Exhibit B49

LIDER ENGINEERING PLLC
Low Impact Development Engineering Resources
Stormwater and Erosion Control Engineering
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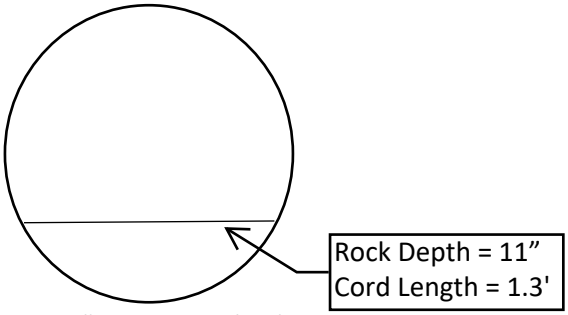
September 27, 2023

Manning Equation Flow Calculation
36-inch Perrinville Creek Culvert
8229 Talbot Road, Edmonds, WA

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$



36” HDPE Pipe (nts)

Background:

Stormwater flow under the BNSF railroad tracks at 8229 Talbot Road, Edmonds, WA consists of the combined stormwater flow from Perrinville Creek and the additional flow added by the City Edmonds in 2012 with the construction of a 36-inch concrete pipe from Talbot Road into the two flow splitters. In turn this combined flow then discharges to the west via a 36-inch HDPE pipe to manhole 2-205 on the east side of the BNSF railroad tracks.

Manhole 2-205 then discharges into a 42-inch ductile iron pipe that outfalls into Browns Bay in Puget Sound immediately west of the BNSF railroad tracks.

Flow Calculation:

According to the City of Edmonds’ July 27, 2023 video inspection, the 36-inch pipe is 25% full or rock and debris (see Figure 1 below). The full cross-sectional area of a 36-inch pipe is 7.07-square feet; however, a 25% reduction in the cross-sectional area provides only 5.30-square feet for flow area. The depth of the rock in the pipe is calculated at approximately 11-inches, or about one-third of the pipe diameter. The cord length of the rock in the floor of the pipe is calculated at 15.6” (1.3-feet) for wetted perimeter, and the remaining wetted pipe perimeter is calculated at 5.91-feet for 36” HDPE pipe.

The Manning Number (n) for the smooth wall HDPE pipe is 0.012. The Manning Number (n) for rock in the pipe is assumed to be 0.030 for the 1.3-foot floor of the pipe. The Manning number reflects the roughness of a surface that retards water flow. The higher the Manning number, the rougher the surface, and lower the flow.

$n_{floor} = 0.030$
$n_{pipe} = 0.012$

The hydraulic radius is equal to the wetted area divided by wetted perimeter of the pipe ($R_w = A_w/P_w$). The wetted perimeter of the rock floor of the pipe is the cord length calculated at 1.3-feet, while the wetted perimeter of the pipe above the rock floor is calculated at 5.91-feet. Therefore:

$R_{floor} = 5.30\ ft^2 / 1.3\ ft = 4.08\ ft$ and $R_{pipe} = 5.30\ ft^2 / 5.91\ ft = 0.897\ ft$

Because different Manning numbers must be used to estimate the flow in the pipe, the hydraulic radius must be calculated separately for the roughness conditions in the pipe by the equation $R^{0.67}/n$, therefore:

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$R_{\Sigma} = (R_{floor}^{0.67} / n_{floor}) + (R_{pipe}^{0.67} / n_{pipe}) = (4.08^{0.67} / 0.030) + (0.897^{0.67}/0.012) = 2.57 \text{ ft} + 362.4 \text{ ft} = 365 \text{ ft}$

The 36-inch pipe slope is estimated at 0.80% (.008 ft/ft) slope, based on the City of Edmonds 2022 preliminary survey invert elevations and pipe length measured at 108-feet by the July 27, 2023 video inspection.

Therefore, plugging into the Manning Equation:

$Q = 1.49 \times 5.30 \text{ ft}^2 \times 365 \text{ ft} \times 0.008^{0.5} = \underline{33.3}$ cubic feet per second.

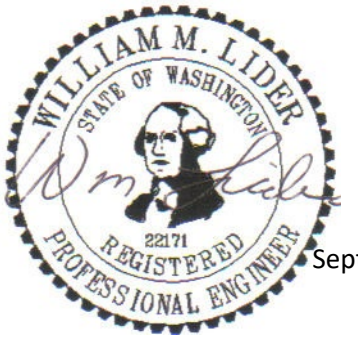
Conclusion:

The 33.30-cfs flow calculation does not include a tailwater condition at high tide, that will further reduce the flow capacity in the 36-inch pipe at high tide. Extreme high tides (aka King Tides) occur during the winter solstice, when extreme storm events are prevalent.

If the rock in the 36-inch pipe is removed, the flow could be increased by 31.5 cfs to 64.8 cfs. However both the flow splitters and pipe become plugged shortly after any cleaning from rock and sediment bedload moving down Perrinville Creek requiring frequent maintenance that is costly and environmentally harmful.

In an August 25, 2023 email from Oscar Antillon, City Public Works Director, to Diane Buckshnis, City Councilperson, Mr. Antillon indicated that the City will no longer maintain the flow splitter or downstream piping under the BNSF railroad tracks in part due to worker safety concerns, but also because WDFW will not renew the City's HPA permit after February 2024 to do maintenance work on the flow splitter. This will likely result in the complete plugging of the pipe later this winter and threaten the BNSF railroad traffic.

It is my professional opinion that the City of Edmonds/Perrinville Creek stormwater conveyance piping immediately upstream of the BNSF railroad tracks is undersized to safely convey a 100-year storm event from the tributary drainage basin. This creates the potential to damage or washout the BNSF railroad tracks in a major storm event, or possibly result in a train derailment with loss of life. A track washout into Browns Bay would be an environmental catastrophe potentially resulting in a take of Federally listed, threatened non-natal juvenile Chinook salmon and harming the eel grass beds near the outfall that Brant Geese rely on.



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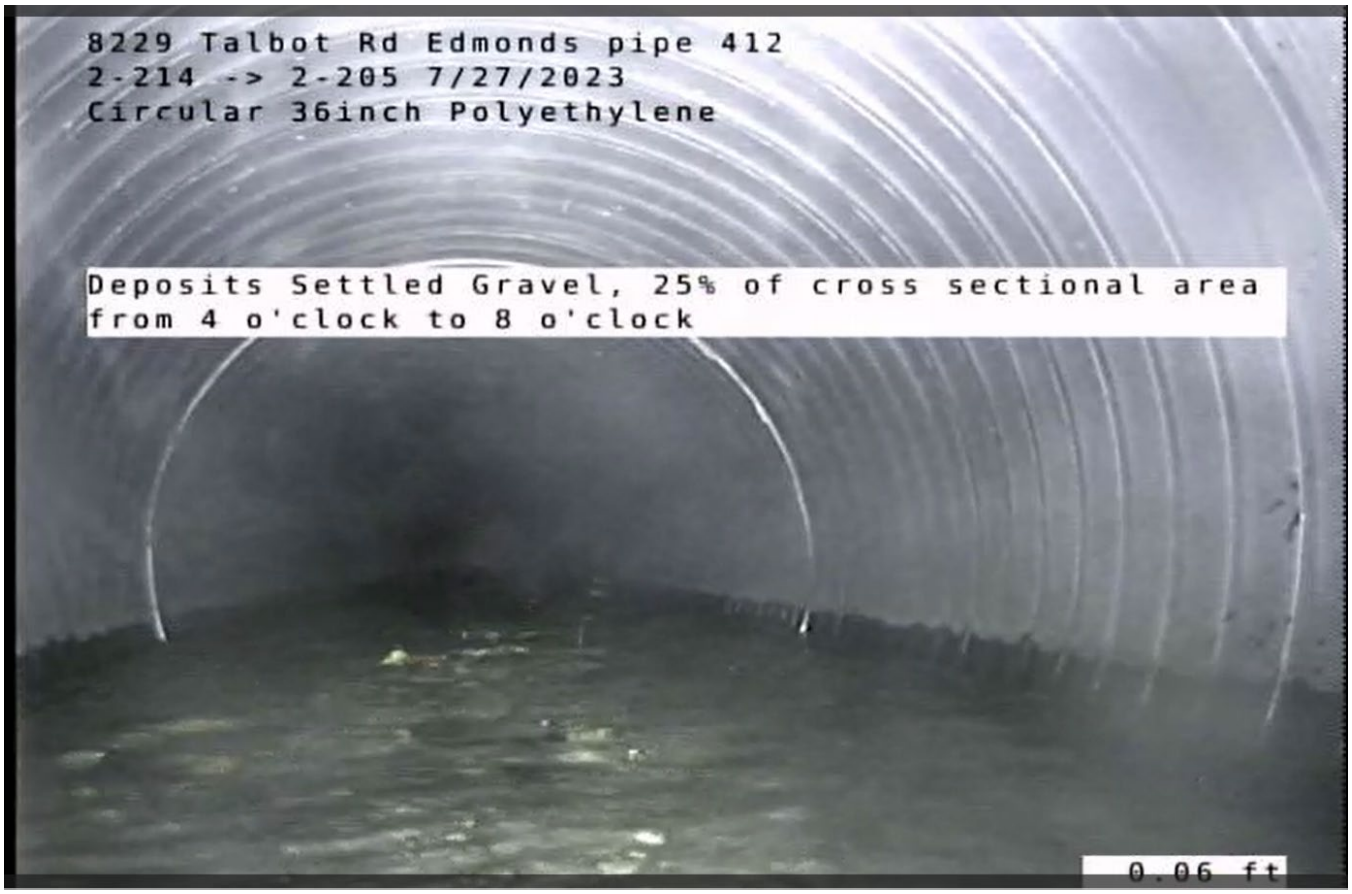

Figure 1: Clip from City of Edmonds July 27, 2023 video inspection, looking west in the 36-inch HDPE pipe from the flow splitter at time stop 0:17.

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