MEMORANDUM

URBAN SYSTEMS

DATE	October 18, 2023	FROM	Mark Stafford, P.Eng
TO	Sivagar Sivabalan, EIT, PMP	FILE	1961.0480.17
CC	Cody Bagg, P.Eng	SUBJECT	6825 West Coast Road Drainage Study

1.0 HYDRAULIC CAPACITY OF WEST COAST ROAD STORM SEWER

The intent of this memo is to summarize the hydraulic capacity review of the existing storm sewer within West Coast Road, for analysis of suitability to reroute flows away from the drainage right-of-way through the property at 6825 West Coast Road.

1.1 RECORD INFORMATION SOURCE

It should be noted that this review is based off of the original as-built drawings and survey pickups completed in 2023. More recent as-builts and current GIS information for the storm sewer in question are reflective of the original storm sewer still being in service, save for the more recently installed drainage easement through the property at 6825 West Coast Road, suggesting that the information within the 1966 as-constructed record drawings are the most up-to-date information available. This set of as-built drawings does not include information describing the drainage right of way through private property, and it is assumed that this drainage easement was installed at a later, unconfirmed date in an effort to redirect runoff away from the capacity-stressed storm sewer.

1.2 SYSTEM DESCRIPTION AND EXISTING HYDRAULIC CAPACITY

System Description:

Generally, the storm sewer system within West Coast Road in the study area consists of asbestos concrete (AC) pipe between 8” (200mm) and 12” (300mm) nominal diameter. The storm sewers appear to be installed fairly deep with cover in the range of 3~4m below finished ground, suggesting that storm mains could likely be upsized without concern for cover requirements. However, removal and replacement of the old AC main would incur additional disposal costs related to disposal of asbestos contaminated materials – consideration could be made for pipe bursting to leave the existing main in the trench after upgrading.

Existing Hydraulic Capacity:

The portion of the storm system in question consists of two main reaches, and a simplified capacity/catchment analysis was completed under the worst-case scenario assumption that each catchment is contributed entirely at the most upstream point of each pipe segment. See **FIGURE 1** and **TABLE 1** below.

FIGURE 1. CATCHMENT AREAS

TABLE 1. EXISTING STORM SEWER CONDITIONS

Catchment	Area (Ha.)	Existing Storm Sewer		
		Grade	Diameter (mm)	Full Pipe Capacity (L/s)
1 (Approx. 6764 West Coast Rd to 6285 West Coast Rd)	5.00	5.5%	200	76.9
2 (6285 West Coast Road to Maple Ave)	6.05	1.85%	250	81

1.3 SHORT TERM STORM RISK ANALYSIS

The 2-year, 5-year, and 10-year storm intensities and durations were assessed for the existing storm system along West Coast Road. An analysis was also undertaken to determine the approximate rainfall intensity required to realize 75% d/D pipe-flow in the storm system. See **TABLE 2** below.

TABLE 2. 2-YEAR, 5-YEAR, AND 10-YEAR STORM ANALYSIS

Design Storm	Intensity (mm/hr)	Catchment	Runoff (L/s)	Cumulative Runoff (L/s)	Comments

N/A	**4.65**	1	33.6		
		2	40.6	74.2	At 75% d/D (capacity
2-Year 1-Hr	10.00	1	72		At capacity
		2	87	159	Surcharged
2-Year 24-Hr	3.05	1	22		d/D ratio = 36%
		2	26	48	d/D ratio = 55%
5-Year 1-Hr	12.20	1	88		Surcharged
		2	106	194	Surcharged
5-Year 24-Hr	3.91	1	28		d/D ratio = 41%
		2	34	62	d/D ratio = 65%
10-Year 1-Hr	16.52	1	101		Surcharged
		2	122	223	Surcharged

PROBABILITY OF OVER-CAPACITY STORM SEWER:

The above rational method calculations assume that the catchment has sufficient time to develop within a one-hour storm event (i.e., storm runoff from the furthest upstream point in the catchment arrives at the storm sewer).

As shown above in **TABLE 2**, a storm with intensity of **4.65 mm/hr** will likely cause the downstream portion of the storm sewer approaching Maple Avenue to reach a flow-depth of approximately **75% d/D, considered as the safe capacity for the purposes of this analysis**. Calculations reveal that a storm intensity **greater than 5.67mm/hr will exceed the full-depth capacity of the sewer.**

This corresponds roughly to the following storm events:

- **10-Year 24-Hr event (4.5 mm/hr): 10% chance of occurring in any given year; or**
- **Any 1hr storm events, for all return periods, indicate exceeding the storm sewer capacity**

The IDF curve referenced for this analysis only estimates storms up to the 2-year return period (synonymous w/ a 50% annual probability) event. The previously discussed rainfall rate of 4.65mm/hr is less than half that of the 2-year 1-hr event (10mm/hr), indicating that the probability of a short duration (<1hr) storm event exceeding the capacity of the existing sewer is greater than 50% in any given year.

For further review, the “A” & “B” coefficients used in the Environment Canada IDF dataset for Victoria-Marine were plotted on a logarithmic chart and reviewed against logarithmic trendlines to estimate the coefficients for a 1-Year Return Period (100% annual probability) and associated 1hr duration rainfall intensity. It is assumed that the corresponding rainfall intensity for a 1hr-1yr storm event is approximately 8.68mm/hr, and will also exceed the system capacity.

While the runoff analysis was simplified and conservative (assuming all flows are introduced at the upstream manhole of each pipe), suggesting that a more nuanced and detailed drainage modelling exercise would likely reveal less conservative conditions and therefore more dispersed loading – it was found that a rainfall intensity of 13.1mm/hr (less than a 1hr – 10yr event) would

exceed the capacity of the downstream sewer main (approaching Maple Ave) from the upstream catchment rerouting alone (assuming 100% of the downstream catchment is directed elsewhere).

OVERLAND FLOW PATHS:
The north side of West Coast Road generally includes a curb adjacent the sidewalk, while the south side of West Coast Road, where excess runoff is anticipated to flow, has a less well-defined asphalt curb or none at all. The asphalt curb on the south side appears to generally extend from the subject property at 6825 West Coast Road to approximately 6842 West Coast Road – a few lots down from the intersection at Maple Avenue. It does not meet the requirements for a standard MoTI curb and gutter, and it is not likely to protect private property to the same degree.

It is recommended that an interim additional asphalt curb and gutter extending down to Maple Avenue would assist in increased protection the last few lots before the intersection.

2.0 DESIGN CRITERIA AND PROPOSED UPGRADES

2.1 DESIGN CRITERIA FOR STORM SEWERS

The BC MoTI supplement to TAC Geometric Design Guide provides recommendations on design of storm sewers within Section 1050.08 – Storm Sewers. Given the simple configuration and short extent of this sewer, analysis using the rational method was completed, as per discussions above. Storm systems should be designed such that they can safely convey 10~25yr storm events, and overland flow routes are utilized for more major events. Current conditions along the study area do not include sufficient curb and gutter to properly route overland flows generated during a major event, but there are near-term plans for surface improvements to the corridor where it is anticipated that curb and gutter would be installed – suggesting that this project should be designed to only handle 'minor' events in the 10~25yr return period. For the purposes of this project, a 25yr return period has been selected as the design event.

Velocities experienced within the storm sewer should be 0.6m/s or greater to prevent settlement of fines within the pipe, eventually reducing capacity. Maximum velocities should be limited to 5m/s if the pipe material is susceptible to erosion.

Finally, storm sewers should be installed at a depth to acquire 1.5m of cover in travelled areas, or 1.0m of covered in untravelled areas.

2.2 CLIMATE CHANGE CONSIDERATIONS

Climate change models are used to predict potential impacts related to our changing climate. specific to this project, it is anticipated that storm events may increase in intensity (mm/hr of rainfall) by approximately 18% over the next 100yrs – for a 25yr ~1hr event, this increases from 16mm/hr today to approximately 19mm/hr in the future. The Design Criteria Sheet for Climate Change Resilience completed for this project is appended to this document for further detail.

2.3 RATIONAL METHOD ANALYSIS & PROPOSED UPGRADES

A rational method analysis was completed for the same catchments described in Figures 1 and Table 1, but accounting for the rainfall intensity seen in a design 1hr-25yr event with climate change (18.9mm/hr) to size the proposed storm sewer upgrades. Refer to Tables 3 and 4 below for a summary of the runoff derivation and proposed storm sewer sizes. The proposed upgrades described in Table 4 align with the sewer design within the drawing set.

TABLE 3. Rational Analysis – Future Climate, 25yr-1hr Design Storm

LOCATION DESCRIPTION	US Node	DS Node	Runoff Derivation (Rational Method)			
			Future 25yr-1hr Rainfall Intensity (mm/hr)	C-Factor	Incremental Catchment Area (ha) at US node	Runoff Flow (m3/s)
West Coast Road	**DMH3**	**DMH2**	18.88	0.520	**5.000**	**0.136**
	DMH2	**DMH1**	18.88	0.520	**6.050**	**0.165**
	DMH1	**EX**	18.88	0.520	**0.000**	**0.000**

TABLE 4. Proposed Sewer Upgrades

US Node	DS Node	Cumulative PWWF (L/s)	Sewer Design Geometry / Hydraulic Parameters										
			Length (m)	Grade (%)	I.D. (mm)	Pipe Full Capacity (L/s)	Q/q (%)	d / D (%)	Min ID Req'd for d/D < 50% (mm)	Min ID Req'd for d/D < 70% (mm)	Velocity (m/s)	Invert Elev. (m) US	Invert Elev. (m) DS
DMH3	**DMH2**	**136.4**	94.19	2.27	**447.9**	501.5	27	35	OK	OK	**2.8**	21.067	18.927
DMH2	**DMH1**	**301.4**	94.2	1.99	**447.9**	468.9	64	***58***	***492***	OK	**3.2**	18.897	17.026
DMH1	**EX**	**301.4**	8.02	3.77	**447.9**	645.6	47	48	OK	OK	**4.0**	16.966	16.664

Seen above, upgrading the West Coast Road storm sewer system to 450mm diameter pipe would provide sufficient capacity to manage runoff generated in a 1:25year storm event, after account for 18% climate change increases. It is anticipated that during this design event, the sewer would flow at a depth of approximately 58% the pipe diameter – suggesting that additional capacity is available to handle flows from more major events in the interim until surface improvements are made to overland flow paths. Flow velocities in the sewers are anticipated to be limited to 4.0m/s at the steep section tying into the existing downstream sewer, and approximately 3m/s for the majority of the proposed sewer upgrades.

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3.0 CONCLUSIONS AND RECOMMENDATIONS

The existing storm sewer within West Coast Road in the study area does not appear to have adequate capacity to support re-routing flows away from the drainage right-of-way at 6285 West Coast Road without upsizing. Indeed, it seems like this right-of-way was installed as a means of alleviating some already existing capacity concerns with the downstream reaches in the system.

It should be noted that the system appears to be undersized to support the existing runoff already reaching the sewer system, and it should likely be considered for upgrading regardless of the ongoing issues at 6285 West Coast Road. The overstressed storm sewer in this area is likely due to increased density in the region as compared to 1966 when the system was originally constructed. Additionally, the concerns are likely to be stressed even further in the future as climate change appears likely to increase storm intensities for some time.

There is a strong likelihood (>50%) of short duration storm events annually exceeding the capacity of the storm sewer if flows are rerouted before upsizing occurs. A temporary extension of the asphalt curb and gutter, until the District of Sooke advances their surface improvements project, would assist with protecting properties between 6842 West Coast Road and Maple Avenue.

There is adequate grade in the area and space below the road corridor to support an upsized storm sewer system. It is recommended that an upsized (450mm PVC) storm sewer be installed along the study area, and the drainage right-of-way at 6285 West Coast Road be abandoned, rerouting flows to the storm sewer. The proposed storm sewer upgrades are located at a depth suitable for future relocation and reconnection of catchbasins & leads to support the future surface improvements project along the corridor.

Sincerely,

URBAN SYSTEMS LTD.

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