PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Bull Run TREATMENT PROJECTS | Filtration

Technical Memorandum

Subject:	Climate Change Considerations in Design of Stormwater Management Systems
PWB Project #s:	W02229
Date:	August 3, 2023
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Exhibit I.94

1.0 Introduction

Climate change is the change in climate patterns attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels. As climate patterns continue to change, climate change has exhibited cascading impacts on the frequency and severity of natural hazards and their impacts.

According to the National Climate Assessment, the Bull Run Watershed has experienced a 1.7°F increase in daytime temperatures and a 3.3°F increase in nighttime temperatures from 1907 to 2007. Recent years, including 2015 and 2018, were among the warmest on record.

Potential impacts of these changes include possible increases or decreases in rainfall depths during storm events and increased evaporation in open stormwater systems. For the purposes of this memorandum, it is assumed that the primary effect of climate change on stormwater management will be an increase in rainfall depths during 24-hour design storm events, as this would have the most significant effect on stormwater management. The current rainfall depths used for this project are listed in the table below.

Current 24-hour Rainfall Depths	
Design Storm Event	**24-hr Rainfall Depth (inches)**
2 Year	2.8
5 Year	3.4
10 Year	3.8
25 Year	4.5
50 Year	5.0
100 Year	5.5

Stormwater management typically involves mitigating the effects of developing a given project on local stormwater systems, both manufactured and natural. Mitigation via stormwater management systems is achieved based on the relevant public agencies' design standards and rainfall depths and intensities based on previously collected local rainfall data. Potential increases in rainfall caused by climate change that cannot be fully predicted by observing previous stormwater data are typically not considered in the design of proposed stormwater management systems and facilities. Excess capacity in the Bull Run Filtration Facility's stormwater management systems and facilities can be used as a buffer to mitigate the effects of this potential rainfall increase.

Should the increase in rainfall depths increase past the stormwater system's capacity, modifications to previously constructed systems can be made to compensate.

2.0 Filtration Facility Stormwater Design

The proposed onsite stormwater management system was designed to meet and, in some cases, exceed the design standards outlined by the City of Portland and Multnomah County. The standards and design methods described below are outlined in detail in the Drainage Report for the Bull Run Filtration Facility.

City of Portland design standards require that the 10-year, 24-hour design storm be conveyed through a piped conveyance system without surcharging. The 25-year design storm is allowed to pass through the conveyance system while surcharging pipe segments, but is required to maintain a minimum freeboard of 6 inches throughout the system. The proposed onsite stormwater conveyance system for Bull Run was conservatively designed to convey the 25-year design storm without surcharging. This conservative approach was selected to provide additional capacity due to the high rainfall intensities and additional snowfall related flows at the project location.

Multnomah County design standards require that peak flow matching detention be provided for the 5-year, 10-year, and 25-year design storms, and that the post-developed 2-year peak flow match ½ of the pre-developed 2-year peak flow. Additionally, the 25-year storm must have a minimum of 1 foot of freeboard to the top of each proposed pond structure. Dry detention ponds, a sloped basin, and an ecoroof are proposed to meet these standards. While the ecoroof and sloped basin are designed exactly to standard and have little excess capacity aside from the 4 inches of freeboard within the basin, all ponds exceed freeboard requirements and have between 0.04 ft to 3.2 ft of extra ponding depth to use in the case of increased rainfall.

3.0 Stormwater System Capacity

In the case of significant rainfall increase due to climate change, the excess capacity in both the onsite conveyance and detention systems will be used to provide mitigation.

The conservative sizing of the proposed conveyance system will allow it to maintain adequate conveyance capacity through significant increases in rainfall. As it is currently sized to convey the 25-year storm without surcharging, the system will continue to convey the relevant storm events to City Portland standards up to the point where the 10-year storm rainfall depth increases to match the current 25-year storm rainfall depth. This would be a depth increase of 18%. While past rainfall data cannot fully predict the rate at which rainfall depths will increase, it can be assumed the excess capacity within the conveyance system will allow for the site to continue to adequately drain during extended periods of significant rainfall.

While the capacity of the ecoroof and sloped basin do not exceed the required detention volumes, the five dry detention ponds have excess ponding depth to use in the case of increased rainfall depths. As the detention ponds manage runoff from approximately 92% of the site's surface area, these facilities will be the most relevant in discussing the detention system's ability to adapt to more intense rainfall. The 25-year storm event is the primary consideration in this discussion as it has the highest design rainfall depth and therefore controls required pond volumes and capacities. In the case that the 25-year storm rainfall depth increases to the point that it matches the current 50-year or 100-year storm events, the current pond geometries will continue to provide adequate peak-flow matching detention, see the table below.

Pond Performance Summaries during the 50-yr & 100-yr Design Storms				
Pond	Pre-developed 50-year flow (cfs)	50-year Release Rate (cfs)	Pre-developed 100-year flow (cfs)	100-year Release Rate (cfs)
A	3.72	2.45	4.34	2.74
B	4.08	2.53	4.75	2.79
C	11.73	3.86	13.61	4.20
D	5.59	3.17	6.49	3.49
E	7.85	3.89	9.13	4.31

Should the current 25-year rainfall event increase to the degree being discussed (~11% to match the current 50-year and ~22% increase to match the current 100-year), minimum freeboard requirements would largely no longer be met. Ponds A, B, and D maintain minimum freeboard during the 50-year storm, but all other situations during the 50-year and 100-year design storm no longer meet freeboard standards. However, none of the ponds overtop during these storm events, and can therefore still function as designed under these potential increased rainfall depths. Redundant overflows within the ponds and downstream flow control manholes further reduce the risk of overtopping the ponds and flooding the proposed development. See the table below for freeboard depths.

Freeboard Summaries during the 50-yr & 100-yr Design Storms					
Pond	50-year Ponding Elevation (ft)	100-year Ponding Elevation (ft)	Top of Pond Elevation (ft)	50-year Freeboard (ft)	100-year Freeboard (ft)
*A	710.71	711.12	711.80	1.09	0.68
B	710.71	711.12	713.00	2.29	1.88
*C	706.19	706.60	706.81	0.62	0.21
D	696.23	696.65	699.00	2.77	2.35
*E	715.33	715.71	715.96	0.63	0.25

*Reported top of pond elevations for Ponds A, C, and E are the rim elevations of the downstream flow control manholes as the rims are lower than the tops of the three ponds.

4.0 Adaptive Management

Because there is significant uncertainty about the pace and magnitude of climate change, Portland Water Bureau will adopt an adaptive approach to managing stormwater at the Facility, consistent with the Bureau's overall commitment to understanding and preparing for a range of climate impacts to the City's drinking water system. This adaptive management approach involves planning for a range of potential outcomes, monitoring system performance and climate change indicators, implementing system improvements proactively, and updating the plan on a regular basis.

By implementing a conservative design for stormwater system capacity, as described above, the Facility will have the capability to respond to near-term increases in rainfall intensity due to climate change. During operation, PWB will monitor stormwater system performance, storm intensity, projections of climate change impacts, and changes in regulations. This information will be used to inform ongoing facility management which will assure the long-term resilience of the stormwater management system. The site layout anticipates the potential for future changes by reserving space for future expansion of treatment processes and supporting facilities such as stormwater ponds or conveyance structures. For example, additional stormwater detention ponds could be placed adjacent to existing pond locations based upon stormwater management system monitoring data.

5.0 Conclusion

The conservative sizing methods used to design the conveyance and detention systems and facilities for the Bull Run Filtration Facility can adequately manage increases in rainfall depths up to 18%. Though freeboard requirements are largely no longer met after this increase, no flooding or overtopping will occur within the system. All other relevant stormwater management standards are met after this potential increase in rainfall depth. This buffer can provide protection against rainfall depth increases brought on by the effects of climate change without additional improvements to the stormwater management design. However, as future impacts of climate change on the frequency and intensity of local storm events over the life of the facility are unknowable, the site layout allows the PWB to proactively implement improvements as part of ongoing facility management if warranted.