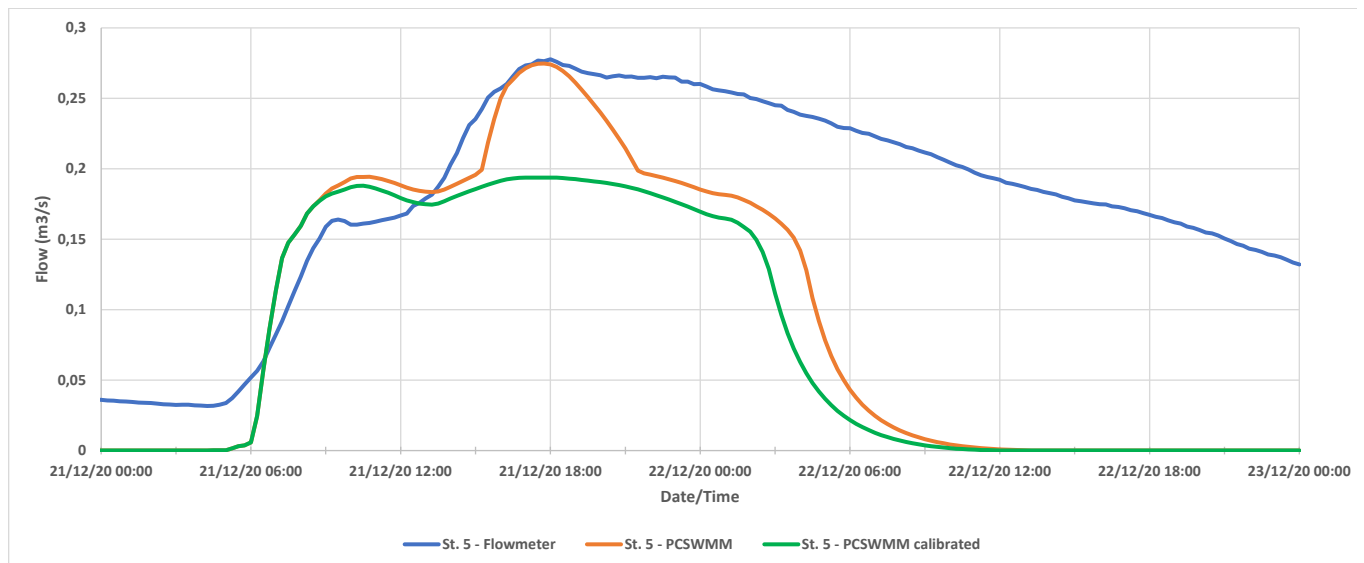


FIGURE 8 - COMPARISON GRAPH FOR FLOW MONITORING STATION 5

Table 7 shows the changes for the measured and predicted flows with the percentage difference. While the calibration reduced the differences at Monitoring Locations 1, 2 and 3 by about 4.5% to 11.7% giving a good fit for peak flows, it also reduced the peak flow for Monitoring Location 5, resulting in an underprediction of the peak flow by 47%. This abrupt change for only one monitoring location was therefore further analyzed and validated.

Flow Monitoring Location	Measured Peak Flow (m ³ /s)	Model Uncalibrated Peak Flow(m ³ /s)	Uncalibrated %-Difference	Model Calibrated Peak Flow(m ³ /s)	Calibrated %-Difference
Monitoring Location 1	1.44 m ³ /s	1.60 m ³ /s	+11.1 %	1.48 m ³ /s	+2.8 %
Monitoring Location 2	0.36 m ³ /s	0.40 m ³ /s	+11.1 %	0.38 m ³ /s	+5.6 %
Monitoring Location 3	0.60 m ³ /s	0.69 m ³ /s	+15.0 %	0.62 m ³ /s	+3.3 %
Monitoring Location 5	0.28 m ³ /s	0.27 m ³ /s	-3.6 %	0.19 m ³ /s	+47.4 %

TABLE 7 – COMPARISON OF PEAK FLOWS OF UNCALIBRATED AND CALIBRATED MODEL, DEC 21ST, 2020

Validation

For further validation of the new calibrated model, information from the site observations made on December 21st, 2020 by Colquitz Engineering was used (refer to **Appendix G**). During this site visit flow depth measurements were taken at different locations, as well as general field observations. Flows at Monitoring Locations 1, 3 and 5 were measured at different times during this field visit and were used to further improve the accuracy of the model. **Table 8** shows that the measured flow depths are close to the predicted flow depths from the model. At Monitoring Location 3 the model slightly underpredicted the flow depths but this is likely the result of the slower flow response from the model as the flow depth at 1:45pm reaches 0.80 m.

Flow Monitoring Location	Time of Measurement	Measured Depth (m)	PCSWMM Calibrated Depth (m)
Monitoring Location 5	12:35 pm	0.53 m	0.58 m
Monitoring Location 3	1:30 pm	0.85 m	0.75 m
Monitoring Location 1	1:43 pm	0.88 m	0.86 m

TABLE 8 – COMPARISON OF MEASURED AND MODELLED FLOW DEPTHS FOR DECEMBER 21ST, 2020

The good prediction of the flow depth of 0.58 m at Monitoring Location 5, compared to the real flow depth of 0.53 m, but poor prediction of the new calibrated total flow for Monitoring Station 5, as described above, is likely an indication that the stage-discharge curve for this particular station is not a good fit at higher flows. As previously described, these curves were created mostly after rainfall events when the peak flow had already occurred, but flows were still high enough that flow measurements could not be safely taken from the middle of the ditch and had to be extrapolated. Since the modelled flow depths were an overall good fit with the measured data, the calibrated and validated model could be expected to produce reliable peak flow results for the Tseycum Creek and McDonald Park watershed, and for the District overall.

2.3 Future Condition

A Future Condition scenario was developed to simulate future performance of the drainage system. The Future Condition scenario includes a conservative prediction of increased imperviousness within the District due to new development and re-development using the maximum allowable coverage for each lot. This increase can be seen as a considered worst-case scenario. Additionally, boundary conditions were adjusted to include predicted sea-level rise for coastal outfalls. (An increase in rainfall intensity due to climate change is already incorporated in the used design storms used and projected to the year 2071).

2.3.1 FUTURE LAND USE

For the Future Scenario an increase in imperviousness was anticipated within the District due to future new and redevelopments for each subcatchment. Received GIS cadastral, zoning and land designation data from the District were used to determine lot sizes and percent imperviousness ratios for each subcatchment throughout the District.

The District has indicated that in recent Preliminary Layout Acceptances (PLAs) the stormwater design has been required to assume lot coverage to the maximum allowed according to the zoning, plus allowance for a driveway. Therefore, the assumed future imperviousness ratios used in the DMP have been based on Zoning Bylaw No. 1255, which sets lot development parameters such as Maximum Lot Coverage and Minimum Lot Size. The used zoning and land use information for the future land use estimation is shown in **Appendix E**.

The imperviousness ratios for future conditions were set according to the greater of the imperviousness ratios found for the following two conditions:

1. Maximum Lot Coverage and Minimum Lot Size Zoning, per Bylaw No. 1255. Allowance is added for impervious driving surfaces such as driveways.
2. Existing Impervious Ratio determined in the Existing Scenario model setup, which was based on review of orthographic images.

Rural Agricultural (RA) Areas

The zoning bylaw does not specify a maximum lot coverage for RA lots greater than 4,000 m². An assumption of 100% lot coverage would be overly conservative on average for RA lots. Furthermore, some existing lots are smaller than allowed in the current zoning bylaw, particularly in some RA-1 areas. Therefore, the following approach for RA areas for future drainage conditions was used:

1. Existing developed lots smaller than allowed in the current bylaw are assumed to remain the same size and maintain the existing percentage of imperviousness.
2. Existing undeveloped lots smaller than allowed in the current bylaw are assumed to remain the same size. These lots are assumed to be developed in the future with the same imperviousness as existing similar lots.
3. Existing lots will not be subdivided in the future to less than the minimum area allowed in the current bylaw.
4. Existing lots smaller than allowed by the zoning bylaw will not be required to amalgamate as a condition for development or redevelopment.

For the public park zones P1, P2, P3, P4 and P5 an additional coverage of 5% over existing conditions was added to account for future improvements, such as new walking paths and park buildings. The imperviousness ratios for streets, roads and the highway were assessed with orthographic images. The percentage imperviousness used in the future conditions modelling is shown in **Appendix F**.

The imperviousness ratios based on the zoning plan were assigned to each subcatchment of the Future Conditions model based on an area-weighted calculation, considering the proportional imperviousness for each of the zoning types that are within a given catchment and summarizing it. For example, if a subcatchment consists of both a low imperviousness green area and an impervious road, then both imperviousness values are accounted for by their relative area in the catchment, multiplied with their imperviousness ratio, and summarized to an area-weighted imperviousness for all subcatchments. These calculations were conducted with an ArcGIS model of the District based on GIS information, and the received cadastral zoning and land designation data.

2.3.2 FUTURE BOUNDARY CONDITIONS

For the Future Condition, sea level rise predictions due to climate change were incorporated as changes to the future boundary conditions of the hydraulic model. Values for projected sea level rise were obtained from “*Relative Sea Level Projections in Canada and the Adjacent Mainland United States*” (James, T.S. et al, 2014). The term Representative Concentration Pathway (RCP) is used to emphasize that the five scenarios in that document are part of a much larger group of emissions scenarios that feature a pathway of greenhouse gas concentration through the 21st century. (Summarized from James, T.S. et al. (2014). A sea level rise of 0.68 m is predicted for North Saanich for the RCP 8.5 (95% confidence

interval). Sea level rise was added to the fixed tidal level of 2 m (Existing Scenario boundary condition) resulting in a tidal level of 2.68 m for the outfalls for the Future Condition.

2.3.3 FUTURE DESIGN STORMS

The Future Condition scenario uses the same **design storm criteria** for the Minor and Major system as the Existing Condition scenario. It was concluded in discussion with the District that this would ensure the results between both scenarios are comparable and clarify the impacts due to projected increasing imperviousness in the watersheds, and due to sea level rise.

Level of Service (LOS) is the performance against which the drainage system is measured, based on agreed criteria. It was agreed in discussion with the District that the system should convey the design storms without localized flooding. It was ultimately decided to set the model threshold to allow pipes to surcharge such that the HGL was greater than 0.1 m below surface grade for the design storms, meaning no localized flooding would occur. Pipes that exceeded this limit would be recommended for hydraulic upgrade.

2.4 Modeling Results

Four scenarios were modeled for the DMP. The number and total length of pipes in the model exceeding their maximum flow capacities for each scenario and system are summarized in **Table 9** below, which summarizes the existing hydraulic capacity of the drainage system and the impacts of future development. The number of pipes exceeding capacity increases, due to the increase in imperviousness expected for the modeled Future Condition scenario, by 1 Major system pipe and 35 Minor system pipes. The table shows that around 80% of the drainage system conveys the design storms within capacity.

EXISTING CONDITION SCENARIO	Number of Pipes Exceeding Capacity	Total Pipe Length Exceeding Capacity (m)	Percentage Length Exceeding Capacity
Minor System (5Y+ CC)	291	6,482 m	17.7%
Major System (25Y+CC)	9	493 m	17.4%
FUTURE CONDITION SCENARIO	Number of Pipes Exceeding Capacity	Total Pipe Length Exceeding Capacity (m)	Percentage Length Exceeding Capacity
Minor System (5Y+ CC)	326	6,567 m	18.9%
Major System (25Y+CC)	10	608 m	21.7%

TABLE 9 - SUMMARY OF MODELLED RESULTS

It should be noted that the number of pipes exceeding capacity includes all pipes within the hydraulic model and is not limited to District-owned infrastructure. The criteria and assessment which pipes are recommended for hydraulic upgrades, and which are owned by the District is detailed in **Section 4.1** and **4.3**.

Detailed model results for the Existing Condition scenario are shown in **Appendix A** and for the Future Condition scenario in **Appendix B**. **Table 10** below is a guide for the model results maps.

Existing Condition Scenario	Referenced Maps in Appendix A
Minor System (5Y+ CC)	Map 1-1 to Map 1-8
Major System (25Y+CC)	Map 2-1 to Map 2-8
Future Condition Scenario	Referenced Maps in Appendix B
Minor System (5Y+ CC)	Map 3-1 to Map 3-8
Major System (25Y +CC)	Map 4-1 to Map 4-8

TABLE 10 – GUIDE FOR MODEL RESULT MAPS

The maps show the overall extent and subcatchments of the model, all modelled elements (pipes, culverts, ditches, creeks, outfalls). Pipes are colour-coded to show their flow capacity for each scenario, with Red highlighting exceeded capacity. As previously described, an exceeded capacity of a pipe does not necessarily indicate flooding potential. The pipe will be surcharged but flooding will only occur if the surcharging reaches within 0.1 m of the grade elevation of either the road or an adjacent property. To indicate where the model predicts flooding the Junction Nodes were coloured Red indicating if the freeboard is within 0.1 m of the surface. The combination of these two colour-codings – Red pipes and Red junctions – show where pipes are restricting flow and may lead to flooding. Flooding near pipes which are not exceeding their capacity can be related to backwatering from flow obstructions downstream of the pipe or insufficient ditch grading or capacity.

The Major system maps show the capacities of the Minor and Major drainage system but only exceeding Major system pipes are annotated, for clarity. It should be noted that exceeding Minor pipes during the Major design storm are not expected to be capable of conveying these high flows and are only displayed for context.

2.5 ARSDA Criteria

The BC Agricultural and Rural Development Subsidiary Agreement (ARSDA), additionally to the 24-hour storm events, requires good drainage for agricultural fields. The regional drainage criteria for agricultural areas are:

- To remove runoff from a 10-Year, 5-Day storm within five days of the dormant period (November 1 to February 28);
- To remove the runoff from a 10-Year, 2-Day storm within two days during the growing season (March 1 to October 31);
- Between storm events and in periods when drainage is required, the baseflow in channels must be 1.2 m lower than field elevation;
- The conveyance system must be sized appropriately for both base flow and design storm flow.

As part of the “Sandown Lands – Onsite and Offsite Stormwater Management Plan” (2017), Kerr Wood Leidal developed ARDSA 10-year 2-day growing season and 10-year 5-day winter storm events for the site location, by scaling the storm events that were first developed for the Serpentine/Nicomekl Rivers floodplain farmlands in Surrey. These storm events were scaled based on the 24-hour storm depth derived from the Victoria International Airport weather station (ID: 1018621). The 24-hour storm depth was used as a long IDF showing 2-day and 5-day 10-year storm depths that were not readily available. The ARDSA storm events developed by Kerr Wood Leidal were applied to the model, since Sandown Lands is in the District within the McDonald Park Road and Tseycum Creek watersheds.

Two representative locations were selected to assess the drainage criteria for agricultural areas. As the flow level needs to be 1.2 m lower than field elevation only major drainage ditches could be considered, as most drainage ditches in the District are only about 1.0 metre deep. It was decided to assess junction node ‘WA-4065’ and ‘AL-485’ both located within the Tseycum Creek watershed. Their locations are shown in **Figure 9** below.



FIGURE 9 - LOCATION OF NODE WA-4065 AND AL-485 IN TSEYCUM CREEK

Junction 'WA-4065', located within Tseycum Creek just downstream of Wilson Road, has a depth of approximately 1.7 m below field elevation. Its allowable elevation for the ARSDA criteria is at 5.1 m, within the 1.2 m freeboard. During the 2-Day growing season storm, the water levels exceed the freeboard for approximately 22.5 hours (see **Figure 10**). During the 5-Day winter storm the water levels exceed the freeboard for approximately 27.75 hours (see **Figure 11**). Both water levels recede within the 2-day or 5-day period, so that the ARSDA drainage criteria for 'WA-4065' are met.

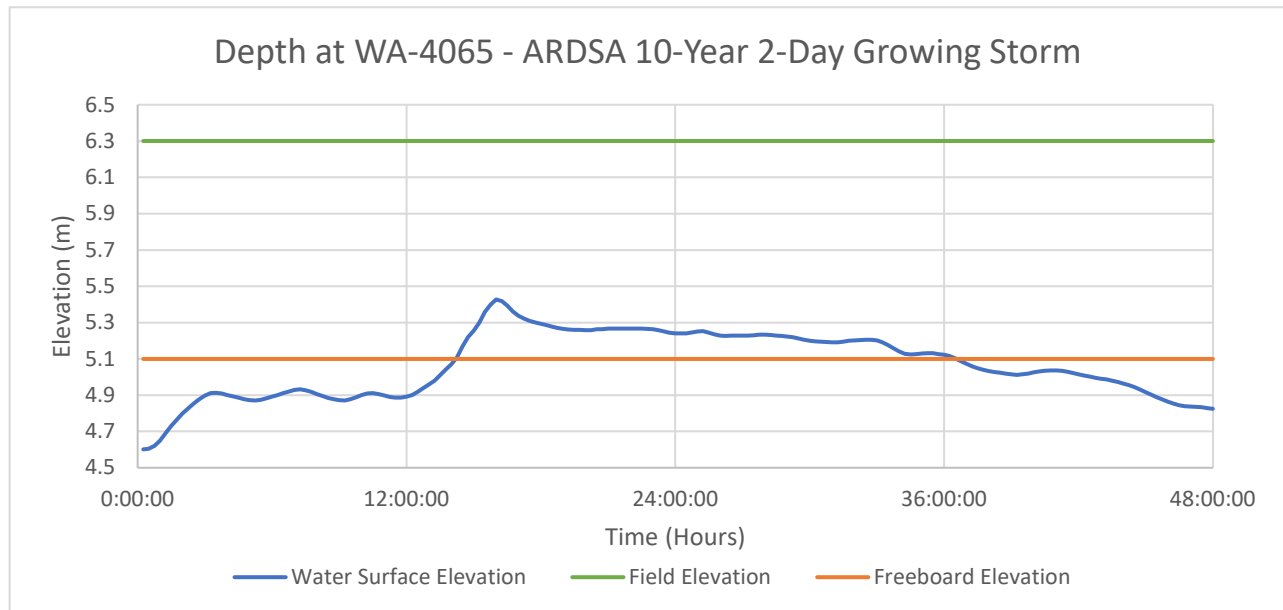


FIGURE 10 - WATER SURFACE ELEVATION AT WA-4065 - ARDSA 10-YEAR 2-DAY GROWING SEASON STORM

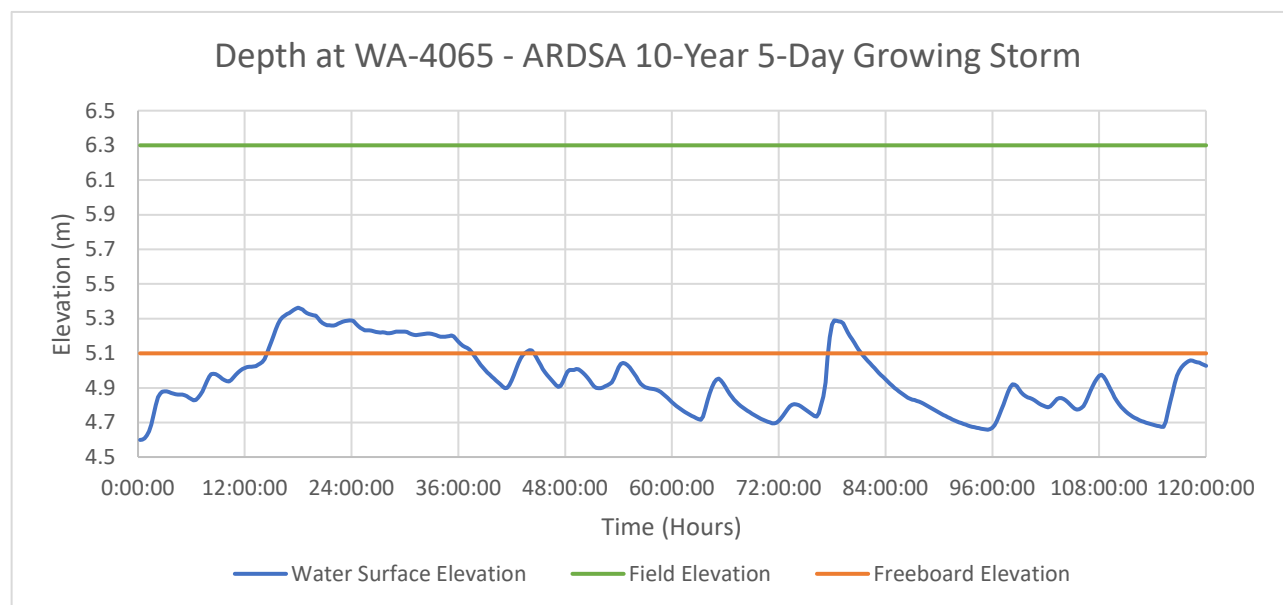


FIGURE 11 - WATER SURFACE ELEVATION AT WA-4065 - ARDSA 10-YEAR 5-DAY WINTER STORM

The second assessed junction 'AL-485' is located within a tributary of Tseycum Creek upstream of John Road and has an approximate depth of 1.5 m. The allowable water elevation within the 1.2 m freeboard is at elevation 9.55 m. During the 2-Day growing season storm, water levels exceed the freeboard for approximately 16.75 hours (see **Figure 12**). During the 5-Day winter storm the water levels exceed the freeboard for approximately 20 hours (see **Figure 13**). For both storms the water levels recede within the 2-day or 5-day period at this location, so that the ARSDA criteria for 'AL-485' are met.

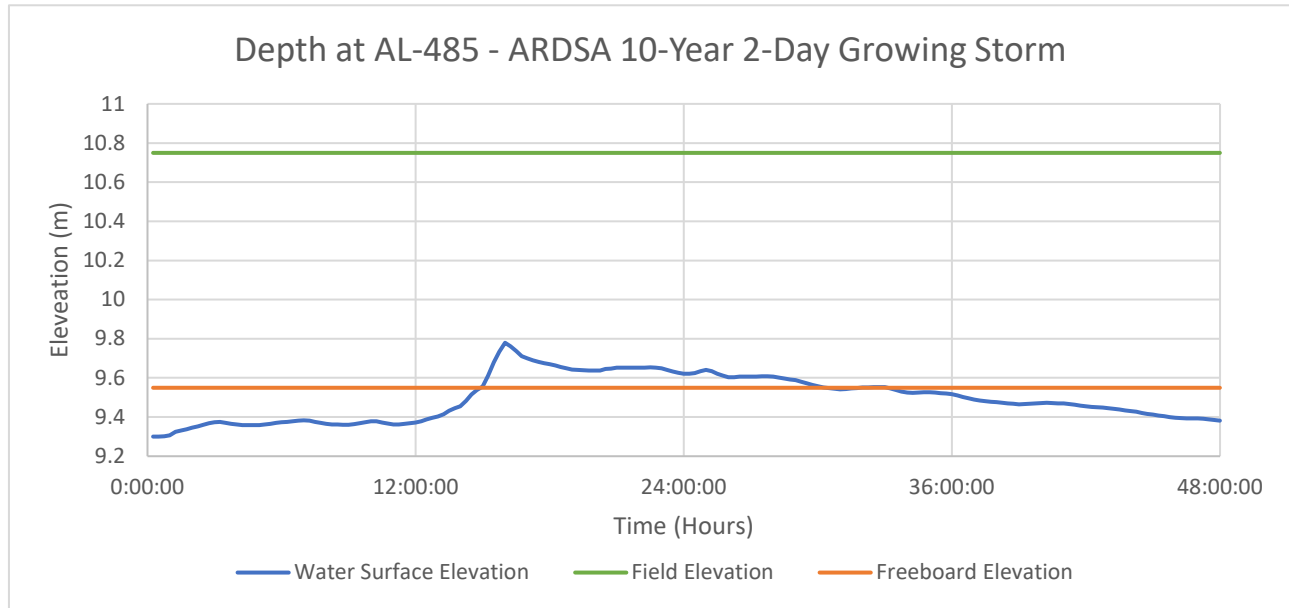


FIGURE 12 – WATER SURFACE ELEVATION AL-485 - ARDSA 10-YEAR 2-DAY GROWING SEASON STORM

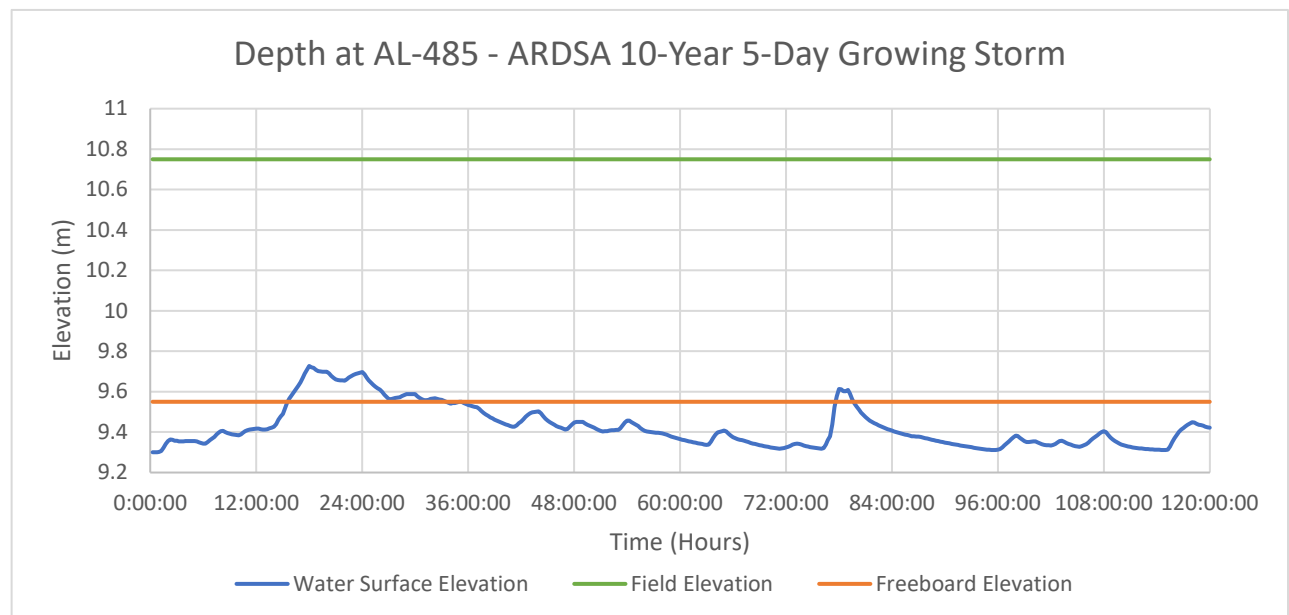


FIGURE 13 – WATER SURFACE ELEVATION AT AL-485 - ARDSA 10-YEAR 5-DAY WINTER STORM

3. Condition Assessment

The DMP includes a condition assessment of the system in addition to the hydraulic performance. The condition assessment when combined with hydraulic performance provides a more complete prioritized infrastructure replacement and upgrade program for the District.

3.1 Field Condition Assessment

A condition assessment was performed in 2020 by Colquitz Engineering staff on a representative sample of 66 culverts located throughout the District. The assessment assigned each culvert one of the following conditions:

- Good Condition: 0 – 1
- Fair Condition: 2 – 3
- Poor Condition: 4
- Critical Condition: 5

This assessment covered approximately 3% of the District's pipes with a focus on road culverts. The full list of the assessed culverts can be found in **Appendix H**. A Condition Assessment Map showing the locations of the culverts that were reviewed is in **Appendix I**. A summary of the material and condition of the assessed culverts is shown in **Figure 14**.

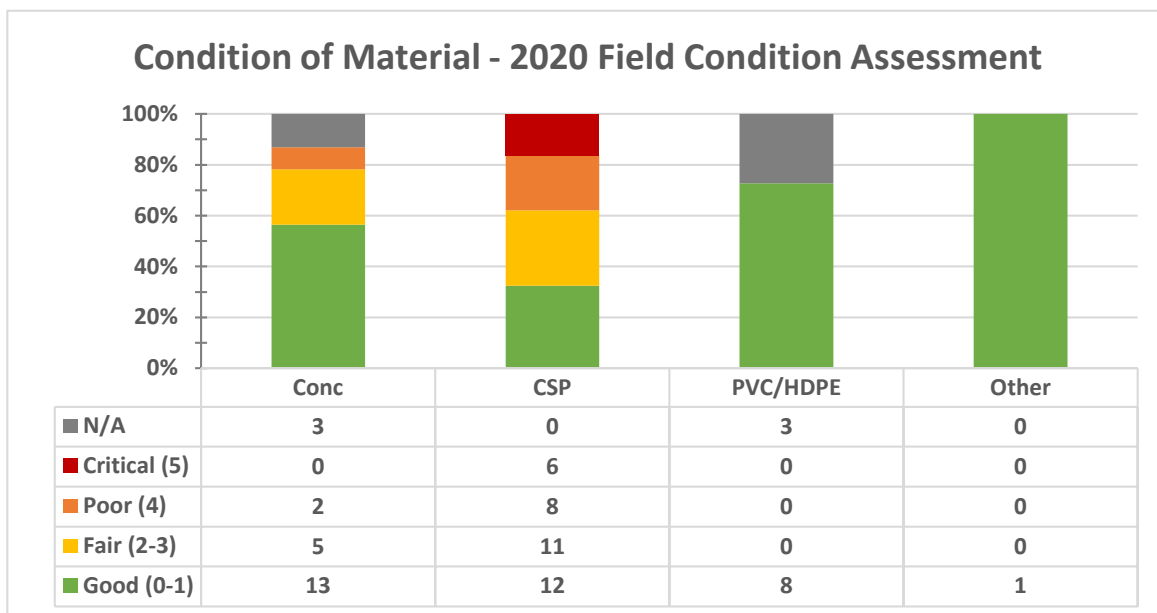


FIGURE 14 - SAMPLE CONDITION ASSESSMENT SUMMARY

Figure 14 shows that the observed condition of culverts greatly correlates with the culvert's material used. Of the 66 culverts that were assessed, 37 were CSP (Corrugated Steel Pipe) with 14 in 'Poor' or 'Critical condition'. Most of these pipes showed corrosion at the inlet, spalling or pipe deformation. From the 20 assessed concrete pipes only 2 were in 'Poor' and none in 'Critical condition'. Poor condition was due to cracking and displaced joints. For the assessed plastic pipes, 3 were PVC (Polyvinylchloride) and 5 were HDPE (High Density Polyethylene), with all in 'Good' condition. It was also observed that approximately 25% of headwalls were in a 'Poor' condition, mostly through displaced or missing sandbags. Approximately 12% of the pipes were filled to at least one-third by sediment or debris.

The field-assessed condition of the sample culverts was compared with the available GIS condition data for the same pipes. The comparison resulted in a 100% match of rated pipe conditions. It was therefore concluded that the GIS data provides a reasonable estimate of the condition of pipes throughout the District.

3.2 Condition Analysis

The focus of the Condition Assessment was to identify and list pipes that were in poor condition based on their condition GIS data, as these pipes are of the highest priority to be replaced. Available condition information categorized pipes into ‘Good’, ‘Fair’ and ‘Poor’.

As the Field Condition Assessment investigation in **Section 3.1** provided confidence in the GIS condition data of the received GIS data feature class “*StormFeature_GPS_Culvert*”, it was decided to proceed with the GIS data as it covers a large portion of District-owned culverts. The data was available as point data taken at the Inlet, Outlet and Centre of the pipes. This information was combined with the pipe length and ownership information from the GIS feature class “*StormFeature_MainLine*”, where culverts and pipes could be filtered from. As the GPS condition information of the culverts did not have the pipe IDs, a GIS analysis was conducted to spatially join condition data with nearby pipe data. A radius of 2.5 m was used to reduce the possibility of multiple condition points overlapping with one pipe. Additional condition data for storm sewer pipes was included from the GIS feature class “*StormFeature_GPS_Manhole_Collection_Complete*”. The included storm sewer pipes were limited to pipes in “Poor” condition, which were owned by the District and in active use.

Condition information was available for approximately 51% of District-owned pipes and culverts, with approximately 49% not having available condition information. Given the data layout in the feature class “*StormFeature_GPS_Manhole_Collection_Complete*” it is possible that there may be duplicate pipes in the approximately 900 pipes in with conditions “Fair” or “Good”. **Figure 15** and **Figure 16** summarize the relative pipe and culvert condition categories.

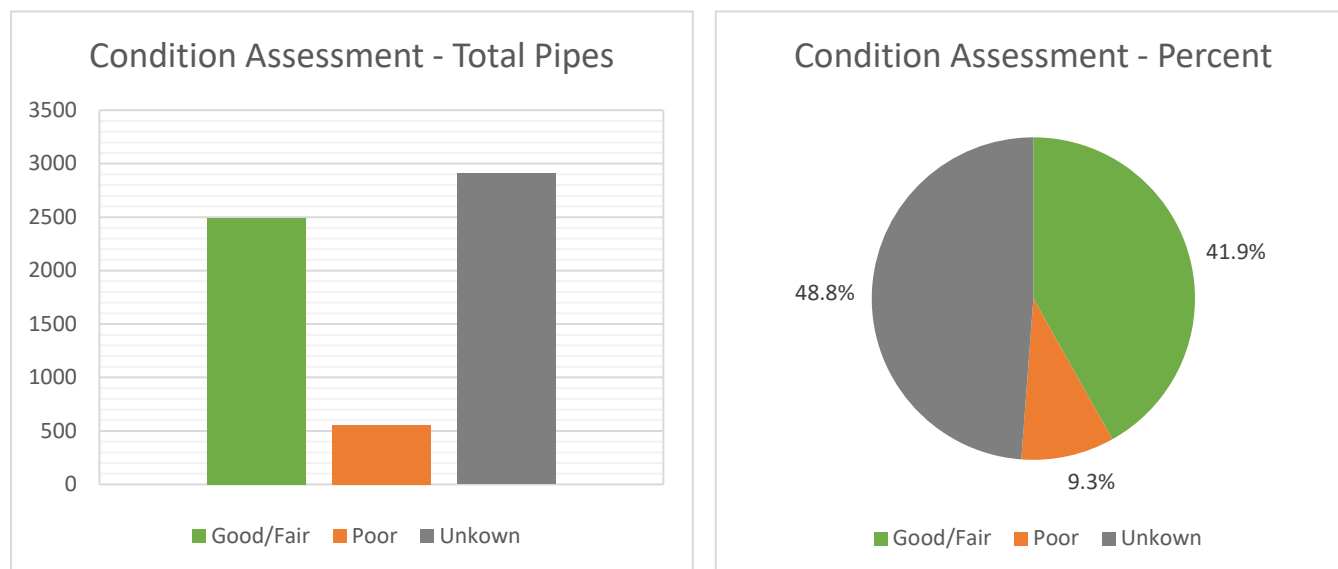


FIGURE 15 AND FIGURE 16 - CONDITION ASSESSMENT ON DISTRICT OWNED GIS PIPES

The overall percentage of District-owned pipes and culverts in poor condition is 9.3%, or 556 pipes. This number will increase with future inspection of the unassessed 49% of drainage pipes. The ratio between pipes in Good/Fair condition to pipes in Poor condition suggests that the District’s pipes are mostly in good or fair condition but with the District’s large inventory of pipes, also a great number of pipes in need of replacement.

PIPE MATERIAL AND SERVICE LIFE

The assessment of available pipe conditions for North Saanich did show a connection between pipe materials and their assessed pipe condition. Metal pipes like CSP and ACMP appeared to be assessed overproportioned in poor condition in comparison to PVC, HDPE, or concrete pipes. **Figure 17** shows the relationship between pipe material and assessed pipe condition. The figure shows that the percentage of metal pipes in good condition is considerably smaller than for concrete or plastic pipes and that almost a third of metal pipes were found to be in poor conditions. Concrete pipes were mostly found to be in a good or fair condition with only 12% in poor condition. Plastic pipes like HDPE and PVC had even a higher percentage to be found in a good condition.

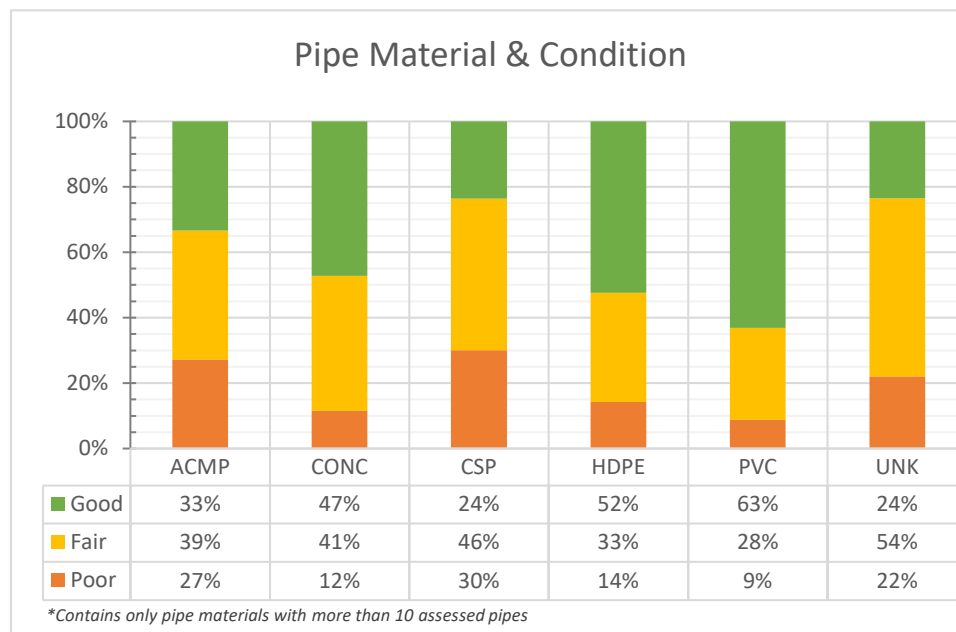


FIGURE 17 - PIPE MATERIAL AND PIPE CONDITION ASSESSED IN DISTRICT OF NORTH SAANICH

The usage of specific pipe materials changes over time. In the last decades metal pipes like CSP were often the standard for culverts while nowadays plastic pipes like PVC are more and more common to be installed. The book “*Service Life of Culverts*” (2015) from the US National Cooperative Highway Research Program (NCHRP) summarizes available reports on culverts service life and the various factors affecting the service life of different pipe materials.

Metal pipes like CSP or ACMP are vulnerable to corrosion from very low or very high pH values of the surrounding soil or water (e.g. $6 > \text{pH}$ or $\text{pH} > 8.5$). Metal pipes are also susceptible to abrasion from particles like sand transported in the water. Depending on the environment where metal pipes are being used, their service life expectancy can vary widely from 10 to 80 years. Generally coated metal pipes are expected to have a longer service life expectancy than uncoated pipes.

Concrete pipes are also affected by corrosion of their reinforced steel but have a protective layer of the concrete. The corrosion occurs if chlorides, moisture and oxygen can reach the reinforced steel inside the concrete. A $\text{pH} < 5.5$ of the soil or water can also cause corrosion. High sulfate concentrations in soils and the flow water can further cause damages to concrete pipes by dissolving their calcium in the concrete. The service of life expectancy of concrete pipes depending on the environment is usually estimated between 75 to 100 years if they are installed in good soil conditions.

Plastic pipes like HDPE or PVC are resistant to abrasion and corrosion but they are susceptible to UV light and therefore exposure to direct sunlight. These pipes should not be stored in the outside for too long and should be installed where they

are protected from direct sunlight exposure. These pipes are generally estimated to have a service life expectancy of 50 to 100 years with no restrictions on pH or resistivity.

Based on the available information from the condition assessment, it is recommended that the District should use concrete or plastic pipes during new pipe installations and replacements. Concrete, PVC and HDPE are more resistant to harmful environments with varying pH or possible abrasion from high flows and are expected to have a longer service life. Plastic pipes are recommended in applications without exposure to direct sunlight f.e. in storm sewers or in non-projecting culverts. Concrete pipes are recommended where long service of life is wanted and where high chloride concentrations (e.g. from winter salt) and very low pH values are not of concern.

4. Capital Replacement Program

To estimate costs for hydraulic upgrades or condition replacements of pipes, Class D estimate unit costs per linear metre were compiled for various pipe size categories (refer to **Table 11**). These estimates were based upon unit costs from recent projects on Vancouver Island and the Lower Mainland and include a 30% contingency. It should be noted that current economic conditions have increased some material prices and they remain volatile, due to both inflation and supply chain problems.

It is assumed that pipe replacements due to condition-only would have the same diameter, while hydraulic upgrades would be sized-up one pipe size category (see **Table 11**). It should be noted that a more detailed design should be completed for each hydraulic upgrade to better define pipe diameter, length, inlet and outlet conditions and costs.

The pipe length to calculate the individual estimated upgrade or replacement costs were taken from the hydraulic model or from available GIS data. Change of the conveyance type, for example enclosing a section of ditch or replacing a pipe with an open ditch, were not considered.

Pipe Size Category (mm)	Unit Cost (\$/m)
< 300	\$ 650
300 - 399	\$ 850
400 - 499	\$ 1,000
500 - 599	\$ 1,200
600 - 699	\$ 1,400
700 - 799	\$ 1,600
800 - 899	\$ 1,700
900 - 1199	\$ 1,800
1200 - 1399	\$ 2,300
1400 - 1599	\$ 2,500
1600 - 2000	\$ 2,700

TABLE 11 – ESTIMATED REPLACEMENT COSTS OF DRAINAGE PIPES

4.1 Replacement Criteria

The requirement for hydraulic upgrade for a particular pipe was generated by the model results (see **Section 2.4**) for the Future Condition scenarios based on:

Minor Drainage System (pipe diameter < 900mm):

- 5-Year 24-Hour plus Climate Change design storm (Rainfall Depth 78.2 mm)

Major Drainage System (pipe diameter ≥ 900mm)

- 25-Year 24-Hour plus Climate Change design storm (Rainfall Depth 113.4 mm)

If a pipe was identified by the model to be surcharged, the hydraulic grade line (HGL) for each pipe was checked to confirm if the HGL elevation was less than 0.1 m below the surface, in which case flooding could reasonably be expected. It was then confirmed whether the pipes reached 90% of maximum flow capacity, which would be close to limiting flow. Pipes achieving both criteria were recommended for hydraulic upgrade.

If the pipes did not reach 90% of their flow capacity but the HGL elevation was within 0.1 m of the surface or above, these pipes were manually checked in the model. This scenario was often connected to obstructions of flow further downstream leading to a backwater effect and the pipes therefore not able to utilize their full capacity. During the manual confirmation, it was checked that the pipes were not of significantly smaller diameter than upstream pipes, and if surrounding pipes were already identified for hydraulic upgrades, as well as their slope and hydraulic performance. Detailed comments for each manually checked pipe have been included in the Recommendation Table in **Appendix J**.

The information for the condition replacements was taken from the GIS condition analysis outlined in **Section 3.2**. Pipes with an assessed ‘Poor’ pipe condition were checked if they were already recommended for a hydraulic upgrade. If this was not the case, they were listed as in need of a condition-only replacement. Pipes assessed in poor condition are expected to need replacement soon to avoid further deterioration or failure. A poor pipe as defined in the GIS data may have corrosion, abrasion, cracks, spalling, scour, piping or other defects which might lead to a failure of the pipe.

The upgrade and replacement decision logic are summarized in **Figure 18** below.

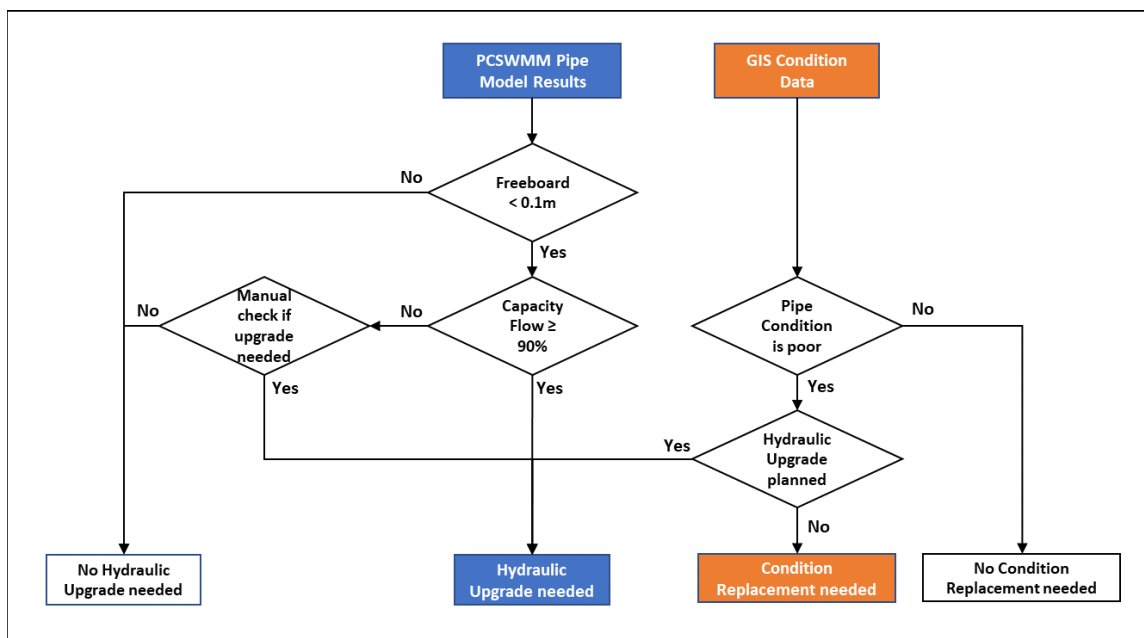


FIGURE 18 - UPGRADE AND REPLACEMENT CRITERIA

4.2 Prioritization

Recommended upgrades and replacements were categorized into four levels, with 1 being highest priority and 4 being lowest. Pipes of the Major system were considered higher priority than Minor system pipes as they convey larger flows and influence wider areas of the District. Pipes within ‘Areas of Concern’, areas of known flooding issues that were identified in discussion with the District throughout the project (shown in **Appendix D**) were also assigned higher priority. These ‘Areas of Concern’ cover approximately 62.9 ha of the district. 15 designated areas were delineated. The priority criteria used are described in **Table 12**.

For example, if a pipe requires hydraulic upgrade AND is in ‘Poor’ condition AND is greater than 900 mm diameter OR is in an Area of Concern, this pipe would be categorized Priority 1.

In comparison, if a pipe DOES NOT require a hydraulic upgrade but DOES require a condition replacement, AND is greater than 900 mm in diameter, it would be Priority 3.

Priority 4 is for pipes less than 900 mm diameter, NOT within an Area of Concern, and NOT requiring a hydraulic upgrade.

Priority	Priority Criteria			
	Hydraulic Upgrade needed	Condition Replacement needed	Pipe Diameter > 900 mm ¹	Pipe within Area of Concern ²
1	X	X	X	
	X	X		X
2	X		X	
	X			X
3	X			
		X	X	
		X		X
4		X		

¹ Pipe diameter of 900 mm was used to differentiate the Major from the Minor drainage system.
² Areas of concern are shown in Appendix D.

TABLE 12 - PRIORITIZATION CRITERIA OF UPGRADES AND REPLACEMENTS

4.3 Hydraulic Upgrades

The recommended hydraulic upgrades based on the results of the model are given in the Recommendation Table in **Appendix J**. The list includes available pipe information including priority, cross-section, existing and proposed pipe diameter, comments from the manual assessment in the model, pipe length, associated unit cost and cost estimate. The map location of each recommended hydraulic upgrade is shown in **Appendix K**.

In total 284 pipes ranging from 300 mm to 1,350 mm are recommended for hydraulic upgrade. Only 8 pipes are Priority 1, and 28 are Priority 2. Most hydraulic upgrades, 248 pipes, are Priority 3. Most of the upgrades are for pipe diameters of 300 mm to 500 mm, with 240 of the total 284 upgrades. Only 7 pipe upgrades are for diameters of 900 mm to 1600 mm considered the Major system.

A summary of the recommended hydraulic upgrades and their size and assigned priority is shown in **Table 13**.

Pipe Size Category (mm)	Priority Class			Total Number
	1	2	3	
300 - 399	4	14	150	168
400 - 499	0	2	56	58
500 - 599	2	1	14	17
600 - 699	1	6	22	29
700 - 799	0	0	2	2
800 - 899	0	0	1	1
900 - 1199	1	3	0	4
1200 - 1399	0	2	0	2
1400 - 1599	0	0	0	0
1600 - 2000	0	0	0	0
Total	8	28	248	284

TABLE 13 - NUMBER OF HYDRAULIC UPGRADES WITH SIZE CLASS AND PRIORITY

Pipe lengths for each conduitas assigned in the model were used in combination with estimated unit costs per linear metre (see **Table 11**) to calculate an estimated upgrade cost for each pipe, detailed in the Recommendation Table in **Appendix J**.

The total estimated cost for hydraulic upgrades is \$7,789,200 (CAD 2022). Sorted by priority, Priority 1 make up only a small portion of the total, at \$123,700. Priority 2 at approximately \$1,986,300 has a significantly higher portion, and most hydraulic upgrade costs are Priority 3 at \$5,679,200.

A summary of the estimate upgrade costs for each priority and the upgrade pipe diameter can be found in **Table 14** below.

Pipe Size Category (mm)	Priority			Total Cost
	1	2	3	
300 - 399	\$31,000	\$981,000	\$1,684,000	\$2,696,000
400 - 499	-	\$28,800	\$2,257,200	\$2,286,00
500 - 599	\$23,800	\$16,800	\$229,600	\$270,200
600 - 699	\$16,000	\$548,800	\$1,185,600	\$1,750,400
700 - 799	-	-	\$249,000	\$249,000
800 - 899	-	-	\$73,800	\$73,800
900 - 1199	\$52,900	\$248,400	-	\$301,300
1200 - 1399	-	\$162,500	-	\$162,500
1400 - 1599	-	-	-	-
1600 - 2000	-	-	-	-
Total	\$123,700	\$1,986,300	\$5,679,200	\$7,789,200

TABLE 14 - COST ESTIMATE OF HYDRAULIC UPGRADES

Table 14 also shows that 91% of hydraulic upgrade costs are associated with the Minor system without pipes equalling 900mm. New pipe diameters of 900 mm or larger (Major system + 900mm pipes) are only 9% of the total upgrade costs.

The distribution of the hydraulic upgrade cost estimates for each priority are shown in **Figure 19**.

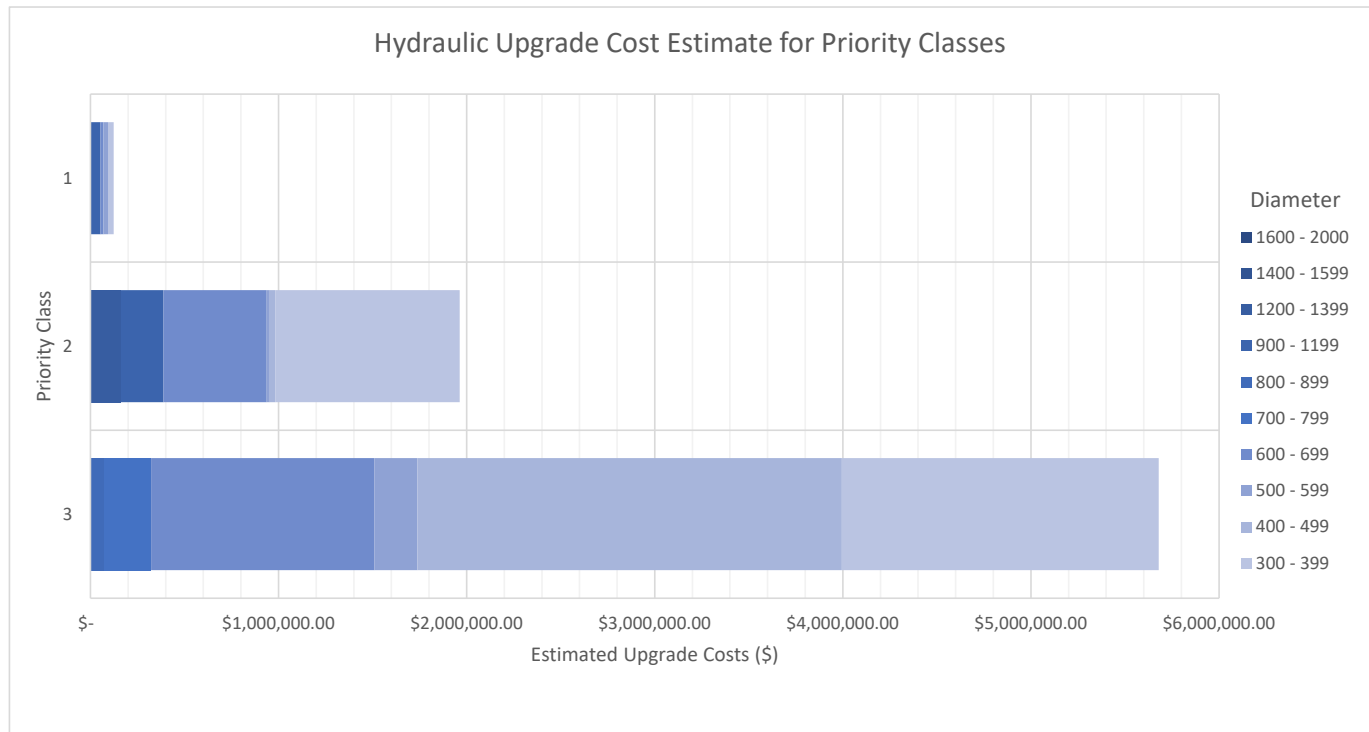


FIGURE 19 - COST ESTIMATE OF HYDRAULIC UPGRADES SORTED BY PRIORITY AND PIPE DIAMETER

4.4 Condition Replacements

The recommended condition replacements were developed from the available GIS condition assessment provided by the District. As described in **Section 4.1** proposed condition replacements were checked to see if they were already covered by a recommended hydraulic upgrade, to avoid duplication. As noted in **Section 3.2**, the available GIS condition assessment information covers approximately 51% of the District's drainage infrastructure of storm sewer pipes and culverts.

The full condition replacements are shown in the Recommendation Table in **Appendix J**. The list contains the available information from the GIS sources including GIS asset ID, pipe diameter, associated unit costs and replacement costs. The condition replacements are shown in the Recommendation Map in **Appendix K**.

The recommended condition replacements cover a total of 500 pipes ranging from less than 300 mm to 1,050 mm. Most condition replacements (81%) are for pipes smaller than 400 mm in diameter. Diameters of 400 mm or higher comprise 19% of the recommended replacements. The recommended condition replacements contain 33 pipes of Priority 3 and 471 pipes of Priority 4. This shows that most recommended condition replacements are for pipes in poor condition which are not within an Area of Concern and are part of the Minor drainage system.

A summary of the recommended condition replacements is shown in **Table 15**.

Pipe Diameter (mm)	Priority		Total Number
	3	4	
< 300	1	28	29
300 - 399	17	359	376
400 - 499	3	52	55
500 - 599	2	21	23
600 - 699	3	10	13
700 - 799	1	0	1
800 - 899	1	1	2
900 - 1199	1	0	1
Total	29	471	500

TABLE 15 - NUMBER OF CONDITION REPLACEMENTS WITH SIZE CLASS AND PRIORITY

The cost estimates for the condition replacements were based on available pipe length information from GIS layers and was used to create the estimate replacement costs for each pipe, shown in the Recommendation Table in **Appendix J**. Multiple pipe length data was available for each pipe but the GIS shape length has been used for this assessment.

The total estimated cost for all condition recommended replacements is \$4,104,925 (CAD 2022). 89% of the cost is associated with Priority 4, with the remaining 11% being Priority 3. 81% of the replacement pipes are smaller than 400 mm diameter and they comprise 65% of the total cost as smaller pipe sizes have lower replacement unit costs.

Pipe Diameter (mm)	Priority		Total Cost
	3	4	
< 300	\$3,965	\$161,395	\$165,360
300 - 399	\$91,885	\$2,405,135	\$2,497,020
400 - 499	\$20,200	\$529,770	\$549,970
500 - 599	\$25,920	\$319,615	\$345,535
600 - 699	\$49,700	\$224,000	\$273,700
700 - 799	\$15,040	-	\$15,040
800 - 899	\$41,480	\$9,100	\$50,580
900 - 1199	\$207,720	-	\$207,720
Total	\$455,910	\$3,649,015	\$4,104,925

TABLE 16 - COST ESTIMATE OF CONDITION REPLACEMENTS

Additional to the linear drainage infrastructure like storm sewers and culverts, point drainage infrastructure has also been recommended to be replaced where condition information based on received GIS files was available. Point drainage infrastructure with poor condition in need of replacement were outfalls, manholes and catch basins. Replacements have been estimated with the following unit costs:

- Catch basins: \$3,000
- Manholes: \$12,000
- Outfalls: \$15,000

As only a small portion of these point-drainage items have been assessed on their condition and other items such as inspection chambers have not been assessed at all, this estimate will increase in the future with more assessed assets. Overall, only 13 point-drainage items have been assessed in poor condition from a total of 1,850 in the District's drainage assets for catch basins, manholes and outfalls. The overall replacement cost is estimated at \$120,000 for the condition replacements and is summarized in **Table 17**.

Point Drainage Infrastructure	Priority 4	
	Number	Cost
Catch Basins	5	\$15,000
Manholes	5	\$60,000
Ocean Outfalls	3	\$45,000
Total	13	\$120,000

TABLE 17 - NUMBER AND COST ESTIMATE OF POINT INFRASTRUCTURE CONDITION REPLACEMENTS

4.5 Replacement Schedule

Overall, 284 culverts and pipes were found to require hydraulic upgrade and 500 culverts and pipes to require replacement due to 'Poor' condition. The total cost for these upgrades is estimated to be \$12.01 million (CAD 2022). Over a 20-year capital asset replacement program this would require a drainage capital budget of approximately \$600,000 per year (CAD 2022).

A summary of the total cost estimates for all recommended piped hydraulic upgrades and condition replacements is shown in **Table 18**.

Pipe Diameter (mm)	Priority				Total Cost
	1	2	3	4	
< 300	\$31,000	\$981,000	\$1687,965	\$161,395	\$2,861,360
300 - 399	-	\$28,800	\$91,885	\$2,405,135	\$2,525,820
400 - 499	\$23,800	\$16,800	\$2,277,400	\$529,770	\$2,847,770
500 - 599	\$16,000	\$548,800	\$255,520	\$319,615	\$1,139,935
600 - 699		-	1,235,300	\$224,000	\$1,459,300
700 - 799	\$-	-	\$264,040	-	\$264,040
800 - 899	\$52,900	\$248,400	\$115,280	\$9,100	\$425,680
900 - 1199	-	\$162,500	\$207,720	-	\$370,220
1200 - 1399	-	-	-	-	-
1400 - 1599	-	-	-	-	-
1600 - 2000	-	-	-	-	-
Total	\$123,700	\$1,986,300	\$6,135,110	\$3,649,015	\$11,894,125

TABLE 18 - COST ESTIMATE FOR PIPE UPGRADES AND REPLACEMENTS

Based on the estimated costs and the prioritization of recommended upgrades and replacements, a 20-year capital asset replacement program has been created. Within this period, it is estimated that all needed upgrades and replacements could be performed with an annual capital cost of approximately \$600,000. The Recommendation Table in **Appendix J** divides upgrades and replacements into 5-year intervals.

As many of these recommendations are located in close proximity or hydraulically influence each other upstream or downstream, efforts should be made to group the recommendations and combine them, as well as with other scheduled work such as road reconstruction or water/sanitary upgrade projects.

The recommended upgrades and replacements are shown in the Recommendation Map in **Appendix K**. The map shows the recommended hydraulic upgrades and condition replacements for linear and point-drainage infrastructure, as well as the route of streams and ditches and other pipe drainage infrastructure for orientation. This map can be utilized in combination with GIS to identify, group and schedule specific upgrade and replacement works.

The priority classes with their estimated total costs and their replacement period are summarized below:

Priority Class 1:

- Hydraulic upgrades
- Estimated costs: \$123,700
- Replacement period: Year 1 - 5

Priority Class 2:

- Hydraulic upgrades
- Estimated costs: \$1,986,300
- Replacement period: Year 1 - 5

Priority Class 3:

- Hydraulic upgrades and condition replacements
- Estimated costs: \$6,135,110
- Replacement period: Year 1 - 10

Priority Class 4:

- Condition replacements
- Estimated costs: \$3,769,015
- Replacement period: Year 11 – 20

Figure 20 shows the recommended 20-year capital asset replacement program with an annual budget of approximately \$600,000 arranged by priority level. It shows when each priority class is estimated to be completed, as well as the annual budget spend on replacements for each priority class per year. If the recommendations are completed in order of their priority class, Class 1 can be finished within the first year, Class 2 by the end of the 4th year, Class 3 by the end of the 14th year, and Class 4 by the end of the 20th year.

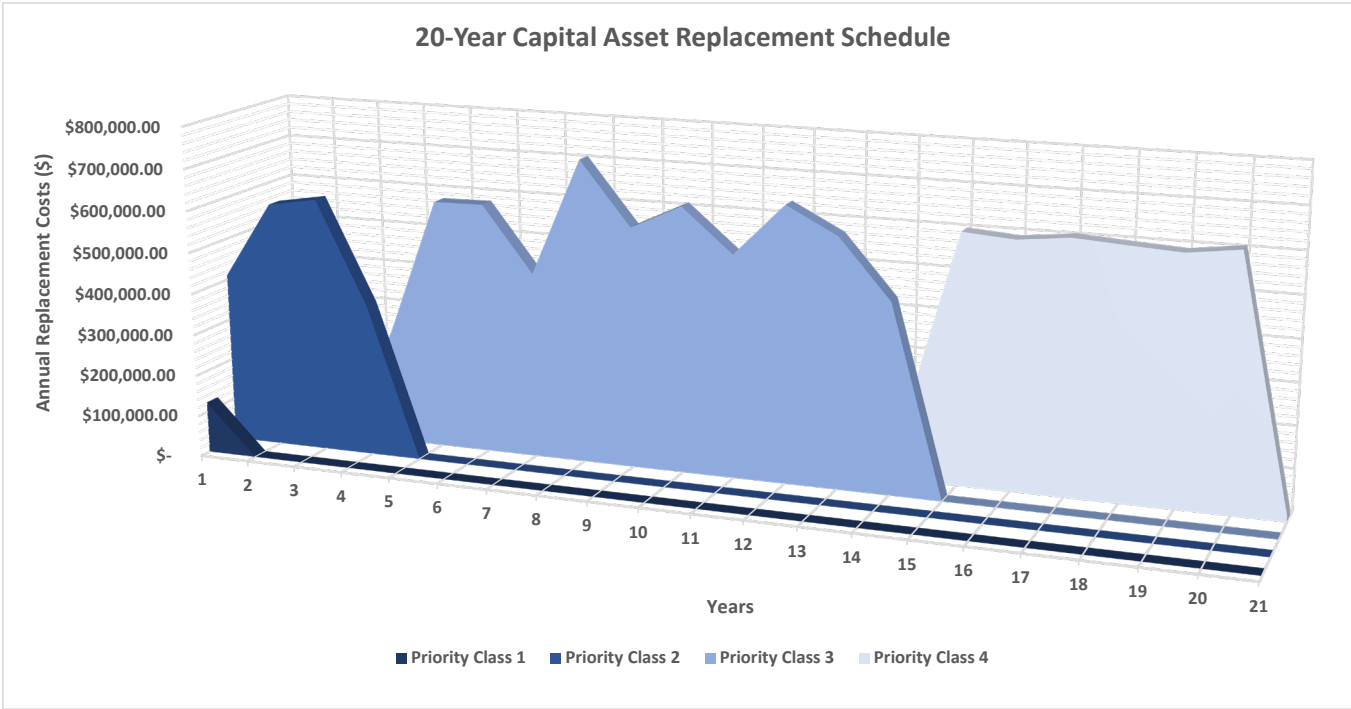


FIGURE 20 – ESTIMATED ANNUAL COSTS FOR THE 20-YEAR CAPITAL ASSET REPLACEMENT PROGRAM

5. Summary and Recommendations

5.1 Summary

The Drainage Master Plan (DMP) for the District of North Saanich was developed using a PCSWMM hydrologic and hydraulic model based on available data for existing and future conditions. The model used two design storms, a 5-year 24-hour storm plus an allowance for climate change for the Minor drainage system (≤ 900 mm diameter) and a 25-year 24-hour storm plus an allowance for climate change for the Major drainage system (> 900 mm diameter). Flow monitoring data from the Tseycum Creek and McDonald Park Road Drain watershed were used to calibrate and validate the hydraulic model and showed good correlation. The hydraulic model results were used to analyze the District's drainage infrastructure and to identify single culverts and storm sewer pipes which are undersized for the Future Condition design storms and that require upgrading. A total of 284 pipes were identified and recommended in a comprehensive list (see **Appendix J**).

A condition assessment was conducted to identify drainage culverts and storm sewer pipes in 'Poor' condition. The available GIS data was validated with a sample field investigation of 66 culverts and the condition assessment information was found to correlate well, meaning that the GIS condition data could be used with reasonable confidence. It is noted however that the GIS data includes condition information on approximately 51% of the total District-owned pipes, and future condition assessment of the remaining 49% may identify additional pipes in poor condition. This would add to the number of pipes to be replaced and potentially increase the duration of the replacement program. A total of 500 pipes were found to be in 'Poor' condition and were recommended for replacement in a comprehensive list (see **Appendix J**).

5.2 Recommendations

5.2.1 DRAINAGE INFRASTRUCTURE REPLACEMENTS AND UPGRADES

Hydrological and hydraulic modeling identified necessary hydraulic upgrades, as well as necessary condition replacements based on received GIS information. The total upgrade and replacement costs are estimated at approximately \$12.01 million (CAD 2022). It is recommended that the District reserves an annual capital budget to complete hydraulic upgrades and condition replacements over the next 20 years (refer to **Table 19**).

Prioritization	Priority Class	Purposes	Number of Pipes/ Items	Pipe Length* (m)	Cost Estimate
Immediate (1 - 5 Years)	1	Hydraulic Upgrades	8	81	\$123,700
Short Term (1 - 5 Years)	2	Hydraulic Upgrades	28	1,533	\$1,986,300
Medium Term (1 - 10 Years)	3	Hydraulic Upgrades & Condition Replacements	277	5,006	\$6,135,110
Long Term (11 - 20 Years)	4	Condition Replacements	484	5,710	\$3,769,015
Total			797	12,330	\$12,014,125

*Pipe Length is only accounted where applicable for linear drainage items such as storm sewers and culverts.

TABLE 19 – PROPOSED DRAINAGE INFRASTRUCTURE REPLACEMENTS AND UPGRADES

5.2.2 DISTRICT-WIDE CONDITION ASSESSMENT

The condition assessment showed that GIS condition information was available for 51% of District-owned pipes and culverts, with 49% not having condition information available. It is therefore recommended that the District conduct a District-wide condition assessment for drainage infrastructure that currently has not been assessed. Additional culverts and pipes found in poor condition should be added to the capital asset replacement program. It is further recommended that the District develops a regular condition assessment program for all culverts and pipes to identify changed conditions and to track deterioration trends.

5.2.3 LIMITING USE OF METAL PIPES

The sample condition assessment of the DMP showed that metal pipes such as ACMP and CSP had a significantly higher chance to be in poor condition compared to other pipe materials such as concrete and plastic. Metal pipes under ideal circumstances may have a long service life but in real-world applications they can deteriorate quickly from erosion, abrasion and deflection. Galvanic corrosion or corrosion due to high concentrations of winter salts are some common examples of how metal pipes can deteriorate quickly. It is recommended that the use of metal pipes is limited and that upgraded or replaced pipes are of different pipe materials such as:

- Plastic pipes such as PVC and HDPE are recommended for locations where they are protected from exposure to direct sunlight (e.g. sewer pipes, non-projecting culverts) due to their sensitivity to UV-radiation. They are generally expected to have a service life of 50 to 100 years and are suitable for most soil conditions.
- Concrete pipes are recommended at locations where high chloride concentrations, for example from winter salts, are not of concern. Concrete pipes generally have a service life expectancy of 50 to 100 years and are especially useful if the pipe needs to withstand high loads.

5.2.4 FLOOD RISK ASSESSMENT

The extreme rainfall event from November 14th to 15th, 2021 had significant impact in the District and did reveal the need to understand and address flooding from extreme rainfall events. It is recommended that the District should conduct a Flood Risk Assessment and map the flood risks and flood hazards district-wide. A Flood Risk Assessment evaluates the potential impacts of flood hazards on people, properties and vulnerable assets like buildings and can be mapped to provide a spatial relationship between potential risks. The next step can be to develop a Flood Management Plan to minimize or mitigate the evaluated risks, as well as for future land use planning and to inform and educate residents.

5.2.5 MUNICIPAL MAINTENANCE PRACTICES

It is recommended that the District obtain appropriate land encumbrances to maintain significant municipal drainage features which extend onto private property. This would include vegetation trimming and removal in swales and ditches, removing accumulated sediment from ditches and culverts, and regular inspection of piped and non-piped infrastructure.

5.2.6 DRAINAGE MASTER PLAN UPDATES

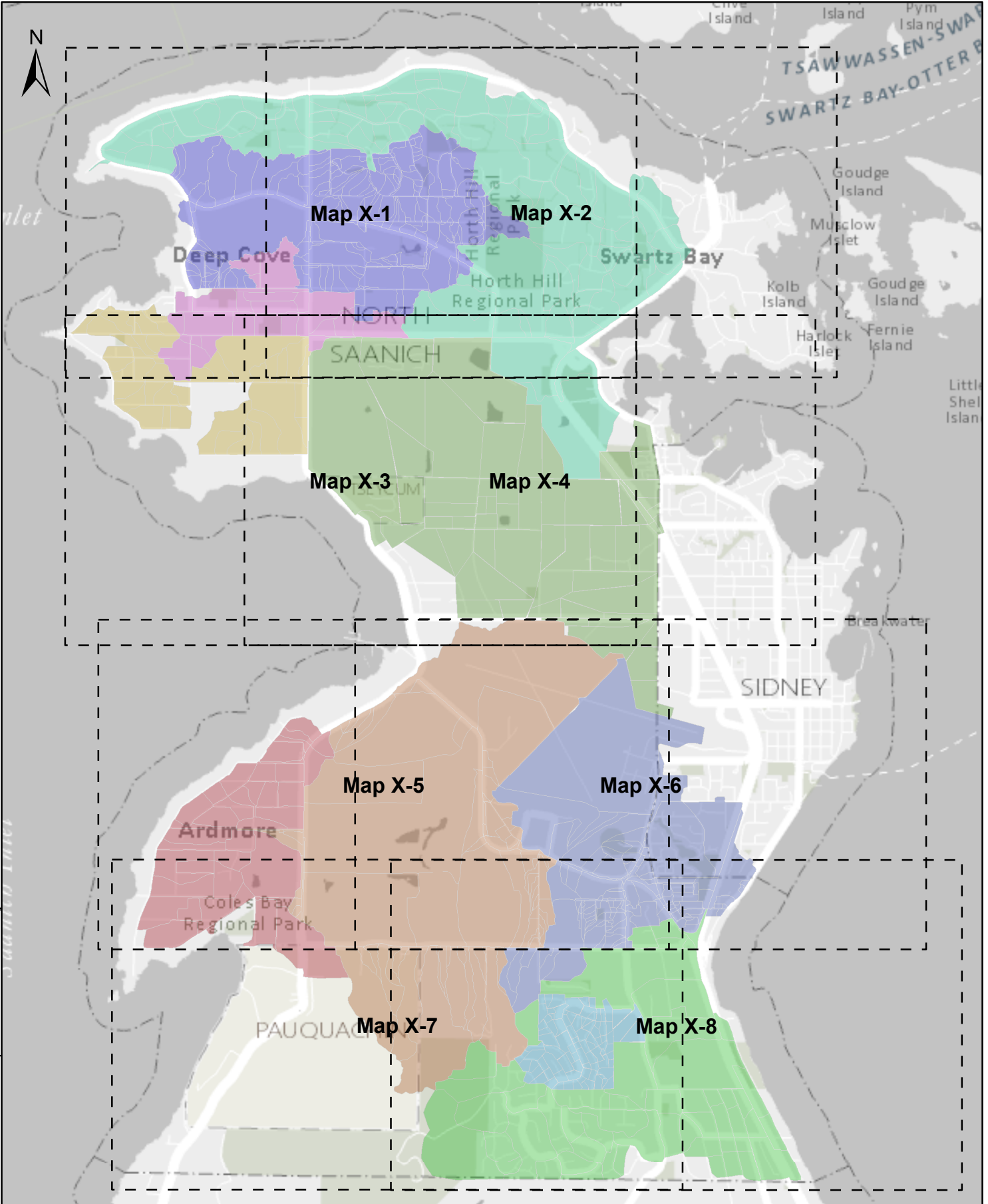
It is recommended that the District should update the Drainage Master Plan every five years to:

- Update the progress made in the capital replacement plan.
- Update the condition replacement plan based on newly conducted condition assessments.
- Re-evaluate the selected design storms based on changes to the IDF curves and climate change projections.
- Update the PCSWMM model to incorporate subcatchment changes (e.g. new developments) and changes to the drainage infrastructure (e.g. upgraded pipes).

APPENDIX A

Hydraulic Modelling Result Maps – Existing Scenario

North Saanich Drainage Master Plan
Overview Map



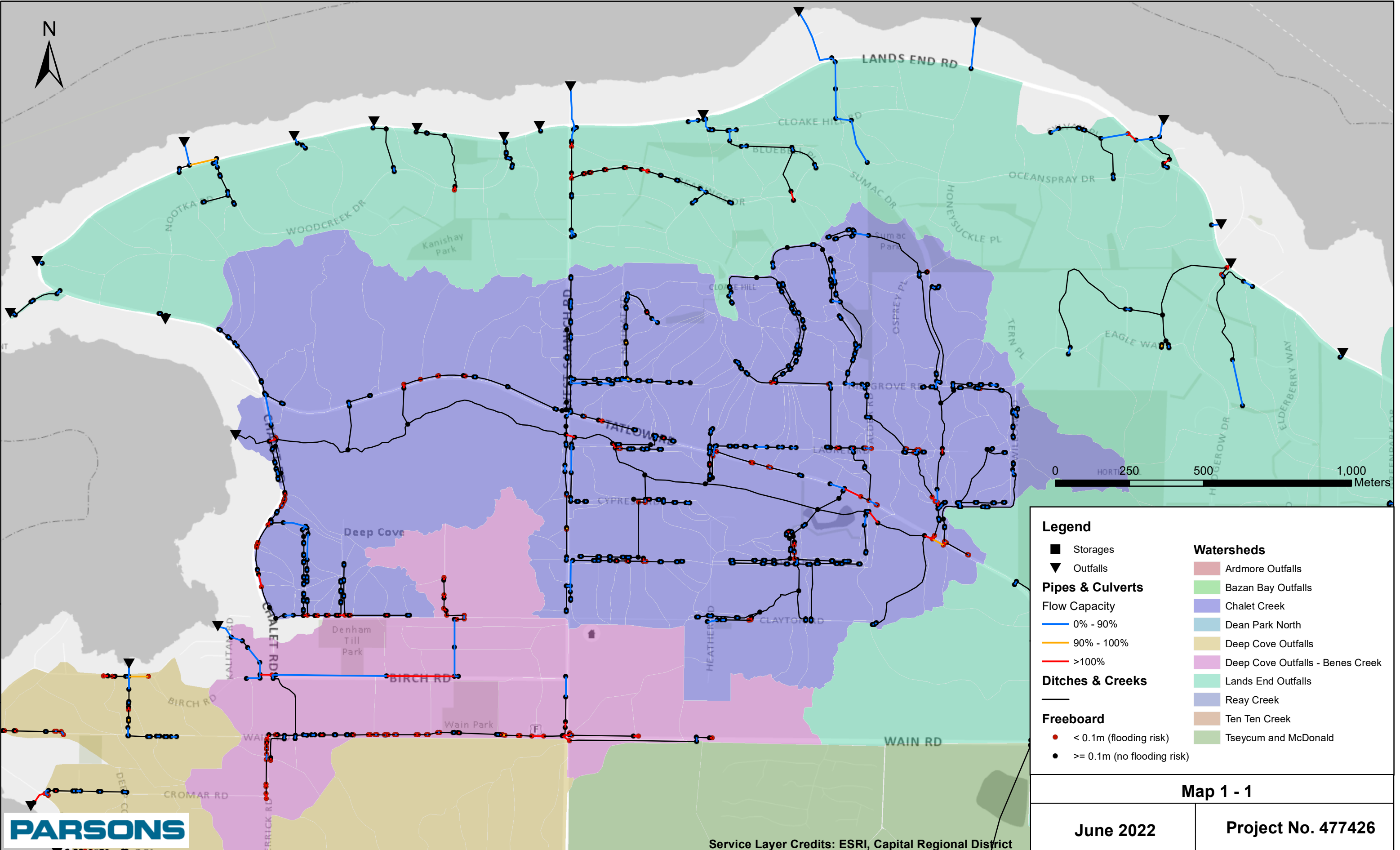
Coordinate System: NAD 1983 CSRS UTM Zone 10N
Datum: NAD83 Canadian Spatial Reference System



Service Layer Credits: ESRI, Capital Regional District

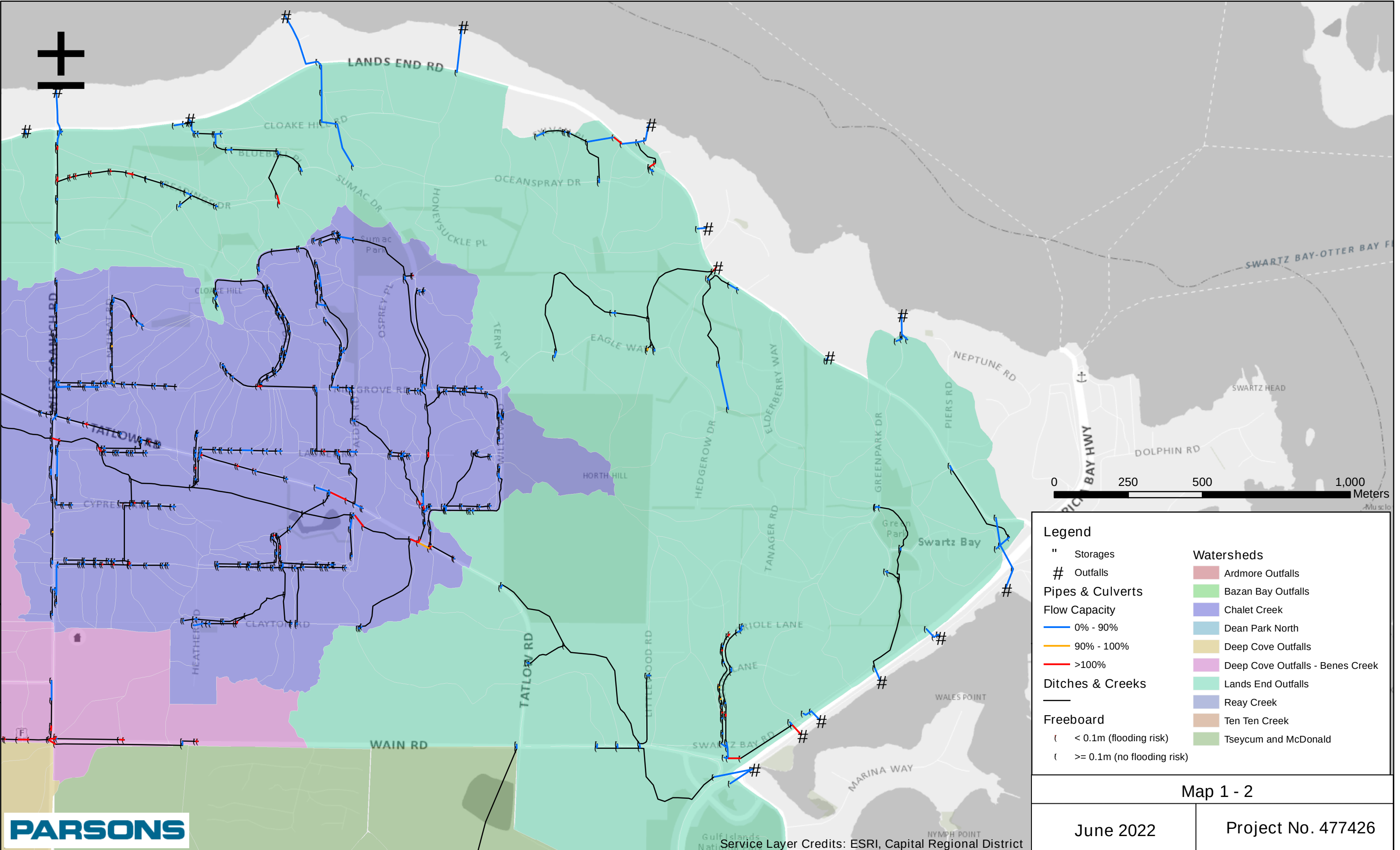
Overview Map	
May 2022	Project No. 477426

North Saanich Drainage Master Plan - Hydraulic Modelling Results - Existing Scenario (Minor System)
5 Year Storm Event with Climate Change

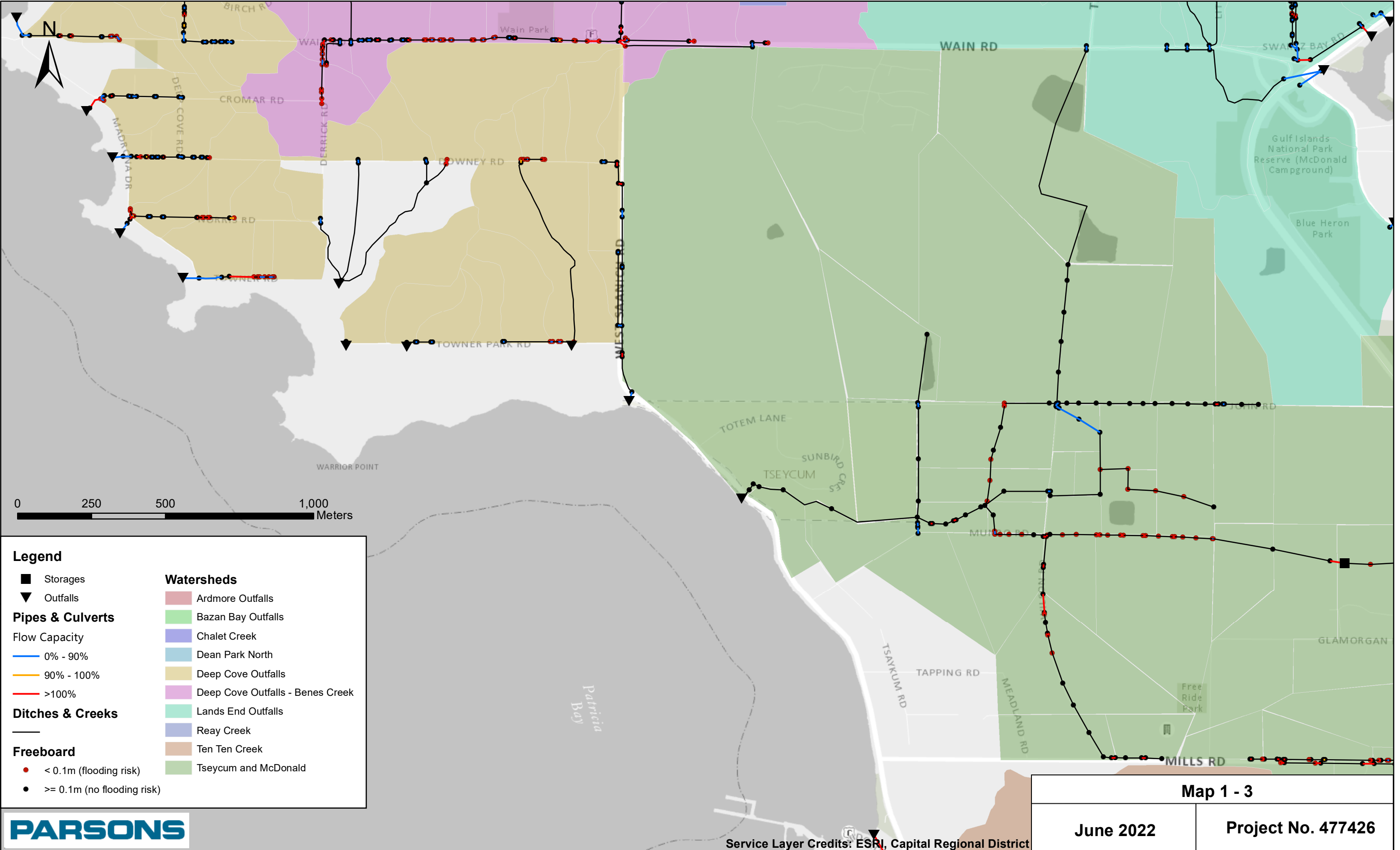


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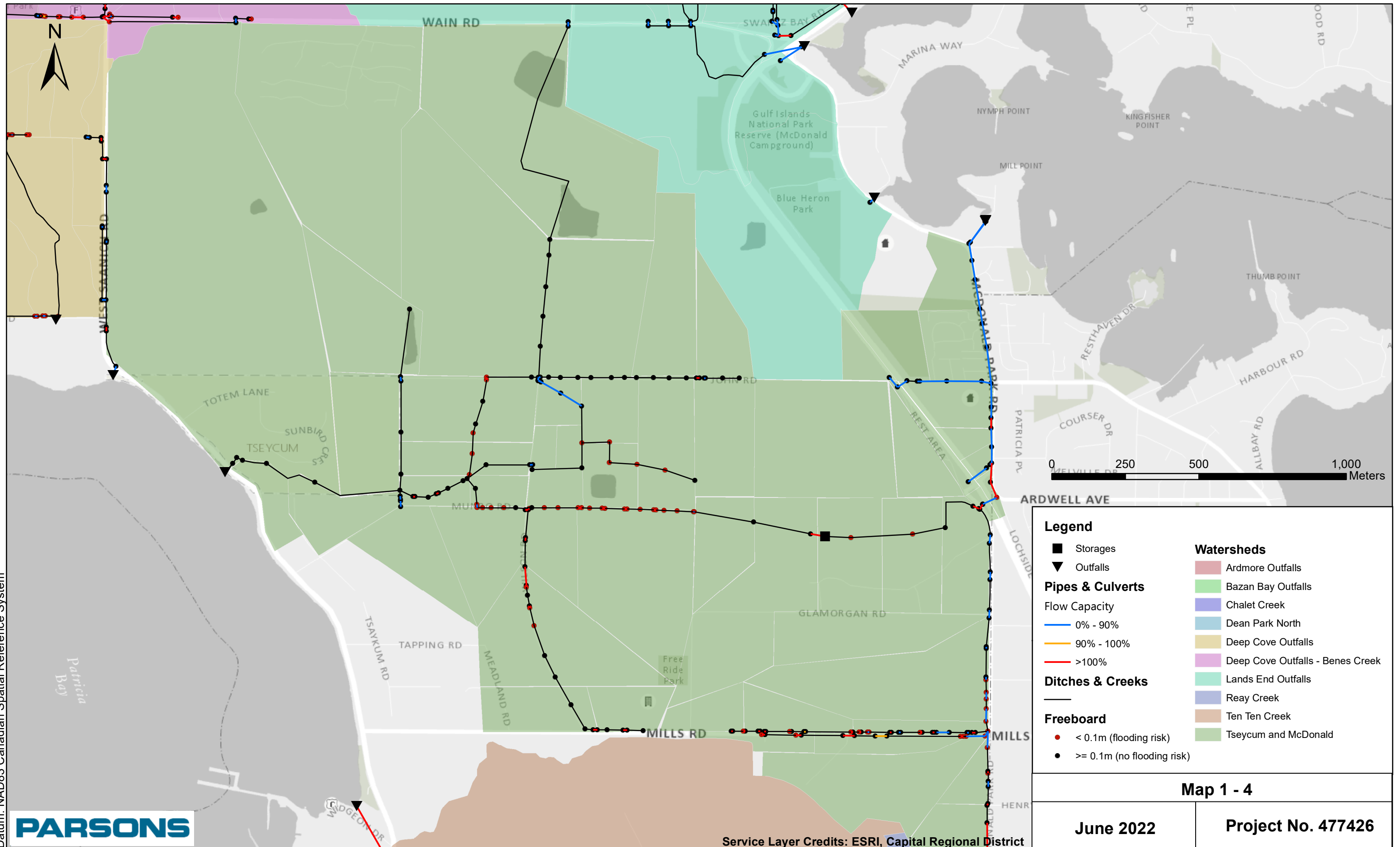
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5 Year Storm Event with Climate Change



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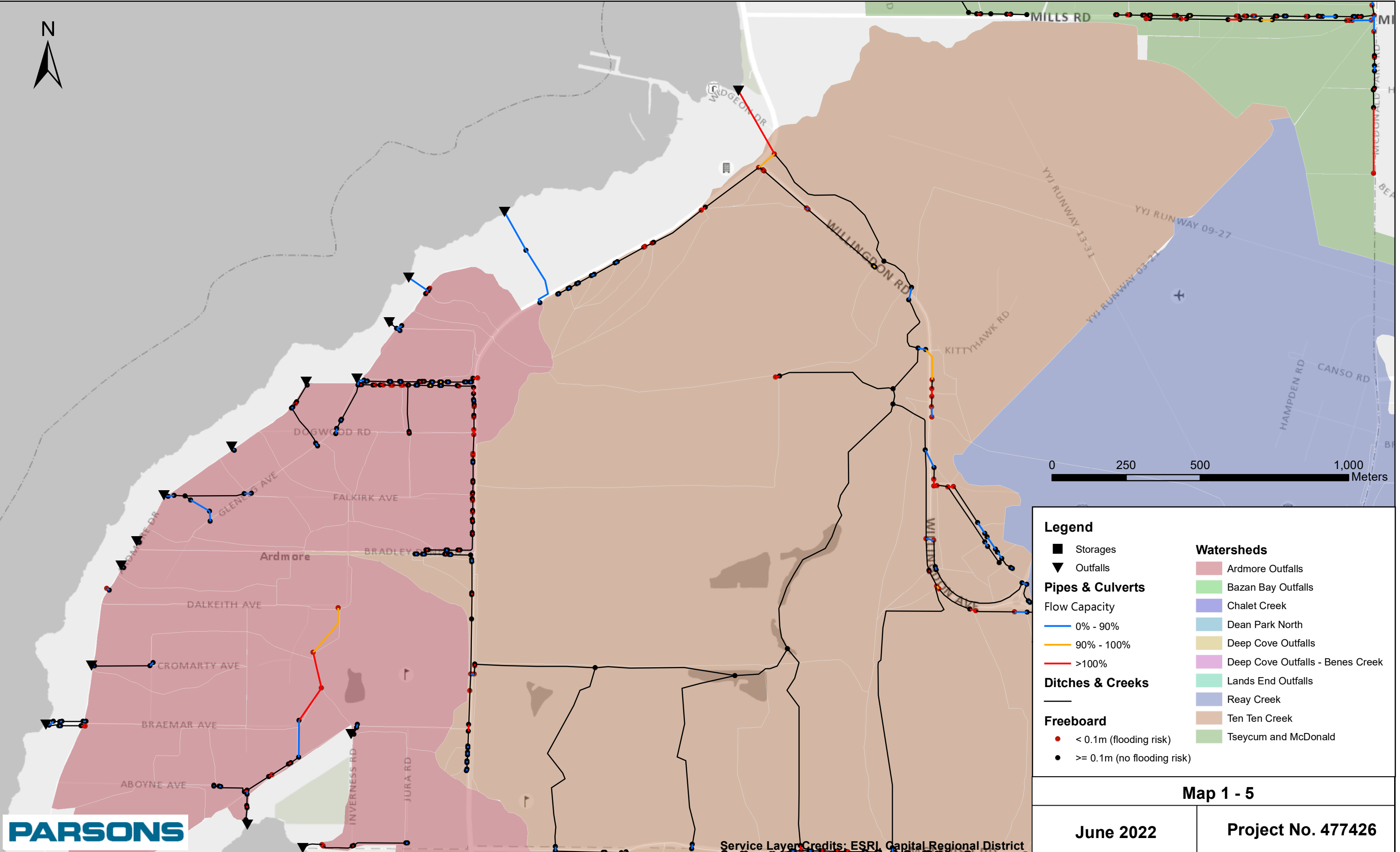


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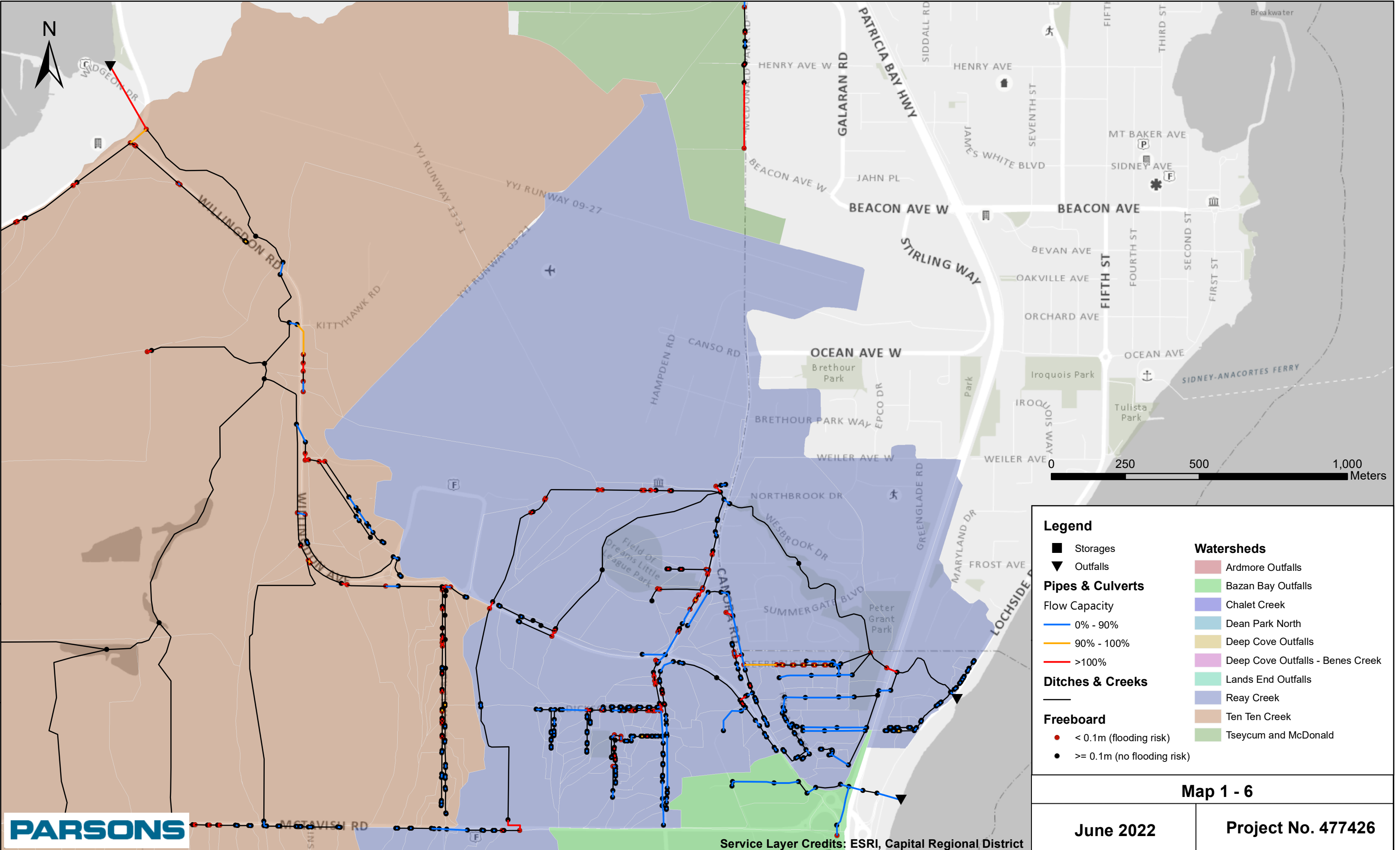
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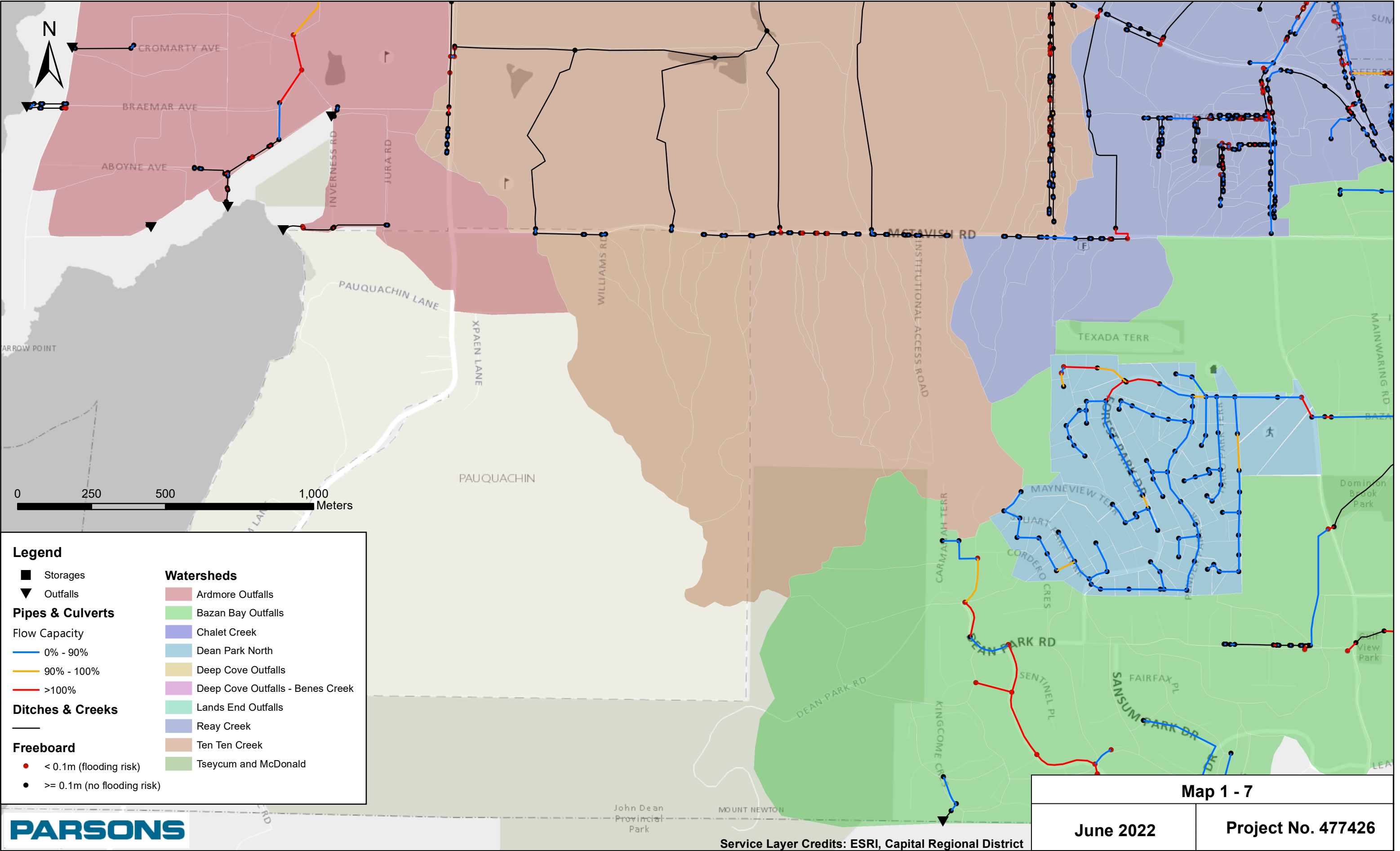


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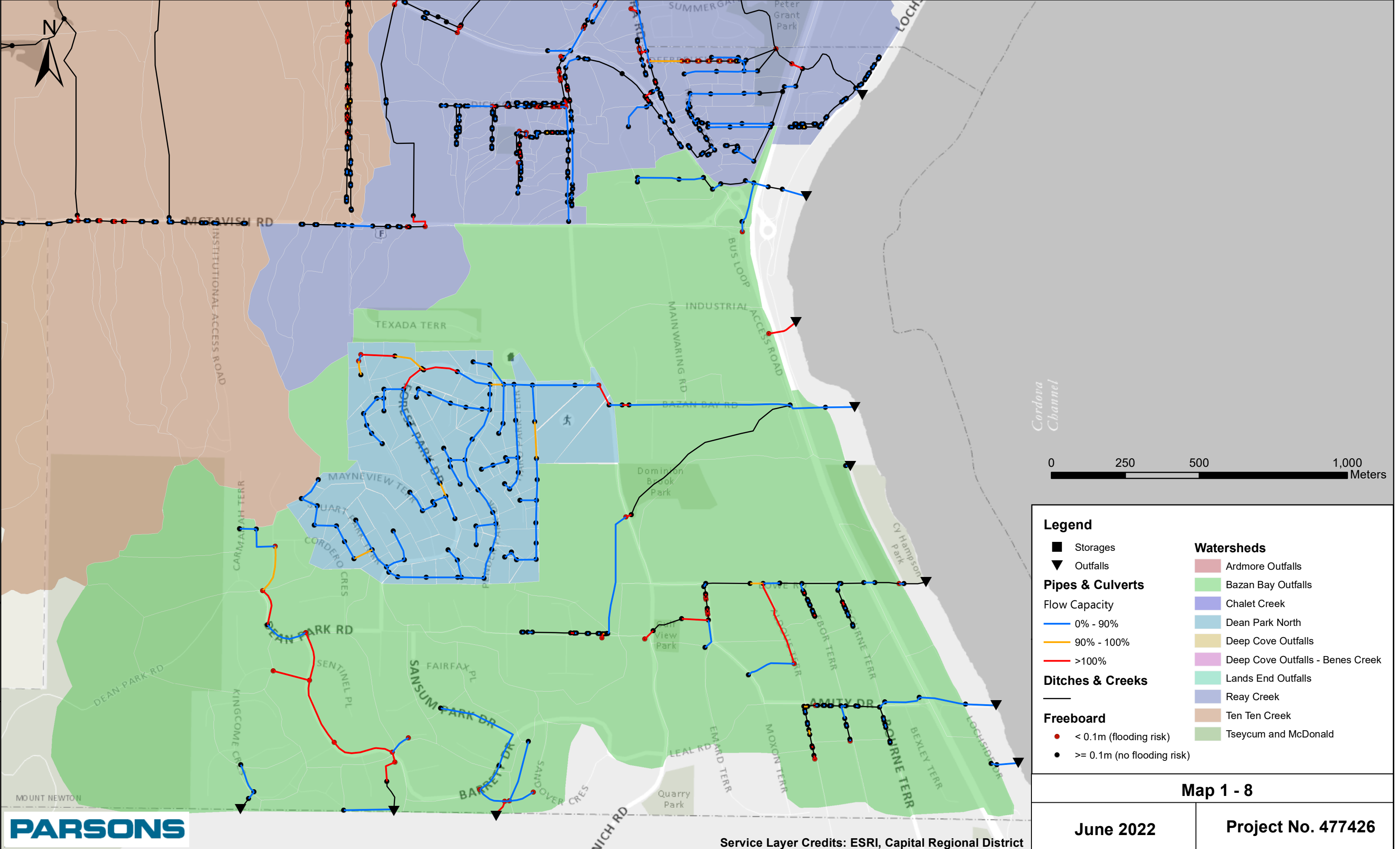


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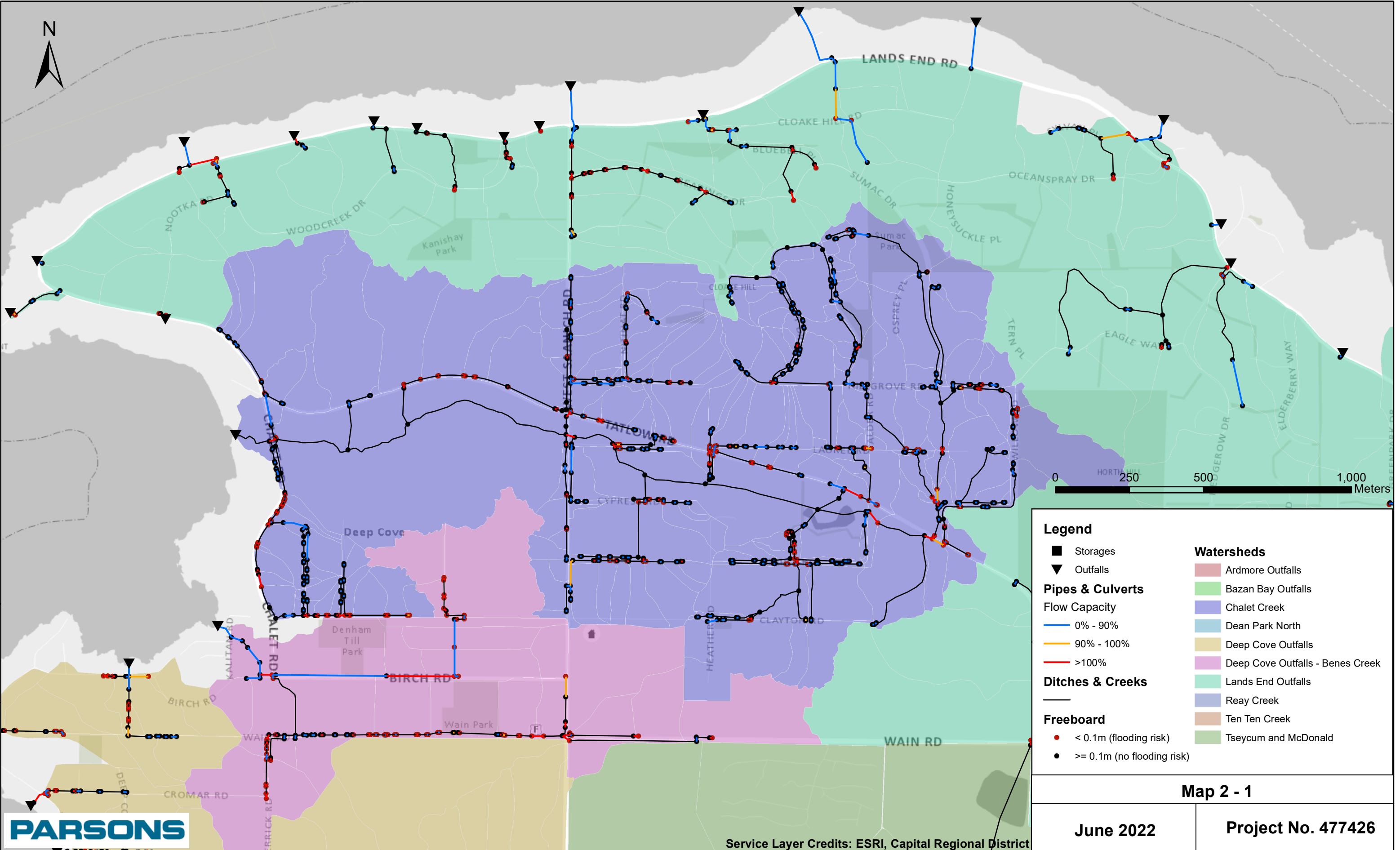


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5 Year Storm Event with Climate Change



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North Saanich Drainage Master Plan - Hydraulic Modelling Results - Existing Scenario (Major System)
25 Year Storm Event with Climate Change

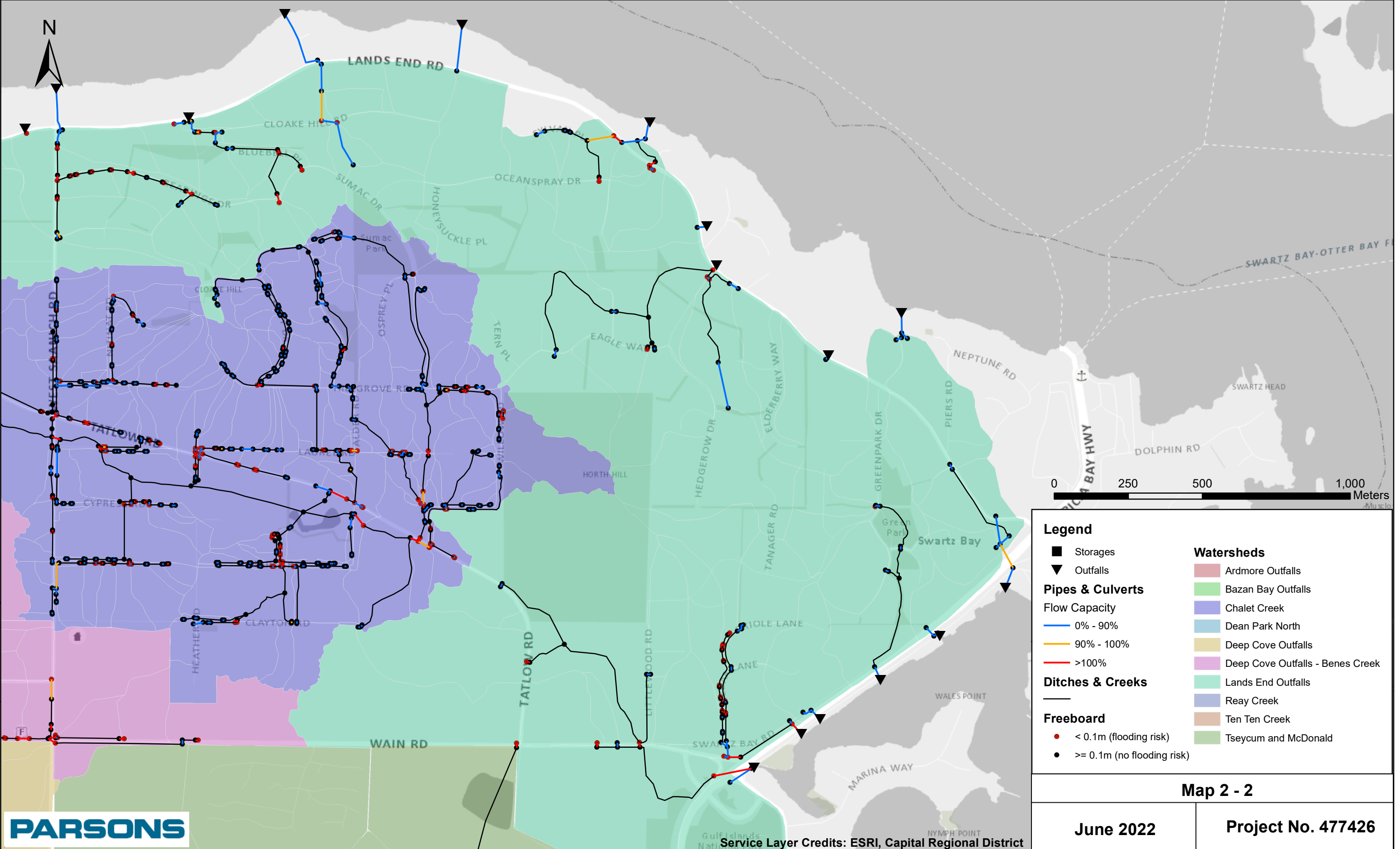


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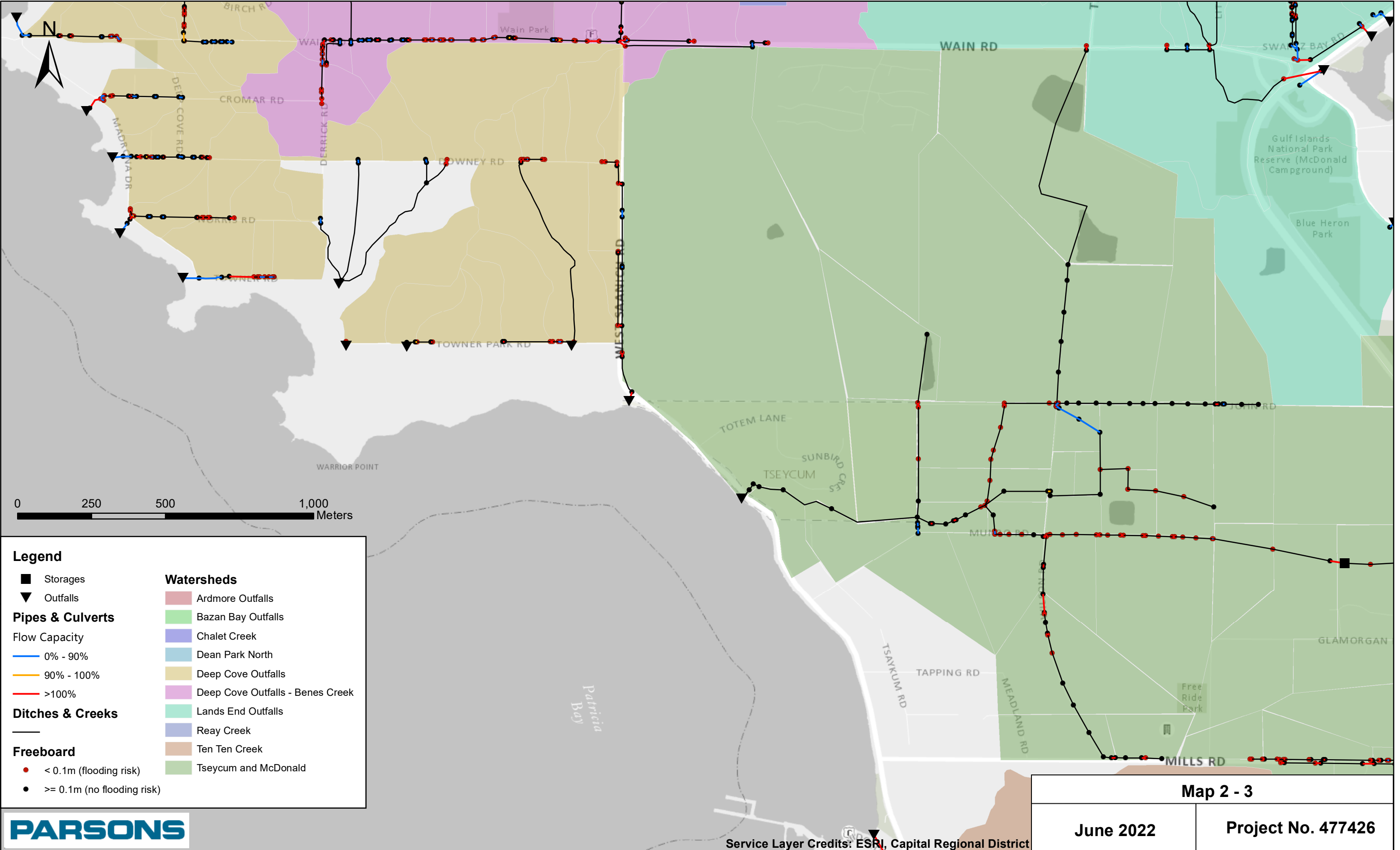


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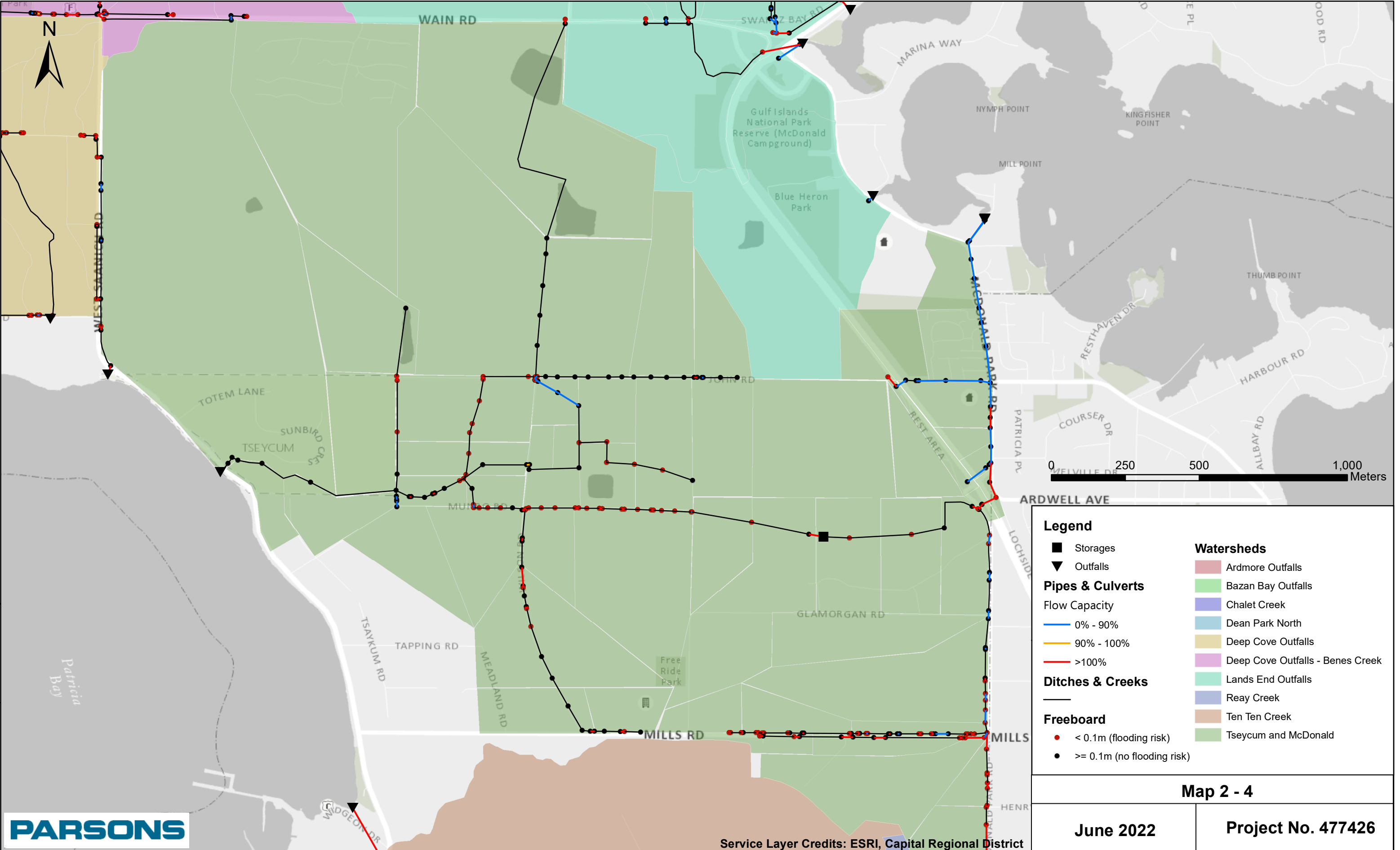


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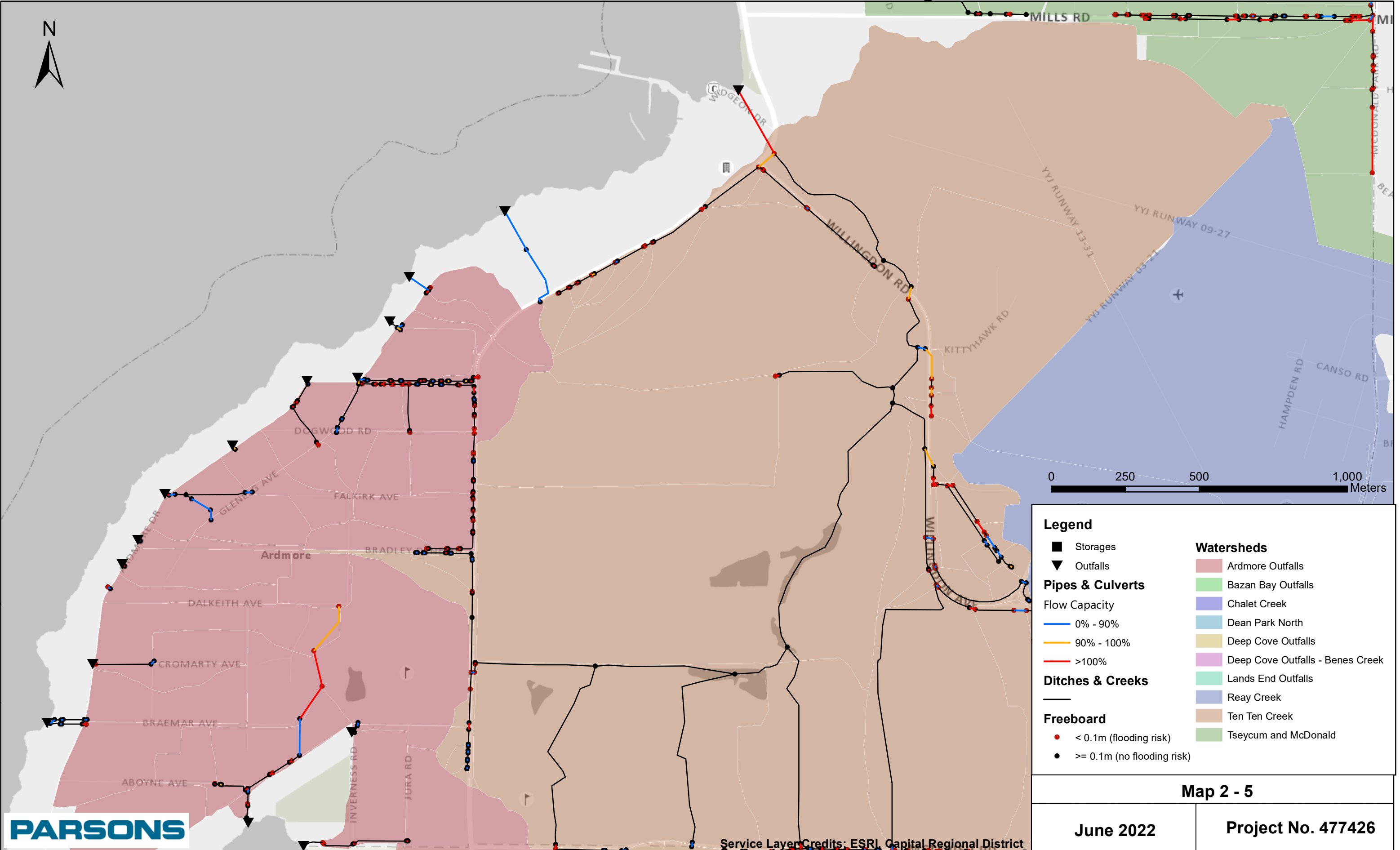
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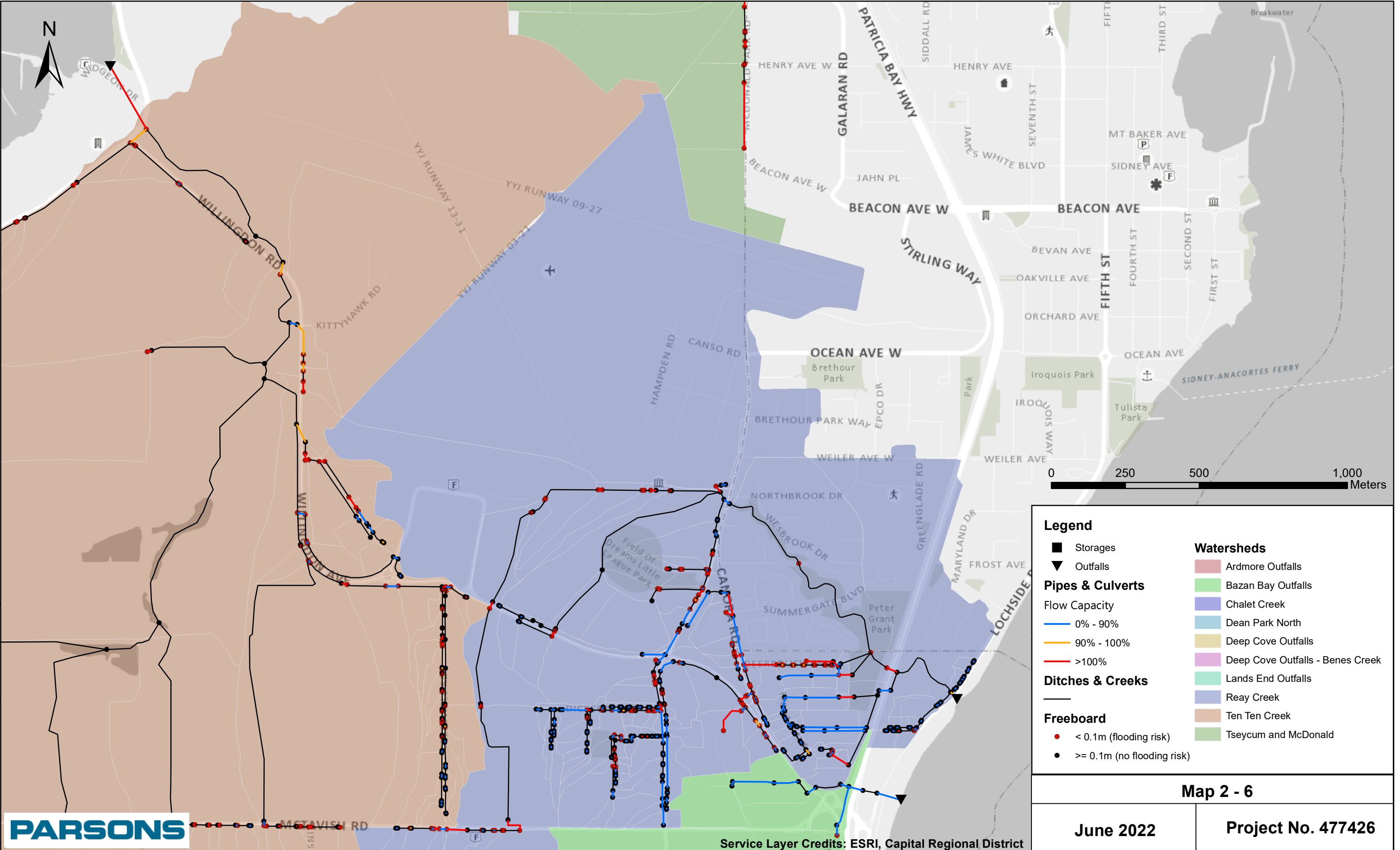
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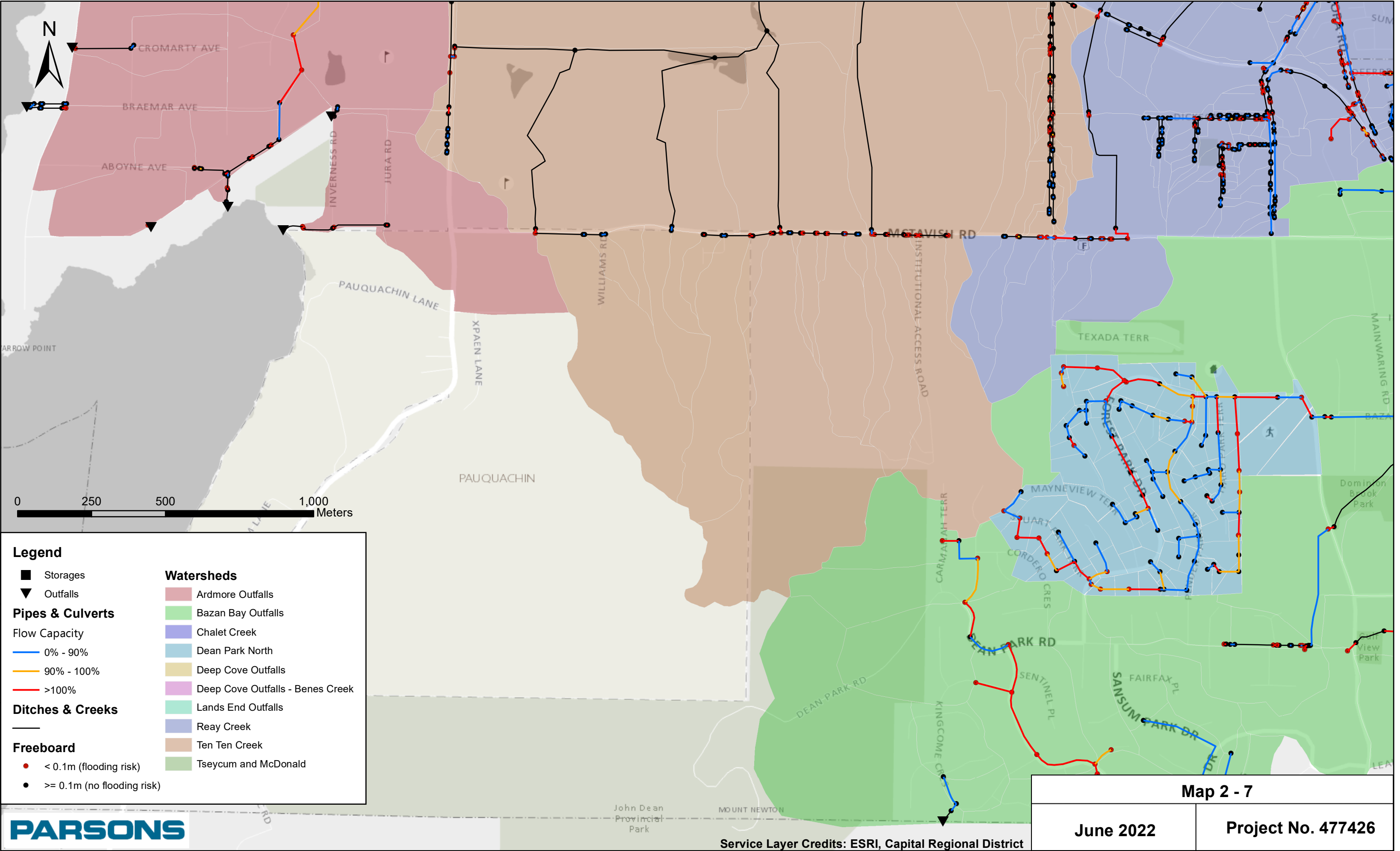


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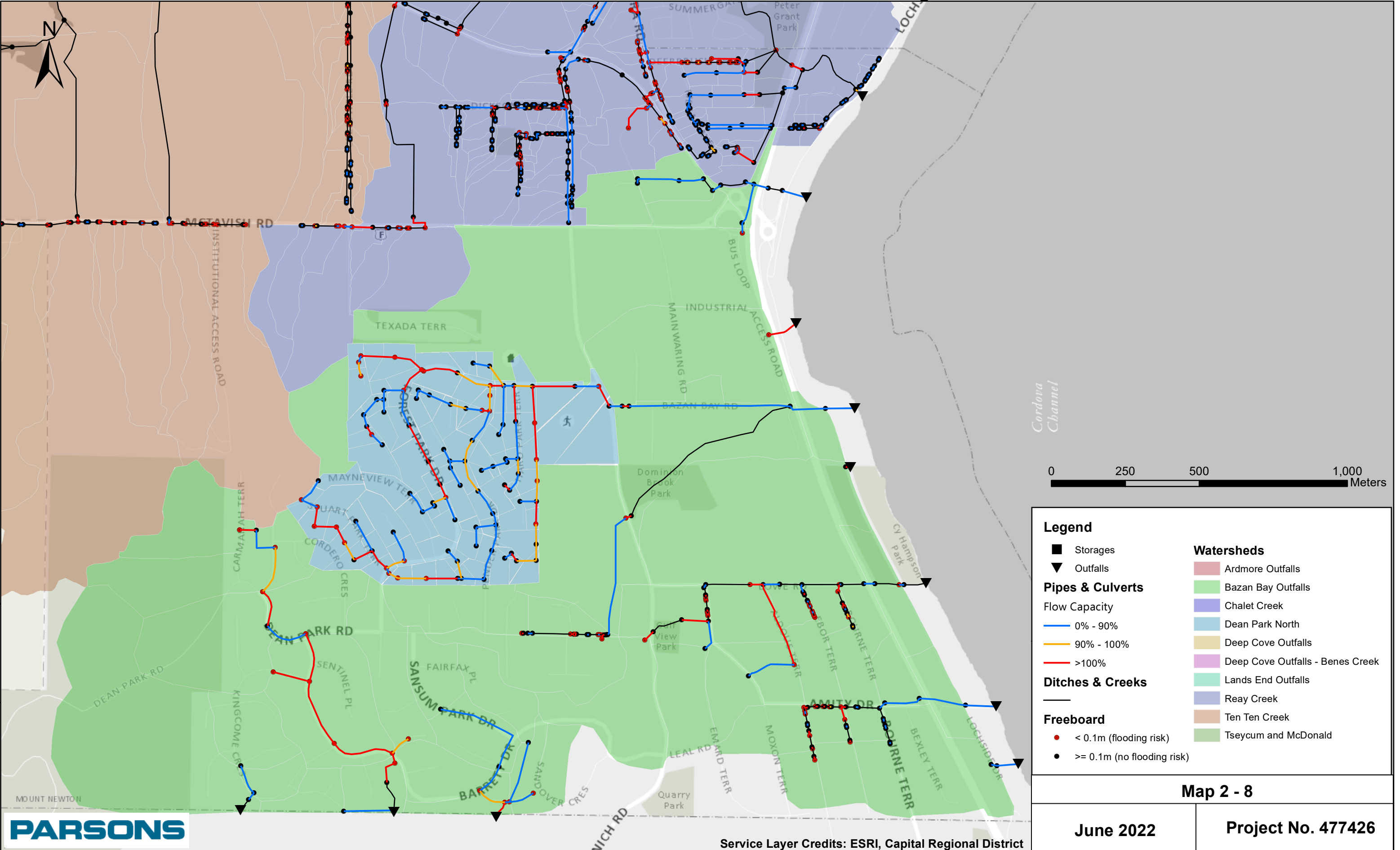


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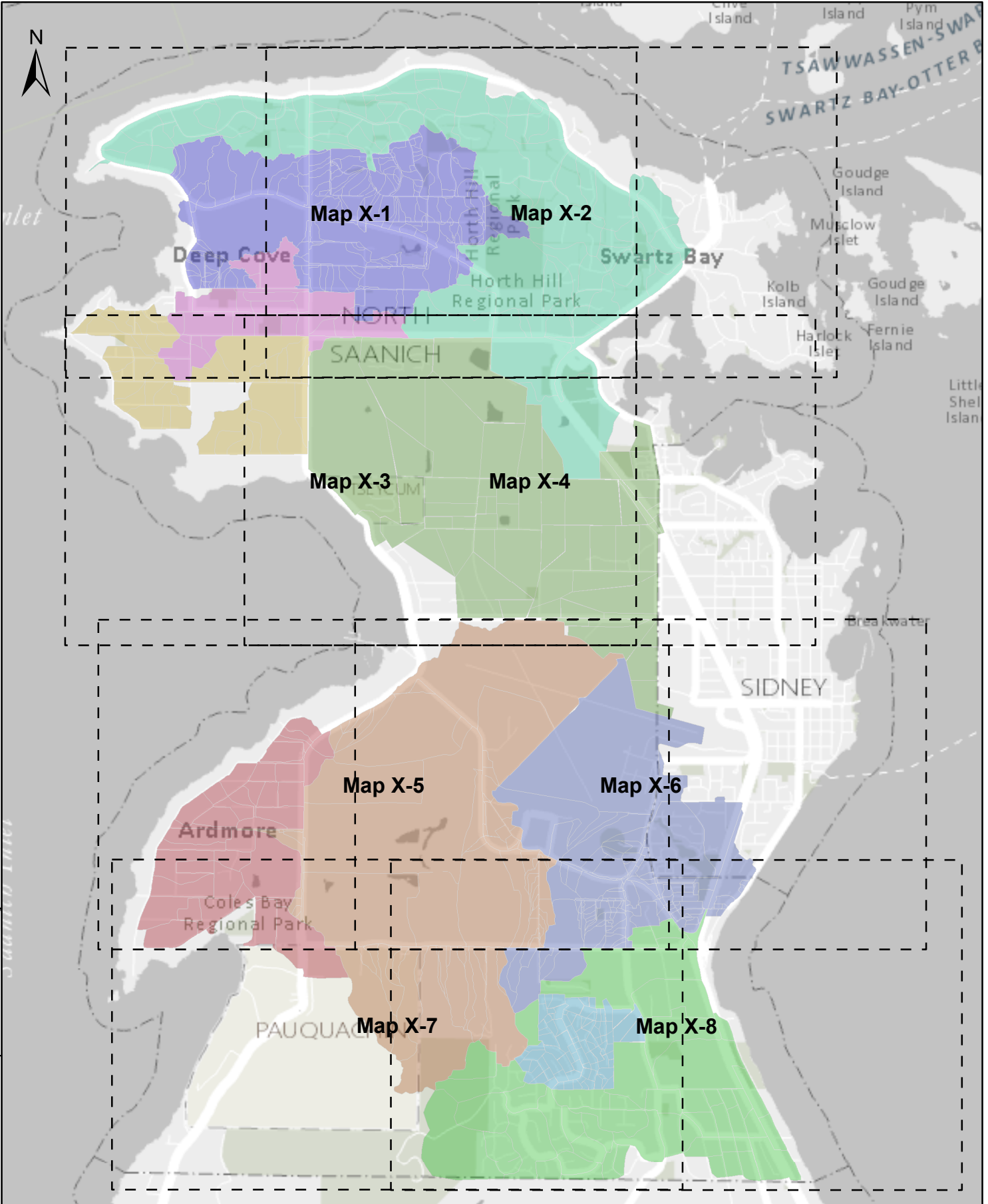


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APPENDIX B

Hydraulic Modelling Result Maps – Future Scenario

North Saanich Drainage Master Plan
Overview Map



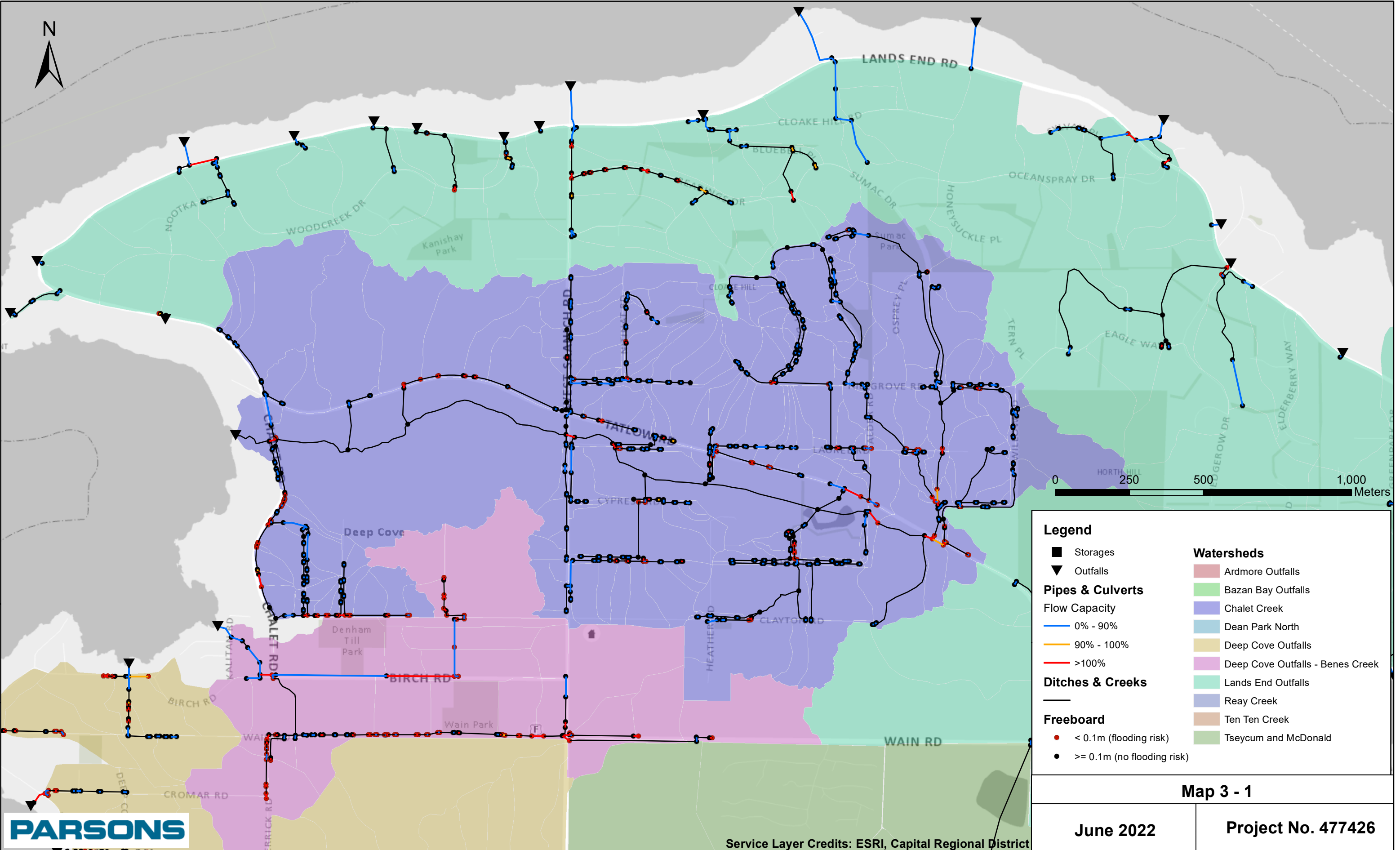
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Overview Map	
May 2022	Project No. 477426

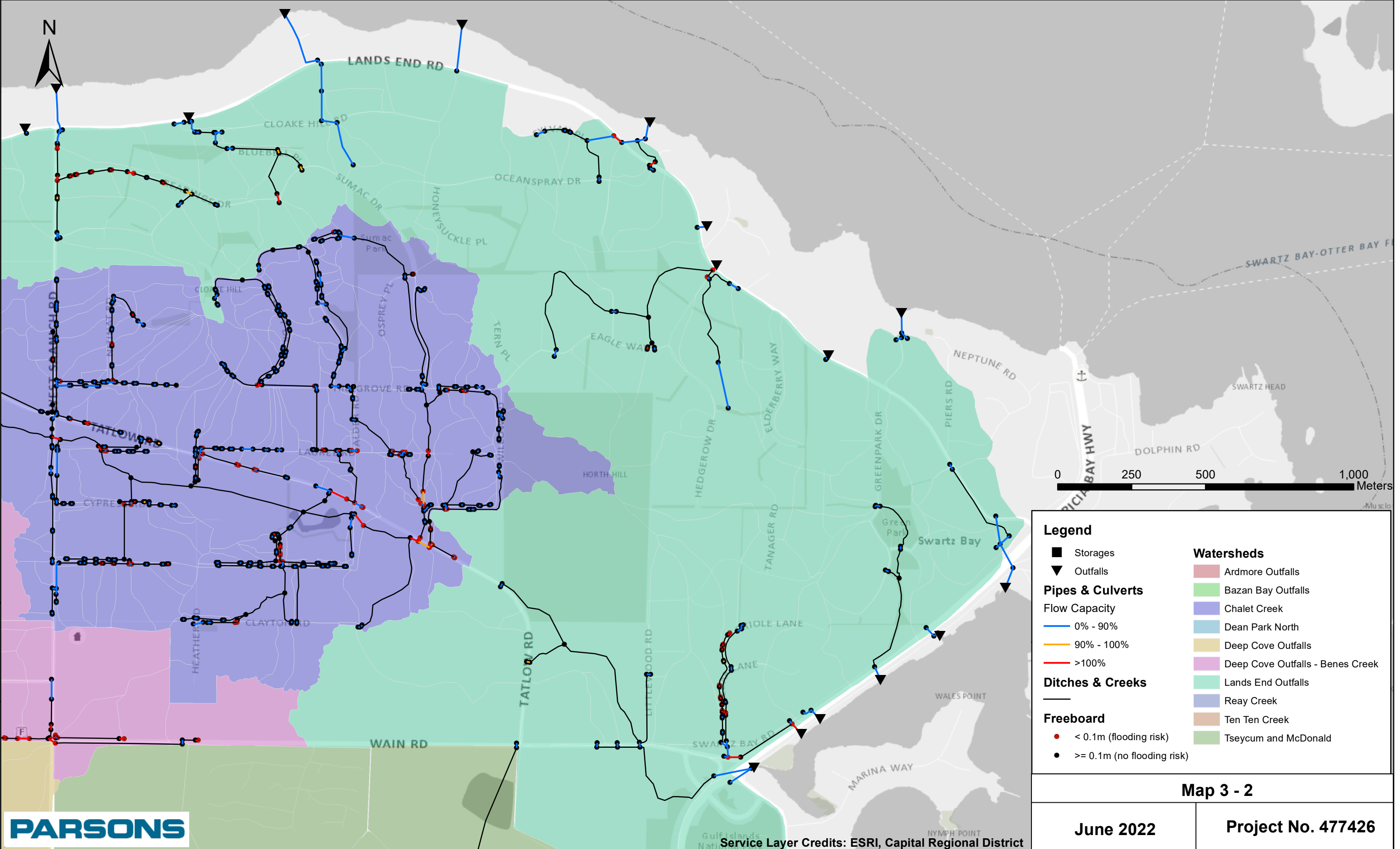
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5 Year Storm Event with Climate Change



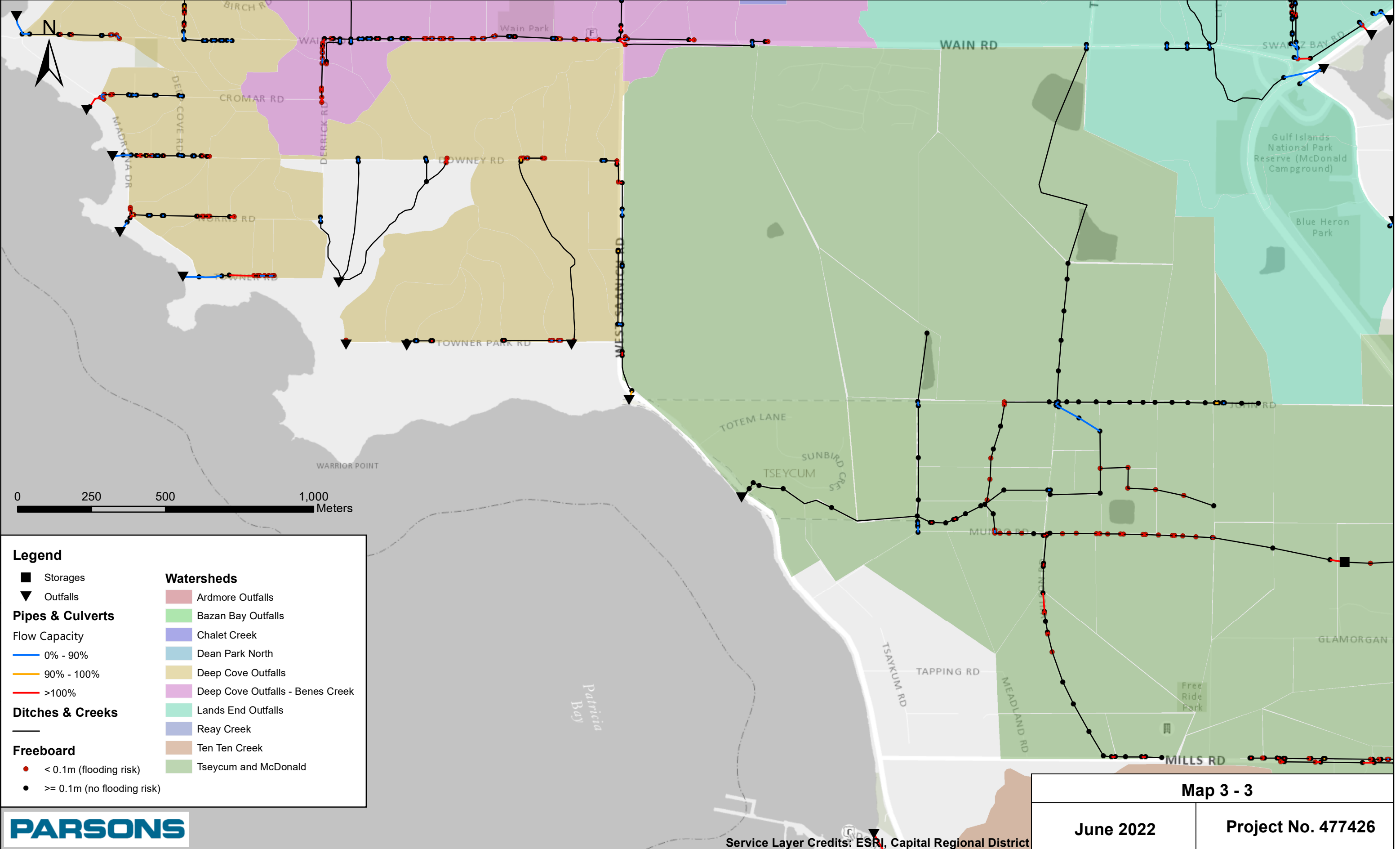
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5 Year Storm Event with Climate Change

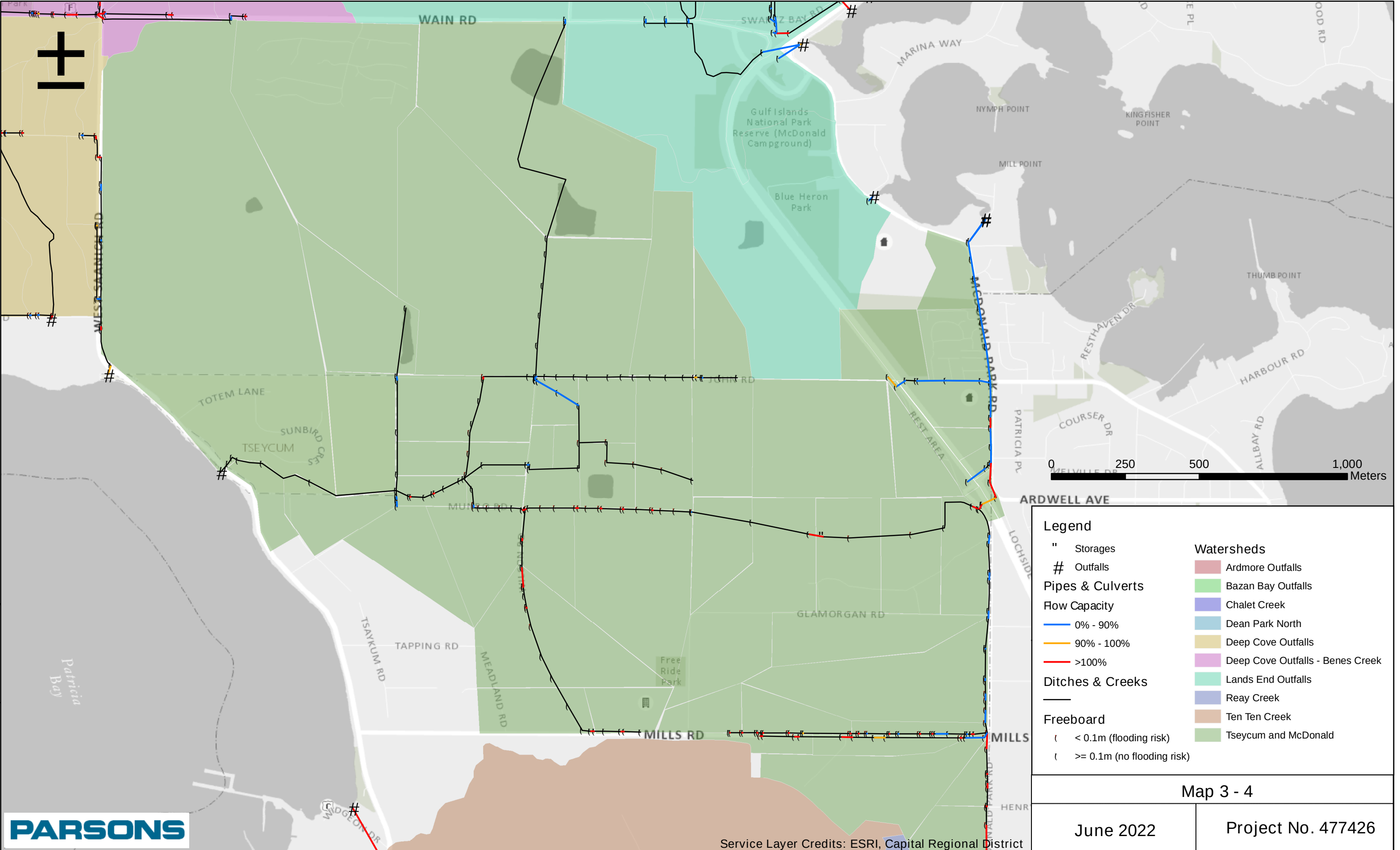


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5 Year Storm Event with Climate Change



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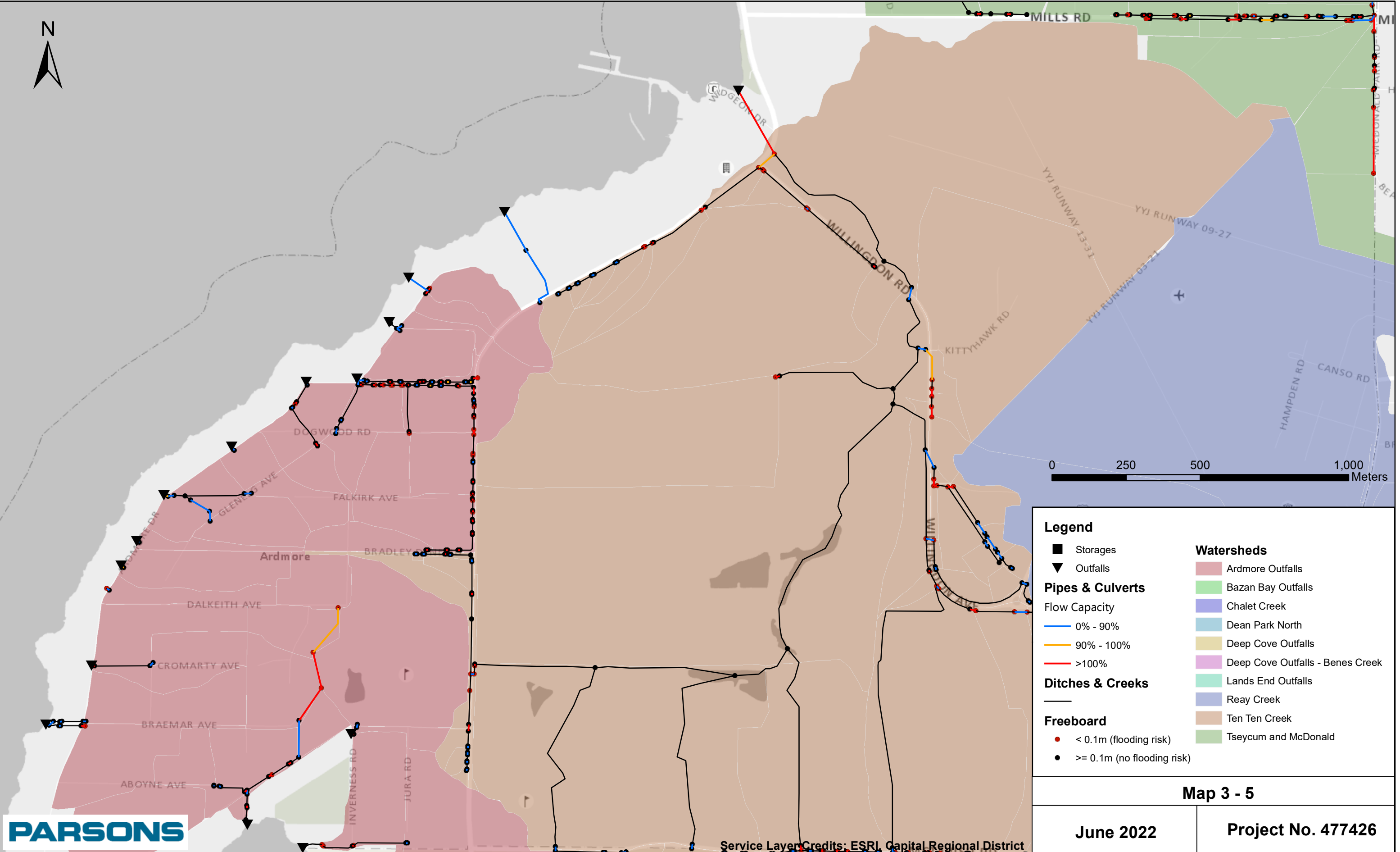
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5 Year Storm Event with Climate Change



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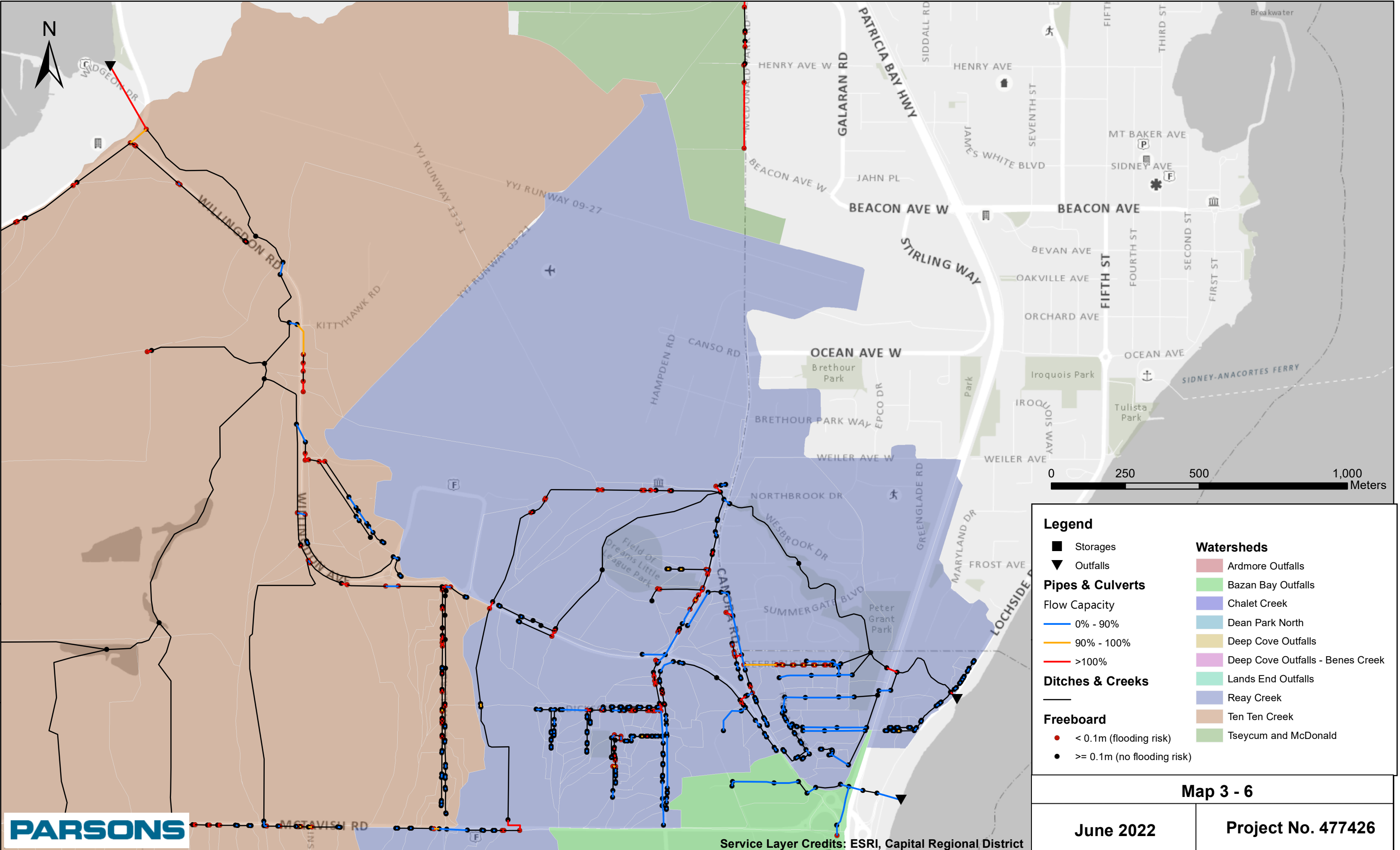


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5 Year Storm Event with Climate Change



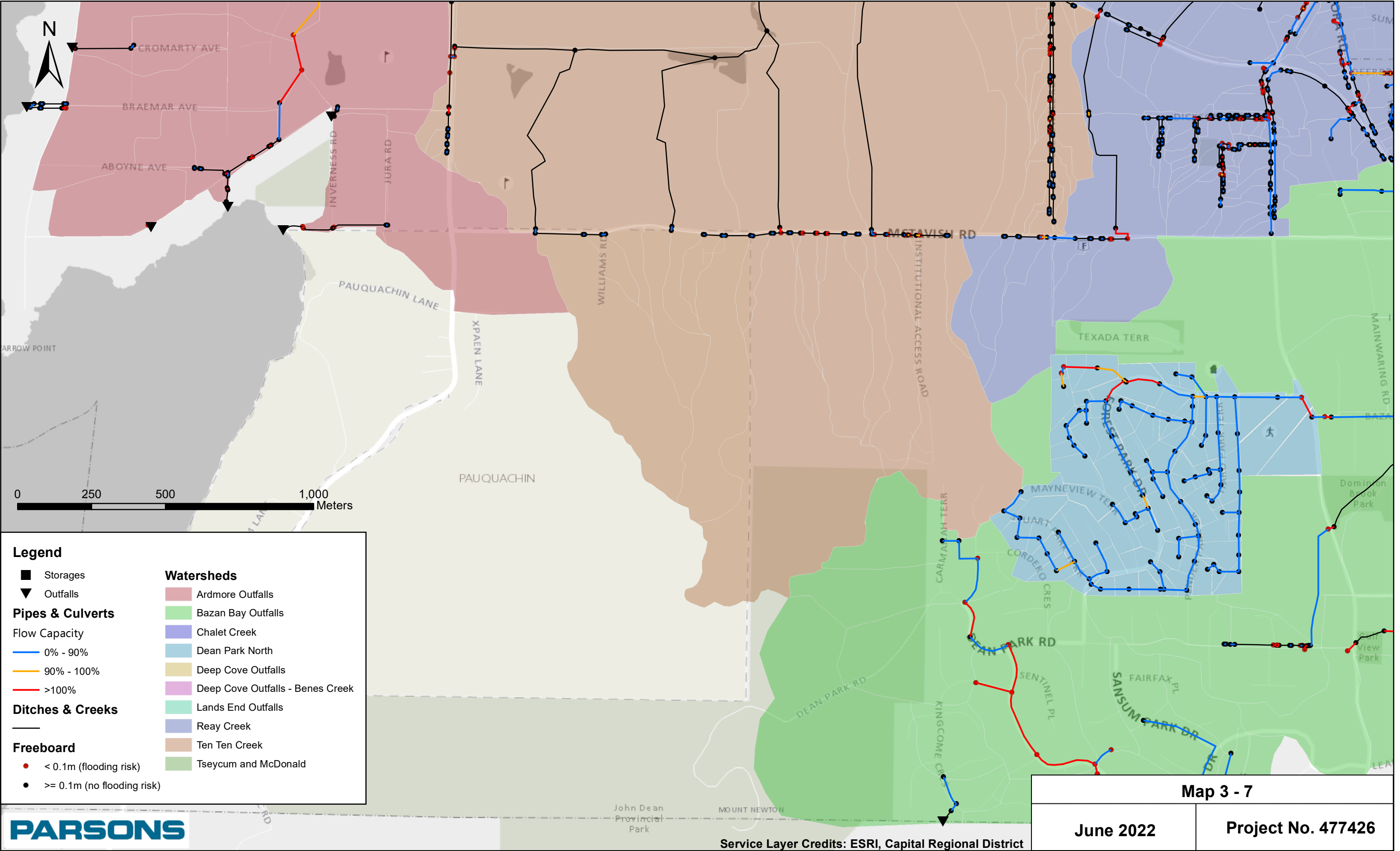
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5 Year Storm Event with Climate Change



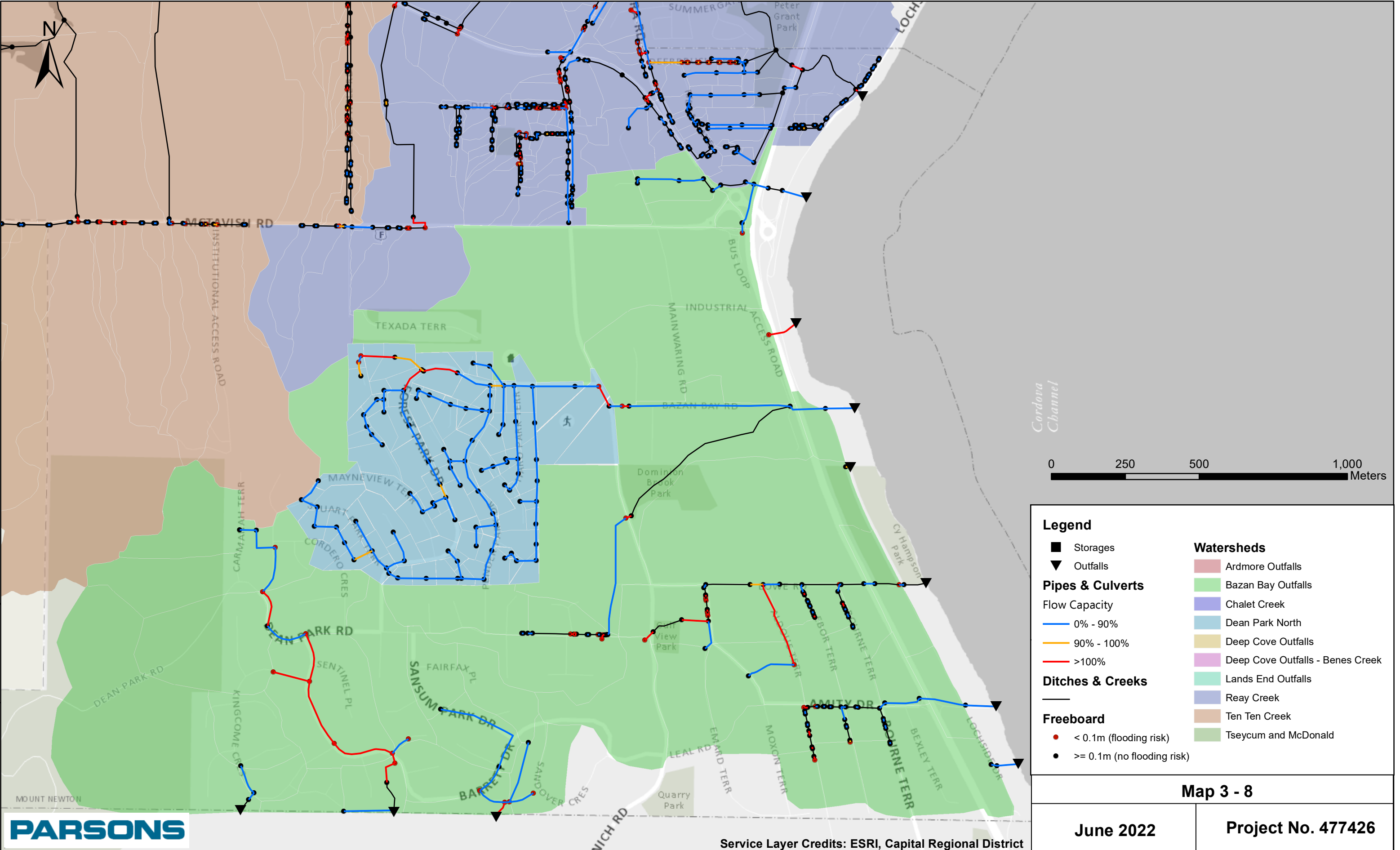
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5 Year Storm Event with Climate Change



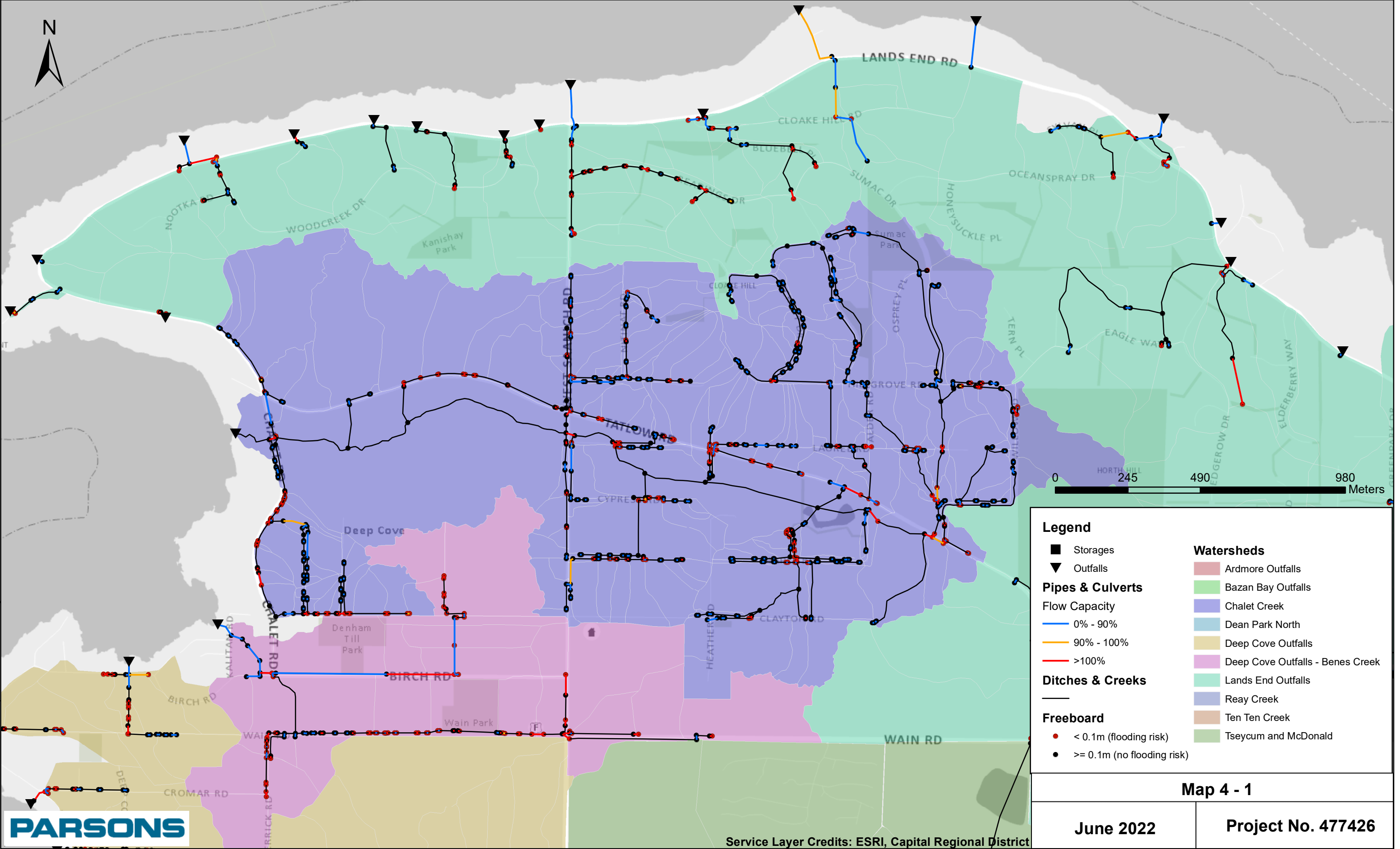
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5 Year Storm Event with Climate Change

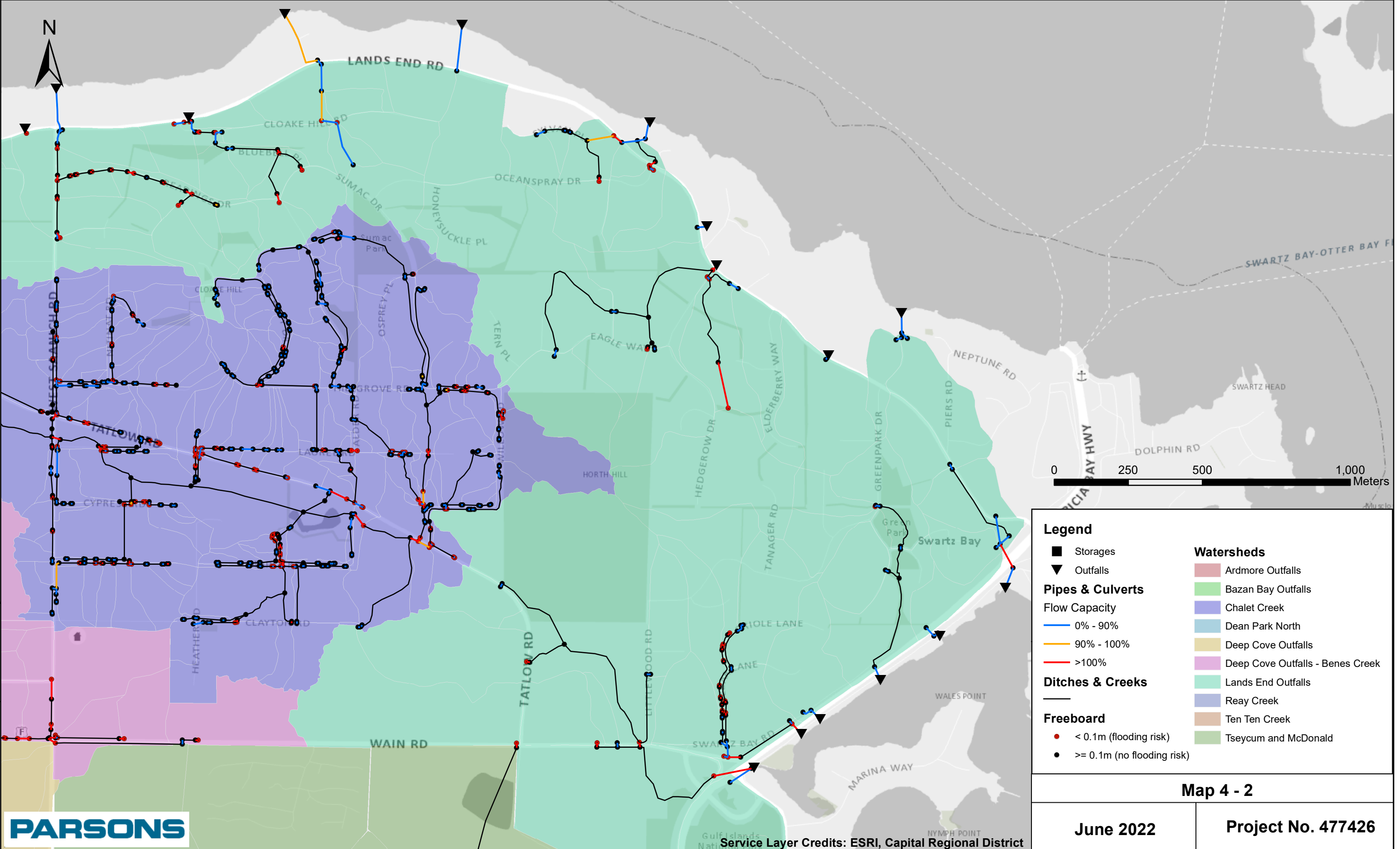


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North Saanich Drainage Master Plan - Hydraulic Modelling Results - Future Scenario (Major System)
25 Year Storm Event with Climate Change



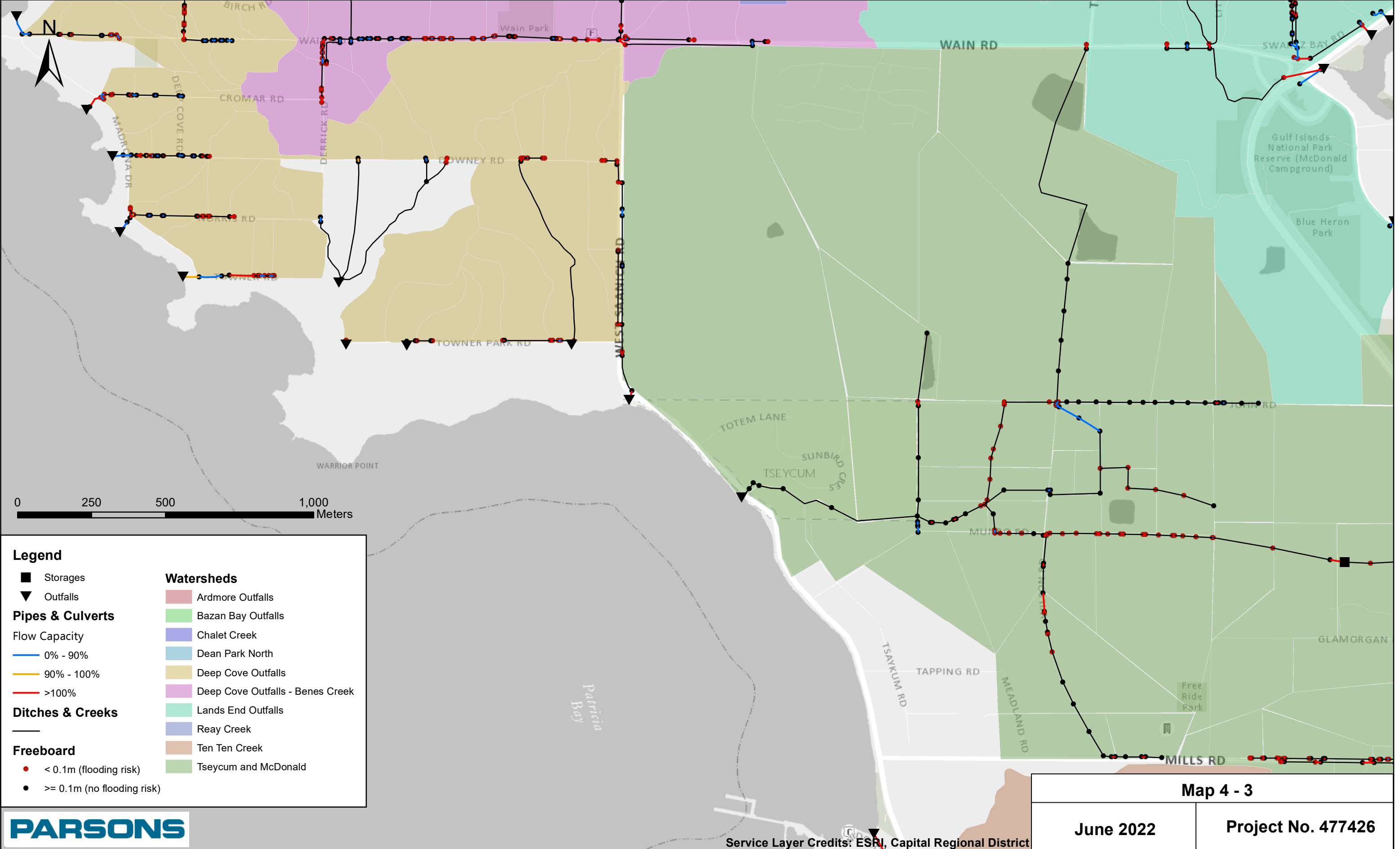
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25 Year Storm Event with Climate Change

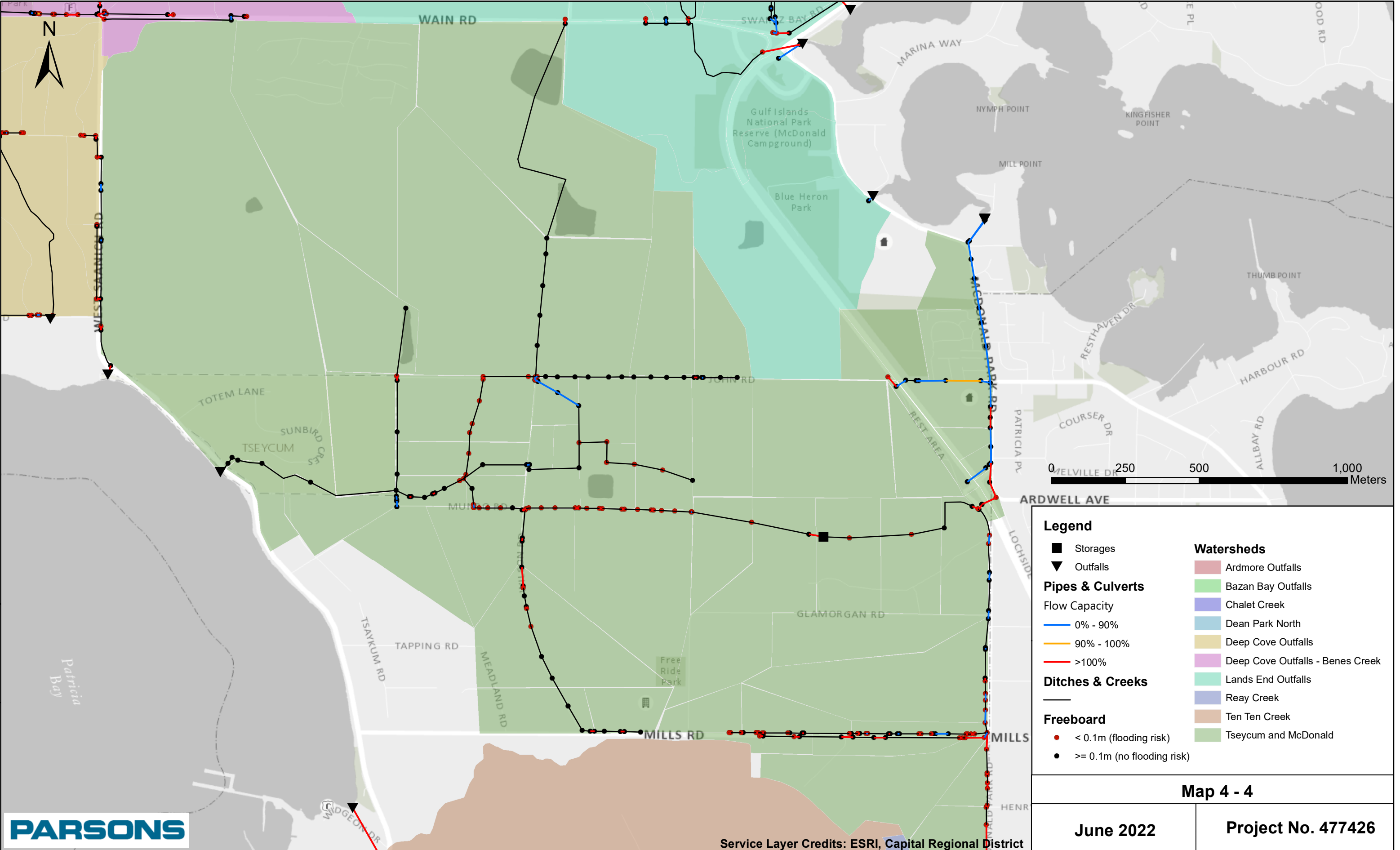


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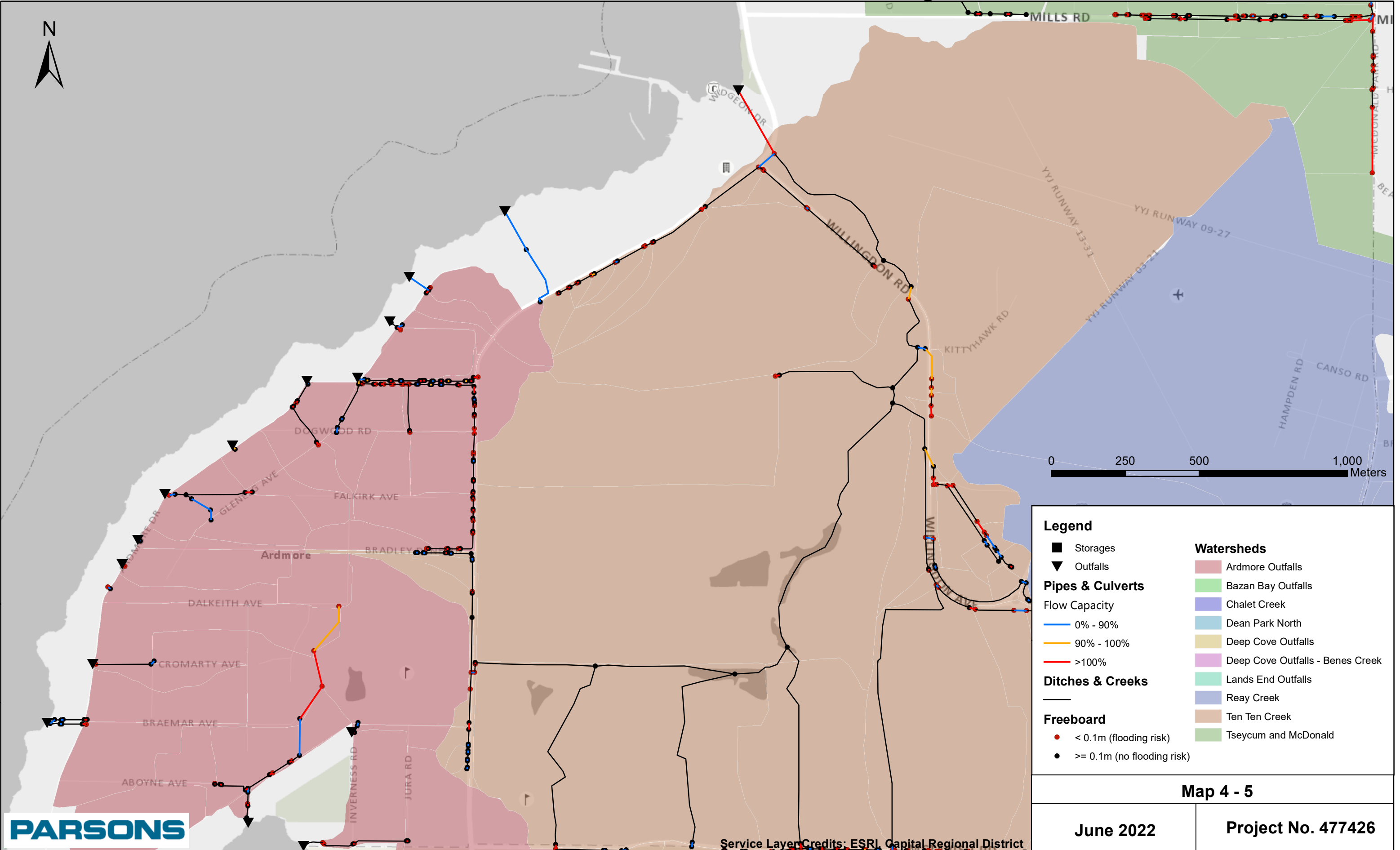


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North Saanich Drainage Master Plan - Hydraulic Modelling Results - Future Scenario (Major System)
25 Year Storm Event with Climate Change

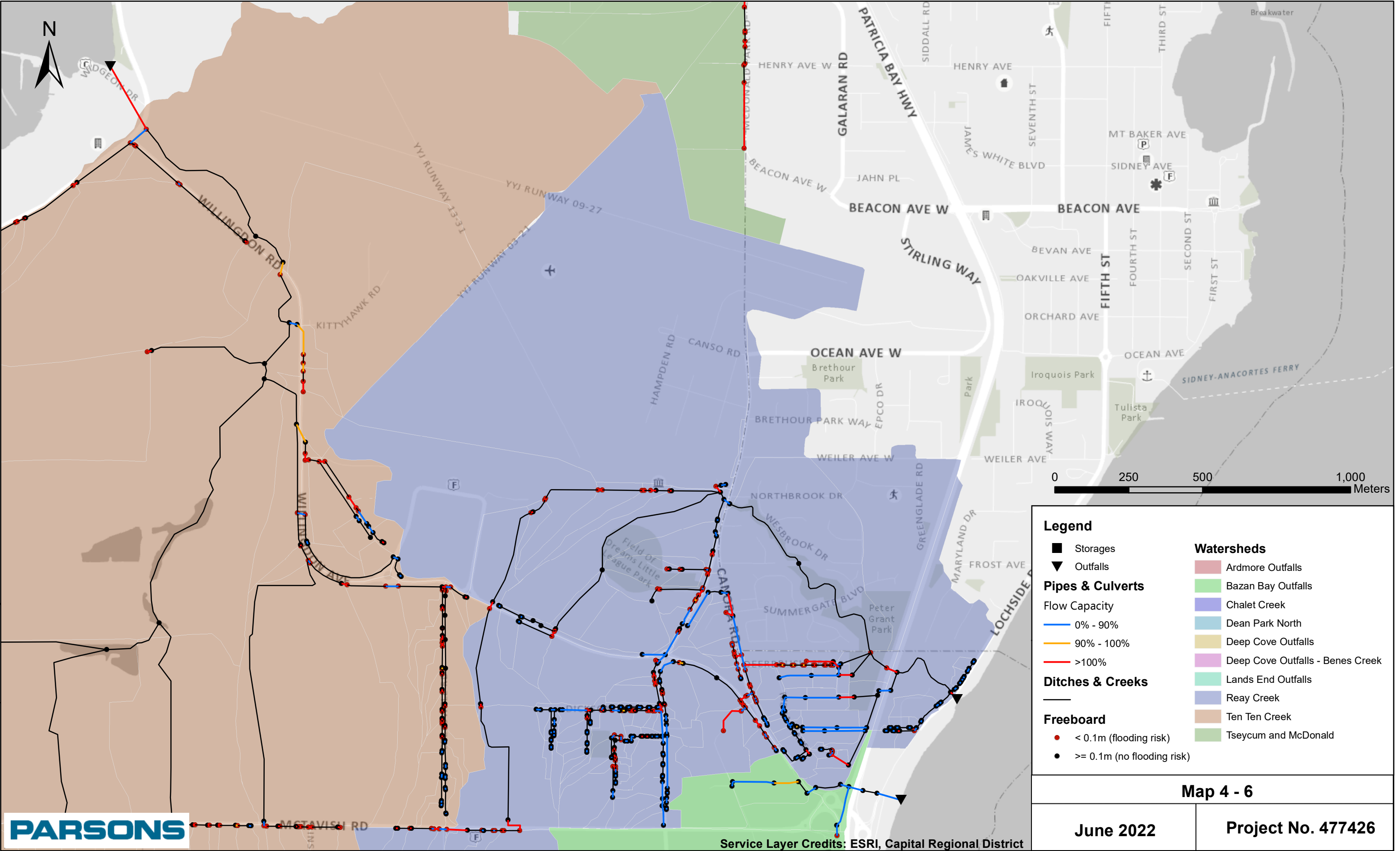


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25 Year Storm Event with Climate Change



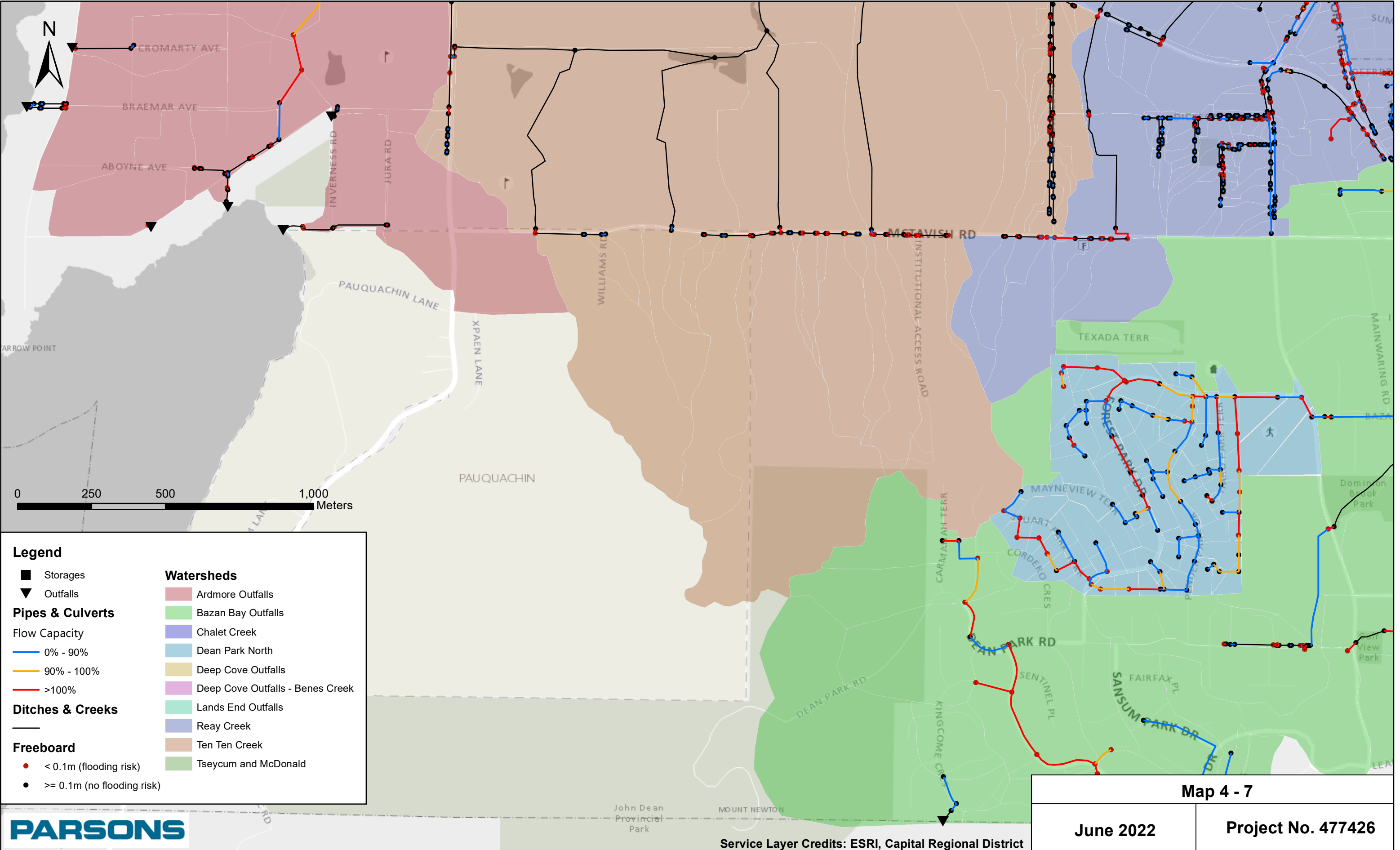
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25 Year Storm Event with Climate Change



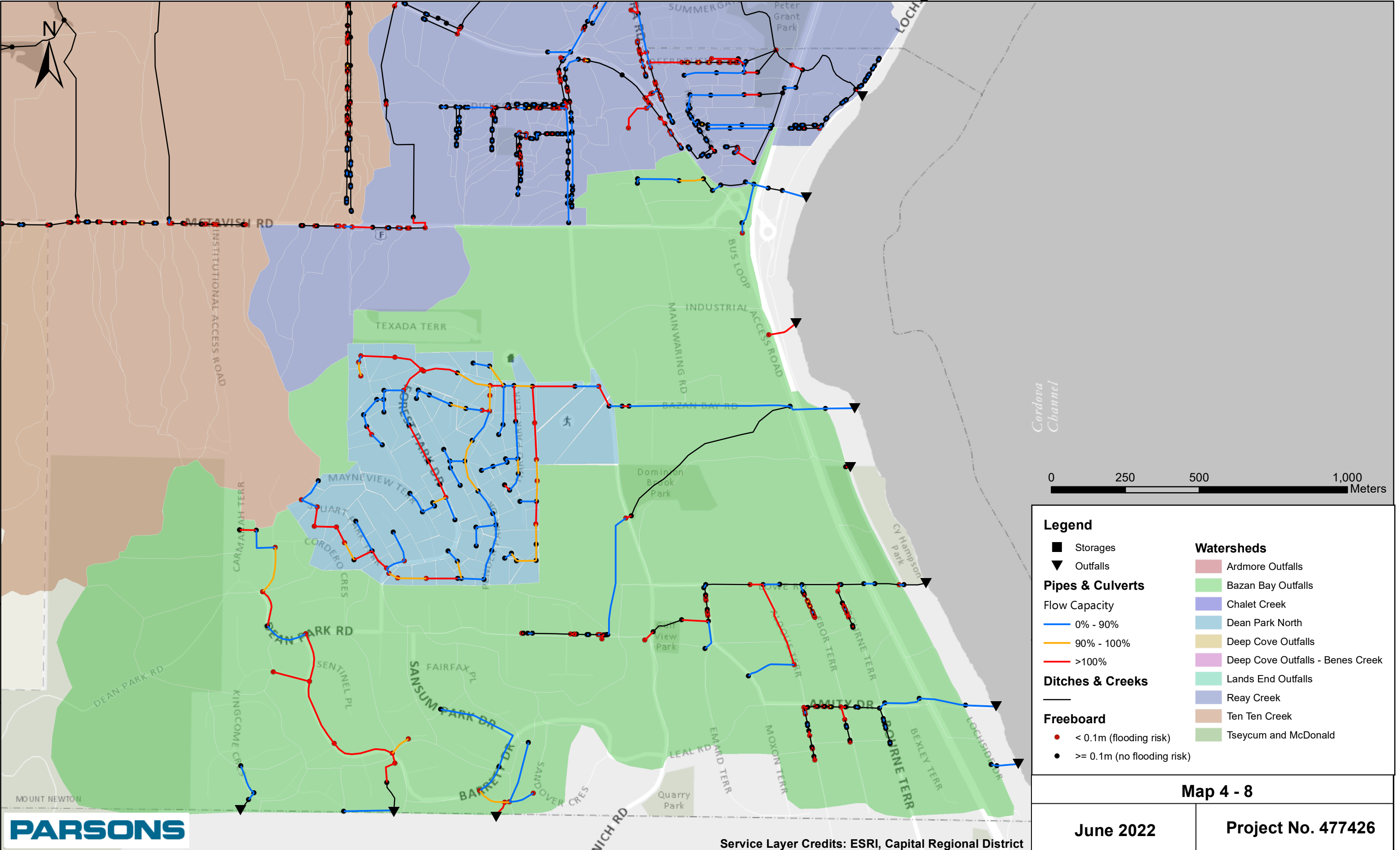
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25 Year Storm Event with Climate Change



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North Saanich Drainage Master Plan - Hydraulic Modelling Results - Future Scenario (Major System)
25 Year Storm Event with Climate Change



Coordinate System: NAD 1983 CSRS UTM Zone 10N
Datum: NAD83 Canadian Spatial Reference System



APPENDIX C

Stakeholder & Interest Group Engagement Summary – Round 1: Issues & Opportunities (Lanarc Consulting)



MEMORADUM

Date: November 30, 2021

To: Ben Martin, P.Eng., Director of Infrastructure Services, District of North Saanich

Cc: Adrian Corlett, P.Eng., Technical Lead, Parsons; Bob Lilly, Landscape Architect and Engagement Consultant, Lanarc

From: Kristen Falconer, Engagement Consultant, Lanarc

Re: District of North Saanich, Drainage Master Plan and Tseycum Creek Integrated Stormwater Management Plan: Round 1 Stakeholder and Interest Group Engagement

INTRODUCTION

The following memorandum provides a summary of key themes and input for consideration from Round 1 of the stakeholder and interest group engagement process for the District of North Saanich's (District's) Drainage Master Plan (DMP) and Tseycum Creek Integrated Stormwater Management Plan (ISMP).

Round 1 of the engagement process occurred from May 2021 to October 2021 to introduce the Tseycum Creek ISMP project to the community and understand stakeholder, interest group, and local First Nations perspectives on issues and opportunities in the Tseycum Creek watershed. Input was considered, along with further technical analysis and feasibility, to develop the draft ISMP. Round 1 engagement also provided participants with an update about the Drainage Master Plan as information only as a concurrent process to the ISMP.

Detailed meeting notes that provide a record of discussion from the meetings are provided in **Attachment A**. Feedback has been incorporated into this summary.

ROUND 1 ENGAGEMENT PROCESS

Outreach Tools

Outreach materials included:

Outreach Tool	Description
Web Content	Project page on Connect North Saanich: project identity, overview, process, project sign-up, relevant background documents, and questions and comments
Study Area Map	Overview map of the Study area within the context of the District and other watershed areas
Utility Bill Notice	Content announcing the process in the mailout through the May utility billing newsletter cycle in May 2021
FAQs	Content developed as questions and answers on the project webpage
E-Notifications	Emails distributed to Connect North Saanich's 600 subscribers; tailored stakeholder and First Nations e-notifications distributed by District
Social media content	Content developed for District distribution on an 'as needed' basis
Stakeholder Letter / Property Owner Mailout	Hardcopy letter with Study area map distributed to local stakeholders / property owners (~190 properties) in August 2021
Calls / email communication	Communication on an 'as needed' basis throughout Round 1 to respond to stakeholder queries and communication

Engagement Activities

Online Meetings

Due to the COVID-19 pandemic, engagement with stakeholders, interest groups, and local First Nations was carried out in an online format. The following online meetings occurred:

Meeting	Stakeholder or Interest Group	Date and Time
Meeting #1	Community and Environmental Stakeholders	July 20, 10:00 am – 11:00 am
Meeting #2	Tseycum First Nation	July 21, 10:00 am – 11:00 am
Meeting #3	Pauquachin First Nation	August 5, 9:00 am – 10:00 am
Meeting #4	WSÁNEĆ Technical Advisory Committee	August 24, 11:00 am – 12:00 pm
Meeting #5	Victoria Airport Authority	July 21, 9:30 am – 10:30 am

In addition to the above meetings, there were also several District-led technical meetings including the Ministry of Transportation and Infrastructure (July) and other local government and agencies as needed.

Online meetings included an overview presentation and discussion for participants to have a dialogue about key issues and opportunities in the Tseycum Creek watershed. Meetings were 1.0 hours in duration and were delivered using Zoom, an online meeting platform. Materials included a meeting agenda, PowerPoint presentation, speaking notes, and notes summary (see **Attachment A**).

Site Visits

Public outreach included notification through the public via utility bill newsletter in May 2021, online content, and a stakeholder/property owner letter in August 2021 to gauge interest in the process and welcome communication about issue and opportunities. As a result of public outreach, site visits and discussions with individual property owners were conducted by the District Project lead.

Site visits included the following:

Site Visit Location	Date
Vicinity of 10287 Wilson Road	July 26
Vicinity of 1340 and 1435 Wain Road	July 21
Vicinity of 1420 Munro Road	September 10
Vicinity of 1390 Munro Road	September 10
Vicinity of 1346 Munro Road	September 10
Vicinity 1401 John Road	September 10
Tseycum First Nation	August 4

The District recorded comments through site notes to provide a record of the site visits and feedback has been incorporated into this summary.

Written / Phone Submissions

Members of the public could also submit written questions or comments online through Connect North Saanich's project page or the District's Project email address. The District also received phone calls and other general written submissions related to flooding events in November and December 2021. Feedback has been incorporated into this summary.

WHAT WE HEARD

The following section summarizes what we heard from input received during Round 1. Please see Attachment A for a detailed summary of meeting notes.

Theme	Consideration
Background Information and Data	▪ Peninsula Streams » Water quality and water quantity data starting from 1998 » Relationship with Tseycum First Nation based on work over the last 20 years ▪ Sandown Centre » Partnership with University of Victoria for environmental research » Ecological / biological information (e.g., riparian/wetland areas, invasive management, and soil quality) » Water quality monitoring since November 2020 (bi-weekly) which have identified that the water quality is poor with high nitrates, phosphorus, and elevated coliform. ▪ Tseycum First Nation » Tseycum First Nation staff biologist can share findings of recent work ▪ Pauquachin First Nation » Consider engaging with local First Nations fishermen to provide historical knowledge ▪ External » Contact Brian Green, Director of Planning at District of North Saanich to obtain information from Modus Consulting about watershed health input as part of Official Community Plan (OCP) planning process » Refer to previous work from former District of Saanich Director of Engineering's work, for opportunities regarding stormwater detention » Reach out to Trailmark Research and Consulting if need information to develop historic baseline (if assumptions not adequate) and review surveyor sketch from 1852 which notes significant features (appended to notes)
Issues – Site Specific	Properties ▪ 1341 to 1393 John Road – seasonal flooding on properties ▪ 1401 John Road – seasonal flooding on property: » Pond flows to 1420 Munro towards creek (not shown on GIS) » Unable to use eastern part of property in winter due to seasonal flooding ▪ 1346 Munro Road – seasonal flooding on properties: » Existence of an old concrete drain cap at highway » Seasonal flows into creek but generally does not overbank » No ditch maintenance at municipal boundary into Tseycum Creek » Concern with fir (near 8m pipe) becoming undermined under creek bank ▪ 1390 Munro Road - seasonal flooding on properties: » 1.8 m pipe and driveway culverts

-
- » Creek flow generally does not overbank although there is a minor area to the south of the property which experiences flooding
 - » Creek on site recently cleared of vegetation
 - **1402 Munro Road** – seasonal flooding on property
 - **1420 and 1421 Munro Road** – localized flooding during seasonal rain events:
 - » Eastern area of the property seasonally floods at the ditch and across the road into the 1421 Munro Road property
 - » Concern about the 600 mm capacity corrugated steel pipe (CSP) that flows under the road culvert
 - » No ditch/shallow on the north side of the road at 1420 Munro Road
 - » Existing drainage ditch is sized ~4'W x 5'H

Tseycum First Nation

- **Tseycum First Nation Community Centre** - new community centre foundation is installed but there are issues with water (despite dewatering) during construction
- **Tseycum First Nations** – 48 residential homes on the reserve:
 - » **1292, 1302, 1312, and 1322 Sunbird Crescent** – flooding north of properties
 - » **10435, 10429, 10417, 10435, and 10415 West Saanich Road** - properties have sumps due to flooding issues
 - » **1180, 1190, 1194, 1200, 120, 1220, and 1230 Totem Lane** - near municipal boundary is an area of seasonal flooding; there is an 1800mm culvert on the reserve (see map attached to site visit notes)
 - » **Totem Road / Wilson Road / Munro Road / West Saanich Road** - north-south ditch east of reserve experiences very low water flows impacting salmon habitats due to development of properties upstream of Tseycum Creek
 - » **North boundary of Tseycum First Nation** - east-west drainage ditch along the chain-link fence and off John Road has historic drainage that flows to Wain Road; not actively monitored
- **Bazan Bay Neighbourhood** has an easement that runs north/south between Mainwaring Rd. and Marshall Rd. that is supposed to function as stormwater runoff/catchment but does not function well as both streets experience major surface water issues in the winter months (potentially due to runoff from Dean Park due to the topography)
- **Hospital Hills to Airport** – a spring contributes to stormwater management issues
- **Brackenhurst Farm** – issues with water quantity:
 - » Irrigation pond collects rainwater and overflows into the main drainage ditch in winter, and water flows out at Wilson Road
 - » Southwest corner of the property cannot fully drain due to the topography
 - » Water from Eagle Ridge drains onto both properties creating seasonal flooding

Issues

Soil Quality and Erosion

- Soil erosion into creek increases sediment in stream (and into Patricia Bay) impacts sensitive habitats
 - Soil erosion especially along the highway
 - Clay soil conditions make the area susceptible to flooding
-

Archaeological / Cultural

- Presence of an unmarked cemetery that is at risk due to erosion
- Remains under the provincial highway which goes through Tseycum First Nation
- Archaeological sites along the highway and at the beach (based on historical photos)

Rights-of-way

- Drainage infrastructure situated on both public and private lands can be a challenge for development (e.g., rights-of-way)

Water Quality

- Contaminants mix with stormwater and flow into the ocean which can impact sensitive habitats (e.g., Coles Bay); there is a desire for an improvement of conditions as local communities depend on habitats for shellfish harvesting which provide a food source
- Desire for more transparency on stormwater impacts on local shellfish habitats
- Concerns about cumulative impacts of septic contamination on environmental habitats
- Concerns about beach closures as a result of water quality impacts
- Swimming pool chlorine drains into the watershed and negatively impacts environment even with newer pool technologies

Agricultural Impacts

- Agricultural practices (e.g., manure, fertilizer) are impacting sensitive environments in local water courses

Resources and Coordination

- Tseycum First Nations has limited resources, funding, and capacity constraints to deal with stormwater management issues although is retaining support
- Tseycum First Nations has challenges coordinating with multiple jurisdictions and bylaws

Opportunities – Site Specific

- **1346 Munro Road** – property owner would consider an easement
 - **1390 Munro Road** – property owner would consider an easement and creating of storage/detention pond at east of property and north of creek
 - **1401 John Road** – property owner would consider an easement and enlarging existing pond on property
 - **1420 Munro Road**
 - » Property owner would consider an easement
 - » Property owner is open to creating detention pond bordering property (see map)
 - » Consider mitigation to alleviate flooding using stormwater drainage into creek (under road and into 1420 Munro to flow away from Munro Road)
 - **10287 Wilson Road**
 - » Munro Road side of property potentially available for a statutory right-of-way (SRW) for detention purposes
 - » An approximate 1.5 m deep ditch (historically connected to Sandown Centre) exists at properties between 10375 and 10335 Wilson Road
-

-
- **Between John Road and Wain Road (at Tatlow Road)**
 - » Strata property west of Wain Road and Tatlow Road intersection (near pond)
 - » 10" culvert connects from strata southwest
 - » East of pond future planed retention pond
 - » A ditch between the properties maintained by strata
 - **John Road and Wilson Road**
 - » Winter flooding experienced north of John Road (just west of intersection of Wilson Road and John Road) and the area is available for possible SRW for retention purposes
-

Opportunities

Vision and Goals

- Ensure ISMP focus is equally concerned about environmental aspects as well as pipe infrastructure
- Promote sustainable practices to minimize impacts on the watershed especially in terms of environmental services (i.e., "giving back" to the natural environment)

Mitigation Planning

- Consider strategies to improve summer base flows (and protection of springs) so water can reach lower creeks around Hospital Hill and Munro Road
- Address site specific issues
- Consider options for storage capture and release (e.g., wetland areas, stormwater detention ponds.
- Mimic natural processes and infiltration to reduce contaminants and ensure water quality in the bays vs. piping solutions

Environmental Enhancement

- Consider environmental strategies to enhance fish habitat in Tseycum Creek
- Increase environmental enhancement and stream restoration projects

Best Management Practices

- Promote best management practices for agriculture
- Enhance soil coverage and soil quality in select areas to improve infiltration to slow water and improve water quality

Local Coordination and Communication

- Enhance relationship building and cooperation so Tseycum First Nation can understand stormwater impacts, diversions, local irrigation practices, and District goals
 - Support local community goals for public education about local habitat areas (e.g., riparian resources, local medicines in local curriculums)
 - Consider potential servicing agreements with Tseycum First Nation (i.e., Memorandum of Understanding) to coordinate on stormwater planning and infrastructure development to ensure outcomes do not negatively impact Tseycum lands)
 - » Clearly outline roles and responsibilities and other administration
 - » Clearly outline land use and erosion impacts (e.g., reserve, highway, waterfront etc.)
-

Future Planning Processes

- Consider restorative planning to mitigate contamination in ocean outflows such as Coles Bay (e.g., fecal coliform and E. Coli contaminants) to revitalize shellfish habitats
 - Incorporate solutions for marine environment and foreshore in planning
 - Consider multijurisdictional collaboration and policy development for septic monitoring and testing to protect waterfront health, especially during drier periods
-

NEXT STEPS

Round 2 of the engagement process will focus on engaging participants to share back what we heard during Round 1 engagement and provide an update about the Drainage Master Plan and Tseycum Creek ISMP process and draft plan recommendations. A public update will be provided online.

At the conclusion of Phase 2, a Final Engagement Summary will be prepared and posted online.

KEY THEMES

ISSUES

- ▶ Existing clay soil conditions and low-laying areas that contribute susceptible flooding areas
- ▶ Climate change impacts (hotter, drier summers and wetter winters)
- ▶ Site specific issues (e.g., seasonal flooding and erosion on both public and private property)
- ▶ Archaeological and cultural impacts due to flooding and erosion
- ▶ Water quality impacts due to development, agricultural practices, and low base flows
- ▶ Impacts to habitats and environmentally sensitive areas
- ▶ Limited resources and capacity
- ▶ Lack of coordination among multiple jurisdictions
- ▶ Size of existing assets and concerns about maintenance
- ▶ Managing issues on private property (rights-of-way)

OPPORTUNITIES

- ▶ Address seasonal flooding (e.g., through mitigation measures such as detention ponds or easements for infrastructure)
- ▶ Mimic natural processes to the extent possible
- ▶ Balance environmental focus with infrastructure focus in vision
- ▶ Promote best management practices to minimize watershed and habitat impacts
- ▶ Promote sound agricultural practices
- ▶ Conduct watershed monitoring and testing
- ▶ Foster relationship building and cooperation within the community
- ▶ Understand roles and responsibilities among jurisdictions for planning and policy development
- ▶ Enhance public education and communication
- ▶ Understand background data and precedents
- ▶ Consider future planning processes

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - ENVIRONMENTAL + COMMUNITY STAKEHOLDERS - JULY 20, 2021

MEETING NOTES

Meeting:	Phase 1: Understanding Issues and Opportunities for the Tseycum Creek Integrated Stormwater Management Plan (IMSP) – Community & Environmental Stakeholders
Date:	Tuesday, July 20
Time:	11:00 am – 12:00 pm
Location:	Zoom Online Meeting
Attendees:	Stakeholders: Ian Bruce (Peninsula Streams), Jennifer Atkins (Sandown Centre), Dave Aylard and Jody Aylard (Brackenhurst Farm) District of North Saanich: Ben Martin, Becky Roder, Boahan Duan, Parsons Engineering: Adrian Corlett, Bastian Johnen, Phil Lobo Lanarc: Bob Lilly, Kristen Falconer
Regrets:	Jen Rashleigh (Sandown Centre)

NOTE: If there are any discrepancies or inconsistencies with the below discussion items, please contact LANARC.

ACTION ITEMS

Item	Action	Responsibility
1	Project team to review and confirm inclusion in the model: east-west drainage ditch at the north boundary of Tseycum reserve (along the chain-link fence and off John Road) and potential opportunities for District maintenance.	Parsons
2	Project team to refer to Patrick O'Reilly's, former District of Saanich Director of Engineering's work, for opportunities for stormwater detention in area.	Project Team
3	Coordinate a site visit to Brackenhurst Farm.	District COMPLETE

DISCUSSION SUMMARY

The following notes are paraphrased with the intent of capturing the questions and comments raised by meeting participants during the Phase 1 stakeholder meeting (Community and Environment Stakeholders) for the project:

Item	Comment
Welcome & Introductions	
1	- BM welcomed participants to the meeting with a land acknowledgement. - KF led a round of introductions: - IB from Peninsula Streams is pleased to see this initiative having been involved in Tseycum since 1998.

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - ENVIRONMENTAL + COMMUNITY STAKEHOLDERS - JULY 20, 2021

Item	Comment
	» JA is an ecological coordinator from Sandown Centre, biologist, and graduate student at University of Victoria. Sandown has a long-term lease on the land and supports Peninsula's Streams and others for leading initiatives for watershed improvement and water supply for 3 specific sites since Nov. 2020. » JA has 68 acres of farmland (Brackenhurst Farm) immediately north of the Tseycum Reserve. » DA owns and operates a 1930s dairy farm as a 9th generation family member.
Introductory Presentation	
2	▪ KF/BL introduced the project including what an integrated stormwater management plan (ISMP) is; the District's watershed areas; and the engagement process. ▪ AC provided a background about the concurrent Drainage Master Plan and outlined goals and objectives of the District's plan for Tseycum Creek watershed.
Group Discussion	
3	Background Data (Peninsula Streams) ▪ IB said he has water quality and water quantity (discharge) data starting from 1998 and has worked with Tseycum First Nation over the last 20 years. IB said Tseycum First Nations are providing great stewardship of their lands. ▪ IB is aware of previous District watershed studies (2008-2009). ▪ IB noted there is a spring from Hospital Hill to Airport and stormwater management issues. Issues and Opportunities (Brackenhurst Farm) ▪ DA said his property drains into the main drainage ditch, but water flows out at Wilson Road. The southwest corner of the property is unable to fully drain due to the topography so it will need a deeper drainage. ▪ DA said Jody's portion has an irrigation pond, which is a quarry that collects rainwater and overflows into the ditch in winter. ▪ DA said Eagle Ridge's stormwater drains between the two properties including the ditch and onto neighbouring driveways. » BM said the intent of the Drainage Master Plan is to help resolve current issues. Property Owner Engagement ▪ JA/DA said other local landowners experience winter flooding and that engagement should include these property owners. » BM noted he will consider more engagement with property owners noting that the studies will provide an allowance for more intense rainfall and higher outfalls in Patricia Bay as a result of climate change. Assets on Both Public & Private Land ▪ JA asked how the study will deal with drainage infrastructure that is on a combination of public and private lands? For example, there is a culvert on the south and west of her property and exits to Patricia Bay. The drainage is grandfathered in and runs parallel to Wain Road. » AC said the study is reviewing both major (>900 mm diameter) and minor (<900 mm diameter) systems starting with the major system and bigger pipes, what flows from each area, and how it exits. ▪ JA asked if open ditches are included in the study. » AC confirmed yes; there will be some survey work but not for all drainage ditches, just the typical ones and how they capture flows. ▪ DA asked about the east-west drainage ditch at the north boundary of Tseycum reserve (along the chain-link fence and off John Road) which is the historic drainage that flows to Wain Road and if it was included in the model. There used to be a nursery at that location (Wain Road and West Saanich Road). The ditch is not actively monitored and is an opportunity for the District to maintain.

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - ENVIRONMENTAL + COMMUNITY STAKEHOLDERS - JULY 20, 2021

Item	Comment
	» KF noted Parsons will review and confirm. » BM noted issues on private property can be a challenge for the District to address, especially when property owners have different needs; however, the Project team will flag this issue. » AC added that some properties are situated on low-lying lands and are susceptible to flooding. » BM suggested a site visit to Brackenhurst Farm. Environmental Aspects in the ISMP ▪ IB is concerned that the focus for the ISMP is on pipes and not environmental aspects. Focusing on environmental aspects is equally important to bring salmon back to watercourses which has been successful in Tseycum Creek based on work in recent years. ▪ IB noted the District of Central Saanich took 12 years to include environmental aspects as opposed to focusing on pipe infrastructure. Is development driving this current initiative? Key Issues and Opportunities (Peninsula Streams) ▪ IB said the largest issue is the north-south ditch, east of the reserve: Totem Road / Wilson Road / Munro Road / West Saanich Road (square). IB said houses upstream of Tseycum Creek dug a ditch so water flows are now very low, and salmon cannot survive. Historically, the creek is deep at 6-7 m below grade so bringing it back to the way it was (as a swamp) could bring salmon back. ▪ IB noted that the Aylards are doing well with stewarding their manure. ▪ IB said a recommended approach is to look for storage opportunities such as stormwater detention in the area (refer to Patrick O'Reilly's, former District of Saanich Director of Engineering's work). » Project team noted there are storage opportunities; however, right-of-way is a challenge. Could properties give up land? How would compensation work? Is there funding available? » Project team said it is important to understand how best to address water quality and quantity issues, for example, there are issues with management of manure and irrigation which impact water quality. ▪ IB asked how the District can improve summer base flow to protect the springs so water can reach the lower creeks around Hospital Hill and Munro? Currently, there are low flows but with a storage/release system there can be more protection. Key Issues and Opportunities (Sandown Centre) ▪ JAT said Sandown's interest in the watershed is from an ecological / biological lens. They understand the area has headwaters, two wetlands, and drainage channels from the creek. ▪ JAT said Sandown has partnered with University of Victoria to research the environment including soils. ▪ JAT said a recent bird survey identified a rare species is nesting in the wetlands. ▪ JAT said they have carried out bi-weekly water quality monitoring since November 2020 and have identified that the water quality is poor with high nitrates, phosphorus, and elevated coliform. ▪ JAT said there are issues with soil eroding into the creek and into Patricia Bay but improving soil coverage, soil quality, and infiltration can slow water so as it does flow through the forest, water quality improves.
Next Steps	
4	▪ BM said the District is focused on two major deliverables: sustainable infrastructure improvements over the next 5-10 years and long-term management and improvements of existing infrastructure. ▪ KF provided a summary of the next steps in the project process as well as contact information.

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - TSEYCUK FIRST NATION - JULY 21, 2021

MEETING NOTES

Meeting:	Phase 1: Understanding Issues and Opportunities for the Tseycum Creek Integrated Stormwater Management Plan (ISMP) – Tseycum First Nation
Date:	Wednesday, July 21
Time:	11:00 am – 12:00 pm
Location:	Zoom Online Meeting
Attendees:	Tseycum First Nation: Karen Harry (Indigenous Consultant for Tseycum First Nation) District of North Saanich: Ben Martin, Boahan Duan Parsons Engineering: Adrian Corlett, Bastian Johnen, Phil Lobo Lanarc: Bob Lilly, Kristen Falconer
Regrets:	Kristen Bill and (Tseycum First Nation – Band Administrator and Economic Development Contact), Tanya Jimmy (Chief)

NOTE: If there are any discrepancies or inconsistencies with the below discussion items, please contact LANARC.

ACTION ITEMS

Item	Action	Responsibility
1	District to schedule a site visit to Tseycum First Nation to walk the creek and key sites to better understand issues and opportunities.	District (BM) COMPLETE
2	KH to share findings with the District from Tseycum First Nation biologist following their upcoming site visit.	Tseycum First Nation (KH)

DISCUSSION SUMMARY

The following notes are paraphrased with the intent of capturing the questions and comments raised by meeting participants during the Phase 1 meeting (Tseycum First Nation) for the project:

Item	Comment
Welcome & Introductions	
1	- BM welcomed participants to the meeting with a land acknowledgement. - KF led a round of introductions: - Ben explained he is new to his role at the District of North Saanich (District) and emphasized the importance of the Integrated Stormwater Management Plan (ISMP) for Tseycum Creek. - KH is an Indigenous consultant for Tseycum First Nation (Tseycum) on behalf of Kristen Bill, Band Administrator and Economic Development Contact and Chief Tanya Jimmy who send their regrets.

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - TSEYCUK FIRST NATION - JULY 21, 2021

Item	Comment
Introductory Presentation	
2	▪ KF/BL introduced the project including what an ISMP is; the District's watershed areas; and the engagement process. ▪ AC provided a background about the concurrent Drainage Master Plan (DMP) and outlined goals and objectives of the District's plan for Tseycum Creek watershed including best management practices.
Group Discussion	
3	Issues and Opportunities (Tseycum First Nation) ▪ KH provided the following comments: » Tseycum's main interests are to stop flooding in homes, revitalize the creek, and better understand stormwater diversions and District intent. » "Tseycum" means "land of clay" in the local Indigenous language which is indicative of the local soil conditions in the area. » Tseycum is 66 acres with 250 members and 48 homes on the land. » A \$3.9 m building with a gymnasium, childcare centre, and community kitchen is being developed. Land was excavated and dewatered, and a foundation put in place for the site four weeks ago, however, there are water issues they are trying to understand. » It is challenging to construct buildings on clay and buildings can experience flooding, so an ongoing interest is to better understand diversion. There are numerous farms around Tseycum that undertake irrigation practices. » Local areas such as Victoria Airport, Swartz Bay etc. were historic lands and the tribe was uprooted from these lands and are settled in Tseycum and Union Bay IR #4. » Tseycum is often overlooked for funding due to its small size, so the band has challenges with resources and capacity. » Tseycum is retaining planning support to assist with stormwater management. Currently, there is a construction hole filled with water and a funding application out for a drainage project. » Tseycum is interested in stream enhancement projects and potential habitat education in local curriculums. The riparian area is a beautiful walkway that is rich with traditional medicines. » Clam beds are the main food source harvested and there is hope that this resource can be revitalized as per Tseycum's strong local belief and traditional knowledge: "when the tide is out, our table is set". » It is challenging for Tseycum to deal with multiple jurisdictions and bylaws, e.g., local government and agencies; provincial organizations such as Ministry of Transportation and Infrastructure (MoTI); and federal bodies such as Department of Fisheries and Oceans (DFO), Transport Canada, Victoria Airport Authority, etc. Reconciliation is an ongoing process. » Tseycum is interested in potential servicing agreements with the District. Tseycum is interested in a Memorandum of Understanding (MOU) regarding any diversions to the creek and outflow pipes that could potentially impact Tseycum lands so Tseycum can understand how and why water diverts. » There is a bus stop on Tseycum land that was determined by a handshake agreement; however, Tseycum wants to move away from agreements like this and have proper management and administration to formalize a MOU between the District and Tseycum First Nation. » Erosion is an issue especially near the highway and there is an unmarked cemetery that is at risk. » There are human remains under the provincial highway which goes through Tseycum First Nation, and there are archaeological sites along the highway and beach (historical photos support this). » In working towards a draft MOU, it will be important to clearly outline administration, erosion (bank erosion is well-documented), and provincial highway impacts on the waterfront. » It is hoped that the ISMP will address specific sites, habitat /clam impacts, where flooding areas are, stream and environmental enhancement, and best management practices especially for agriculture.

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - TSEYCUK FIRST NATION - JULY 21, 2021

Item	Comment
	» There is interest in potential options for wetland areas / stormwater detention ponds.
Next Steps	
4	▪ Ben would like to walk the creek and impacted lands to gain a better understanding of the issues and opportunities. ▪ BD agreed that a site visit will be important. ▪ BJ noted that fish population was reported in 2003 in the Tseycum Creek and that the current study will help understand why there may be impacts to the fish habitat. ▪ KH said that Tseycum First Nation has a biologist on staff that will undertake a site visit shortly and that Tseycum can share any findings. ▪ KH offered to provide contacts from the other local Indigenous communities for engagement. ▪ KF provided a summary of the next steps in the project process as well as contact information.

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - PAUQUACHIN FIRST NATION - AUGUST 5, 2021

MEETING NOTES

Meeting:	Phase 1: Understanding Issues and Opportunities for the Tseycum Creek Integrated Stormwater Management Plan (IMSP) – Pauquachin First Nation
Date:	Thursday, August 5, 2021
Time:	9:00 am – 10:00 am
Location:	Zoom Online Meeting
Attendees:	Pauquachin First Nation: Martin Louis (Marine Liaison) District of North Saanich: Ben Martin, Boahan Duan Parsons Engineering: Adrian Corlett Lanarc: Bob Lilly, Kristen Falconer
Regrets:	Herman Henry, Darlene Henry, Maureen Tommy (left), Shawnee (Pauquachin Administrator)

NOTE: If there are any discrepancies or inconsistencies with the below discussion items, please contact LANARC.

ACTION ITEMS

Item	Action	Responsibility

DISCUSSION SUMMARY

The following notes are paraphrased with the intent of capturing the questions and comments raised by meeting participants during the Phase 1 meeting for Pauquachin First Nation for the project:

Item	Comment
Welcome & Introductions	
1	▪ BM welcomed participants to the meeting with a land acknowledgement. ▪ KF led a round of introductions: » ML is the Marine Liaison for Pauquachin First Nation (Pauquachin) and has been in the role for the last year. Pauquachin must be at the table to work in partnership with the District on initiatives. » ML said “Pauquachin” means “people of the land of cliffs and bluffs” and they are stewards of the watershed. » ML said sustainability to minimize impacts on the watershed is a key interest for the community. It is important to “give back” to the natural environment. » ML said he grew up in Vancouver and in the District of North Saanich (District) and Pauquachin is his mother’s territory. He appreciates the opportunity to voice concerns and learn about projects.

**DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - PAUQUACHIN FIRST NATION - AUGUST 5, 2021**

Item	Comment
Introductory Presentation	
2	▪ KF/BL introduced the project including what an integrated stormwater management plan (ISMP) is; the District's watershed areas; why an IMSP; and the engagement process. ▪ AC provided a background about the concurrent Drainage Master Plan (DMP) and outlined goals and objectives of the District's plan for Tseycum Creek watershed and what will be considered in the planning process such as climate change impacts like flooding and heat waves.
Group Discussion	
3	▪ ML referred to Musqueam First Nation that has native salmon returning and spawning on their lands which could be a precedent for the District. » BM noted that Reay Creek has seen the re-introduction of salmon; however, he understands that there are no summer flows in Tseycum Creek and no fish habitat. » BM said around Pauquachin First Nation, stormwater outflows from Salmon Brook into Coles Bay. » BM said Tseycum area is the lowest elevation of the district with clay soils that have little capacity to absorb seasonal rains, so the area has faced challenges with water quantity from some time. ▪ ML said his focus is Coles Bay and he supports the Marine Dept. with efforts to improve conditions. Pauquachin's main concern is always water quality. ▪ ML asked if there will be compensation for impervious development impacting the reserve. » AC said there is no net increase of stormwater flows; the goal is not to increase impervious areas. » KF noted that the ISMP will include best management practices such as rain gardens and permeable pavers to encourage impervious areas for existing development. » AC said water needs places to "sit" and settle – the more natural, the better. ▪ Project team asked if there is any available historical information that may help with the planning process. ▪ ML said the fishermen have strong local knowledge. ▪ ML asked about the District's sewer system, how it is integrated, and how it effects modelling. » BM said the sewage system is supposed to be a closed system with overflow that goes into the ocean. Increasing pervious areas can encourage infiltration especially during large rain events. The system only helps in part. » Ben understands that Pauquachin has a sewage pump station.
Next Steps	
4	▪ KF explained that the District's engagement process is ongoing during the project and to reach out if further questions or comments. ▪ KF explained the next steps in the process and shared the contact details for communications. ▪ ML said he appreciates the meeting and learned a lot about the purpose of the ISMP and process.

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - **WSÁNEĆ** - AUGUST 24, 2021

MEETING NOTES

Meeting:	Phase 1: Understanding Issues and Opportunities for the Tseycum Creek Integrated Stormwater Management Plan (IMSP) – WSÁNEĆ
Date:	Tuesday, August 24, 2021
Time:	11:00 am – 12:00 pm
Location:	Zoom Online Meeting (as part of WSANEC Meeting)
Attendees:	WSÁNEĆ Leadership Council (Technical Advisory Committee): Justin Fritz (WSANEC); Joni Olsen (WSÁNEĆ); Peter Evans (Advisor, Trailmark Research and Consulting); Donald Williams (Councillor, Tsawout First Nation); Tiffany Joseph (GIS Planner, WSÁNEĆ); David Dick (WSÁNEĆ); Dave Paul (Capital Regional District Liaison, WSÁNEĆ); Shauna Johnson (WSÁNEĆ); Gord Elliott (WSÁNEĆ); Will Morris (Technical Advisor, Tseycum First Nation) District of North Saanich: Ben Martin, Boahan Duan Parsons Engineering: Bastian Johnen, Phil Lobo Lanarc: Bob Lilly, Kristen Falconer
Regrets:	Parsons: Adrian Corlett WSÁNEĆ Leadership Council: Katelyn Beale; Rob Cliff; Tanya Jimmy (Tseycum First Nation); Annie Chalifour (Senior Aquatic Biologist, LGL); Eric Pelkey (WSANEC); Bruce Underwood (Coast Salish Employment and Training Society); Trevor Hamelin (Senior Environmental Protection Specialist, Ministry of Climate and Environment); Liz Archibald (Section Head, Municipal Liquid Waste Cranbrook, Ministry of Climate and Environment); Julie Porter (Environmental Impact Assessment Biologist, Ministry of Climate and Environment); Diane Sutherland (Acting Senior Environmental Impact Assessment Biologist, Ministry of Climate and Environment); Stanley Sam (Tsawout First Nation)

NOTE: If there are any discrepancies or inconsistencies with the below discussion items, please contact LANARC.

ACTION ITEMS

Item	Action	Responsibility
1	Contact Brian Green, Director of Planning at District of North Saanich to obtain information from Modus Consulting as part of Official Community Plan (OCP) planning process and comments from TAC regarding watershed health.	District (BM) for Project team
2	Confirm need for information to develop historic baseline (if assumptions not adequate) and reach out to Peter Evans if necessary for information.	District (BM) for Project team
3	Review early surveyor sketch from 1852 (attached) provided by Peter Evans noting locations of agricultural land (potato fields), the neighbouring flats, and a pond which has archaeological significance.	Project team

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCUK CREEK ISMP
STAKEHOLDER MEETING NOTES - WSÁNEĆ - AUGUST 24, 2021

Item	Action	Responsibility
4	Distribute a stakeholder letter to engage larger property owners for additional information and background knowledge.	- Lanarc to draft (KF) - District to review, approve, and distribute (BE) COMPLETE

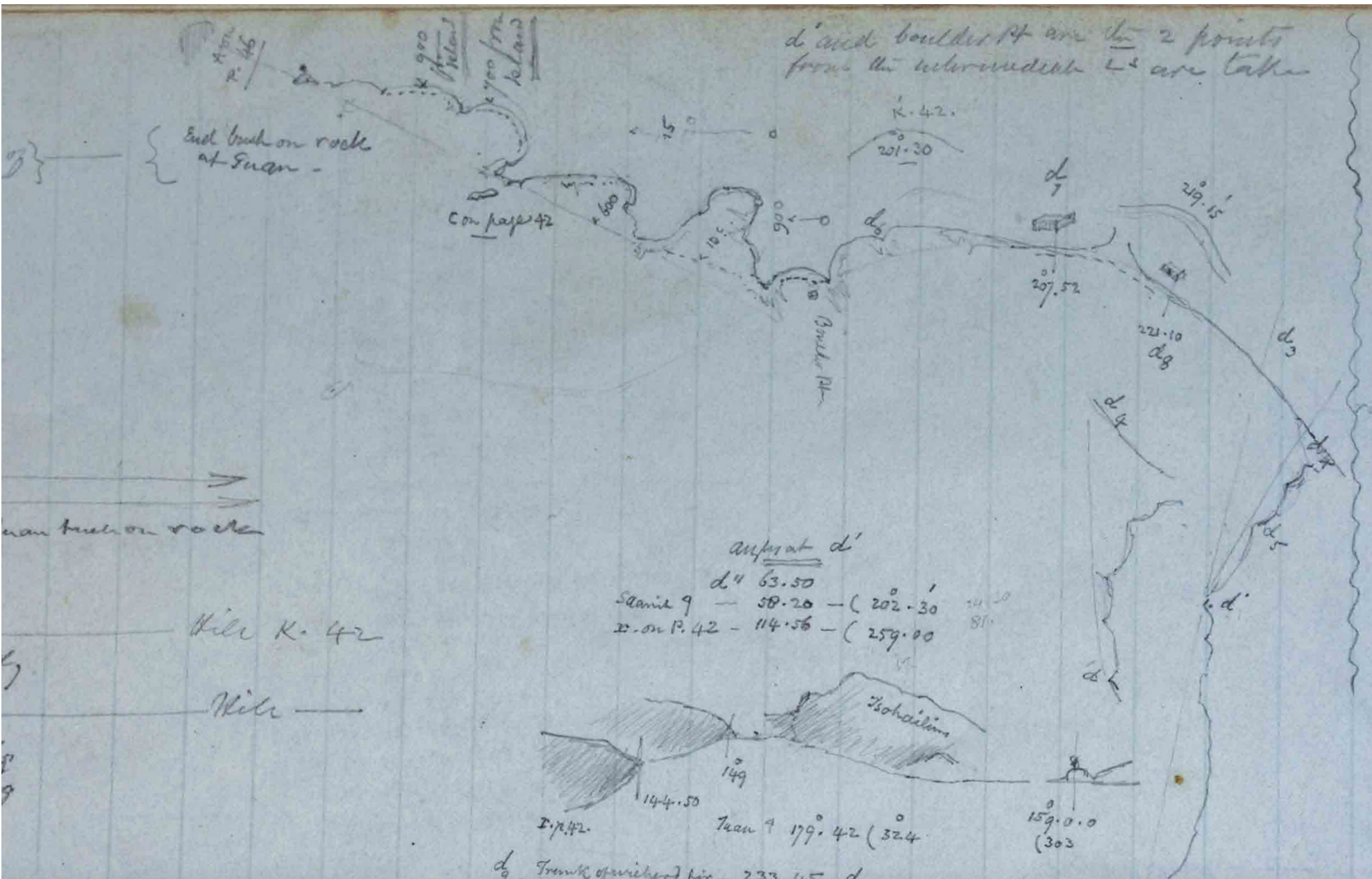
DISCUSSION SUMMARY

The following notes are paraphrased with the intent of capturing the questions and comments raised by meeting participants during the Phase 1 meeting for WSÁNEĆ for the project:

Item	Comment
Welcome & Introductions	
1	JF led a round of introductions for WSÁNEĆ Technical Advisory Committee (TAC) noting that they provide recommendations to chiefs and council.
Introductory Presentation	
2	- KF/BL introduced the project including what an integrated stormwater management plan (ISMP) is; the District's watershed areas; why an ISMP, and the engagement process. - PL provided a summary of the concurrent Drainage Master Plan (DMP). - BJ provided a background about the goals and objectives of the District's ISMP and plan for Tseycum Creek watershed noting that the ISMP intends to mimic the watershed prior to development.
Group Discussion	
3	Shellfish Harvesting, Septic Contamination, and Beach Closures - TJ asked about stormwater impacts to clam beds and if this will be addressed in the ISMP. - TJ said the closure of shellfish harvesting is significant – there is a desire for more transparency on this topic as this impacts the way of life for many First Nations and is of great concern. - BM noted the water and land use designations of North Saanich but acknowledged the effects of stormwater and trying to minimize impacts. - JO said since the 1800s, industrial development has impacted harvesting. What role will the ISMP play in septic contamination and beach closures? - BM said harvest issues and closures are a great concern to the District. - JO said one or two septic systems can shut down a beach. The First Nations has legislated rights to harvest which supersede property owners' rights. - JO said cumulative impacts create semi-permanent closures which are a concern. More testing and septic monitoring through municipal policy is very important to protect the health of the beaches and watercourses, especially during drier periods. - JO acknowledged that access to harvesting is a complex topic and a multi-jurisdictional issue and why further conversation is needed. - BM said the District is addressing septic as some private property owners have raised the issue and there is evidence of local septic issues. Natural Processes - GE said mimicking natural processes and infiltration is important to ensure water quality in the bays as modern drainage systems create contaminants from industrial activities, airport, and ditch areas.

DISTRICT OF NORTH SAANICH DRAINAGE MASTER PLAN & TSEYCU CREEK ISMP
STAKEHOLDER MEETING NOTES - WSÁNEĆ - AUGUST 24, 2021

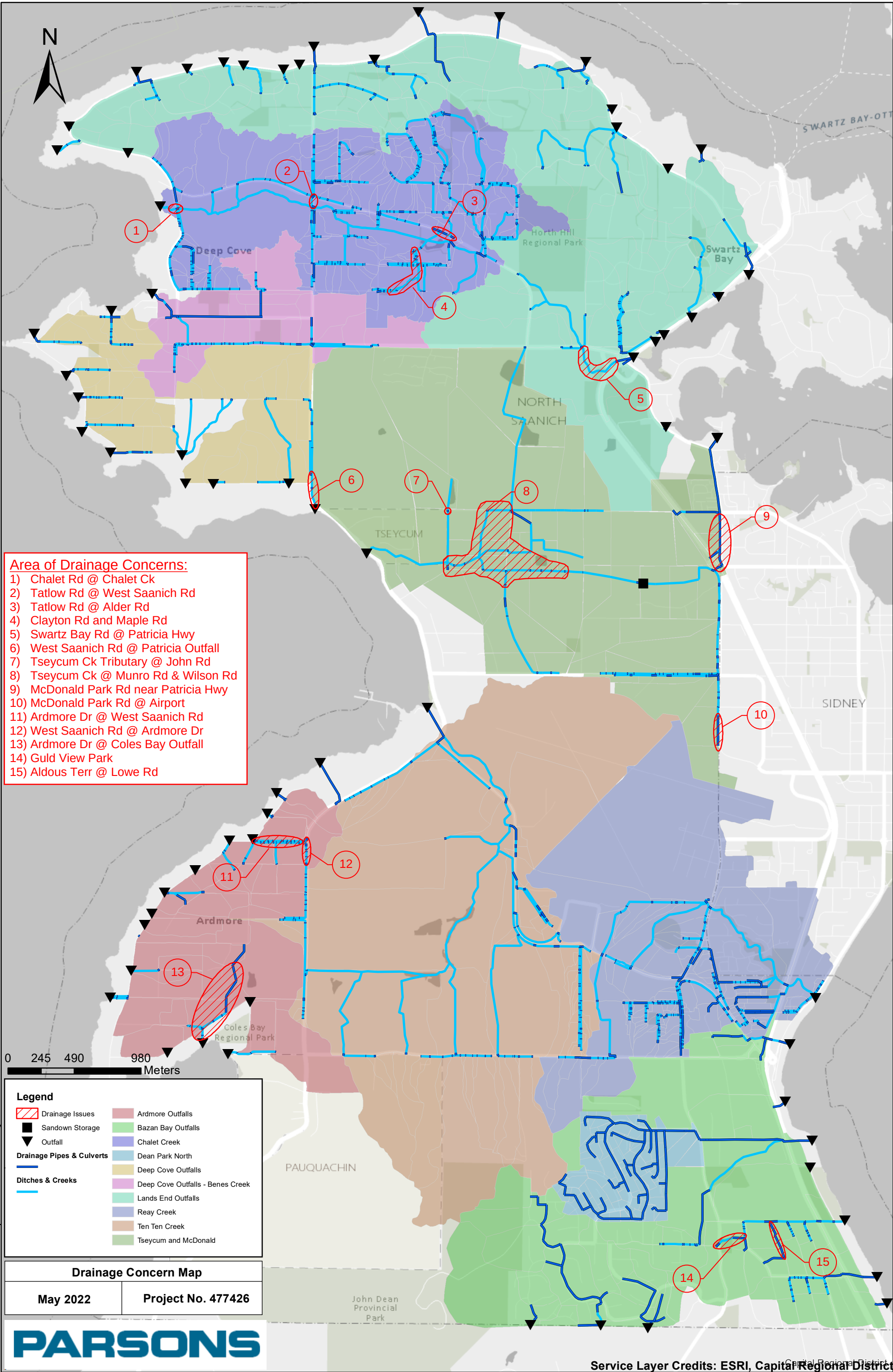
Item	Comment
	▪ GE said pollutants and piping are concerns for elders which have caused creeks to dry out and impact creek trout. The issue is a result of swimming pool chlorine which drains into the watershed. Even with some new approaches, contaminants still end up in creeks. ▪ GE asked how we can enhance our natural flows as he used to be able to wade across the creeks and now creeks have silted up due to drainage from modern living. Natural solutions are needed. » BM said the District prefers open bioswales to closed pipes systems. » BJ said low flow rates can have multiple benefits such as settling contaminants and longer irrigation through best management practices. » BJ said larger pipes mean faster waterflow whereas meandering creeks slow things down and encourage contaminants to be filtered out. The goal is not to balance (i.e., not build a system in a straight line to either create a bigger, faster flow or reduce flooding). Information Sharing ▪ JF said Modus Consulting is part of the District's municipal Official Community Plan process and it may be of benefit for the District to have a discussion and see if information Modus has collected can be shared. ▪ JF noted that the TAC has provided comments about the watershed for the OCP planning process. ▪ JF said Brian Green is the Director of Planning. ▪ TJ asked if the special biological framework has this been reviewed as input to the ISMP. » BM said yes and it has been discussed with Council. Baseline Information ▪ PE asked for the Drainage Master Plan if there will be an establishment of natural areas and if is there a historic baseline. He has a good based if not possible with assumptions. » BJ said space often constrains complete naturalization. ▪ PE said First Nations knowledge will be critical to establishing a baseline. First Nations Knowledge ▪ PE shared an early surveyor sketch from 1852 (attached) noting locations of agricultural land (potato fields), the neighbouring flats, and a pond which has archaeological significance (considered sacred and not just a swamp). ▪ PE said there is much to learn from First Nations and people in general suggesting a mailout to engage the larger property owners may be warranted. ▪ TJ said controlled burns can be a positive function of a watershed as the charcoal captures and holds water. Historical stewardship of these lands included burns. » BM said the District is looking for information on how to attain more First Nations knowledge for significant sites and other information as clay soils are very challenging.
Next Steps	
4	▪ KF provided a summary of next steps and contact information for providing further comments.



APPENDIX D

Areas of Drainage Concern Map

North Saanich Drainage Master Plan - Areas of Drainage Concern

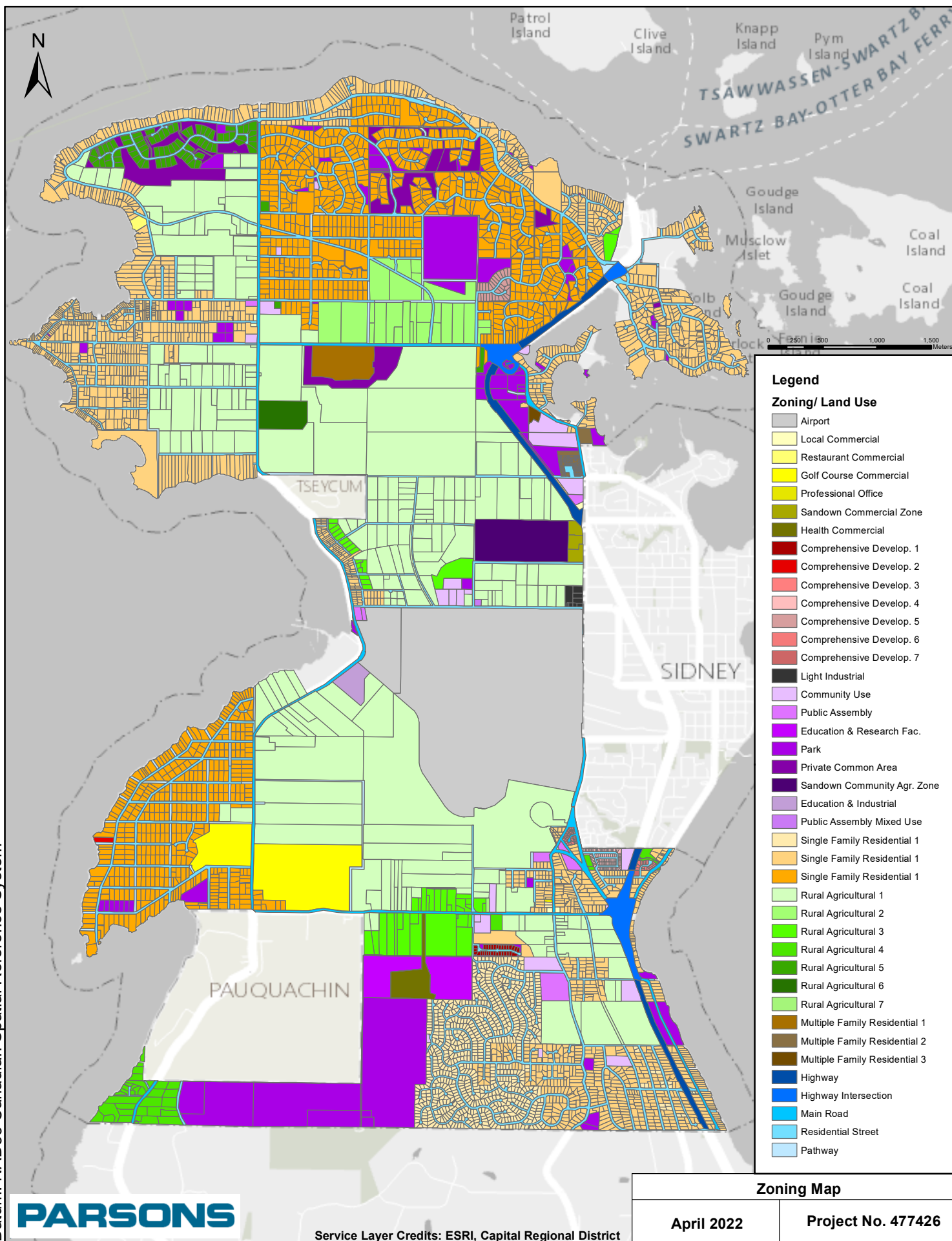


Coordinate System: NAD 1983 CSRS UTM Zone 10N
Datum: NAD83 Canadian Spatial Reference System

APPENDIX E

Zoning/Land Use Map

North Saanich Drainage Master Plan - Zoning/Land Use Map

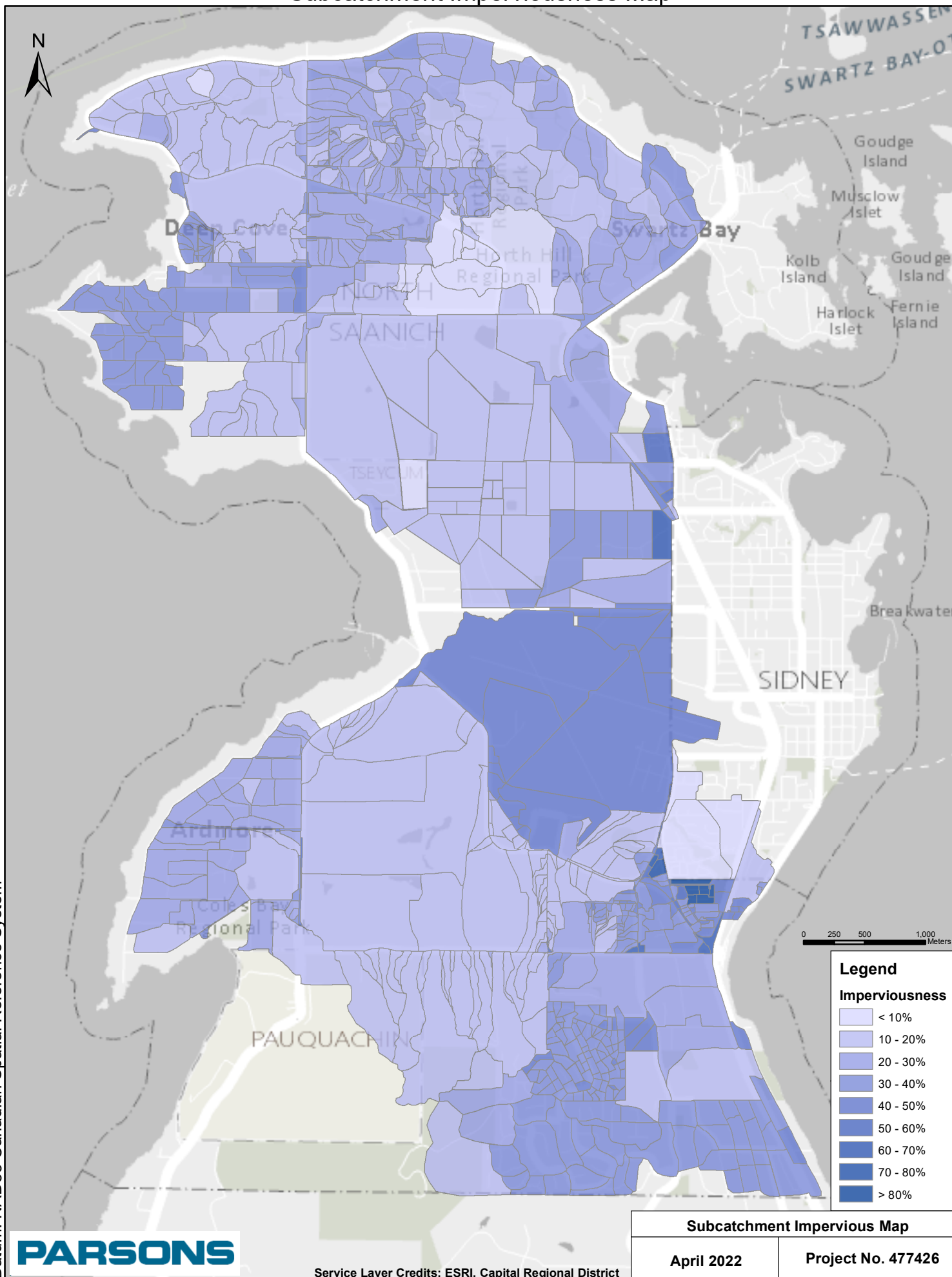


APPENDIX F

Subcatchment Imperviousness Map – Future Scenario

North Saanich Drainage Master Plan - Future Scenario

Subcatchment Imperviousness Map



Coordinate System: NAD 1983 CSRS UTM Zone 10N
Datum: NAD83 Canadian Spatial Reference System



Service Layer Credits: ESRI, Capital Regional District

Date Saved: 20/04/2022 15:33:25

Document Name: North_Saanich_Watershed_Imp_Map

APPENDIX G

**Field Observations December 21, 2020
(Colquitz Engineering)**

FIELD OBSERVATIONS

Inspection Date: December 21, 2020

Report Date: January 11, 2020

RE: NORTH SAANICH – DRAINAGE MASTER PLAN
Field Measurements and Photos Recording Impacts of December 21, 2020 Storm Event
Project Number: 405.006

Introduction

On December 21, 2020 a significant snow and rainfall event occurred in the Capital Regional District. The District of North Saanich noted that between 5:00 am and 9:00 am there was approximately 20 mm and road flooding was occurring. It was decided to make measurements at the flow monitoring sites and then visit other locations within the District to record culver surcharging and flooding. These field observations are summarized below, and can be used to calibrate/validate the capacity assessment model.

The total recorded precipitation is summarized in Figure 1 and Table 1 below. This data is sourced from <http://www.victoriaweather.ca/> for the North Saanich Middle School.

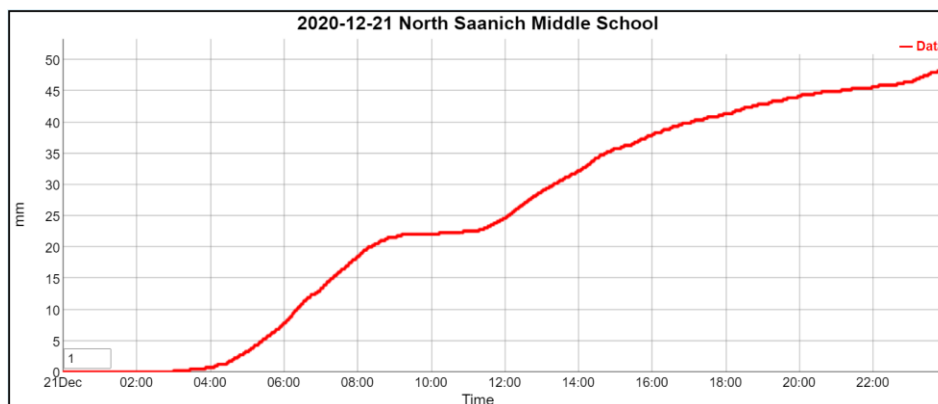
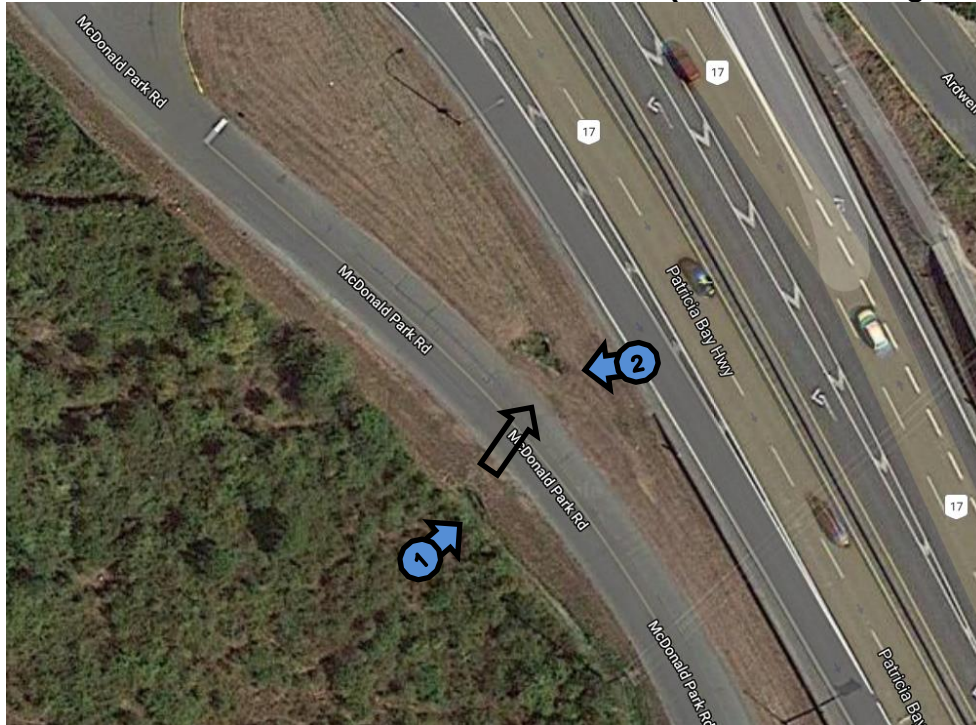


Figure 1 – December 21, 2020 Rainfall Total

Hour	Rainfall (mm)	Hour	Rainfall (mm)
1	0	13	4.06
2	0	14	3.56
3	0	15	3.55
4	0.76	16	2.04
5	2.54	17	2.03
6	4.32	18	1.52
7	5.33	19	1.53
8	5.34	20	1.27
9	3.3	21	0.76
10	0.51	22	0.76
11	0.51	23	0.76
12	2.03	24	2.03

Table 1 – December 21, 2020 Rainfall – Hourly Data

Field Observation 1 – McDonald Park Road (Flow Monitoring Site 5)



Legend

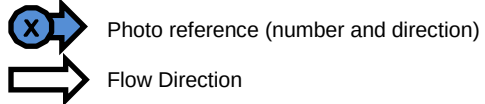


Photo 1: Inlet @ 12:30 pm
Recorded Water Level – 0.66m (staff gauge)



Photo 2: Outlet @ 12:35 pm
Recorded Water Level – 0.53m (above invert)

Field Observation 2 – John Road (Flow Monitoring Site 3)



Legend

-  Photo reference (number and direction)
-  Flow Direction



Photo 3: Flow Meter @ 1:30 pm
Recorded Water Level – 0.85m (staff gauge)



Photo 4: Inlet to Twin Culvert @ 1:30 pm
Recorded Water Level – Fully submerged



Photo 3: Outlet from Twin Culvert @ 1:30 pm
Recorded Water Level – Fully submerged



Photo 4: Inlet to Culvert @ 1:36 pm
Recorded Water Level – Inlet fully submerged

Field Observation 3 – Munro Road



Legend

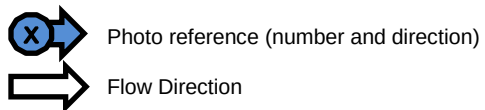


Photo 5: Munro Road @ 1:40 pm
Recorded Water Level – Flow over Munro Road



Photo 6: Field @ 1:47 pm
Recorded Water Level – Flooded field

Field Observation 4 – Tseycum Creek



Legend

-  Photo reference (number and direction)
-  Flow Direction

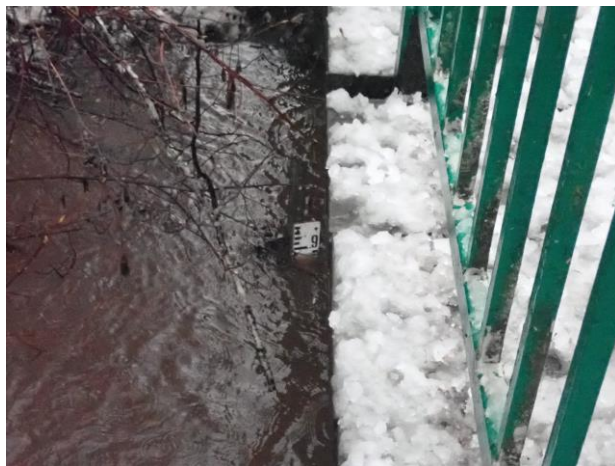


Photo 7: Tseycum Creek @ 1:43 pm
Recorded Water Level – 0.88m (staff gauge)



Photo 8: North Tributary @ 1:44 pm
Recorded Water Level – N/A

Field Observation 5 – Chalet Creek at Alder Road



Legend

-  Photo reference (number and direction)
-  Flow Direction



Photo 9: Pond @ 1:59 pm
Recorded Water Level – Flooding around pond

Field Observation 6 – Chalet Creek at West Saanich Road



Legend

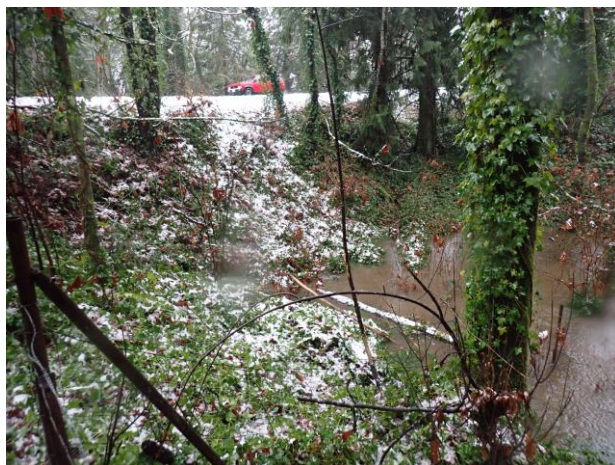
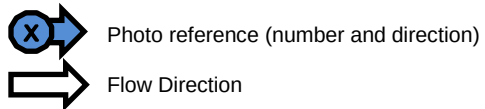
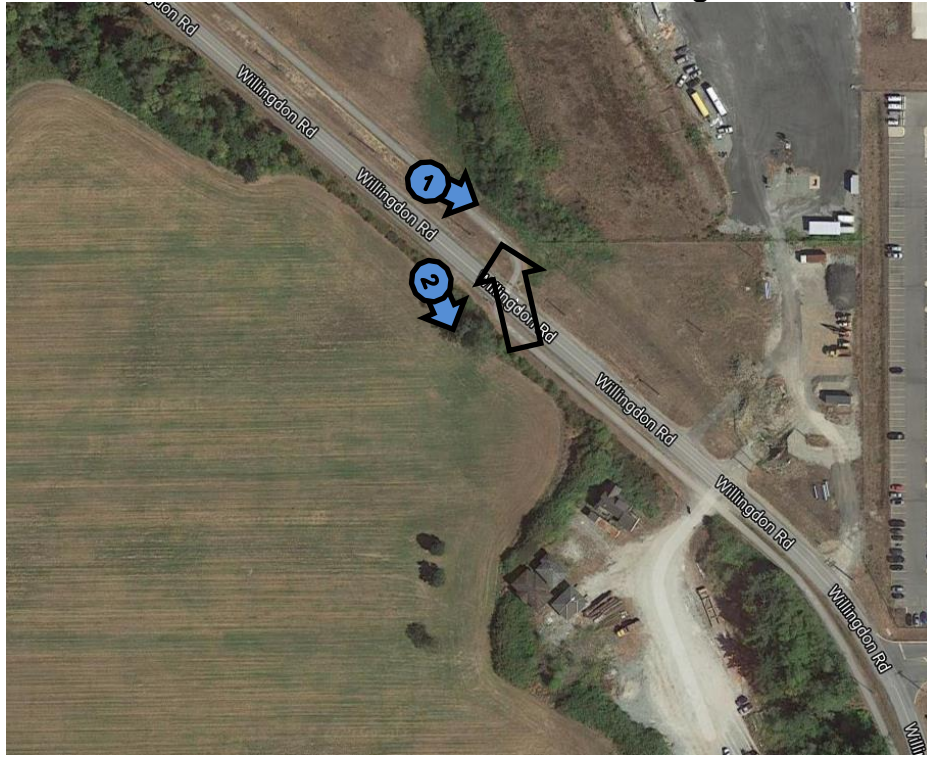


Photo 10: Culvert Inlet @ 2:03 pm
Recorded Water Level – Inlet surcharged



Photo 2: Culvert Outlet @ 2:05 pm
Recorded Water Level – N/A

Field Observation 7 – Ten Ten Creek at Willingdon



Legend

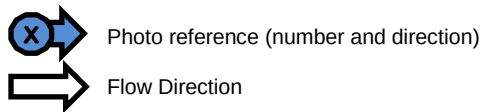


Photo 11: Culvert Outlets @ 2:14 pm
Recorded Water Level – N/A



Photo 2: Culvert Inlet @ 2:14 pm
Recorded Water Level – Surcharged and staff gauged observed just below surface

Field Observation 8 – Ten Ten Creek at Willingdon



Legend

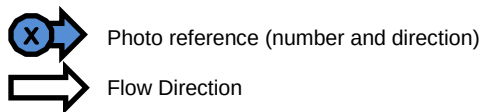
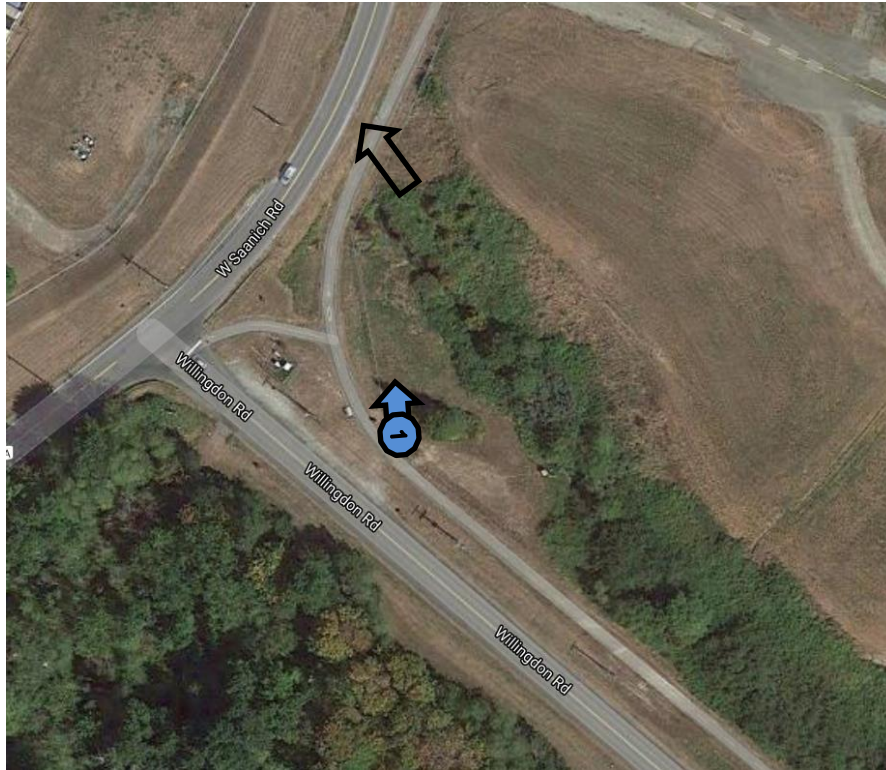


Photo 12: Culvert Inlets @ 2:21 pm
Recorded Water Level – Submerged Inlet



Photo 2: Culvert Inlet/Outlets @ 2:24 pm
Recorded Water Level – Submerged

Field Observation 9 – Ten Ten Creek at West Saanich



Legend

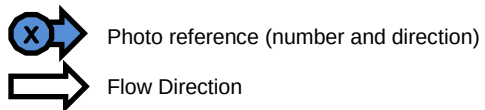


Photo 13: Culvert Inlets @ 2:28 pm
Recorded Water Level – Submerged inlet

Field Observation 10 – McDonald Park Road



Legend

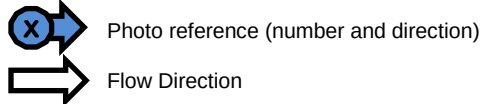


Photo 14: Culvert Inlet @ 2:34 pm
Recorded Water Level – Submerged inlet



Photo 2: Culvert Inlet @ 2:35 pm
Recorded Water Level – 0.25 m to Obvert (+/-)

Field Observation 10 – Munro Road



Legend

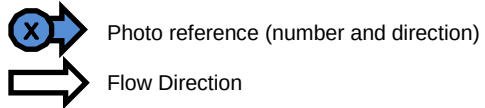


Photo 15: Munro at Wilson @ 3:07 pm
Recorded Water Level – Road flooded



Photo 2: Munro Road @ 2:58 pm
Recorded Water Level – 0.05 m over road

APPENDIX H

2020 Condition Assessment Investigation, Table
(Colquitz Engineering)

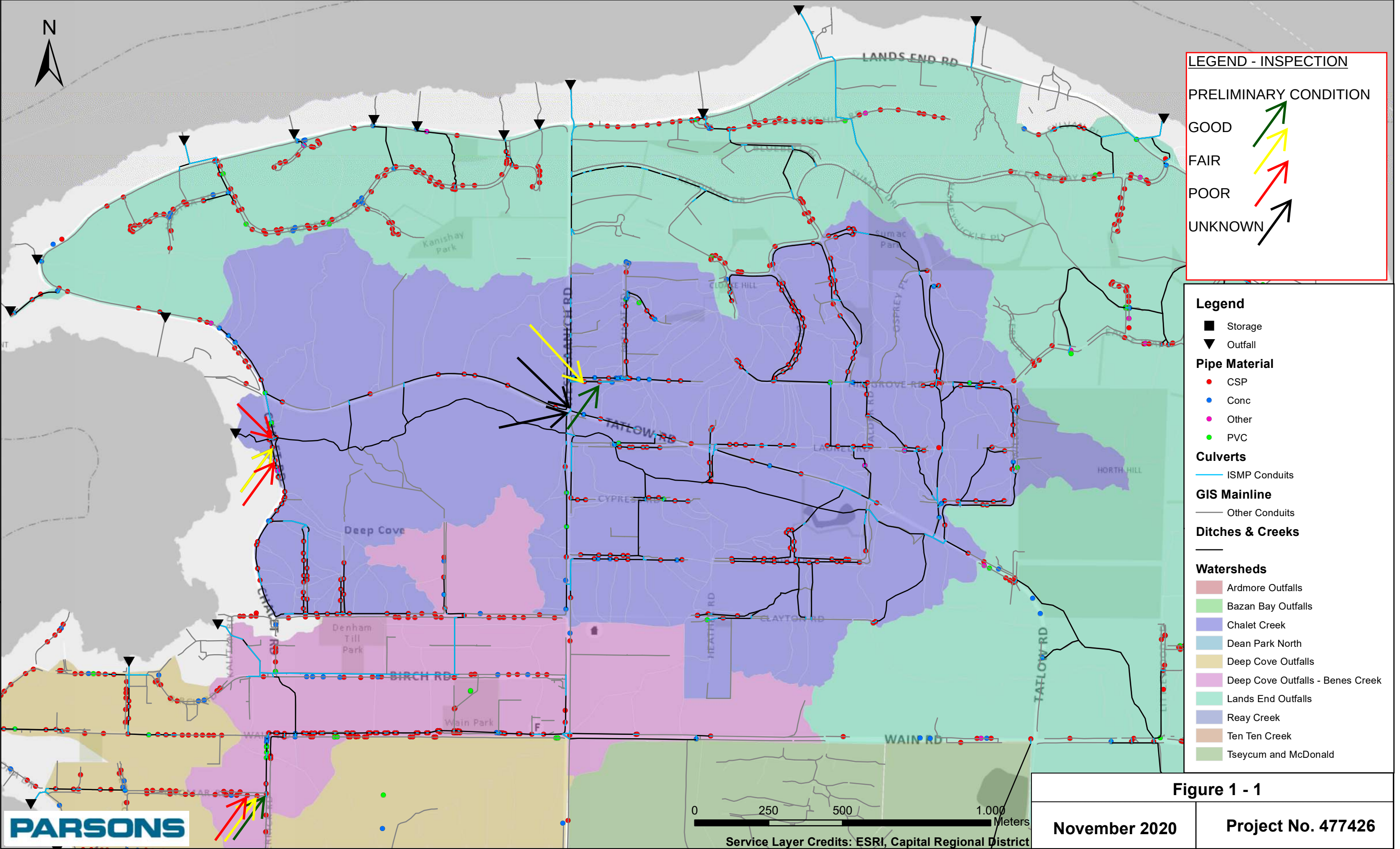
2020 Condition Assessment Investigation Table (Colquitz Engineering)

Model I.D.	Waypoint	Latitude (Degrees)	Longitude (Degrees)	Elevation (m)	Location	Flow Direction	Pipe 1 Material	Pipe 2 Material	Pipe 1 Dia. (mm)	Pipe 2 Dia. (mm)	Pipe 1 Cond Score (0 to 5)	Pipe 2 Cond Score (0 to 5)	Pipe 1 Defect	Pipe 2 Defect	Inlet Headwall Type	Inlet Headwall Defect Score (0 to 5)	Inlet Headwall Defect	Outlet Headwall Type	Outlet Headwall Defect Score (0 to 5)	Outlet Headwall Defect	Pipe Blockage (%)	Pipe Blockage Type	Surface Cond Score (0 to 5)	Surface Condition Defect	Notes
SEJO-10A	77	48,666088	-123,437742	-98,644	Wilson Rd @ John Rd	NW	Concrete	Concrete	600	600	2	2	Longitude Cracks	Longitude Cracks	Sandbag	4	Missing Rocks/Voids	Sandbag	3	Aging	20%	Vegetation	0	N/A	Dual pipes
SEJO-0A	78	48,666078	-123,437699	-98,579	John Rd @ Wilson Rd	N	Concrete	Concrete	600	600	2	2	Aging	Aging	Mortared Rock	2	Aging	Mortared Rock	2	Aging	20%	Vegetation	0	N/A	Dual pipes
N/A	79	48,666176	-123,437844	12,496	#1485 John Rd	E	CSP		300		5		Shape Deformation		Sandbag	5	Broken	Sandbag	5	Broken	50%	Fine Sediments / Vegetation	0	N/A	Outlet pipe bent
TS-2280	80	48,666176	-123,438126	12,496	Btwn #1401 and #1485 John Rd	S	CSP	CSP	1050	1050	5	5	Spalling / Abrasion / Shape Deformation / Holes	Spalling / Abrasion / Shape Deformation / Holes	None	5	Erosion	None	0	N/A	20%	Fine Sediments / Vegetation	4	Settlement	Invert missing at inlet and outlet
N/A	81	48,666176	-123,438126	12,496									Spalling / Pitting / Abrasion / Shape Deformation / Holes												Downstream through private property
N/A	82	48,673441	-123,457728	-73,041	W. Saanich Rd @ Downey Rd	S	CSP		500		5				Sandbag	5	Broken / Cracking	Sandbag	5	Broken / Cracking	5%	Vegetation	0	N/A	Outlet pipe bent
N/A	83	48,673441	-123,457728	32,324	W. Saanich Rd @ Downey Rd	S	CSP		600		0		N/A		Sandbag	0	N/A	Sandbag	0	N/A	0%	N/A	0	N/A	New culvert
DML7103385	84	48,673441	-123,457728	32,324	Downey Rd @ W. Saanich Rd	S	Concrete		375		1		N/A		Sandbag	1	Cracking	None	1	Vegetation	20%	Vegetation	1	Cracks	
N/A	85	48,677729	-123,457714	46,938	W. Saanich Rd @ Wain Rd	S	Concrete		N/A		N/A		N/A		Sandbag	5	Broken / Cracking / Overturning	DMH	1	Chipping	100%	Rocks	0	N/A	Unable to inspect due to rocks
N/A	86	48,677729	-123,457714	46,938	W. Saanich Rd @ Wain Rd	S	CSP		450		2		Spalling / Abrasion		DMH	1	Chipping	Sandbag	5	Broken / Cracking	25%	Vegetation	0	N/A	Remove rocks immediately
N/A	87	48,677729	-123,457714	46,938	Cromar Rd @ Derrick Rd	N	CSP		300		1		Spalling / Perforating / Joint Separation		Sandbag	1	N/A	Sandbag	1	N/A	0%	N/A	0	N/A	Same DMH for Waypoint 85
N/A	88	48,677729	-123,457714	46,938	#655 Cromar Rd	E	CSP		300		2		Spalling / Pitting		Sandbag	1	N/A	Sandbag	1	N/A	5%	N/A	0	N/A	
N/A	89	48,675914	-123,47193	40,539	#635 Cromar Rd	E	CSP		300		1		Spalling / Pitting		Sandbag	1	N/A	Sandbag	1	N/A	10%	Gravel / Vegetation	0	N/A	
DML7102163	90	48,675914	-123,47193	40,539	#11160 Chalet Rd	N	CSP		300		2		Spalling / Abrasion		Sandbag	1	N/A	Sandbag	2	Overturning	25%	Fine Sediments / Vegetation	0	N/A	
Dml7100921	91	48,675914	-123,47193	40,539	#11166 Chalet Rd	N	CSP		300		1		Spalling		Sandbag	1	N/A	Sandbag	2	Overturning	10%	Fine Sediments / Vegetation	0	N/A	
DML7102217	92	48,675914	-123,47193	40,539	Btwn #11166 and #11176 Chalet Rd	W	CSP		900		5		Spalling / Pitting / Abrasion / Holes		Sandbag	3	Cracking / Overturning	Sandbag	4	Broken / Cracking	5%	Gravel / Fine Sediments	0	N/A	Sandbags missing for outlet headwall
DML7107778	93	48,675914	-123,47193	40,539	W. Saanich Rd @ Tatlow Rd	S	Concrete		750		1		Joint Separation		Sandbag	1	N/A	DMH	1	N/A	5%	Vegetation	0	N/A	Unable to inspect inside DMH
DML7107802	94	48,687365	-123,4578	30,789	W. Saanich Rd @ Tatlow Rd	N	Concrete		750		1		N/A		Sandbag	4	Broken / Overturning	DMH	1	N/A	5%	Vegetation	0	N/A	Same DMH for Waypoint 93
DML7107779	95	48,687365	-123,4578	30,789	W. Saanich Rd @ Tatlow Rd	SW	Concrete		750		1		N/A		DMH	1	N/A	Sandbag	4	Broken / Cracking	5%	Vegetation	1	Longitudunal Cracks	Surface trench cracks
DML7102203	96	48,687365	-123,4578	30,789	#1033 Hillgrove Rd (Main Access)	W	CSP		300		1		Spalling		Rock	1	N/A	Rock	1	N/A	40%	Fine Sediments	0	N/A	Same DMH for Waypoint 93
C-97	97	48,687365	-123,4578	30,789	#1064 Hillgrove Rd	W	Concrete		300		1		N/A		None	1	N/A	None	1	N/A	25%	Fine Sediments	0	N/A	
C-99	98	48,687365	-123,4578	30,789	#1033 Hillgrove Rd (2nd Access)	W	CSP		300		1		Spalling		Sandbag	0	N/A	Sandbag	0	N/A	10%	Fine Sediments / Vegetation	0	N/A	New culvert
N/A	99	48,687365	-123,4578	30,789	#11086 Larkspur Ln	S	CSP		375		3		Spalling / Pitting		Sandbag	1	N/A	Sandbag	5	Broken / Cracking	5%	Vegetation	0	N/A	Loss of headwall material at outlet invert
N/A	100	48,682658	-123,418819	36,887	Salal Pl @ Larkspur Ln	S	Concrete		300		1		N/A		Sandbag	1	N/A	Sandbag	5	Broken / Cracking	5%	Vegetation	0	N/A	Missing sandbags on outlet headwall
N/A	101	48,682658	-123,418819	36,887	Salal Pl Pathway Access	W	HDPE		300		0		N/A		Sandbag	0	N/A	Sandbag	0	N/A	5%	Gravel	0	N/A	New culvert
DML7100559	102	48,682658	-123,418819	36,887	Salal Pl (bend in road)	S	Concrete		600		1		N/A		Sandbag	1	N/A	Sandbag	4	Broken / Cracking	0%	N/A	0	N/A	Loose sandbags on outlet
12A-19	103	48,682658	-123,418819	36,887	#1986 Mills Rd	E	CSP		375		4		Spalling / Pitting / Abrasion		Sandbag	3	Overturning	Sandbag	4	Broken / Cracking	10%	Fine Sediments / Vegetation	0	N/A	Large tree on top of pipe
12A-17	104	48,682658	-123,418819	36,887	#1974 Mills Rd	E	CSP		375		4		Spalling / Abrasion / Holes		Sandbag	1									Loose sandbags on outlet
12A-13	105	48,682658	-123,418819	36,887	#1952 and #1946 Mills Rd	E	CSP		300		1		N/A		Sandbag	1	N/A	Pipe	N/A	N/A			0	N/A	Single pipe with 2 materials, upstream section
6-1	105	48,682658	-123,418819	36,887	#1952 and #1946 Mills Rd	E	Concrete		375		4		Spalling / Abrasion / Holes / Pipe Penetration		Pipe	N/A	N/A	Sandbag	1	N/A	50%	Vegetation	0	N/A	CB lead into this or downstream pipe
6-1	106	48,682658	-123,418819	36,887	McDonald Park Rd @ Ardwell Ave	E	Concrete		750		0		N/A		Precast	0	N/A	Precast	0	N/A	0%	N/A	1	Aligator Cracking	Single pipe with 2 materials, downstream section
N/A	108	48,682658	-123,418819	36,887	#10100 Meadland Rd (North Access)	S	CSP		250		1		Spalling		Mortared Rock	1	N/A	Mortared Rock	2	Broken	10%	Fine Sediments	1	Longitudunal Cracks	CB lead into this or upstream pipe
N/A	109	48,655635	-123,43927	-52,280	#10100 Meadland Rd (South Access)	S	CSP		250		1		Spalling		Mortared Rock	1	N/A	Mortared Rock	1	N/A	5%	Fine Sediments	0	N/A	No signs of settlement on pavement
N/A	110	48,655493	-123,439038	-52,765	Meadland Rd @ Mills Rd	E	Concrete		200		1		N/A		None	5	Vegetation	N/A	N/A	N/A	100%	Fine Sediments / Vegetation	1	Longitudunal Cracks	Unable to locate outlet
DML7109616	111	48,637122	-123,418593	19,828	#9393 E. Saanich Rd	N	PVC		150		1		N/A		CB	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Longitudunal Cracks	Unable to locate outlet to garden
DML7107466	112	48,637197	-123,417696	19,828	#9398 Canora Rd	E	Concrete		450		4		Holes		DMH	4	Joint Separation	DMH	1	N/A	5%	Fine Sediments / Vegetation	0	N/A	Joint at downstream manhole separated
DML7108118	113	48,636807	-123,417377	19,352	Canora Rd @ Summergate Blvd	S	Concrete		450		N/A		N/A		DMH	1	N/A	DMH	1	N/A	0%	N/A	0	N/A	Same DMH for Waypoint 112
DML7101277	114	48,639038	-123,417343	12,977	#1900 Dickson Ave	E	CSP		375		1		N/A		Sandbag	1	N/A	Sandbag	1	N/A	10%	Vegetation	0	N/A	
DML7103252	115	48,639038	-123,417343	12,977	#1897 Dickson Ave	E	CSP		250		4		Broken		Mortared Rock	4	Broken	Mortared Rock	4	Broken	10%	Fine Sediments / Vegetation	0	N/A	Inlet and outlet made out of rocks
DML7103251	116	48,639038	-123,417343	12,977	#9260 E. Saanich Rd	E	CSP		300		2		Spalling / Abrasion		Sandbag	4	Broken	Sandbag	4	Broken	10%	Gravel	0	N/A	
N/A	117	48,639038	-123,417343	12,977	Gleneig Ave @ Bradley Dyne Rd (SE Side)	W	CSP		300		4		Spalling / Abrasion / Holes		Sandbag	1	N/A	Sandbag	1	N/A	10%	Fine Sediments / Vegetation	0	N/A	Hydrant culvert
N/A	118	48,639038	-123,417343	12,977	#683 Bradley Dyne Rd	W	CSP		300		4		Spalling / Abrasion / Shape Deformation / Holes		Sandbag	1	N/A	Sandbag	1	N/A	10%	Fine Sediments	0	N/A	No invert at inlet and outlet
N/A	119	48,639038	-123,417343	12,977	#697 Bradley Dyne Rd	W	Concrete		300		1		N/A		Sandbag	1	N/A	Sandbag	1	N/A	5%	Vegetation	0	N/A	
C-480	120	48,639038	-123,417343	12,977	#971 Bradley Dyne Rd	E	CSP		300		2		Spalling / Abrasion		Sandbag	1	N/A	Sandbag	1	N/A	50%	Fine Sediments / Vegetation	0	N/A	Major build-up of roots, vegetation, and dirt
DML7102776	121	48,639038	-123,417343	12,977	#974 Bradley Dyne Rd	W	CSP		300		4		Spalling / Abrasion / Holes		Rock	5	Broken	Rock	5	Broken	25%	Vegetation	0	N/A	Inlet and outlet made out of rocks
DML7100000	122	48,639038	-123,417343	12,977	W. Saanich Rd. @ Bradley Dyne Rd	S	HDPE		450		0		N/A		Mortared Rock	0	N/A	Mortared Rock	0	N/A	0%	N/A	0	N/A	Bus stop culvert
DML7101165	123	48,639038	-123,417343	12,977	#9490 W. Saanich Rd	S	HDPE		450		0		N/A		Mortared Rock	0	N/A	Mortared Rock	0	N/A	0%	N/A	0	N/A	New culvert
DML7103093	124	48,639038	-123,417343	12,977	Aboyne Ave @ Ardmore Rd	E	CSP		375		3		Spalling / Pitting / Abrasion		Sandbag	1	N/A	Sandbag	1	N/A	0%	N/A	0	N/A	
DML7103094	125	48,639038	-123,417343	12,977																					Same as Waypoint #124
DML7103094	126	48,639038	-123,417343	12,977	Ardmore Rd @ Aboyne Rd	S	Concrete		450		1		N/A		Mortared Rock	4	Broken	Mortared Rock	1	N/A	0%	N/A	0	N/A	
N/A	127	48,639038	-123,417343	12,977	#8930 Lochside Dr	E	CSP		600		2		Spalling / Abrasion / Shape Deformation		Sandbag	4	Deteriorated	DMH	5	Non-conforming	10%	Fine Sediments / Vegetation	0	N/A	Bent pipe at inlet
N/A	128	48,639038	-123,417343	12,977	Bazan Bay Rd @ Lochside Dr	S	CSP		300		1		N/A		Sandbag	1	N/A	DMH	5	Non-conforming	10%	Fine Sediments / Vegetation	0	N/A	Sandbag manhole, non-conforming
N/A	129	48,639038	-123,417343	12,977	Bazan Bay Rd @ Lochside Dr	SE	Concrete		900		1		N/A		DMH	5	Non-conforming	DMH	5	Non-conforming	0%	N/A	0	N/A	No access / ladder rungs
N/A	130	48,639038	-123,417343	12,977	Bazan Bay Rd @ Lochside Dr	N	HDPE		200		1		N/A		Rock	5	Undermined	DMH	5	Non-conforming	0%	N/A	0	N/A	Same upstream DMH for Waypoint 127
C-1006	131	48,639038	-123,417343	12,977	#1955 Dean Park Rd	N	Concrete		450		2		Aging		CBMH	1	N/A	N/A	N/A	N/A	25%	Gravel	0	N/A	Sandbag manhole, non-conforming
C-1001_6	132	48,639038	-123,417343	12,977	#1954 Dean Park Rd	E	CSP		600		4		Spalling / Abrasion / Longitudinal Cracks / Holes		Sandbag	3	Broken / Cracking	Sandbag	4	Broken / Cracking / Undermined	10%	Gravel / Fine Sediments	1	Cracks	No access / ladder rungs
C-1002	133	48,639038	-123,417343	12,977	#1970 Dean Park Rd - BC Hydro Access	E	CSP		600		2		Spalling / Abrasion		Sandbag	4	Deteriorated	Sandbag	4	Deteriorating	0%	N/A	0	N/A	Same upstream DMH for Waypoint 127
N/A	134	48,639038	-123,417343	12,977	#1970 Dean Park Rd	NE	CSP		600		4		Spalling / Abrasion / Longitudinal Cracks / Shape Deformation / Holes		Sandbag	0	N/A	N/A	N/A	N/A	0%	N/A	0	N/A	Sandbag manhole, non-conforming
C-938	135	48,639038	-123,417343	12,977	Barrett Rd @ Dean Park Rd	E	?		450		N/A		N/A		DMH	4	Ladder Rung needed	DMH	4	Ladder Rung needed	0%	N/A	0	N/A	No access / ladder rungs
C-939	136	48,617464	-123,432272	145,363	Barrett Rd, btwn Dean Park Rd & Sentinel Pl	W	Concrete		450		N/A		N/A		DMH	4	Ladder Rung needed	DMH	4	Ladder Rung needed	0%	N/A	0	N/A	Upstream DMH @ #1604 Dean Park Rd
N/A	137	48,615013	-123,405672																						

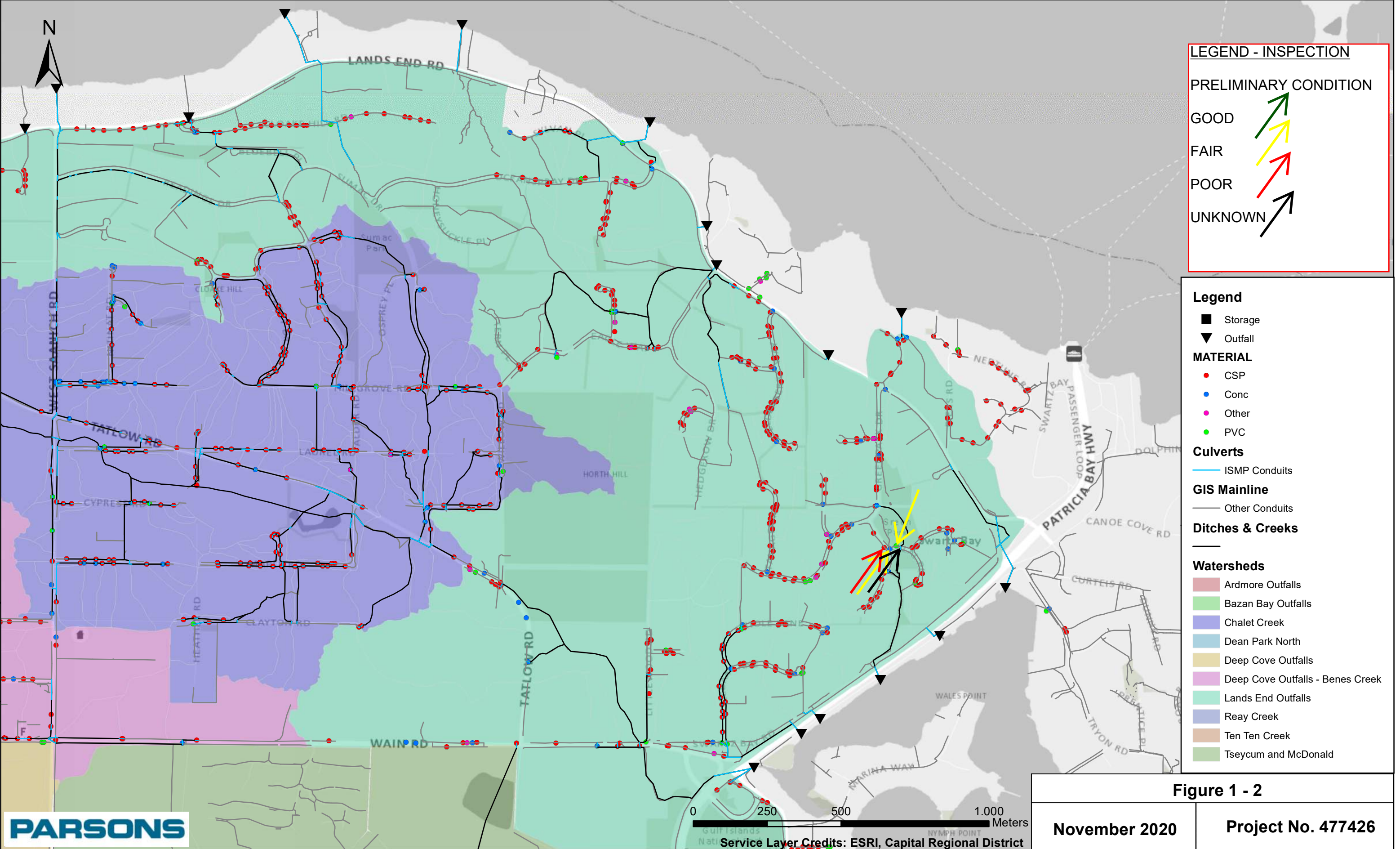
APPENDIX I

**2020 Condition Assessment Investigation, Map
(Colquitz Engineering)**

North Saanich Drainage Master Plan - Pipe Material

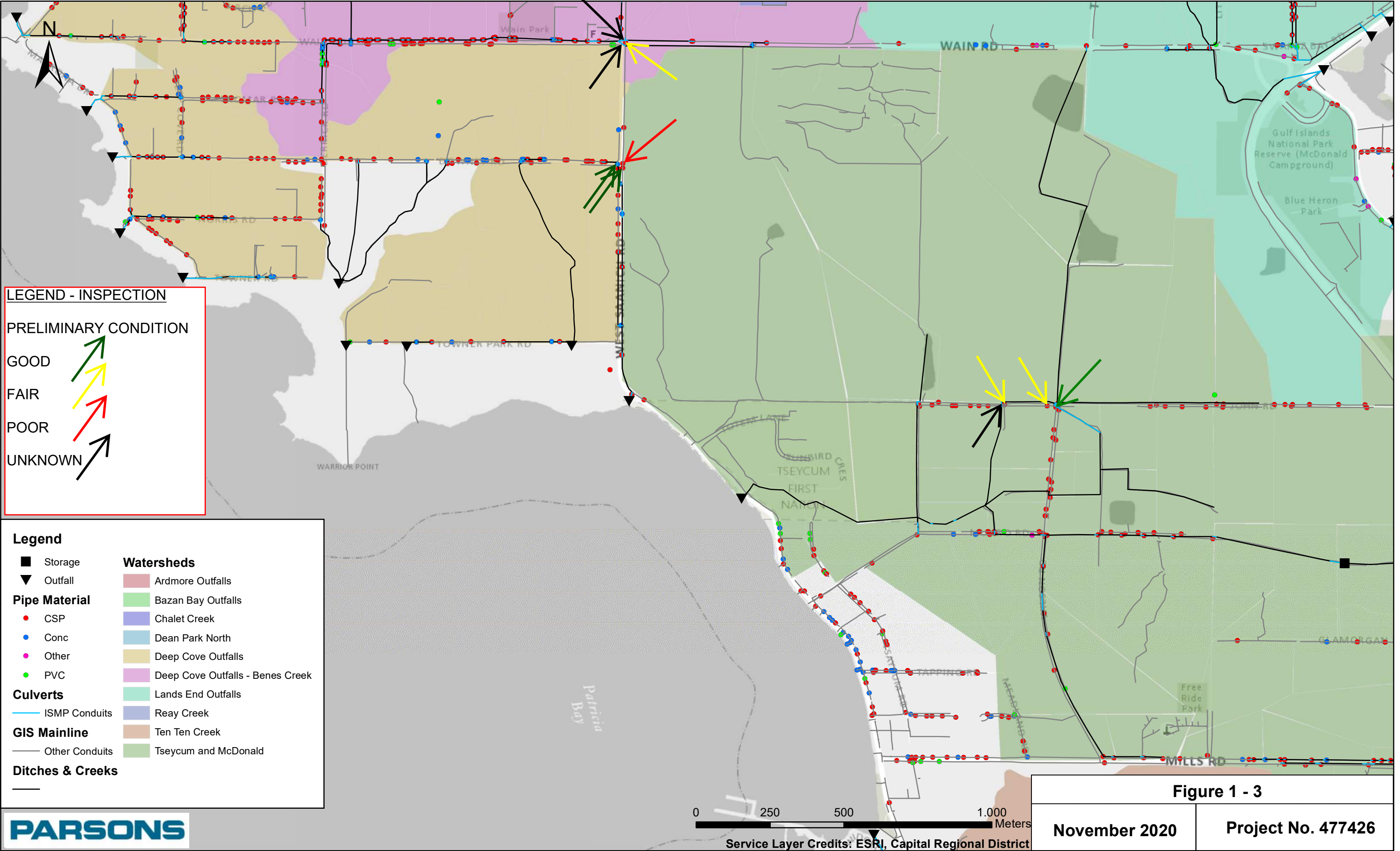


North Saanich Drainage Master Plan - Pipe Material

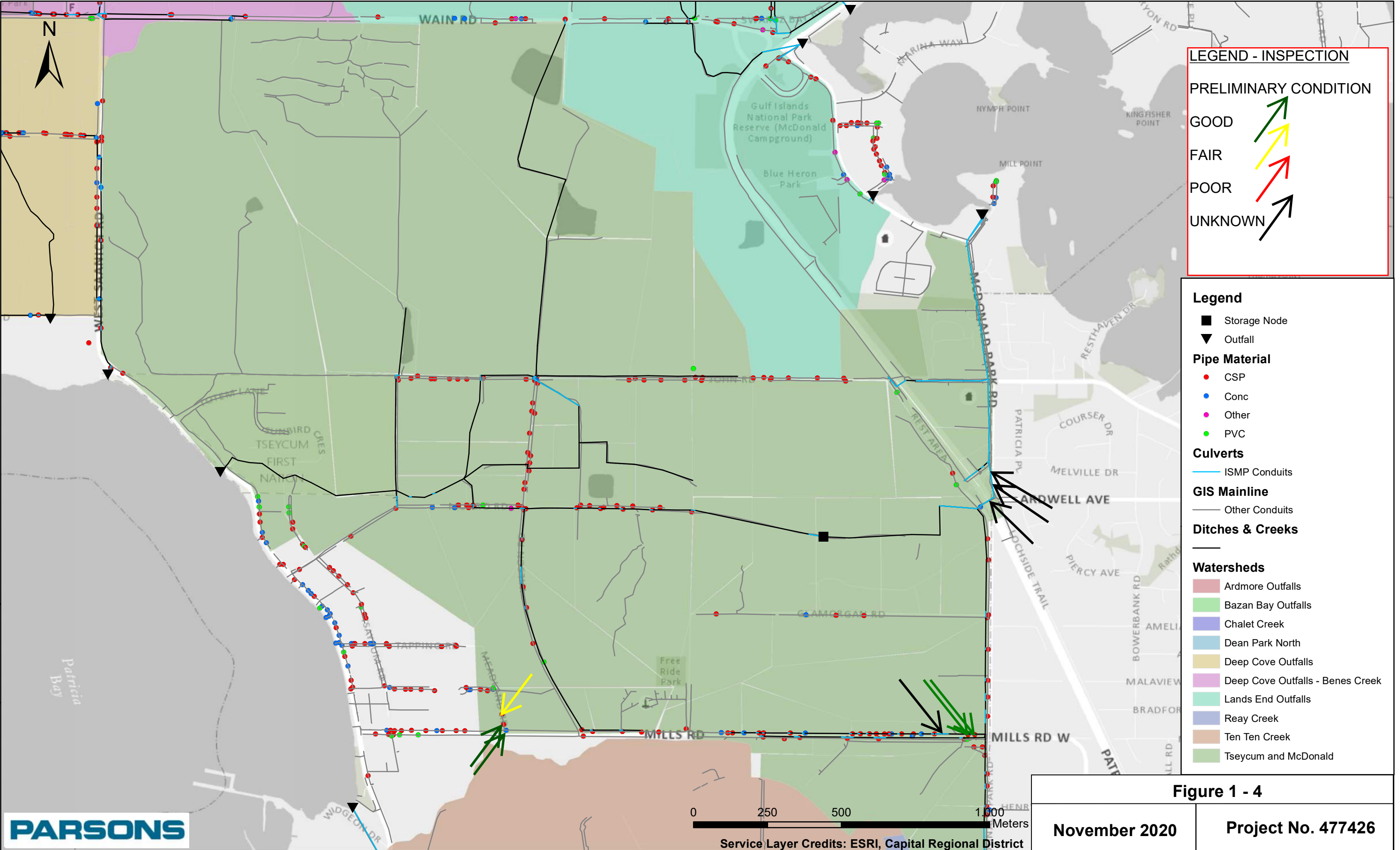


Coordinate System: NAD 1983 CSRS UTM Zone 10N
Datum: NAD83 Canadian Spatial Reference System

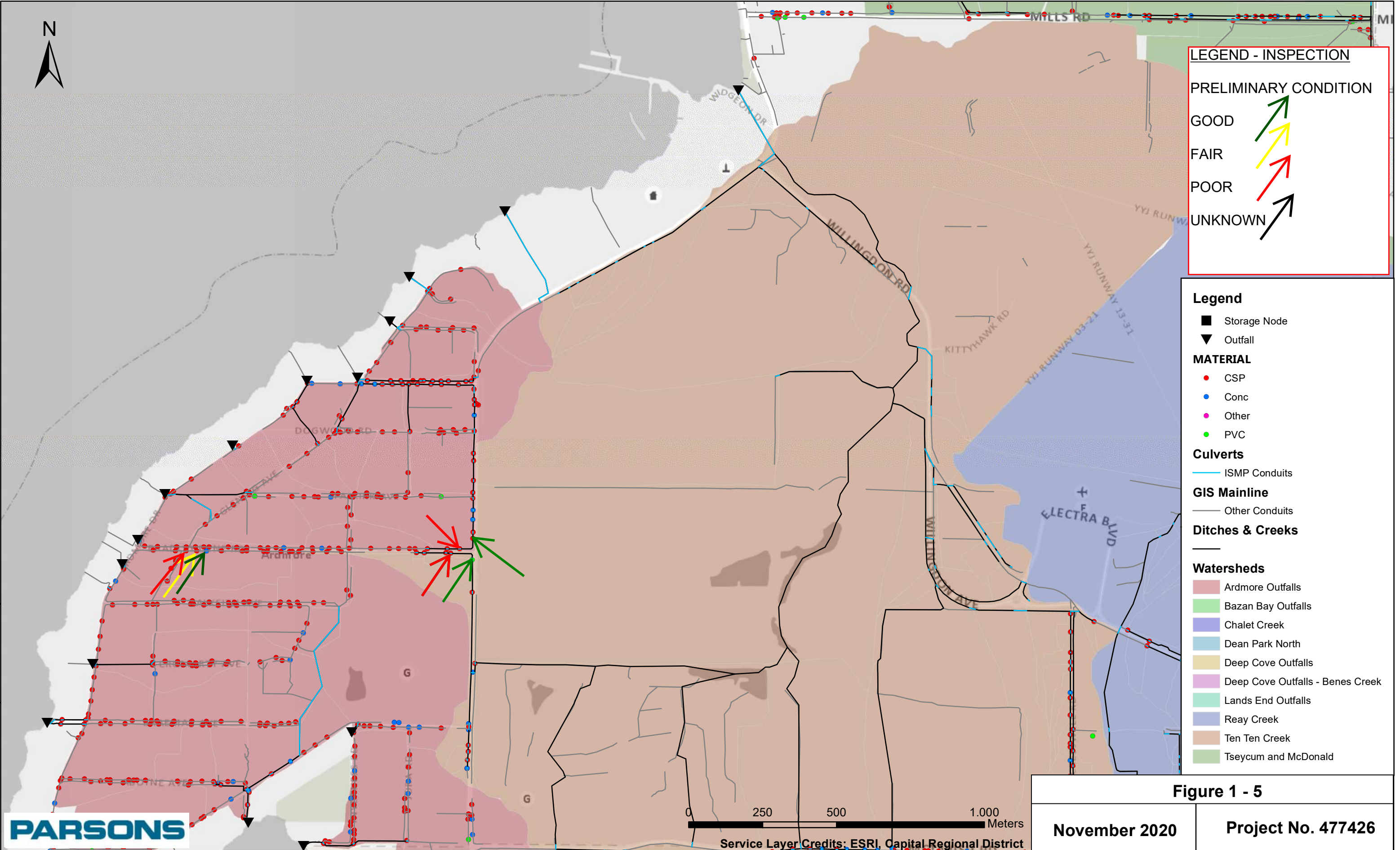
North Saanich Drainage Master Plan - Pipe Material



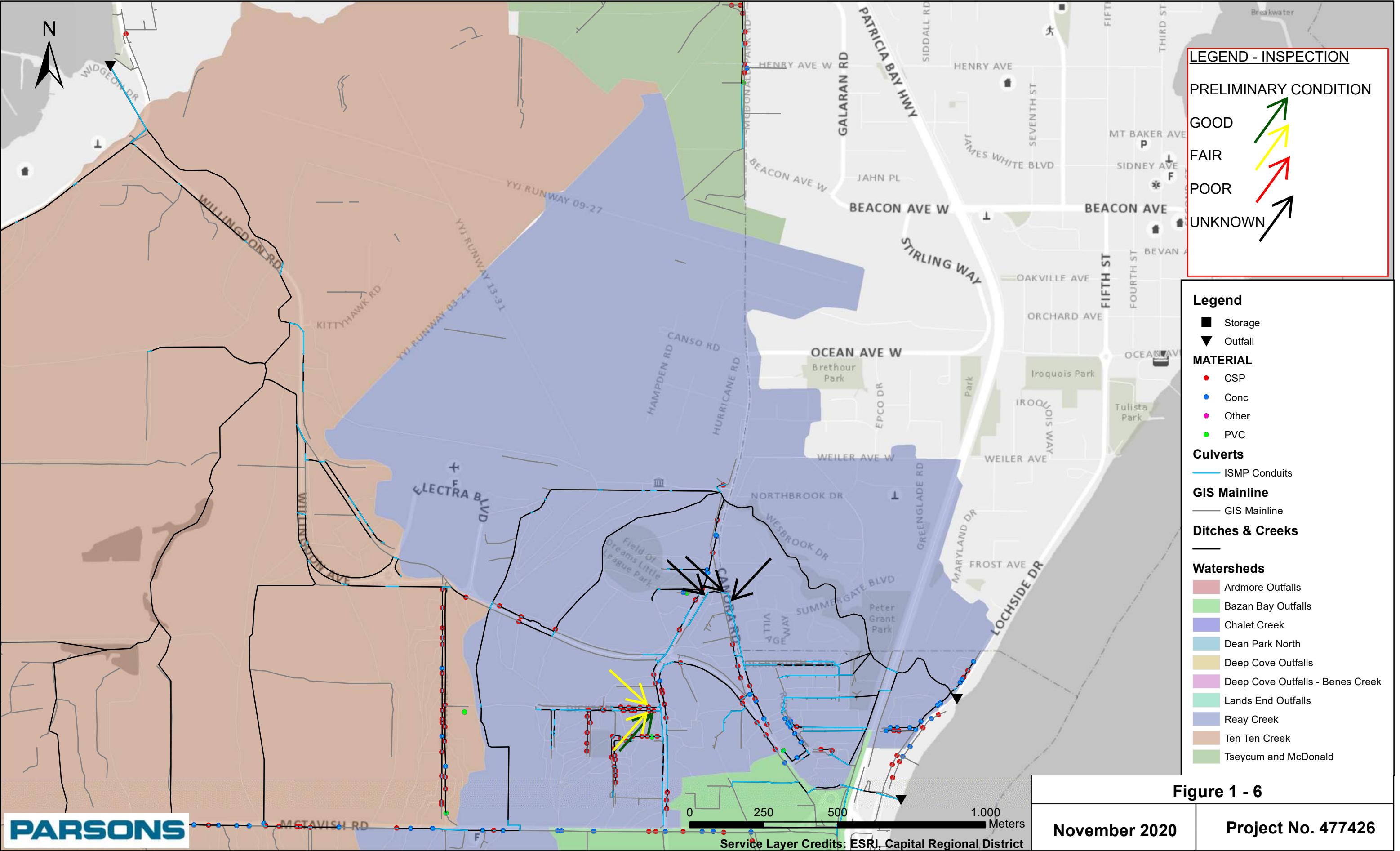
North Saanich Drainage Master Plan - Pipe Material



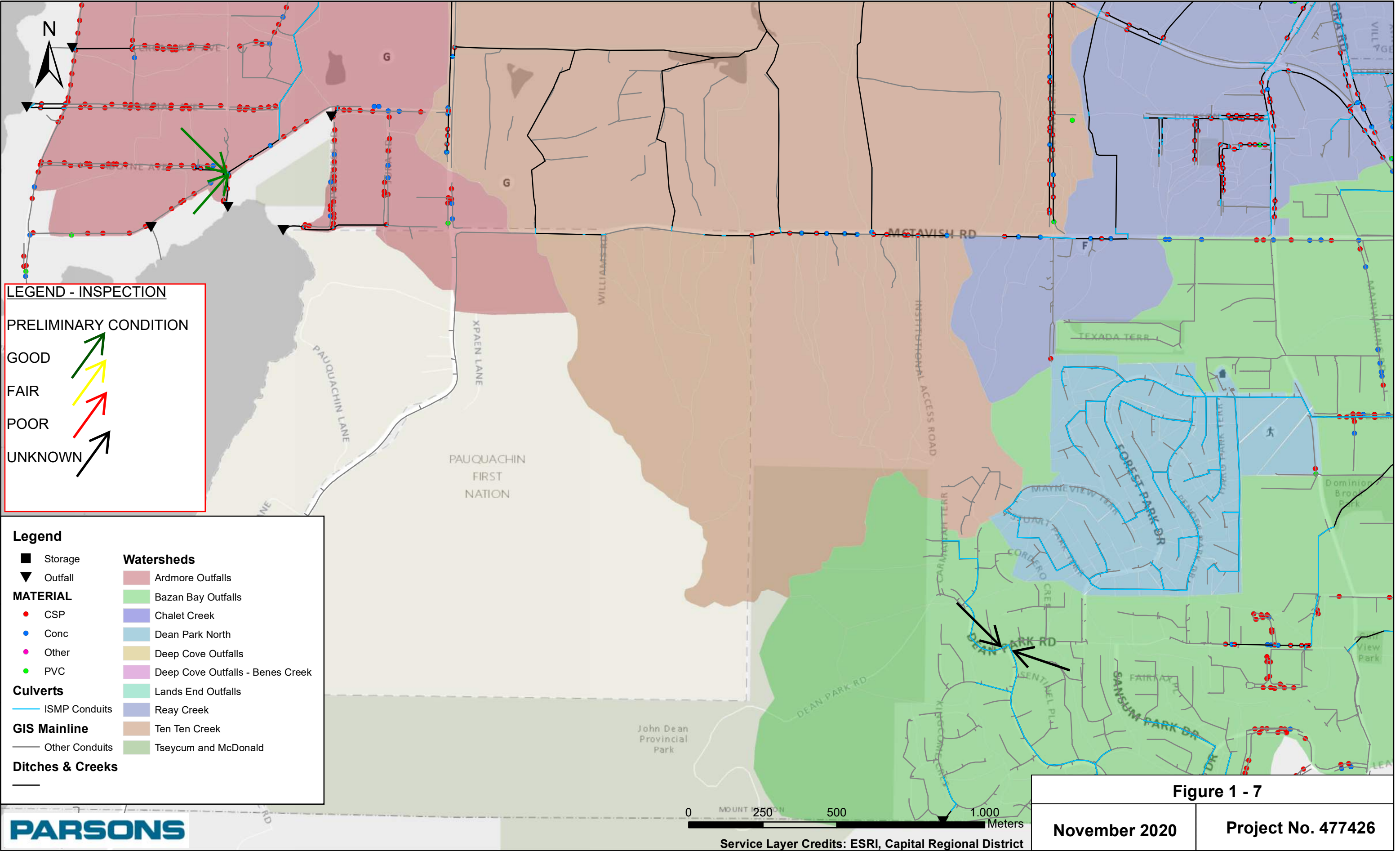
North Saanich Drainage Master Plan - Pipe Material



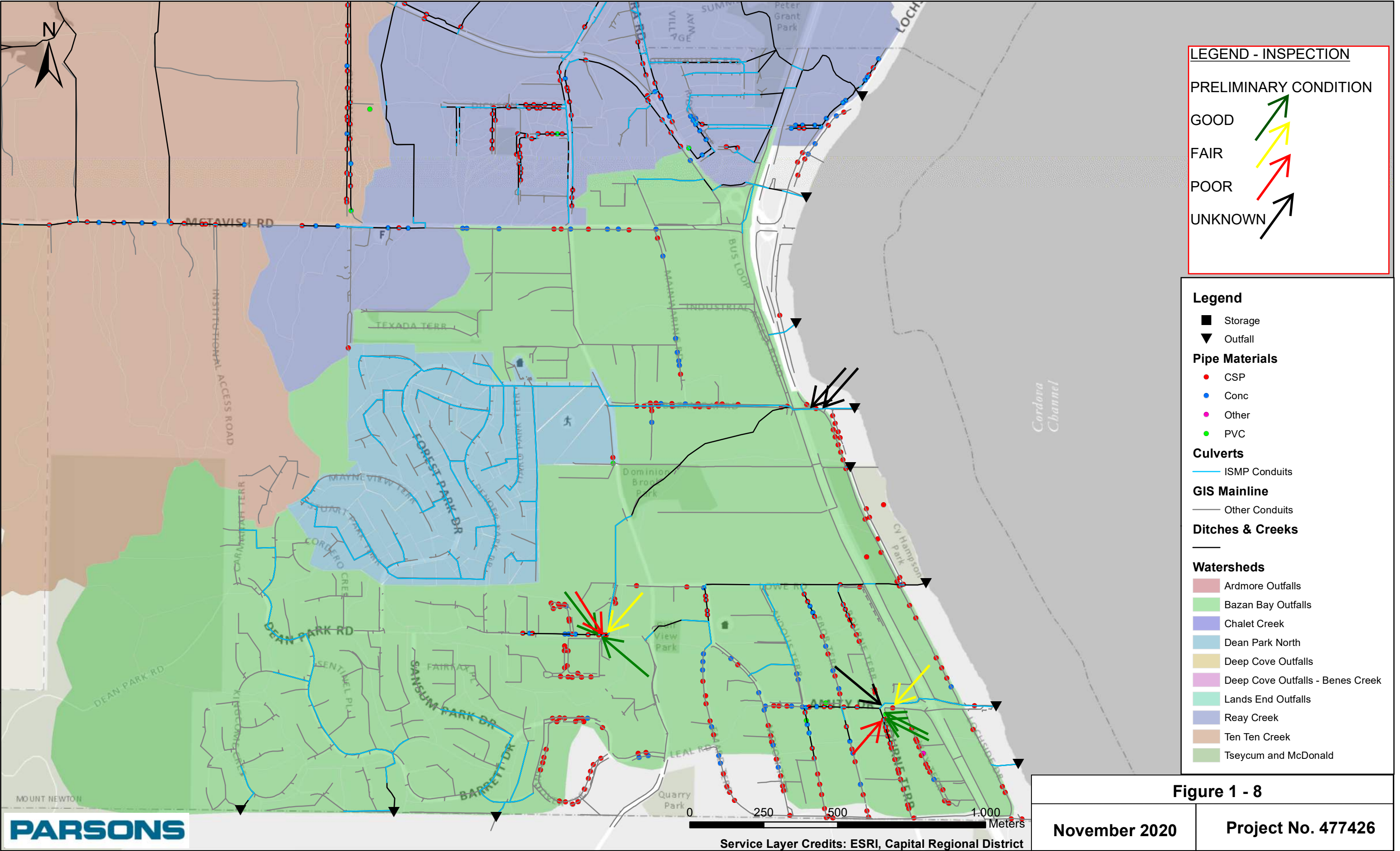
North Saanich Drainage Master Plan - Pipe Material



North Saanich Drainage Master Plan - Hydraulic Modelling Results - Existing Conditions
10 Year Storm Event



North Saanich Drainage Master Plan - Pipe Material



Coordinate System: NAD 1983 CSRS UTM Zone 10N
Datum: NAD83 Canadian Spatial Reference System

APPENDIX J

Drainage Master Plan - Recommendation Table



North Saanich - Drainage Master Plan - Recommendation Table

Date 08/08/2022

Note: Data derived from hydraulic PCSWMM model and received GIS files

Hydraulic Upgrades - Linear Drainage Infrastructure

Prioritization Class (1 High - 4 Low)	Year	Conduit ID	Cross-Section	Existing Pipe Diameter/Size (mm)	Assessment of Upgrade/Comments	Proposed Pipe Diameter/Size (mm)	Pipe Length (m)	Unit Cost Upgrade (\$/m)	Replacement Cost (\$)
1	Year 1-5	9-4	CIRCULAR	1,000	Upgrade to 1800x900mm box culvert as DS with adjacent culverts. Regrade ditch. DNS Operations confirms highest priority	1800x900	23.0	\$ 2,500	\$ 52,900.00
1	Year 1-5	MU-610	CIRCULAR	600		700	10.0	\$ 1,600	\$ 16,000.00
1	Year 1-5	DML7102239	CIRCULAR	500		600	11.0	\$ 1,400	\$ 15,400.00
1	Year 1-5	DML7102240	CIRCULAR	500		600	6.0	\$ 1,400	\$ 8,400.00
1	Year 1-5	C-958	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00
1	Year 1-5	C-960	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00
1	Year 1-5	DML7101151	CIRCULAR	300		400	11.0	\$ 1,000	\$ 11,000.00
1	Year 1-5	DML7101158	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00
2	Year 1-5	Cn-20	CIRCULAR	1,350		1400	20.0	\$ 2,500	\$ 50,000.00
2	Year 1-5	9-2	CIRCULAR	1,200	Operations confirms highest priority	1800x900	45.0	\$ 2,500	\$ 112,500.00
2	Year 1-5	9-6	CIRCULAR	1,000	Operations confirms highest priority	1800x900	10.0	\$ 2,500	\$ 23,000.00
2	Year 1-5	52	CIRCULAR	900		1200	23.0	\$ 2,300	\$ 52,900.00
2	Year 1-5	53	CIRCULAR	900		1200	75.0	\$ 2,300	\$ 172,500.00
2	Year 1-5	C-976	CIRCULAR	600		700	294.0	\$ 1,600	\$ 470,400.00
2	Year 1-5	Cn-39	CIRCULAR	600		700	10.0	\$ 1,600	\$ 16,000.00
2	Year 1-5	Cn-56	CIRCULAR	600		700	5.0	\$ 1,600	\$ 8,000.00
2	Year 1-5	MU-281	CIRCULAR	600		700	16.0	\$ 1,600	\$ 25,600.00
2	Year 1-5	MU-460	CIRCULAR	600		700	9.0	\$ 1,600	\$ 14,400.00
2	Year 1-5	MU-710	CIRCULAR	600		700	9.0	\$ 1,600	\$ 14,400.00
2	Year 1-5	DML7102674	CIRCULAR	500		600	12.0	\$ 1,400	\$ 16,800.00
2	Year 1-5	DML7101153	CIRCULAR	450		500	7.0	\$ 1,200	\$ 8,400.00
2	Year 1-5	DML7102851	CIRCULAR	400		500	17.0	\$ 1,200	\$ 20,400.00
2	Year 1-5	DML7107169	CIRCULAR	350		400	133.0	\$ 1,000	\$ 133,000.00
2	Year 1-5	11-1	CIRCULAR	300	DNS Operations commented that this might be in VAA ownership	400	220.0	\$ 1,000	\$ 220,000.00
2	Year 1-5	C-1039	CIRCULAR	300	Upgrade very long culvert.	400	165.0	\$ 1,000	\$ 165,000.00
2	Year 1-5	C-951	CIRCULAR	300	Upgraded to priority 1 based on comments from DNS Operations	400	40.0	\$ 1,000	\$ 40,000.00
2	Year 1-5	DML7101149	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00
2	Year 1-5	DML7101150	CIRCULAR	300		400	9.0	\$ 1,000	\$ 9,000.00
2	Year 1-5	DML7101152	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00
2	Year 1-5	DML7101741	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00
2	Year 1-5	DML7101742	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00
2	Year 1-5	DML7102918	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00
2	Year 1-5	DML7103121	CIRCULAR	300		400	15.0	\$ 1,000	\$ 15,000.00
2	Year 1-5	DML7107443	CIRCULAR	300		400	182.0	\$ 1,000	\$ 182,000.00
2	Year 1-5	DML7107444	CIRCULAR	300		400	122.0	\$ 1,000	\$ 122,000.00
2	Year 1-5	DML7107808	CIRCULAR	300		400	62.0	\$ 1,000	\$ 62,000.00
3	Year 1-5	10-1	HORIZ_ELLIPSE	500x680		700	53.0	\$ 1,600	\$ 84,800.00
3	Year 1-5	13A-7	HORIZ_ELLIPSE	500x680	Upgrade with DS culverts and ditches.	700	63.0	\$ 1,600	\$ 100,800.00
3	Year 1-5	13B-1	HORIZ_ELLIPSE	500x680	Upgrade with DS culverts and ditches.	700	12.0	\$ 1,600	\$ 19,200.00
3	Year 1-5	DML7107130_2	CIRCULAR	800		900	41.0	\$ 1,800	\$ 73,800.00
3	Year 1-5	DML7109644	CIRCULAR	710		800	20.0	\$ 1,700	\$ 34,000.00
3	Year 1-5	DML7109627	CIRCULAR	700		800	6.0	\$ 1,700	\$ 10,200.00
3	Year 1-5	DML7101403	CIRCULAR	645		700	18.0	\$ 1,600	\$ 28,800.00
3	Year 1-5	C-1002	CIRCULAR	600		700	6.0	\$ 1,600	\$ 9,600.00
3	Year 1-5	DML7100573	CIRCULAR	600	Upgrade to match US 1000mm culvert.	700	17.0	\$ 1,600	\$ 27,200.00
3	Year 1-5	DML7100796	CIRCULAR	600		700	10.0	\$ 1,600	\$ 16,000.00
3	Year 1-5	DML7101199	CIRCULAR	600		700	10.0	\$ 1,600	\$ 16,000.00
3	Year 1-5	DML7101584	CIRCULAR	600		700	7.0	\$ 1,600	\$ 11,200.00
3	Year 1-5	DML7101586	CIRCULAR	600	Regrading due to neg. slope. Upgrade neg. sloped 300mm DS culvert C716.	700	3.0	\$ 1,600	\$ 4,800.00
3	Year 1-5	DML7101587	CIRCULAR	600		700	6.0	\$ 1,600	\$ 9,600.00
3	Year 1-5	DML7101589	CIRCULAR	600		700	6.0	\$ 1,600	\$ 9,600.00
3	Year 1-5	DML7101591	CIRCULAR	600	Regrading due to neg. slope. Upgrade neg. sloped 300mm DS culvert C716.	700	6.0	\$ 1,600	\$ 9,600.00
3	Year 1-5	DML7103138	CIRCULAR	600		700	17.0	\$ 1,600	\$ 27,200.00
3	Year 1-5	DML7105288	CIRCULAR	600	Regrade culvert and upgrade 450mm DS culvert C-599	700	19.0	\$ 1,600	\$ 30,400.00
3	Year 1-5	DML7106668	CIRCULAR	600	Upgrade pipe with DS pipes C-599, DML7109702, DML7109706, DML7109709, DML7109712, DML7109715, DML7109717	700	87.0	\$ 1,600	\$ 139,200.00
3	Year 1-5	DML7107167	CIRCULAR	600	Upgrade with 600mm DS culvert DML7107733	700	98.0	\$ 1,600	\$ 156,800.00
3	Year 1-5	DML7107177	CIRCULAR	600	Upgrade with 600mm DS culvert DML7107177	700	13.0	\$ 1,600	\$ 20,800.00
3	Year 1-5	DML7107221	CIRCULAR	600	Upgrade and regrade culvert.	700	13.0	\$ 1,600	\$ 20,800.00
3	Year 1-5	DML7107282	CIRCULAR	600		700	14.0	\$ 1,600	\$ 22,400.00
3	Year 6 -10	DML7107733	CIRCULAR	600		700	229.0	\$ 1,600	\$ 366,400.00
3	Year 6 -10	DML7107793	CIRCULAR	600		700	30.0	\$ 1,600	\$ 48,000.00
3	Year 6 -10	DML7107896	CIRCULAR	600		700	77.0	\$ 1,600	\$ 123,200.00
3	Year 6 -10	DML7108224	CIRCULAR	600		700	43.0	\$ 1,600	\$ 68,800.00
3	Year 6 -10	MU-860A	CIRCULAR	600	Regrade as neg. sloped	700	12.0	\$ 1,600	\$ 19,200.00
3	Year 6 -10	DML7101190	CIRCULAR	550		600	12.0	\$ 1,400	\$ 16,800.00
3	Year 6 -10	DML7102090	CIRCULAR	510		600	13.0	\$ 1,400	\$ 18,200.00
3	Year 6 -10	CML7107806	CIRCULAR	500		600	43.0	\$ 1,400	\$ 60,200.00
3	Year 6 -10	DML7100797	CIRCULAR	500		600	12.0	\$ 1,400	\$ 16,800.00
3	Year 6 -10	DML7100865	CIRCULAR	500	Regrading of culvert and US and DS ditches for a more continous slope.	600	12.0	\$ 1,400	\$ 16,800.00
3	Year 6 -10	DML7100977	CIRCULAR	500	Upgrade to match 800mm US culvert and regrade ditch for contious slope US and DS.	600	5.0	\$ 1,400	\$ 7,000.00
3	Year 6 -10	DML7101220	CIRCULAR	500		600	7.0	\$ 1,400	\$ 9,800.00
3	Year 6 -10	DML7101227	CIRCULAR	500		600	12.0	\$ 1,400	\$ 16,800.00
3	Year 6 -10	DML7101318	CIRCULAR	500	Regrade culvert due to neg. slope and upgrade 300mm and 375mm DS culvert DML7107933, DML7107205.	600	13.0	\$ 1,400	\$ 18,200.00
3	Year 6 -10	DML7101595	CIRCULAR	500		600	7.0	\$ 1,400	\$ 9,800.00
3	Year 6 -10	DML7102933	CIRCULAR	500	Regrade culvert and US ditch to match a more continous slope.	600	10.0	\$ 1,400	\$ 14,000.00
3	Year 6 -10	DML7103105	CIRCULAR	500		600	6.0	\$ 1,400	\$ 8,400.00
3	Year 6 -10	DML7103106	CIRCULAR	500		600	6.0	\$ 1,400	\$ 8,400.00
3	Year 6 -10	DML7103228	CIRCULAR	500		600	6.0	\$ 1,400	\$ 8,400.00
3	Year 6 -10	DML7107283	CIRCULAR	460	Upgrade with 510mm DS culvert DML7102090	500	8.0	\$ 1,200	\$ 9,600.00
3	Year 6 -10	11A-3	CIRCULAR	450		500	17.0	\$ 1,200	\$ 20,400.00
3	Year 6 -10	11A-5	CIRCULAR	450		500	7.0	\$ 1,200	\$ 8,400.00
3	Year 6 -10	C-1006	CIRCULAR	450		500	13.0	\$ 1,200	\$ 15,600.00
3	Year 6 -10	C-152	CIRCULAR	450	Upgrade culvert and DS culvert after regrading and upgrading of DS ditch and 300mm culvert.	500	10.0	\$ 1,200	\$ 12,000.00
3	Year 6 -10	C-599	CIRCULAR	450		500	112.0	\$ 1,200	\$ 134,400.00
3	Year 6 -10	C-936	CIRCULAR	450	Upgrade with 450mm DS storm sewer C-937.	500	162.0	\$ 1,200	\$ 194,400.00
3	Year 6 -10	C-937	CIRCULAR	450		500	128.0	\$ 1,200	\$ 153,600.00
3	Year 6 -10	C-938	CIRCULAR	450	Upgrade with US and DS storm sewers.	500	151.0	\$ 1,200	\$ 181,200.00
3	Year 6 -10	C-939	CIRCULAR	450		500	168.0	\$ 1,200	\$ 201,600.00
3	Year 6 -10	C-940	CIRCULAR	450		500	234.0	\$ 1,200	\$ 280,800.00
3	Year 6 -10	C-941	CIRCULAR	450		500	215.0	\$ 1,200	\$ 258,000.00
3	Year 6 -10	C-942	CIRCULAR	450		500	34.0	\$ 1,200	\$ 40,800.00
3	Year 6 -10	C-943	CIRCULAR	450		500	86.0	\$ 1,200	\$ 103,200.00
3	Year 6 -10	C-946	CIRCULAR	450		500	126.0	\$ 1,200	\$ 151,200.00
3	Year 6 -10	DML7101594	CIRCULAR	450		500	4.0	\$ 1,200	\$ 4,800.00
3	Year 6 -10	DML7102191	CIRCULAR	450		500	6.0	\$ 1,200	\$ 7,200.00
3	Year 6 -10	DML7102914	CIRCULAR	450		500	16.0	\$ 1,200	\$ 19,200.00
3	Year 6 -10	DML7103118	CIRCULAR	450		500	6.0	\$ 1,200	\$ 7,200.00
3	Year 6 -10	DML7105289	CIRCULAR	450	Upgrade pipe with DS pipes C-599, DML7109702, DML7109706, DML7109709, DML7109712, DML7109715, DML7109717	500	34.0	\$ 1,200	\$ 40,800.00
3	Year 6 -10	DML7107154	CIRCULAR	450		500	35.0	\$ 1,200	\$ 42,000.00
3	Year 6 -10	DML7107393	CIRCULAR	450		500	8.0	\$ 1,200	\$ 9,600.00
3	Year 6 -10	DML7107801	CIRCULAR	450	Upgrade culvert and regrade DS ditch and 300mm culvert	500	3.0	\$ 1,200	\$ 3,600.00
3	Year 6 -10	DML7108177	CIRCULAR	450		500	40.0	\$ 1,200	\$ 48,000.00
3	Year 6 -10	DML7109586	CIRCULAR	450		500	8.0	\$ 1,200	\$ 9,600.00
3	Year 6 -10	DML7109702	CIRCULAR	450		500	5.0	\$ 1,200	\$ 6,000.00
3	Year 6 -10	DML7109706	CIRCULAR	450		500	5.0	\$ 1,200	\$ 6,000.00
3	Year 6 -10	DML7109709	CIRCULAR	450		500	5.0	\$ 1,200	\$ 6,000.00
3	Year 6 -10	DML7109712	CIRCULAR	450		500	5.0	\$ 1,200	\$ 6,000.00
3	Year 6 -10	DML7109715	CIRCULAR	450		500	5.0	\$ 1,200	\$ 6,000.00
3	Year 6 -10	DML7109717	CIRCULAR	450		500	3.0	\$ 1,200	\$ 3,600.00
3	Year 6 -10	DML7102965	CIRCULAR	410		500	13.0	\$ 1,200	\$ 15,600.00
3	Year 6 -10	DML7107795	CIRCULAR	410		500	3.0	\$ 1,200	\$ 3,600.00
3	Year 6 -10	C-1000	CIRCULAR	400		500	11.0	\$ 1,200	\$ 13,200.00
3	Year 6 -10	C-1001_4	CIRCULAR	400		500	6.0	\$ 1,200	\$ 7,200.00
3	Year 6 -10	DML7100762	CIRCULAR	400		500	9.0	\$ 1,200	\$ 10,800.00
3	Year 6 -10	DML7100917	CIRCULAR	400		500	3.0	\$ 1,200	\$ 3,600.00
3	Year 6 -10	DML7100928	CIRCULAR	400		500	3.0	\$ 1,200	\$ 3,600.00
3	Year 6 -10	DML7101020	CIRCULAR	400	Regrade culvert due to neg. slope and upgrade 350mm DS culvert DML7101019.	500	6.0	\$ 1,200	\$ 7,200.00
3	Year 6 -10	DML7101162	CIRCULAR	400		500	6.0	\$ 1,200	\$ 7,200.00
3	Year 6 -10	DML7101201	CIRCULAR	400		500	6.0	\$ 1,200	\$ 7,200.00
3	Year 6 -10	DML7101233	CIRCULAR	400		500	8.0	\$ 1,200	\$ 9,600.00

Subtotal Cost Year 1-5
\$ 2,992,800.00



Prioritization Class (1 High - 4 Low)	Year	Conduit ID	Cross-Section	Existing Pipe Diameter/Size (mm)	Assessment of Upgrade/Comments	Proposed Pipe Diameter/Size (mm)	Pipe Length (m)	Unit Cost Upgrade (\$/m)	Replacement Cost (\$)	
3	Year 6 -10	DML7101377	CIRCULAR	400		500	16.0	\$ 1,200	\$ 19,200.00	
3	Year 6 -10	DML7101596	CIRCULAR	400		500	5.0	\$ 1,200	\$ 6,000.00	
3	Year 6 -10	DML7101645	CIRCULAR	400		500	9.0	\$ 1,200	\$ 10,800.00	
3	Year 6 -10	DML7101687	CIRCULAR	400		500	7.0	\$ 1,200	\$ 8,400.00	
3	Year 6 -10	DML7101688	CIRCULAR	400		500	9.0	\$ 1,200	\$ 10,800.00	
3	Year 6 -10	DML7102158	CIRCULAR	400		500	6.0	\$ 1,200	\$ 7,200.00	
3	Year 6 -10	DML7102192	CIRCULAR	400		500	6.0	\$ 1,200	\$ 7,200.00	Subtotal Cost Year 6-10
3	Year 11-15	DML7102222	CIRCULAR	400	Regrade neg. sloped culvert to match continous sloping US and DS.	500	6.0	\$ 1,200	\$ 7,200.00	\$ 3,004,400.00
3	Year 11-15	DML7102267	CIRCULAR	400	Upgrade culvert and 300mm DS culvert DML7102258.	500	5.0	\$ 1,200	\$ 6,000.00	
3	Year 11-15	DML7102908	CIRCULAR	400		500	15.0	\$ 1,200	\$ 18,000.00	
3	Year 11-15	DML7107206	CIRCULAR	400		500	12.0	\$ 1,200	\$ 14,400.00	
3	Year 11-15	DML7107207	CIRCULAR	400		500	5.0	\$ 1,200	\$ 6,000.00	
3	Year 11-15	DML7107208	CIRCULAR	400	Upgrade with 400mm DS culvert DML7107208	500	4.0	\$ 1,200	\$ 4,800.00	
3	Year 11-15	DML7108924	CIRCULAR	400		500	43.0	\$ 1,200	\$ 51,600.00	
3	Year 11-15	C-947	CIRCULAR	375	Upgrade with US and DS storm sewers.	400	74.0	\$ 1,000	\$ 74,000.00	
3	Year 11-15	DML7106589	CIRCULAR	375		400	66.0	\$ 1,000	\$ 66,000.00	
3	Year 11-15	C-1016	CIRCULAR	350		400	12.0	\$ 1,000	\$ 12,000.00	
3	Year 11-15	C-1018	CIRCULAR	350	Upgrade to 450mm culvert similar to DS culvert.	400	8.0	\$ 1,000	\$ 8,000.00	
3	Year 11-15	Cn-40	CIRCULAR	350		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7100735	CIRCULAR	350		400	13.0	\$ 1,000	\$ 13,000.00	
3	Year 11-15	DML7100744	CIRCULAR	350		400	3.0	\$ 1,000	\$ 3,000.00	
3	Year 11-15	DML7101019	CIRCULAR	350		400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	DML7101232	CIRCULAR	350		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102250	CIRCULAR	350		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102852	CIRCULAR	350		400	14.0	\$ 1,000	\$ 14,000.00	
3	Year 11-15	DML7102913	CIRCULAR	350		400	17.0	\$ 1,000	\$ 17,000.00	
3	Year 11-15	DML7107211	CIRCULAR	350		400	14.0	\$ 1,000	\$ 14,000.00	
3	Year 11-15	DML7100469	CIRCULAR	310		400	17.0	\$ 1,000	\$ 17,000.00	
3	Year 11-15	DML7103246	CIRCULAR	310		400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	DML7107179	CIRCULAR	310	Upgrade with 300mm DS culverts C-567, C-572	400	3.0	\$ 1,000	\$ 3,000.00	
3	Year 11-15	DML7109651	CIRCULAR	310		400	8.0	\$ 1,000	\$ 8,000.00	
3	Year 11-15	12A-1	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00	
3	Year 11-15	12A-11	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	12A-3	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00	
3	Year 11-15	13-1	CIRCULAR	300		400	12.0	\$ 1,000	\$ 12,000.00	
3	Year 11-15	13-3	CIRCULAR	300		400	18.0	\$ 1,000	\$ 18,000.00	
3	Year 11-15	13A-5	CIRCULAR	300		400	10.0	\$ 1,000	\$ 10,000.00	
3	Year 11-15	C-1001	CIRCULAR	300		400	12.0	\$ 1,000	\$ 12,000.00	
3	Year 11-15	C-1024	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	C-161	CIRCULAR	300		400	17.0	\$ 1,000	\$ 17,000.00	
3	Year 11-15	C-183	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00	
3	Year 11-15	C-27	CIRCULAR	300		400	3.0	\$ 1,000	\$ 3,000.00	
3	Year 11-15	C-293	CIRCULAR	300		400	20.0	\$ 1,000	\$ 20,000.00	
3	Year 11-15	C-491	CIRCULAR	300		400	17.0	\$ 1,000	\$ 17,000.00	
3	Year 11-15	C-524	CIRCULAR	300	Upgrade with DS culverts DML7101406, DML7103258.	400	82.0	\$ 1,000	\$ 82,000.00	
3	Year 11-15	C-565	CIRCULAR	300	Upgrade with DS culverts and ditches C-565, DML7107179, C-567, C-572.	400	18.0	\$ 1,000	\$ 18,000.00	
3	Year 11-15	C-567	CIRCULAR	300		400	14.0	\$ 1,000	\$ 14,000.00	
3	Year 11-15	C-572	CIRCULAR	300		400	12.0	\$ 1,000	\$ 12,000.00	
3	Year 11-15	C-583	CIRCULAR	300		400	12.0	\$ 1,000	\$ 12,000.00	
3	Year 11-15	C-624	CIRCULAR	300	Upgrade with DS culvert C-630, optimize DS stormsewer slopes.	400	10.0	\$ 1,000	\$ 10,000.00	
3	Year 11-15	C-630	CIRCULAR	300		400	21.0	\$ 1,000	\$ 21,000.00	
3	Year 11-15	C-716	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	C-751	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	C-782	CIRCULAR	300		400	3.0	\$ 1,000	\$ 3,000.00	
3	Year 11-15	C-788	CIRCULAR	300		400	11.0	\$ 1,000	\$ 11,000.00	
3	Year 11-15	C-866	CIRCULAR	300		400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	C-928	CIRCULAR	300		400	20.0	\$ 1,000	\$ 20,000.00	
3	Year 11-15	C-962	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00	
3	Year 11-15	C-964	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7100729	CIRCULAR	300		400	3.0	\$ 1,000	\$ 3,000.00	
3	Year 11-15	DML7100738	CIRCULAR	300	Upgrade with 300mm DS culverts DML7101618, C-788.	400	3.0	\$ 1,000	\$ 3,000.00	
3	Year 11-15	DML7100749	CIRCULAR	300		400	11.0	\$ 1,000	\$ 11,000.00	
3	Year 11-15	DML7100754	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7100757	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7100764	CIRCULAR	300		400	15.0	\$ 1,000	\$ 15,000.00	
3	Year 11-15	DML7100771	CIRCULAR	300		400	4.0	\$ 1,000	\$ 4,000.00	
3	Year 11-15	DML7100876	CIRCULAR	300		400	5.0	\$ 1,000	\$ 5,000.00	
3	Year 11-15	DML7100918	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7100943	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7100944	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7100976	CIRCULAR	300	Upgrade with 450mm DS storm sewer C-152.	400	8.0	\$ 1,000	\$ 8,000.00	
3	Year 11-15	DML7100978	CIRCULAR	300		400	13.0	\$ 1,000	\$ 13,000.00	
3	Year 11-15	DML7100979	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101054	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101159	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101163	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101188	CIRCULAR	300		400	4.0	\$ 1,000	\$ 4,000.00	
3	Year 11-15	DML7101189	CIRCULAR	300		400	4.0	\$ 1,000	\$ 4,000.00	
3	Year 11-15	DML7101202	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101203	CIRCULAR	300		400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	DML7101204	CIRCULAR	300		400	14.0	\$ 1,000	\$ 14,000.00	
3	Year 11-15	DML7101205	CIRCULAR	300		400	11.0	\$ 1,000	\$ 11,000.00	
3	Year 11-15	DML7101207	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00	
3	Year 11-15	DML7101208	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101231	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101406	CIRCULAR	300		400	12.0	\$ 1,000	\$ 12,000.00	
3	Year 11-15	DML7101556	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101577	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00	
3	Year 11-15	DML7101608	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101609	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101610	CIRCULAR	300		400	15.0	\$ 1,000	\$ 15,000.00	
3	Year 11-15	DML7101616	CIRCULAR	300		400	8.0	\$ 1,000	\$ 8,000.00	
3	Year 11-15	DML7101618	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101630	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101631	CIRCULAR	300		400	8.0	\$ 1,000	\$ 8,000.00	
3	Year 11-15	DML7101664	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101672	CIRCULAR	300		400	5.0	\$ 1,000	\$ 5,000.00	
3	Year 11-15	DML7101679	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7101701	CIRCULAR	300		400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	DML7102137	CIRCULAR	300		400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	DML7102141	CIRCULAR	300		400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	DML7102142	CIRCULAR	300		400	8.0	\$ 1,000	\$ 8,000.00	
3	Year 11-15	DML7102143	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102159	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102160	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102161	CIRCULAR	300		400	15.0	\$ 1,000	\$ 15,000.00	
3	Year 11-15	DML7102172	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102179	CIRCULAR	300		400	18.0	\$ 1,000	\$ 18,000.00	
3	Year 11-15	DML7102180	CIRCULAR	300		400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	DML7102209	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102246	CIRCULAR	300	Upgrade culvert and 300mm DS culverts. Regrade ditch and culverts for min. slope	400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	DML7102258	CIRCULAR	300		400	9.0	\$ 1,000	\$ 9,000.00	
3	Year 11-15	DML7102350	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102351	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102352	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102353	CIRCULAR	300		400	22.0	\$ 1,000	\$ 22,000.00	
3	Year 11-15	DML7102355	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102467	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102468	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102470	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00	
3	Year 11-15	DML7102471	CIRCULAR	300		400				



Prioritization Class (1 High - 4 Low)	Year	Conduit ID	Cross-Section	Existing Pipe Diameter/Size (mm)	Assessment of Upgrade/Comments	Proposed Pipe Diameter/Size (mm)	Pipe Length (m)	Unit Cost Upgrade (\$/m)	Replacement Cost (\$)
3	Year 11-15	DML7103258	CIRCULAR	300	Regrade neg. sloped culvert and ditches with a continous min. slope.	400	6.0	\$ 1,000	\$ 6,000.00
3	Year 11-15	DML7103377	CIRCULAR	300		400	6.0	\$ 1,000	\$ 6,000.00
3	Year 11-15	DML7103385	CIRCULAR	300	Upgrade with 300mm DS culvert C-572	400	12.0	\$ 1,000	\$ 12,000.00
3	Year 11-15	DML7107180	CIRCULAR	300		400	11.0	\$ 1,000	\$ 11,000.00
3	Year 11-15	DML7107205	CIRCULAR	300	Upgrade with 300mm DS culvert DML7107253	400	84.0	\$ 1,000	\$ 84,000.00
3	Year 11-15	DML7107252	CIRCULAR	300		400	12.0	\$ 1,000	\$ 12,000.00
3	Year 11-15	DML7107253	CIRCULAR	300	Upgrade with 300mm DS culvert DML7107253	400	53.0	\$ 1,000	\$ 53,000.00
3	Year 11-15	DML7107254	CIRCULAR	300		400	20.0	\$ 1,000	\$ 20,000.00
3	Year 11-15	DML7107403	CIRCULAR	300		400	10.0	\$ 1,000	\$ 10,000.00
3	Year 11-15	DML7107463	CIRCULAR	300		400	7.0	\$ 1,000	\$ 7,000.00
3	Year 11-15	DML7107464	CIRCULAR	300	Upgrade with 300mm DS culvert DML7109652	400	7.0	\$ 1,000	\$ 7,000.00
3	Year 11-15	DML7107517	CIRCULAR	300		400	8.0	\$ 1,000	\$ 8,000.00
3	Year 11-15	DML7107780	CIRCULAR	300		400	13.0	\$ 1,000	\$ 13,000.00
3	Year 11-15	DML7107788	CIRCULAR	300		400	11.0	\$ 1,000	\$ 11,000.00
3	Year 11-15	DML7107789	CIRCULAR	300	Upgrade with 300mm DS culverts DML7107788, DML7107792	400	3.0	\$ 1,000	\$ 3,000.00
3	Year 11-15	DML7107790	CIRCULAR	300		400	5.0	\$ 1,000	\$ 5,000.00
3	Year 11-15	DML7107792	CIRCULAR	300		400	42.0	\$ 1,000	\$ 42,000.00
3	Year 11-15	DML7107796	CIRCULAR	300	Upgrade culvert	400	3.0	\$ 1,000	\$ 3,000.00
3	Year 11-15	DML7107810	CIRCULAR	300	Upgrade with 300mm DS culvert DML7107812	400	8.0	\$ 1,000	\$ 8,000.00
3	Year 11-15	DML7107811	CIRCULAR	300	Upgrade with 300mm DS culvert DML7107812	400	2.0	\$ 1,000	\$ 2,000.00
3	Year 11-15	DML7107812	CIRCULAR	300		400	10.0	\$ 1,000	\$ 10,000.00
3	Year 11-15	DML7107869	CIRCULAR	300		400	10.0	\$ 1,000	\$ 10,000.00
3	Year 11-15	DML7109653	CIRCULAR	300		400	29.0	\$ 1,000	\$ 29,000.00
3	Year 11-15	WI-340	CIRCULAR	300		400	10.0	\$ 1,000	\$ 10,000.00
Hydraulic Upgrades Total Costs									\$ 7,789,200.00

Condition Replacements - Linear Drainage Infrastructure

Priority Class (1 High - 4 Low)	Year	Asset ID		Pipe Diameter (mm)		Pipe Material	Pipe Lenth (m)	Unit Cost Replacement (\$/m)	Replacement Cost (\$)
3	Year 11-15	DML7100711		600		CSP	11.0	\$ 1,400.00	\$ 15,400.00
3	Year 11-15	DML7100828		350		CSP	4.3	\$ 850.00	\$ 3,655.00
3	Year 11-15	DML7100829		600		CSP	8.8	\$ 1,400.00	\$ 12,320.00
3	Year 11-15	DML7100870		350		CSP	6.2	\$ 850.00	\$ 5,270.00
3	Year 11-15	DML7101147		350		CSP	6.2	\$ 850.00	\$ 5,270.00
3	Year 11-15	DML7101154		300		CSP	3.2	\$ 850.00	\$ 2,720.00
3	Year 11-15	DML7101157		500		CSP	6.2	\$ 1,200.00	\$ 7,440.00
3	Year 11-15	DML7102181		300		CSP	8.8	\$ 850.00	\$ 7,480.00
3	Year 11-15	DML7102217		800	Culvert has already been replaced in due to Nov. 2021 storm	CSP	24.4	\$ 1,700.00	\$ 41,480.00
3	Year 11-15	DML7102229		400		CSP	6.1	\$ 1,000.00	\$ 6,100.00
3	Year 11-15	DML7102235		300		CSP	3.7	\$ 850.00	\$ 3,145.00
3	Year 11-15	DML7102238		300		CSP	9.6	\$ 850.00	\$ 8,160.00
3	Year 11-15	DML7102686		300		CSP	7.5	\$ 850.00	\$ 6,375.00
3	Year 11-15	DML7102714		300		CSP	6.2	\$ 850.00	\$ 5,270.00
3	Year 11-15	DML7102715		250		CSP	6.1	\$ 650.00	\$ 3,965.00
3	Year 11-15	DML7102717		300		CSP	6.2	\$ 850.00	\$ 5,270.00
3	Year 11-15	DML7102718		300		CSP	6.2	\$ 850.00	\$ 5,270.00
3	Year 11-15	DML7102719		300		CSP	6.1	\$ 850.00	\$ 5,185.00
3	Year 11-15	DML7102847		300		CSP	6.2	\$ 850.00	\$ 5,270.00
3	Year 11-15	DML7102855		600		CSP	15.7	\$ 1,400.00	\$ 21,980.00
3	Year 11-15	DML7102902		700		CSP	9.4	\$ 1,600.00	\$ 15,040.00
3	Year 11-15	DML7102980		300		CSP	9.6	\$ 850.00	\$ 8,160.00
3	Year 11-15	DML7103019		300		CSP	3.0	\$ 850.00	\$ 2,550.00
3	Year 11-15	DML7107335		1050		CSP	115.4	\$ 1,800.00	\$ 207,720.00
3	Year 11-15	DML7107980		500		CSP	15.4	\$ 1,200.00	\$ 18,480.00
3	Year 11-15	DML7100555*		450		Conc	8.9	\$ 1,000.00	\$ 8,900.00
3	Year 11-15	DML7100555*		450		Conc	5.2	\$ 1,000.00	\$ 5,200.00
3	Year 11-15	DML7100562		300		CSP	9.3	\$ 850.00	\$ 7,905.00
3	Year 11-15	DML7100565		300		CSP	5.8	\$ 850.00	\$ 4,930.00
4	Year 11-15	DML7100567		400		CSP	13.9	\$ 850.00	\$ 11,815.00
4	Year 11-15	DML7100584		300		CSP	7.0	\$ 850.00	\$ 5,950.00
4	Year 11-15	DML7100586		300		CSP	7.8	\$ 850.00	\$ 6,630.00
4	Year 11-15	DML7100588		300		CSP	7.6	\$ 850.00	\$ 6,460.00
4	Year 11-15	DML7100613		450		CSP	8.6	\$ 1,000.00	\$ 8,600.00
4	Year 11-15	DML7100646		450		CSP	6.4	\$ 1,000.00	\$ 6,400.00
4	Year 11-15	DML7100664		300		CSP	6.6	\$ 850.00	\$ 5,610.00
4	Year 11-15	DML7100673		300		CSP	6.5	\$ 850.00	\$ 5,525.00
4	Year 11-15	DML7100674		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 11-15	DML7100675		300		Conc	13.8	\$ 850.00	\$ 11,730.00
4	Year 11-15	DML7100680		300		Conc	7.2	\$ 850.00	\$ 6,120.00
4	Year 11-15	DML7100685		300		CSP	7.2	\$ 850.00	\$ 6,120.00
4	Year 11-15	DML7100688		250		Conc	8.8	\$ 650.00	\$ 5,720.00
4	Year 11-15	DML7100691		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 11-15	DML7100706		350		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 11-15	DML7100707		300		CSP	9.3	\$ 850.00	\$ 7,905.00
4	Year 11-15	DML7100708		300		CSP	6.9	\$ 850.00	\$ 5,865.00
4	Year 11-15	DML7100727		300		CSP	2.8	\$ 850.00	\$ 2,380.00
4	Year 11-15	DML7100728		300		CSP	3.0	\$ 850.00	\$ 2,550.00
4	Year 11-15	DML7100732		300		CSP	15.0	\$ 850.00	\$ 12,750.00
4	Year 11-15	DML7100739		400		CSP	6.1	\$ 1,000.00	\$ 6,100.00
4	Year 11-15	DML7100746		300		CSP	5.8	\$ 850.00	\$ 4,930.00
4	Year 11-15	DML7100747		300		CSP	6.5	\$ 850.00	\$ 5,525.00
4	Year 11-15	DML7100750		300		CSP	3.1	\$ 850.00	\$ 2,635.00
4	Year 11-15	DML7100755		300		CSP	8.0	\$ 850.00	\$ 6,800.00
4	Year 11-15	DML7100761		300		CSP	16.5	\$ 850.00	\$ 14,025.00
4	Year 11-15	DML7100763		300		CSP	10.8	\$ 850.00	\$ 9,180.00
4	Year 11-15	DML7100766		300		CSP	6.9	\$ 850.00	\$ 5,865.00
4	Year 11-15	DML7100767		300		CSP	5.6	\$ 850.00	\$ 4,760.00
4	Year 11-15	DML7100768		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 11-15	DML7100776		350		CSP	2.8	\$ 850.00	\$ 2,380.00
4	Year 11-15	DML7100784		300		Conc	7.4	\$ 850.00	\$ 6,290.00
4	Year 11-15	DML7100785		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 11-15	DML7100799		600		CSP	12.7	\$ 1,400.00	\$ 17,780.00
4	Year 11-15	DML7100836		350		CSP	14.6	\$ 850.00	\$ 12,410.00
4	Year 11-15	DML7100842		400		CSP	16.4	\$ 1,000.00	\$ 16,400.00
4	Year 11-15	DML7100855		500		CSP	15.1	\$ 1,200.00	\$ 18,120.00
4	Year 11-15	DML7100885		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 11-15	DML7100887		300		CSP	12.4	\$ 850.00	\$ 10,540.00
4	Year 11-15	DML7100888		300		CSP	7.0	\$ 850.00	\$ 5,950.00
4	Year 11-15	DML7100889		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 11-15	DML7100890		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 11-15	DML7100891		300		CSP	6.4	\$ 850.00	\$ 5,440.00
4	Year 11-15	DML7100892		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 11-15	DML7100893		400		CSP	6.2	\$ 1,000.00	\$ 6,200.00
4	Year 11-15	DML7100895		350		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 11-15	DML7100907		300		CSP	9.3	\$ 850.00	\$ 7,905.00
4	Year 11-15	DML7100913		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 11-15	DML7100931		300		CSP	6.8	\$ 850.00	\$ 5,780.00
4	Year 11-15	DML7100933		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 11-15	DML7100946		300		CSP	7.5	\$ 850.00	\$ 6,375.00
4	Year 11-15	DML7100948		300		CSP	3.1	\$ 850.00	\$ 2,635.00
4	Year 11-15	DML7100952		300		CSP	9.3	\$ 850.00	\$ 7,905.00
4	Year 11-15	DML7100960		300		CSP	6.9	\$ 850.00	\$ 5,865.00
4	Year 11-15	DML7100961		300		CSP	7.0	\$ 850.00	\$ 5,950.00
4	Year 11-15	DML7100962		300		CSP	6.8	\$ 850.00	\$ 5,780.00
4	Year 11-15	DML7100963		300		CSP	9.1	\$ 850.00	\$ 7,735.00
4	Year 11-15	DML7100965		300		CSP	3.7	\$ 850.00	\$ 3,145.00
4	Year 11-15	DML7100975		300		CSP	9.3	\$ 850.00	\$ 7,905.00
4	Year 11-15	DML7101012		400		CSP	9.8	\$ 1,000.00	\$ 9,800.00
4	Year 11-15	DML7101021		300		CSP	20.5	\$ 850.00	\$ 17,425.00
4	Year 11-15	DML7101038		300		CSP	6.4	\$ 850.00	\$ 5,440.00
4	Year 11-15	DML7101048		300		CSP	11.3	\$ 850.00	\$ 9,605.00
4	Year 11-15	DML7101089		400		CSP	5.9	\$ 1,000.00	\$ 5,900.00
4	Year 11-15	DML7101091		300		CSP	5.9	\$ 850.00	\$ 5,015.00
4	Year 11-15	DML7101095		0		CSP	5.7	\$ 650.00	\$ 3,705.00
4	Year 11-15	DML7101104		500		CSP	12.0	\$ 1,200.00	\$ 14,400.00
4	Year 11-15	DML7101109		350		CSP	2.8	\$ 850.00	\$ 2,380.00
4	Year 11-15	DML7101115		300		CSP	3.1	\$ 850.00	\$ 2,635.00
4	Year 11-15	DML7101143		500		CSP	8.7	\$ 1,200.00	\$ 10,440.00
4	Year 11-15	DML7101173		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 11-15	DML7101175		300		CSP	9.2	\$ 850.00	\$ 7,820.00
4	Year 11-15	DML7101193		500		CSP	19.9	\$ 1,200.00	\$ 23,880.00
4	Year 11-15	DML7101212		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 11-15	DML7101216		300		CSP	9.3	\$ 850.00	\$ 7,905.00
4	Year 11-15	DML7101225		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 11-15	DML7101229		300		Conc	8.5	\$ 850.00	\$ 7,225.00
4	Year 11-15	DML7101239		400		Conc	10.0	\$ 1,000.00	\$ 10,000.00
4	Year 11-15	DML7101244		350		CSP	6.7	\$ 850.00	\$ 5,695.00
4	Year 11-15	DML7101246		300		CSP	9.4	\$ 850.00	\$ 7,990.00
4	Year 11-15	DML7101251		300		CSP	6.8	\$ 850.00	\$ 5,780.00
4	Year 11-15	DML7101252		300		Conc	6.6	\$ 850.00	\$ 5,610.00
4	Year 11-15	DML7101255		300		CSP	10.0	\$ 850.00	\$ 8,500.00



Priority Class (1 High - 4 Low)	Year	Asset ID		Pipe Diameter (mm)		Pipe Material	Pipe Lenth (m)	Unit Cost Replacement (\$/m)	Replacement Cost (\$)	
4	Year 11-15	DML7101280		300		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 11-15	DML7101292		300		CSP	6.0	\$ 850.00	\$ 5,100.00	
4	Year 11-15	DML7101293		300		CSP	10.1	\$ 850.00	\$ 8,585.00	
4	Year 11-15	DML7101302		300		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 11-15	DML7101311		300		CSP	9.2	\$ 850.00	\$ 7,820.00	
4	Year 11-15	DML7101312		300		CSP	10.7	\$ 850.00	\$ 9,095.00	
4	Year 11-15	DML7101317		300		CSP	10.0	\$ 850.00	\$ 8,500.00	
4	Year 11-15	DML7101340		200		PVC	6.3	\$ 650.00	\$ 4,095.00	
4	Year 11-15	DML7101341		300		CSP	14.6	\$ 850.00	\$ 12,410.00	
4	Year 11-15	DML7101344		300		CSP	6.3	\$ 850.00	\$ 5,355.00	
4	Year 11-15	DML7101345		300		CSP	5.9	\$ 850.00	\$ 5,015.00	
4	Year 11-15	DML7101349		300		Conc	8.1	\$ 850.00	\$ 6,885.00	
4	Year 11-15	DML7101357		300		CSP	6.5	\$ 850.00	\$ 5,525.00	
4	Year 11-15	DML7101359		300		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 11-15	DML7101364		350		Conc	8.6	\$ 850.00	\$ 7,310.00	
4	Year 11-15	DML7101373		300		CSP	3.5	\$ 850.00	\$ 2,975.00	
4	Year 11-15	DML7101380		300		CSP	48.8	\$ 650.00	\$ 31,720.00	
4	Year 11-15	DML7101388		300		CSP	8.7	\$ 850.00	\$ 7,395.00	
4	Year 11-15	DML7101411		300		CSP	3.0	\$ 850.00	\$ 2,550.00	
4	Year 16-20	DML7101418		350		CSP	7.2	\$ 850.00	\$ 6,120.00	
4	Year 16-20	DML7101419		450		CSP	6.1	\$ 1,000.00	\$ 6,100.00	
4	Year 16-20	DML7101425		300		CSP	7.0	\$ 650.00	\$ 4,550.00	
4	Year 16-20	DML7101426		300		CSP	6.3	\$ 850.00	\$ 5,355.00	
4	Year 16-20	DML7101433		300		CSP	6.6	\$ 850.00	\$ 5,610.00	
4	Year 16-20	DML7101461		350		CSP	9.0	\$ 850.00	\$ 7,650.00	
4	Year 16-20	DML7101467		350		CSP	8.4	\$ 850.00	\$ 7,140.00	
4	Year 16-20	DML7101469		350		CSP	3.8	\$ 850.00	\$ 3,230.00	
4	Year 16-20	DML7101471		300		CSP	6.1	\$ 850.00	\$ 5,185.00	
4	Year 16-20	DML7101482		250		CSP	7.5	\$ 650.00	\$ 4,875.00	
4	Year 16-20	DML7101497		300		CSP	6.1	\$ 850.00	\$ 5,185.00	
4	Year 16-20	DML7101535		300		CSP	5.9	\$ 850.00	\$ 5,015.00	
4	Year 16-20	DML7101537		300		CSP	6.8	\$ 850.00	\$ 5,780.00	
4	Year 16-20	DML7101541		600		0	7.9	\$ 1,400.00	\$ 11,060.00	
4	Year 16-20	DML7101542		400		Conc	9.2	\$ 1,000.00	\$ 9,200.00	
4	Year 16-20	DML7101551		300		CSP	6.4	\$ 850.00	\$ 5,440.00	
4	Year 16-20	DML7101554		300		CSP	6.6	\$ 850.00	\$ 5,610.00	
4	Year 16-20	DML7101555		300		CSP	6.4	\$ 850.00	\$ 5,440.00	
4	Year 16-20	DML7101558		300		CSP	6.3	\$ 850.00	\$ 5,355.00	
4	Year 16-20	DML7101562		400		CSP	9.3	\$ 1,000.00	\$ 9,300.00	
4	Year 16-20	DML7101563		400		CSP	17.5	\$ 1,000.00	\$ 17,500.00	
4	Year 16-20	DML7101564		400		CSP	9.3	\$ 1,000.00	\$ 9,300.00	
4	Year 16-20	DML7101565		400		CSP	9.1	\$ 1,000.00	\$ 9,100.00	
4	Year 16-20	DML7101566		400		CSP	9.0	\$ 1,000.00	\$ 9,000.00	
4	Year 16-20	DML7101570		300		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 16-20	DML7101578		650		CSP	12.3	\$ 1,400.00	\$ 17,220.00	
4	Year 16-20	DML7101579		650		CSP	11.7	\$ 1,400.00	\$ 16,380.00	
4	Year 16-20	DML7101581		600		CSP	6.1	\$ 1,400.00	\$ 8,540.00	
4	Year 16-20	DML7101597		300		CSP	6.6	\$ 850.00	\$ 5,610.00	
4	Year 16-20	DML7101599		300		CSP	6.6	\$ 850.00	\$ 5,610.00	
4	Year 16-20	DML7101605		300		CSP	6.4	\$ 850.00	\$ 5,440.00	
4	Year 16-20	DML7101611		400		CSP	10.4	\$ 1,000.00	\$ 10,400.00	
4	Year 16-20	DML7101626		350		CSP	6.9	\$ 850.00	\$ 5,865.00	
4	Year 16-20	DML7101627		300		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 16-20	DML7101634		300		CSP	6.1	\$ 850.00	\$ 5,185.00	
4	Year 16-20	DML7101648		300		CSP	6.4	\$ 850.00	\$ 5,440.00	
4	Year 16-20	DML7101651		300		CSP	6.0	\$ 850.00	\$ 5,100.00	
4	Year 16-20	DML7101658		300		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 16-20	DML7101675		300		CSP	7.2	\$ 850.00	\$ 6,120.00	
4	Year 16-20	DML7101676		300		CSP	7.6	\$ 850.00	\$ 6,460.00	
4	Year 16-20	DML7101678		300		CSP	6.3	\$ 850.00	\$ 5,355.00	
4	Year 16-20	DML7101690		300		CSP	8.7	\$ 850.00	\$ 7,395.00	
4	Year 16-20	DML7101691		350		CSP	15.4	\$ 850.00	\$ 13,090.00	
4	Year 16-20	DML7101692		300		CSP	8.7	\$ 850.00	\$ 7,395.00	
4	Year 16-20	DML7101697		300		CSP	7.7	\$ 850.00	\$ 6,545.00	
4	Year 16-20	DML7101698		300		Conc	10.9	\$ 850.00	\$ 9,265.00	
4	Year 16-20	DML7101705		300		CSP	7.9	\$ 850.00	\$ 6,715.00	
4	Year 16-20	DML7101719		300		CSP	9.2	\$ 850.00	\$ 7,820.00	
4	Year 16-20	DML7101731		300		CSP	18.2	\$ 850.00	\$ 15,470.00	
4	Year 16-20	DML7101746		300		Conc	6.7	\$ 850.00	\$ 5,695.00	
4	Year 16-20	DML7101751		300		CSP	2.8	\$ 850.00	\$ 2,380.00	
4	Year 16-20	DML7101753		300		CSP	6.1	\$ 850.00	\$ 5,185.00	
4	Year 16-20	DML7101756		300		CSP	6.1	\$ 850.00	\$ 5,185.00	
4	Year 16-20	DML7102104		300		CSP	6.4	\$ 850.00	\$ 5,440.00	
4	Year 16-20	DML7102105		300		CSP	8.0	\$ 850.00	\$ 6,800.00	
4	Year 16-20	DML7102112		300		CSP	6.1	\$ 850.00	\$ 5,185.00	
4	Year 16-20	DML7102122		450		CSP	7.8	\$ 1,000.00	\$ 7,800.00	
4	Year 16-20	DML7102131		300		CSP	8.7	\$ 850.00	\$ 7,395.00	
4	Year 16-20	DML7102136		300		CSP	6.3	\$ 850.00	\$ 5,355.00	
4	Year 16-20	DML7102145		300		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 16-20	DML7102147		300		CSP	10.6	\$ 850.00	\$ 9,010.00	
4	Year 16-20	DML7102149		300		CSP	6.5	\$ 850.00	\$ 5,525.00	
4	Year 16-20	DML7102151		300		CSP	7.7	\$ 850.00	\$ 6,545.00	
4	Year 16-20	DML7102152		300		CSP	7.3	\$ 850.00	\$ 6,205.00	
4	Year 16-20	DML7102153		300		CSP	6.9	\$ 850.00	\$ 5,865.00	
4	Year 16-20	DML7102154		300		CSP	7.3	\$ 850.00	\$ 6,205.00	
4	Year 16-20	DML7102155		300		CSP	7.4	\$ 850.00	\$ 6,290.00	
4	Year 16-20	DML7102156		300		CSP	7.2	\$ 850.00	\$ 6,120.00	
4	Year 16-20	DML7102162		500		CSP	6.4	\$ 1,200.00	\$ 7,680.00	
4	Year 16-20	DML7102163		300		CSP	7.1	\$ 850.00	\$ 6,035.00	
4	Year 16-20	DML7102166		500		CSP	6.1	\$ 1,200.00	\$ 7,320.00	
4	Year 16-20	DML7102175		300		CSP	7.0	\$ 850.00	\$ 5,950.00	
4	Year 16-20	DML7102178		300		CSP	6.1	\$ 850.00	\$ 5,185.00	
4	Year 16-20	DML7102182		300		CSP	6.9	\$ 650.00	\$ 4,485.00	
4	Year 16-20	DML7102183		350		CSP	10.2	\$ 850.00	\$ 8,670.00	
4	Year 16-20	DML7102184		300		CSP	12.4	\$ 850.00	\$ 10,540.00	
4	Year 16-20	DML7102185		300		CSP	6.6	\$ 850.00	\$ 5,610.00	
4	Year 16-20	DML7102212		300		CSP	5.6	\$ 850.00	\$ 4,760.00	
4	Year 16-20	DML7102215		300		CSP	7.8	\$ 850.00	\$ 6,630.00	
4	Year 16-20	DML7102220		300		CSP	8.0	\$ 850.00	\$ 6,800.00	
4	Year 16-20	DML7102223		300		CSP	6.3	\$ 850.00	\$ 5,355.00	
4	Year 16-20	DML7102231		350		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 16-20	DML7102243		300		CSP	6.1	\$ 850.00	\$ 5,185.00	
4	Year 16-20	DML7102245		300		CSP	11.2	\$ 850.00	\$ 9,520.00	
4	Year 16-20	DML7102248		400		CSP	8.3	\$ 1,000.00	\$ 8,300.00	
4	Year 16-20	DML7102254		500		CSP	4.8	\$ 1,200.00	\$ 5,760.00	
4	Year 16-20	DML7102256		400		CSP	17.0	\$ 1,000.00	\$ 17,000.00	
4	Year 16-20	DML7102257		300		CSP	7.8	\$ 850.00	\$ 6,630.00	
4	Year 16-20	DML7102259		300		CSP	6.6	\$ 850.00	\$ 5,610.00	
4	Year 16-20	DML7102260		500		CSP	9.2	\$ 650.00	\$ 5,980.00	
4	Year 16-20	DML7102269		450		CSP	6.6	\$ 1,000.00	\$ 6,600.00	
4	Year 16-20	DML7102277		300		CSP	9.4	\$ 850.00	\$ 7,990.00	
4	Year 16-20	DML7102278		300		CSP	6.6	\$ 850.00	\$ 5,610.00	
4	Year 16-20	DML7102279		300		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 16-20	DML7102281		300		CSP	8.5	\$ 850.00	\$ 7,225.00	
4	Year 16-20	DML7102282		300		CSP	7.3	\$ 850.00	\$ 6,205.00	
4	Year 16-20	DML7102357		300		CSP	6.1	\$ 850.00	\$ 5,185.00	
4	Year 16-20	DML7102361		300		CSP	6.2	\$ 850.00	\$ 5,270.00	
4	Year 16-20	DML7102364		300		CSP	4.8	\$ 850.00	\$ 4,080.00	
4	Year 16-20	DML7102372		400		CSP	10.3	\$ 1,000.00	\$ 10,300.00	
4	Year 16-20	DML7102375		300		CSP	7.7	\$ 850.00	\$ 6,545.00	
4	Year 16-20	DML7102382		300		CSP	6.7	\$ 850.00	\$ 5,695.00	
4	Year 16-20	DML7102386		300		CSP	8.3	\$ 850.00	\$ 7,055.00	
4	Year 16-20	DML7102387		300		CSP	7.9	\$ 850.00	\$ 6,715.00	
4	Year 16-20	DML7102388		300		CSP	12.4	\$ 850.00	\$ 10,540.00	
4	Year 16-20	DML7102389		300		CSP	7.0	\$ 850.00	\$ 5,950.00	
4	Year 16-20	DML7102392		300		CSP	7.2	\$ 850.00	\$ 6,120.00	
4	Year 16-20	DML7102403		300		CSP	6.3	\$ 850.00	\$ 5,355.00	
4	Year 16-20	DML7102422		300						



Priority Class (1 High - 4 Low)	Year	Asset ID		Pipe Diameter (mm)		Pipe Material	Pipe Lenth (m)	Unit Cost Replacement (\$/m)	Replacement Cost (\$)
4	Year 16-20	DML7102490		300		CSP	7.6	\$ 850.00	\$ 6,460.00
4	Year 16-20	DML7102492		300		CSP	6.9	\$ 850.00	\$ 5,865.00
4	Year 16-20	DML7102504		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102521		300		CSP	6.6	\$ 850.00	\$ 5,610.00
4	Year 16-20	DML7102525		300		CSP	8.6	\$ 850.00	\$ 7,310.00
4	Year 16-20	DML7102528		300		CSP	7.9	\$ 850.00	\$ 6,715.00
4	Year 16-20	DML7102538		300		CSP	12.0	\$ 850.00	\$ 10,200.00
4	Year 16-20	DML7102543		300		CSP	5.4	\$ 850.00	\$ 4,590.00
4	Year 16-20	DML7102551		300		CSP	10.2	\$ 850.00	\$ 8,670.00
4	Year 16-20	DML7102553		300		CSP	7.1	\$ 850.00	\$ 6,035.00
4	Year 16-20	DML7102555		300		CSP	6.7	\$ 850.00	\$ 5,695.00
4	Year 16-20	DML7102573		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7102574		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102578		300		CSP	7.2	\$ 850.00	\$ 6,120.00
4	Year 16-20	DML7102582		300		CSP	10.1	\$ 850.00	\$ 8,585.00
4	Year 16-20	DML7102583		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102586		300		CSP	6.4	\$ 850.00	\$ 5,440.00
4	Year 16-20	DML7102591		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102597		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102602		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102603		300		CSP	8.5	\$ 850.00	\$ 7,225.00
4	Year 16-20	DML7102604		300		CSP	5.9	\$ 850.00	\$ 5,015.00
4	Year 16-20	DML7102605		300		CSP	9.0	\$ 850.00	\$ 7,650.00
4	Year 16-20	DML7102606		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102607		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7102609		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7102610		300		CSP	13.7	\$ 850.00	\$ 11,645.00
4	Year 16-20	DML7102611		400		CSP	6.1	\$ 1,000.00	\$ 6,100.00
4	Year 16-20	DML7102614		400		CSP	6.1	\$ 1,000.00	\$ 6,100.00
4	Year 16-20	DML7102634		300		CSP	11.2	\$ 850.00	\$ 9,520.00
4	Year 16-20	DML7102642		200		CSP	6.0	\$ 650.00	\$ 3,900.00
4	Year 16-20	DML7102643		200		CSP	9.0	\$ 650.00	\$ 5,850.00
4	Year 16-20	DML7102644		300		CSP	12.1	\$ 850.00	\$ 10,285.00
4	Year 16-20	DML7102647		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102653		300		CSP	9.2	\$ 850.00	\$ 7,820.00
4	Year 16-20	DML7102655		300		CSP	9.6	\$ 850.00	\$ 8,160.00
4	Year 16-20	DML7102656		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102662		400		CSP	6.1	\$ 1,000.00	\$ 6,100.00
4	Year 16-20	DML7102663		350		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102664		300		CSP	6.6	\$ 850.00	\$ 5,610.00
4	Year 16-20	DML7102665		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102666		300		CSP	8.9	\$ 850.00	\$ 7,565.00
4	Year 16-20	DML7102667		300		CSP	8.7	\$ 850.00	\$ 7,395.00
4	Year 16-20	DML7102669		350		CSP	6.9	\$ 850.00	\$ 5,865.00
4	Year 16-20	DML7102670		0		CSP	13.5	\$ 650.00	\$ 8,775.00
4	Year 16-20	DML7102672		300		CSP	9.9	\$ 850.00	\$ 8,415.00
4	Year 16-20	DML7102682		200		Conc	7.5	\$ 650.00	\$ 4,875.00
4	Year 16-20	DML7102683		200		CSP	6.2	\$ 650.00	\$ 4,030.00
4	Year 16-20	DML7102690		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102702		350		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102705		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102706		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102712		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102725		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102728		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102730		300		CSP	14.8	\$ 850.00	\$ 12,580.00
4	Year 16-20	DML7102731		300		CSP	7.1	\$ 850.00	\$ 6,035.00
4	Year 16-20	DML7102732		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7102734		300		CSP	7.0	\$ 850.00	\$ 5,950.00
4	Year 16-20	DML7102735		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102740		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102747		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7102748		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102750		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7102754		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102759		300		CSP	6.9	\$ 850.00	\$ 5,865.00
4	Year 16-20	DML7102761		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7102765		300		CSP	7.7	\$ 850.00	\$ 6,545.00
4	Year 16-20	DML7102766		300		CSP	11.1	\$ 850.00	\$ 9,435.00
4	Year 16-20	DML7102767		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102768		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102769		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102772		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102775		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102776		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102778		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102779		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102780		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102781		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102786		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102787		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102789		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102790		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102791		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102792		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102795		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102796		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7102797		200		PVC	6.4	\$ 650.00	\$ 4,160.00
4	Year 16-20	DML7102799		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102803		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102804		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102813		300		CSP	14.9	\$ 850.00	\$ 12,665.00
4	Year 16-20	DML7102814		300		CSP	9.0	\$ 850.00	\$ 7,650.00
4	Year 16-20	DML7102816		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102820		300		CSP	6.4	\$ 850.00	\$ 5,440.00
4	Year 16-20	DML7102822		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102823		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7102824		300		CSP	6.4	\$ 850.00	\$ 5,440.00
4	Year 16-20	DML7102825		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7102828		300		CSP	6.4	\$ 850.00	\$ 5,440.00
4	Year 16-20	DML7102860		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7102864		300		CSP	3.0	\$ 850.00	\$ 2,550.00
4	Year 16-20	DML7102876		300		CSP	3.0	\$ 850.00	\$ 2,550.00
4	Year 16-20	DML7102878		300		Conc	14.4	\$ 850.00	\$ 12,240.00
4	Year 16-20	DML7102879		400		CSP	12.4	\$ 1,000.00	\$ 12,400.00
4	Year 16-20	DML7102882		400		CSP	15.4	\$ 1,000.00	\$ 15,400.00
4	Year 16-20	DML7102883		500		CSP	9.9	\$ 1,200.00	\$ 11,880.00
4	Year 16-20	DML7102884		300		CSP	13.6	\$ 850.00	\$ 11,560.00
4	Year 16-20	DML7102885		400		CSP	15.0	\$ 1,000.00	\$ 15,000.00
4	Year 16-20	DML7102894		300		CSP	9.7	\$ 850.00	\$ 8,245.00
4	Year 16-20	DML7102895		400		CSP	24.4	\$ 1,000.00	\$ 24,400.00
4	Year 16-20	DML7102896		250		CSP	7.4	\$ 650.00	\$ 4,810.00
4	Year 16-20	DML7102904		800		CSP	14.0	\$ 650.00	\$ 9,100.00
4	Year 16-20	DML7102923		300		CSP	11.9	\$ 850.00	\$ 10,115.00
4	Year 16-20	DML7102929		300		CSP	17.6	\$ 850.00	\$ 14,960.00
4	Year 16-20	DML7102930		600		CSP	14.6	\$ 1,400.00	\$ 20,440.00
4	Year 16-20	DML7102960		0		CSP	13.2	\$ 650.00	\$ 8,580.00
4	Year 16-20	DML7102963		400		CSP	8.7	\$ 1,000.00	\$ 8,700.00
4	Year 16-20	DML7102964		300		CSP	7.0	\$ 650.00	\$ 4,550.00
4	Year 16-20	DML7102989		300		CSP	3.4	\$ 850.00	\$ 2,890.00
4	Year 16-20	DML7102992		200		Conc	1.9	\$ 650.00	\$ 1,235.00
4	Year 16-20	DML7102996		350		Conc	9.9	\$ 850.00	\$ 8,415.00
4	Year 16-20	DML7102997		250		CSP	6.3	\$ 650.00	\$ 4,095.00
4	Year 16-20	DML7102998		400		CSP	6.1	\$ 1,000.00	\$ 6,100.00
4	Year 16-20	DML7103005		300		CSP	3.1	\$ 850.00	\$ 2,635.00
4	Year 16-20	DML7103006		300		CSP	7.3	\$ 850.00	\$ 6,205.00
4	Year 16-20	DML7103007		300		CSP	3.0	\$ 850.00	\$ 2,550.00
4	Year 16-20	DML7103008		200		CSP	21.9	\$ 650.00	\$ 14,235.00
4	Year 16-20	DML7103018		300		CSP	9.0	\$ 850.00	\$ 7,650.00
4	Year 16-20	DML7103020		300		CSP	7.1	\$ 850.00	\$ 6,035.00
4	Year 16-20	DML7103023		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7103027		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7103028		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7103							



Priority Class (1 High - 4 Low)	Year	Asset ID		Pipe Diameter (mm)		Pipe Material	Pipe Lenth (m)	Unit Cost Replacement (\$/m)	Replacement Cost (\$)
4	Year 16-20	DML7103069		300		Conc	2.5	\$ 850.00	\$ 2,125.00
4	Year 16-20	DML7103070		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7103078		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7103079		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7103081		300		CSP	4.8	\$ 850.00	\$ 4,080.00
4	Year 16-20	DML7103092		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7103096		400		CSP	6.1	\$ 1,000.00	\$ 6,100.00
4	Year 16-20	DML7103099		350		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7103110		350		PVC	7.9	\$ 850.00	\$ 6,715.00
4	Year 16-20	DML7103111		0		CSP	6.2	\$ 650.00	\$ 4,030.00
4	Year 16-20	DML7103113		300		Conc	7.5	\$ 650.00	\$ 4,875.00
4	Year 16-20	DML7103114		400		CSP	14.5	\$ 1,000.00	\$ 14,500.00
4	Year 16-20	DML7103119		400		CSP	11.0	\$ 1,000.00	\$ 11,000.00
4	Year 16-20	DML7103135		400		CSP	7.7	\$ 1,000.00	\$ 7,700.00
4	Year 16-20	DML7103137		400		CSP	9.0	\$ 1,000.00	\$ 9,000.00
4	Year 16-20	DML7103149		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7103164		100		PVC	7.2	\$ 650.00	\$ 4,680.00
4	Year 16-20	DML7103166		300		Conc	9.1	\$ 850.00	\$ 7,735.00
4	Year 16-20	DML7103168		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7103170		300		Conc	6.4	\$ 850.00	\$ 5,440.00
4	Year 16-20	DML7103172		250		CSP	6.4	\$ 650.00	\$ 4,160.00
4	Year 16-20	DML7103174		200		PVC	12.2	\$ 650.00	\$ 7,930.00
4	Year 16-20	DML7103179		300		Conc	11.1	\$ 850.00	\$ 9,435.00
4	Year 16-20	DML7103184		400		CSP	12.1	\$ 1,000.00	\$ 12,100.00
4	Year 16-20	DML7103187		300		Other	2.8	\$ 850.00	\$ 2,380.00
4	Year 16-20	DML7103188		300		PVC	3.3	\$ 850.00	\$ 2,805.00
4	Year 16-20	DML7103189		400		CSP	14.2	\$ 1,000.00	\$ 14,200.00
4	Year 16-20	DML7103190		500		CSP	20.0	\$ 1,200.00	\$ 24,000.00
4	Year 16-20	DML7103191		350		Conc	14.4	\$ 850.00	\$ 12,240.00
4	Year 16-20	DML7103234		200		Conc	4.8	\$ 650.00	\$ 3,120.00
4	Year 16-20	DML7103239		250		CSP	1.5	\$ 650.00	\$ 975.00
4	Year 16-20	DML7103244		350		CSP	9.2	\$ 850.00	\$ 7,820.00
4	Year 16-20	DML7103248		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7103271		300		CSP	6.4	\$ 850.00	\$ 5,440.00
4	Year 16-20	DML7103276		300		CSP	1.7	\$ 850.00	\$ 1,445.00
4	Year 16-20	DML7103284		500		CSP	6.7	\$ 1,200.00	\$ 8,040.00
4	Year 16-20	DML7103287		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7103302		250		CSP	6.0	\$ 650.00	\$ 3,900.00
4	Year 16-20	DML7103306		20			6.5	\$ 650.00	\$ 4,225.00
4	Year 16-20	DML7103310		200		Conc	6.1	\$ 650.00	\$ 3,965.00
4	Year 16-20	DML7103319		300		CSP	6.9	\$ 850.00	\$ 5,865.00
4	Year 16-20	DML7103320		200		CSP	6.2	\$ 650.00	\$ 4,030.00
4	Year 16-20	DML7103321		20		CSP	6.6	\$ 650.00	\$ 4,290.00
4	Year 16-20	DML7103323		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7103346		500		CSP	10.2	\$ 1,200.00	\$ 12,240.00
4	Year 16-20	DML7103362		500		Conc	6.2	\$ 1,200.00	\$ 7,440.00
4	Year 16-20	DML7104270		300		CSP	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7104331		250		CSP	3.2	\$ 650.00	\$ 2,080.00
4	Year 16-20	DML7105194		300		Conc	7.4	\$ 850.00	\$ 6,290.00
4	Year 16-20	DML7105195		450		Conc	13.8	\$ 1,000.00	\$ 13,800.00
4	Year 16-20	DML7106020		300		Conc	9.6	\$ 850.00	\$ 8,160.00
4	Year 16-20	DML7106318		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7106606		450		Conc	52.6	\$ 1,000.00	\$ 52,600.00
4	Year 16-20	DML7106617		500		CSP	40.3	\$ 650.00	\$ 26,195.00
4	Year 16-20	DML7107134		300		CSP	8.6	\$ 850.00	\$ 7,310.00
4	Year 16-20	DML7107137		300		0	17.9	\$ 850.00	\$ 15,215.00
4	Year 16-20	DML7107162		300		CSP	49.6	\$ 650.00	\$ 32,240.00
4	Year 16-20	DML7107184		400		0	10.8	\$ 1,000.00	\$ 10,800.00
4	Year 16-20	DML7107209		450		CSP	19.0	\$ 1,000.00	\$ 19,000.00
4	Year 16-20	DML7107280		500		CSP	20.8	\$ 1,000.00	\$ 20,800.00
4	Year 16-20	DML7107292		500		CSP	41.6	\$ 1,200.00	\$ 49,920.00
4	Year 16-20	DML7107303		500		CSP	8.8	\$ 1,200.00	\$ 10,560.00
4	Year 16-20	DML7107316		400		0	3.4	\$ 1,000.00	\$ 3,400.00
4	Year 16-20	DML7107411		500		CSP	4.5	\$ 1,200.00	\$ 5,400.00
4	Year 16-20	DML7107412		500		CSP	22.8	\$ 1,200.00	\$ 27,360.00
4	Year 16-20	DML7107413		375		CSP	35.5	\$ 850.00	\$ 30,175.00
4	Year 16-20	DML7107484		300		0	10.1	\$ 850.00	\$ 8,585.00
4	Year 16-20	DML7107530		300		CSP	20.3	\$ 850.00	\$ 17,255.00
4	Year 16-20	DML7107727		600		CSP	48.4	\$ 1,400.00	\$ 67,760.00
4	Year 16-20	DML7107746		600		0	11.1	\$ 1,400.00	\$ 15,540.00
4	Year 16-20	DML7107823		500		CSP	12.4	\$ 1,200.00	\$ 14,880.00
4	Year 16-20	DML7107832		600		CSP	16.1	\$ 1,400.00	\$ 22,540.00
4	Year 16-20	DML7107834		600		CSP	19.1	\$ 1,400.00	\$ 26,740.00
4	Year 16-20	DML7107837		300		CSP	38.6	\$ 850.00	\$ 32,810.00
4	Year 16-20	DML7107843		400		CSP	2.9	\$ 1,000.00	\$ 2,900.00
4	Year 16-20	DML7107844		400		CSP	11.6	\$ 1,000.00	\$ 11,600.00
4	Year 16-20	DML7107975		300		0	78.4	\$ 850.00	\$ 66,640.00
4	Year 16-20	DML7108009		400		Conc	1.5	\$ 850.00	\$ 1,275.00
4	Year 16-20	DML7108010		400		Conc	1.5	\$ 850.00	\$ 1,275.00
4	Year 16-20	DML7108011		400		Conc	3.7	\$ 650.00	\$ 2,405.00
4	Year 16-20	DML7108204		200		0	47.8	\$ 650.00	\$ 31,070.00
4	Year 16-20	DML7109191		300		CSP	8.9	\$ 850.00	\$ 7,565.00
4	Year 16-20	DML7109451		350		CSP	7.7	\$ 850.00	\$ 6,545.00
4	Year 16-20	DML7109818		500		CSP	6.1	\$ 1,200.00	\$ 7,320.00
4	Year 16-20	DML7109877		350		CSP	8.9	\$ 850.00	\$ 7,565.00
4	Year 16-20	DML7109881		300		CSP	5.0	\$ 850.00	\$ 4,250.00
4	Year 16-20	DML7109882		300		Conc	11.6	\$ 850.00	\$ 9,860.00
4	Year 16-20	DML7109883		300		Conc	9.4	\$ 850.00	\$ 7,990.00
4	Year 16-20	DML7109977		450		CSP	6.6	\$ 1,000.00	\$ 6,600.00
4	Year 16-20	DML7109980		300		Conc	6.3	\$ 850.00	\$ 5,355.00
4	Year 16-20	DML7109986		300		Conc	4.9	\$ 850.00	\$ 4,165.00
4	Year 16-20	DML7109990		300		CSP	2.9	\$ 650.00	\$ 1,885.00
4	Year 16-20	DML7110007		300		CSP	6.0	\$ 850.00	\$ 5,100.00
4	Year 16-20	DML7110452		300		CSP	6.1	\$ 850.00	\$ 5,185.00
4	Year 16-20	DML7110461		300		CSP	3.7	\$ 850.00	\$ 3,145.00
4	Year 16-20	DML7110470		300		CSP	6.7	\$ 850.00	\$ 5,695.00
4	Year 16-20	DML7110472		300		CSP	6.2	\$ 850.00	\$ 5,270.00
4	Year 16-20	DML7110473		300		CSP	12.1	\$ 850.00	\$ 10,285.00
Lineare Infrastructure Condition Replacement Total Costs									\$ 4,104,925.00

Condition Replacements - Point Drainage Infrastructure

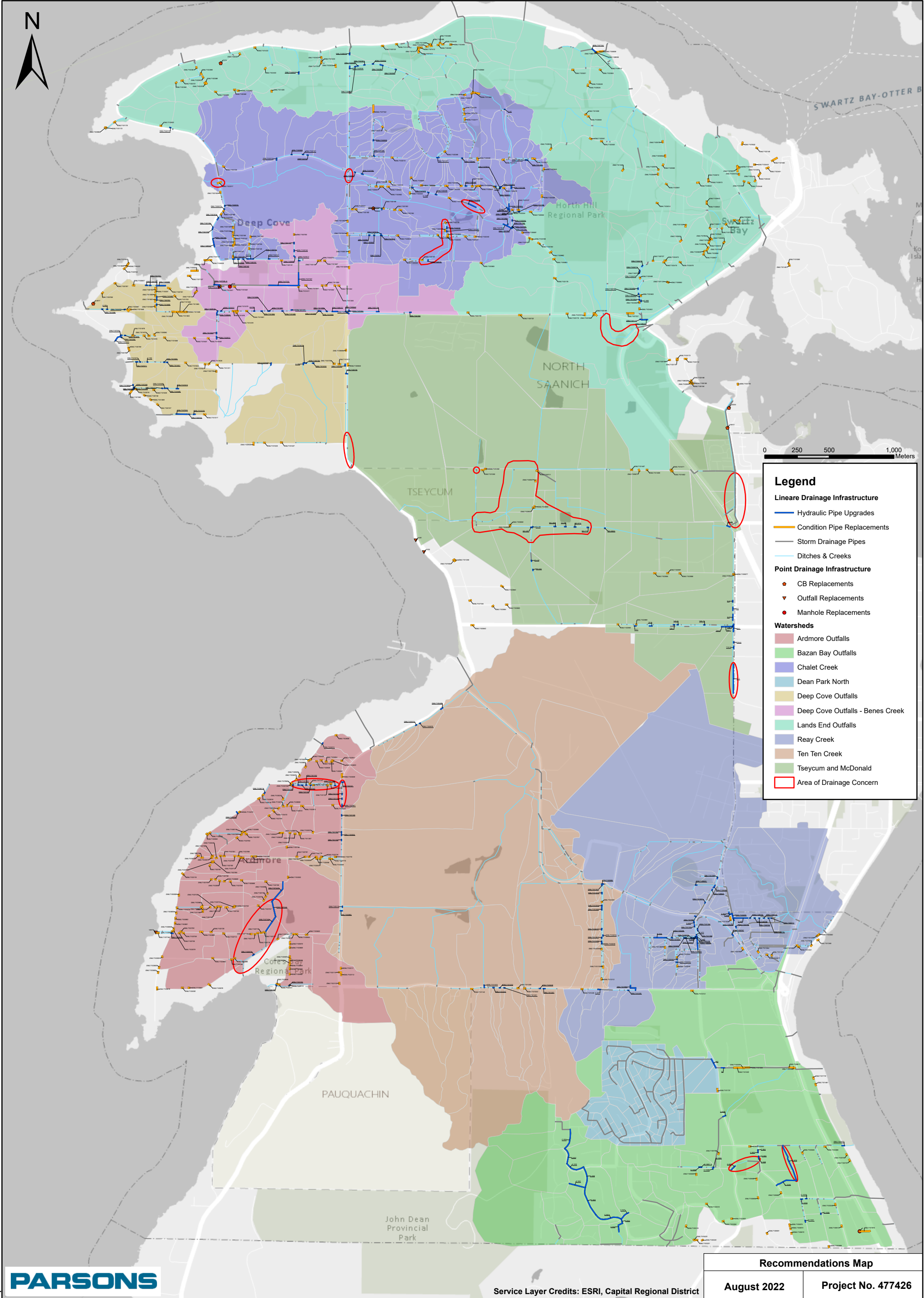
Prioritization Class (1 High - 4 Low)	Year	Asset ID	Drainage Asset Type	Existing Pipe Diameter (mm)		Material	Proposed Pipe Diameter/Size (mm)	Unit Cost Upgrade (\$)	Replacement Cost (\$)
4	Year 16-20	1424	Ocean Outfall	500		CSP	500	\$ 15,000.00	\$ 15,000.00
4	Year 16-20	1481	Ocean Outfall	500		CSP	500	\$ 15,000.00	\$ 15,000.00
4	Year 16-20	10975	Ocean Outfall	600		CSP	600	\$ 15,000.00	\$ 15,000.00
4	Year 16-20	DMH7300644	Manhole			Sand Bag		\$ 12,000.00	\$ 12,000.00
4	Year 16-20	DMH7300197	Manhole			Concrete		\$ 12,000.00	\$ 12,000.00
4	Year 16-20	DMH7300198	Manhole			Concrete		\$ 12,000.00	\$ 12,000.00
4	Year 16-20	14600	Manhole					\$ 12,000.00	\$ 12,000.00
4	Year 16-20	14602	Manhole			Sand Bag		\$ 12,000.00	\$ 12,000.00
4	Year 16-20	1313	Catch Basin					\$ 3,000.00	\$ 3,000.00
4	Year 16-20	14977	Catch Basin					\$ 3,000.00	\$ 3,000.00
4	Year 16-20	18463	Catch Basin					\$ 3,000.00	\$ 3,000.00
4	Year 16-20	15005	Catch Basin					\$ 3,000.00	\$ 3,000.00
4	Year 16-20	15072	Catch Basin					\$ 3,000.00	\$ 3,000.00
Point Infrastructure Condition Replacement Total Costs									\$ 120,000.00
TOTAL COSTS									\$ 12,014,125.00

Subtotal Cost Year 16-20
\$ 3,020,825.00

APPENDIX K

Drainage Master Plan - Recommendations Map

North Saanich Drainage Master Plan - Recommendations Map



Spatial Reference: NAD 1983 CSRS UTM Zone 10N

PARSONS

Date Saved: 02/08/2022 13:36

Document Name: North Saanich DMP

Service Layer Credits: ESRI, Capital Regional District

Recommendations Map

August 2022

Project No. 477426

APPENDIX L

Reference Documents

Reference Documents

The following information has been received and gathered to complete the Drainage Master Plan:

North Saanich Geoinformation System Data

The District provided the following Geographic Information System (GIS) data:

- LiDAR Raster covering the District's area
- Cadastral Zoning Land Designation of North Saanich - Shapefiles
- Storm Drainage Geodatabase
 - Utility Storm Drainage – Shapefiles (various)
 - Utility Storm Drainage GPS – Shapefiles (various)
 - Utility Storm Drainage Manhole Collection 2018 – Shapefiles (various)
- Clayton Maple – Shapefiles
- Dean Park North – Shapefiles
- Chalet Creek – Catchment Boundary
- Reay Creek – Catchment Boundary
- Ten-Ten Creek – Catchment Boundary
- Tseycum Creek – Catchment Boundary

Reports and Studies

The following previous reports and studies of the area have been assessed to complete the Drainage Master Plan:

- *District of North Saanich - Master Storm Drainage Study* (Reid Crowther & Partners, 1985)
- *Soils of Southern Vancouver Island* (BC Ministry of Environment, 1985)
- *McDonald Park Road Drainage Study* (Reid Crowther & Partners, 2000)
- *Aquifers of the Capital Regional District* (Capital Regional District, 2004)
- *North Saanich Stream Survey Report* (Swell Environmental Consulting, 2007)
- *Hydrological Assessment of Tseycum Creek* (Parsons, as Delcan, 2009)
- *Saanich Peninsula – Liquid Waste Management Plan* (Capital Regional District, 2016)
- *Sandown Lands – Onsite and Offsite Stormwater Management Plan* (Kerr Wood Leidal, 2017)
- *Climate Projections for the Capital Region* (Capital Regional District, 2017)
- *Utility Study Report* (Kerr Wood Leidal, 2018) for the Town of Sidney including a hydrology and hydraulic model.
- *Sandown Community Farm Plan* (Greene et al., 2018)
- *Environmental Mitigation Strategy – Reay Creek Remediation* (SLR, 2019)

Record Drawings

Record drawings received from the District included:

- *Reconstruction of McDonald Park Road* (Ker, Priestman & Associates, 1974)
- *Deep Cove Sewer System – Munro Road* (1st Team Consulting, 2005)
- *McDonald Park Road Area Sewerage System* (Parsons, as Delcan, 2006)
- *McDonald Park Road Drains 2008, Phase 1* (RCL Consulting, 2009)
- *Munro Road Detention Pond* (Parsons, as Delcan, 2009)
- *1974, 1986 & 1996 John Road – Multi-Family Development Servicing Plan & General Notes* (Teccana, 2014)
- *Sandown Park Limited Partnership Sandown Park Shopping Centre* (Kerr Wood Leidal, 2016)
 - *Overall Development Utility Plan*
 - *Phasing Plan*
 - *Phase 1 Sanitary Force Main Plan & Profile 1*
 - *Phase 1 McDonald Park Road Upgrades 1*
 - *Phase 1 McDonald Park Road Upgrades 2*

- *Phase 1 McDonald Park Road Upgrades 3*
- *Phase 1 Site Servicing Plan 1*
- *Phase 1 Site Servicing Plan 2*
- *Phase 1 Paint Markings Plan*
- *Phase 1 Main Area Grading Plan*
- *Phase 1 Rear Grading Plan*
- *Phase 1 Watermain Details*
- *Typical Road Sections*
- *1964 John Road, North Saanich, BC (McElhanney, 2020)*

Record drawings received from the Ministry of Transportation & Infrastructure BC included:

- *McTavish Road Pedestrian Overpass No. 7814 (Associated Engineering, 2009)*
- *Highway 17 / McTavish Interchange Highway 17 (Urban Systems, 2012)*
- *Highway 17 / McTavish Interchange McTavish Road Underpass No. 2457 (Associated Engineering, 2018)*

North Saanich Bylaws and Regional Bylaws

Reviewed bylaws included:

- No. 246 – Subdivision and Development Control By-Law (1991)
- No. 1130 – Official Community Plan Bylaw (2018)
- No. 1150 – Building and Plumbing Bylaw (2019)
- No. 1255 – Zoning Bylaw (2019)
- No. 1324 – Development Applications Procedures Bylaw (2018)
- No. 1433 – Bylaw to establish a Community Agricultural Commission (2017)
- No. 1439 – Bylaw to mitigate Coastal Flooding Hazards (2018)
- No. 3642 – Bylaw to establish a Service to identify Stormwater Pollution (2010)
- No. 4017 – Bylaw to adopt a Regional Growth Strategy for the Capital Regional District (2018)
- No. 7501 – Bylaw for the Regulation and Protection of Natural Water Courses, Ditches and Drains (1996)

North Saanich Existing Hydraulic Models

The District provided the following model data:

- McDonald Park Road Drain Study – SWMM Model
- McDonald Park Road Drain Study – HEC-RAS Model
- McDonald Park Road Drain Study – HYDSYS Model
- Tseycum Creek and McDonald Park Road Drain with Sandown – Shapefile (KWL, 2019)
- Tseycum Creek – PCSWMM