

DRAFT Greer Park South Flood Control Project Preliminary Design Report

November 13, 2024

PRESENTED TO

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1 INTRODUCTION

The City of Huntington Beach’s 2018 Master Plan of Drainage (MPD) evaluated the capacity of the city’s storm drain infrastructure using the best available data to assess its ability to meet service requirements for a 100-year, 24-hour design storm. Greer Park was designated as the top priority in the 2021 Drainage Improvement Prioritization memo, prepared alongside the MPD, to address these service expectations. The drainage system in Greer Park has been facing significant challenges due to insufficient capacity and outdated infrastructure, as detailed in **Section 2** . Recent service calls from residents in late 2023 and early 2024 described severe flooding conditions, with residents noting it was “the worst they have ever seen,” as heavy rains rendered the area inaccessible for maintenance. Additionally, the groundwater table has reached one of its highest levels in recent years, causing seepage into the lake, which was likely not designed to accommodate such flows. In fact, city maintenance crews had to use a raft to access parts of the park. Recognizing the critical nature of these issues, the City of Huntington Beach initiated this feasibility study to evaluate flood risks, gain insights into the area’s drainage challenges, and develop recommendations for effective flood mitigation.

1.1 Site Background

Greer Park is a 10.44-acre park that began development in June of 1966 located on the corner of Goldenwest Street and McFadden Ave in Huntington Beach. The park is divided into two sections. The northern half features playground equipment, basketball courts, softball fields, picnic tables, and a spacious grassy area. The southern half of the park, this project’s area of interest, holds a lake that serves as both a recreational area and a stormwater detention pond to relieve City street drainage from the surrounding residential area (**Figure 1-1**). In addition, Greer Park houses a critical sewer lift station that helps lift sewage from low points in the collection system to receiving sewers at higher elevations.

Greer Park Lake has been assessed through the Clean Water Act Section 303(d) list and has a WARM beneficial use, meaning that it currently supports warm freshwater habitat. This lake is categorized as Category 2 on the 303(d) list, meaning that while there may be some evidence of a water quality problem, there is not enough to show persistent impairment.

Many ducks were observed at the lake, suggesting it provides a suitable habitat for them. However, the City has received complaints from residents expressing concerns about the increasing duck population, which has resulted in significant amounts of duck droppings along the park’s walkways. In addition, the lake attracts many people for recreational fishing (**Figure 1-2**).



Figure 1-1. View of the lake (Greer Park South) looking south from McFadden Ave. Many ducks call this lake home.



Figure 1-2. Recreational fishing at Greer Park lake.

1.2 Drainage Patterns

The overall Greer Park drainage area is 71.0 acres (**Figure 1-3**) and consists of two subareas. The northern drainage area is 30.3 acres while the southern drainage area is 40.7 acres. Drainage from this area is conveyed to the Murdy Channel, which eventually ends up in the East Garden Grove Wintersburg Channel, nearly 1.4 miles downstream of the Greer Park site.

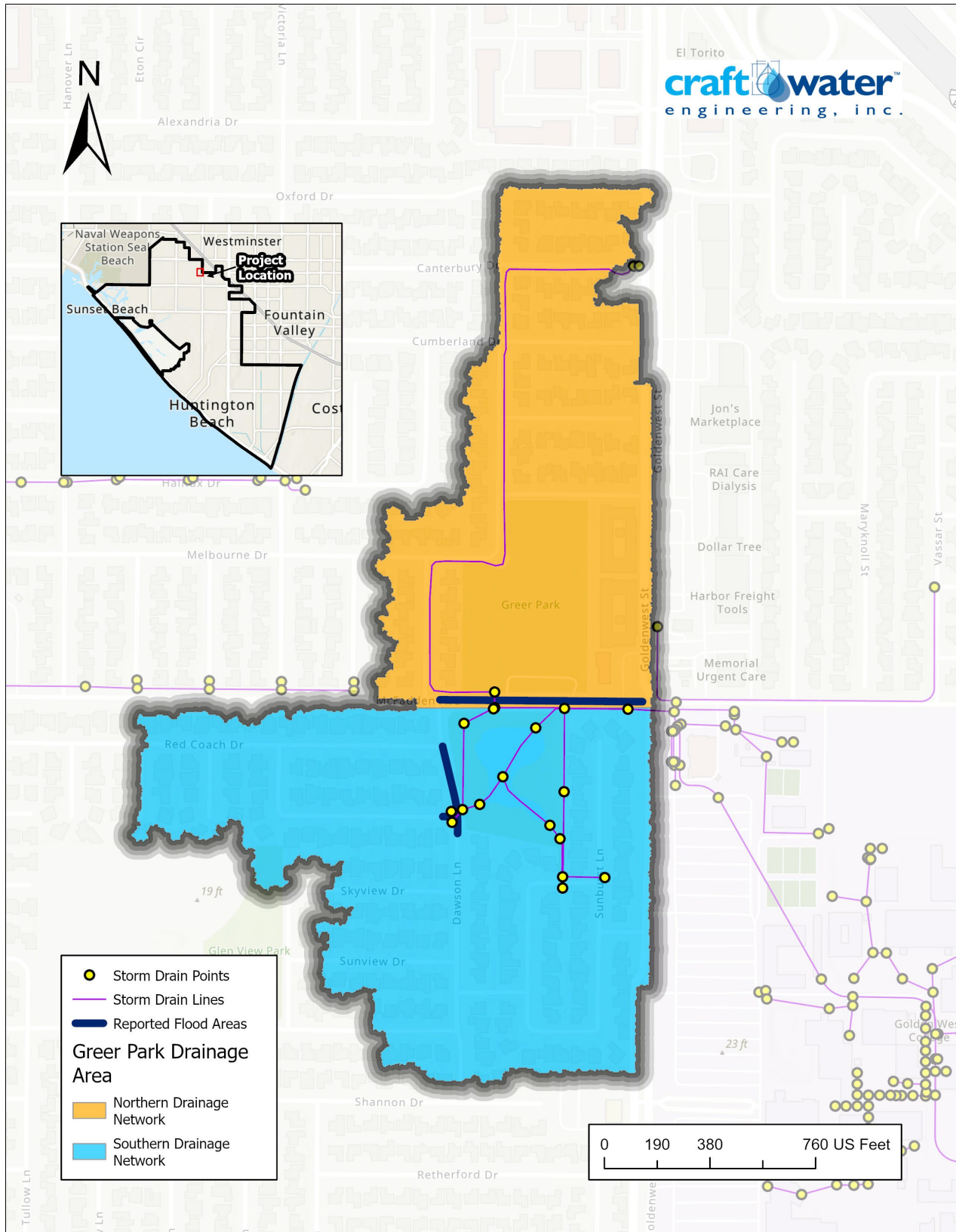


Figure 1-3. Greer Park northern and southern drainage network.

The Craftwater and Villa Civil team conducted a site visit to Greer Park on May 8th, 2024, which provided insight into the existing drainage patterns. Flows from the northern end of the drainage area—starting from the southbound residential blocks north of Goldenwest St and Canterbury Dr—first make their way to a 4’ curb inlet on the east side of Goldenwest St where some flows are intercepted and conveyed via an under sidewalk drain underneath Goldenwest St to a curb outlet at the cul-de-sac on Canterbury Dr. Flows from Canterbury Dr proceed westbound via gutters before turning southbound on Yorkshire Ln, westbound again on Melbourne Dr near the northern Greer Park site, and southbound on Salisbury Ln before reaching an 18-inch square grate on the north side of McFadden Ave. Consequently, there is reported flooding along McFadden Ave.

Flows from the northbound lanes of Goldenwest St starting from the residential neighborhood on Georgetown Ave are conveyed to a 30” RCP (owned by the City of Westminster) that connects to the existing 63” RCP at the intersection of Goldenwest St and McFadden Ave. Along Goldenwest St between Bolsa Ave and McFadden Ave, the southbound lanes are within the City of Huntington Beach’s jurisdiction while the northbound lanes are within the City of Westminster’s jurisdiction.

The Greer Park lake is intended to act as a detention pond and detain runoff from the southern drainage area. Flows coming from the southwestern end of the drainage area—the residential area encompassing Dawson Ln between Glen Dr and Red Coach Dr—make their way to the southwest side of the lake via gutters before entering two 24” X 36” grates located at the intersection of Dawson Ln and Gas Light Dr. These two grates convey flow via two 6-inch pipes to a 16’ curb inlet (located in sag) on the east side of the Dawson Ln and Gas Light Dr intersection. The flows outlet to a riprap area at the southwest point of the lake. Stagnant water as well as rusting concrete at the curb was observed at this point, indicating that the runoff is improperly draining at the location (**Figure 1-4**).



Figure 1-4. 16' curb inlet at eastern side of intersection of Dawson Ln and Gas Light Dr.

Besides these two grates, there are no other inlets along this residential area to alleviate flooding. There is reported flooding along Dawson Ln between Gas Light Dr and Red Coach Dr. This is evident through Google Street View showing how high the water gets relative to the property (**Figure 1-5**).



Figure 1-5. Water marks past the curb due to inadequate drainage near the intersection of Dawson Ln and Gas Light Dr.

Flows from the eastern end of the southern drainage area—the residential area encompassing Briarwood Dr, Sunflower Ln, Moonbeam Dr, and Sunburst Ln, drain to three inlets located near the intersection of Chestnut Dr and Sunburst Ln. Similarly to the western end of the southern drainage area, there are no other inlets besides these three inlets along this residential area to alleviate flooding. Flow from these inlets outlet via a box culvert headwall located at the southeast corner of the lake (**Figure 1-6**).



Figure 1-6. Headwall at southeast corner of Greer Park lake.

The team engaged with City of Huntington Beach Public Works staff regarding current operations at the lake during flooding events. Staff noted that the existing pump station on the east side of the lake will need to be fixed since it is unable to draw down water from the lake as the discharge point is below the hydraulic grade line in the 63" pipe in McFadden. A review of the lake annexation as-builts (further discussed in **Section 1.3**) show a 6-inch pipe at the pump station that outlets at the lake outlet structure to help lower lake levels; however, the elevation of the lake outlet structure is similar to the storm drain system on McFadden Ave (slope of 0.1%), thereby preventing proper drawdown. Therefore, a portable pump is usually brought onto the site following storm events to evacuate water into the top of a manhole located on McFadden Ave. After major storm events, staff reported that traffic control on McFadden Ave is often complicated due to flooding of several lanes on McFadden Ave as well as challenges with the existing portable pumping operations. Staff expressed a need to have a permanent pumping solution to evacuate water from Greer Park. In addition, staff explained that drainage infrastructure surrounding Greer Park is undersized and that increasing the capacity of the lake without updating the capacity of the drainage infrastructure would not alleviate the existing flooding issues.

The grass surrounding the lake was soggy, indicating potential saturation of the soil, hypothesized to be either due to high groundwater levels (would need to be confirmed by a geotechnical investigation) and/or lack of

proper drawdown from the lake. As shown in **Figure 1-7**, the water currently ponds past the existing lake edge due to the inability of the lake outlet to properly drain to the existing storm drains on McFadden Ave. **Figure 1-8** illustrates the lake outlet structure at the park.



Figure 1-7. Zoomed-in view of the lake looking south from the existing lake edge. Water currently ponds past the existing lake edge due to the inability of the lake outlet to properly drain to the existing storm drains on McFadden Ave.



Figure 1-8. Lake outlet structure and emergency evacuation pump line at Greer Park South.

1.3 Lake Annexation As-Builts

The City provided as-built drawings for the Greer Annex Lake Rehabilitation project, completed in 1992. The purpose of the project was to rehabilitate the manmade lake at Greer Park Annex to restore the aesthetics of the lake, improve lake water quality, and provide a healthy habitat for fish and fowl. The fish species present at the lake include rainbow trout and channel catfish per information from the FishCaddy website. Fish is stocked at the lake by the California Department of Fish and Wildlife (CDFW). The project entailed construction of pump facilities, removal of lake sediment, stabilization of the lake edge, and installation of a concrete path along the lake edge (Huntington Beach Office of Zoning Administrator, 1992).

Per the as-built drawings, stormwater from the southwest end (drainage from Dawson Ln) and the southeast end (drainage from Chestnut Dr/Sunburst Ln) outlet to a mortared rip rap area that extends into the lake to a 6-inch water depth. The lake bottom is made of cement stabilized sand, which is water permeable, while the lake edge is comprised of concrete blocks reinforced with rebar. There are several utilities present on the site:

- **Water supply line:** There is a 2" PVC water supply line west of the lake that supplies makeup water to the lake as needed.
- **Electrical conduits:** An electrical conduit is present north of the lake to supply power to the pump house.

There are several treatment technologies within in the lake area to improve the lake water quality as detailed below:

- **Aerators:** Several aerators are placed near the bottom of the lake to improve dissolved oxygen levels for habitat to thrive.
- **Venturi Aerator Return:** Several venturi aerators are placed below the surface of the lake to improve dissolved oxygen levels.
- **Biofilter:** Two biofilters are stationed at the bottom of the lake.
- **Skimmer:** There are skimmer boxes on the east edge of the lake to clear debris on the surface of the water.

The pump room is housed in a building east of the lake and houses equipment to ensure proper operations of the above treatment technologies. In addition, the pump room houses a 6" drain pipe that connects to the lake outlet structure.

It is likely that any alterations made to the existing lake's capacity will require replacement of the existing lake treatment technologies and will need to be coordinated with a firm specialized in lake treatment.

2 HYDROLOGIC AND HYDRAULICS (H&H) ANALYSIS

In the 2018 MPD, many assumptions regarding invert depths and conveyance slopes within the Greer Park drainage network were made in the analysis. Only one invert depth at the most downstream point within the Greer Park drainage network was known (invert of 63" reinforced concrete pipe (RCP) near intersection of McFadden Ave and Goldenwest Ave); as a result, assumptions using standard slopes were input for upstream invert elevations within the network. Therefore, this hydrologic and hydraulic (H&H) analysis focused on updating the Greer Park drainage network with invert and conveyance slopes information obtained from as-builts as well as the field investigation.

The updated H&H assessment of the existing conditions within the Greer Park drainage network was simulated to determine the number of nodes where 1) the water surface elevation (WSE) is above the curb height for the 10-year, 24-hour design storm, 2) the WSE is above 1-foot behind the back-of-walk for the 100-year, 24-hour design storm, and 3) there is inundation of driving lanes for arterial roads during the 100-year, 24-hour design storm. The results of this existing condition analysis will guide the evaluation of the proposed improvements within the Greer Park drainage network to ensure it meets the level of service necessary to prevent flooding from the 100-year, 24-hour design storm.

This section summarizes the results of the updated baseline hydrologic and hydraulic (H&H) analysis for the Greer Park drainage network and recommends proposed improvements for evaluation in subsequent sections.

2.1 Updates to MPD PCSWMM Model

The following updates were made to the MPD PCSWMM model: **1) invert elevations and depths**, **2) major system representation**, and **3) 1D-2D mesh representation**. No other updates were made to the model representing existing conditions.

2.1.1 Invert Elevations and Depths

The updates to the MPD PCSWMM model were made based on available as-built drawings from Tracts 7489, 7664, and the lake annexation drawings. In addition, invert elevations from the as-built drawings were increased by 2.247 feet per the NGS Coordinate Conversion and Transformation Tool to account for the difference in the NGVD 1929 versus NAVD 1988 datum. Updates were only made to the nodes within the Greer Park drainage network shown in **Figure 2-1**. **Table 2-1** displays the invert elevations and invert depths assumed within the MPD 2018 versus the updated invert elevations and invert depths based on review of as-built drawings.

Information from the as-built drawings confirmed the insufficient capacity or lack of drainage infrastructure within the Greer Park drainage area as noted by City staff. The northern Greer Park drainage area has little drainage infrastructure, potentially contributing to flooding along McFadden Ave. The infrastructure within the southern Greer Park drainage area is severely undersized; most pipes ranged from 6" to 8" at a slope of 0.1%, which is insufficient for the peak flow rates observed from contributing subcatchments at the simulated design storms. In addition, the existing drainage infrastructure was installed at shallow depths due to the lack of vertical relief within the area, which likely contributes to surface flooding along McFadden Ave and Dawson Ln.

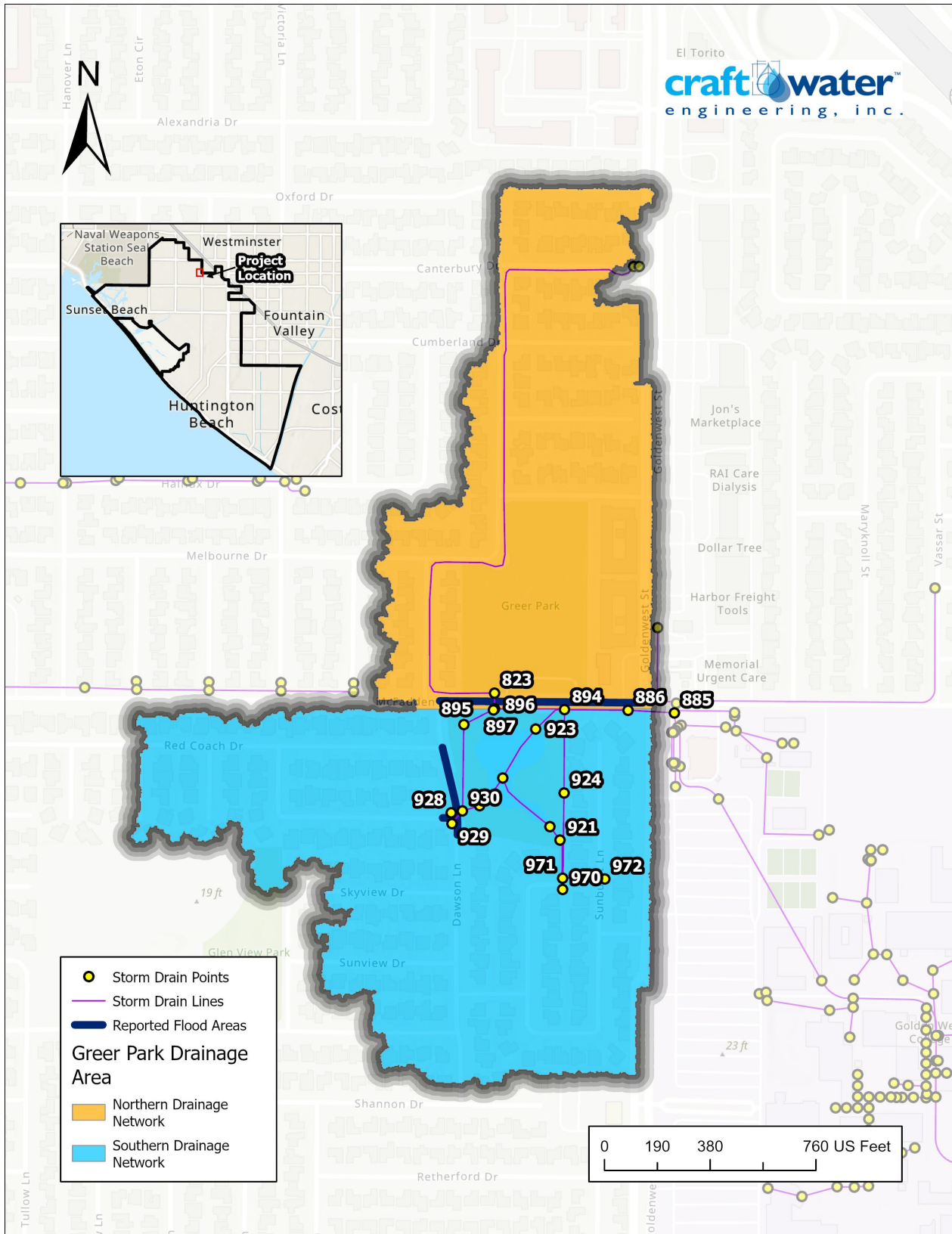


Figure 2-1. Greer Park drainage network with nodes identified.

Table 2-1. Invert elevation and depth updates within the PCSWMM model.

Node	Invert Elevations		Invert Depths	
	MPD 2018	Greer Park Update	MPD 2018	Greer Park Update
Chestnut Dr				
970 (24" X 36" Grate)	15.607	15.897	0.880	1.420
971 (10' Curb Inlet)	15.278	15.767	1.074	1.050
972 (24" X 36" Grate)	15.384	16.537	1.459	1.000
Dawson Ln				
928 (24" X 36" Grate)	15.430	16.247	29.970	1.300
929 (24" X 36" Grate)	15.443	16.247	29.957	1.280
930 (16' Curb Inlet)	15.401	16.147	1.169	1.500
Lake				
895 (Manhole)	15.288	15.537	2.105	3.910
921 (Headwall)	15.481	15.607	2.619	1.880
923 (Lake Outlet)	15.116	15.347	2.500	2.300
924 (Manhole)	15.133	15.467	2.522	2.180
McFadden Ave				
823 (18" X 18" Grate)	15.241	15.457	4.361	4.145 ¹
896 (Manhole)	15.201	15.417	4.308	5.030
897 (12" X 12" Grate)	15.206	15.422	4.710	4.494 ¹
894 (Manhole)	15.024	15.147	5.520	6.250
886 (Manhole)	14.864	14.917	6.114	7.150
885 (Connection to 63" RCP)	14.747	14.747	8.386	9.300

1. No updates were made to the invert elevation or depths of these nodes given the lack of information from existing City as-built drawings.

2.1.2 Major System Representation

Autodesk Civil 3D's Hydraflow Express Extension was used to update the head-flow relationships for the City's existing curb inlets/grates that are currently represented with the dual drainage modeling tool within the Greer Park drainage network. This update only affected two inlets along Chestnut Dr/Sunburst Ln which were originally modeled with a dual drainage system in the 2018 MPD. The differences in the head-flow outlet relationships can be seen in **Figure 2-2**.

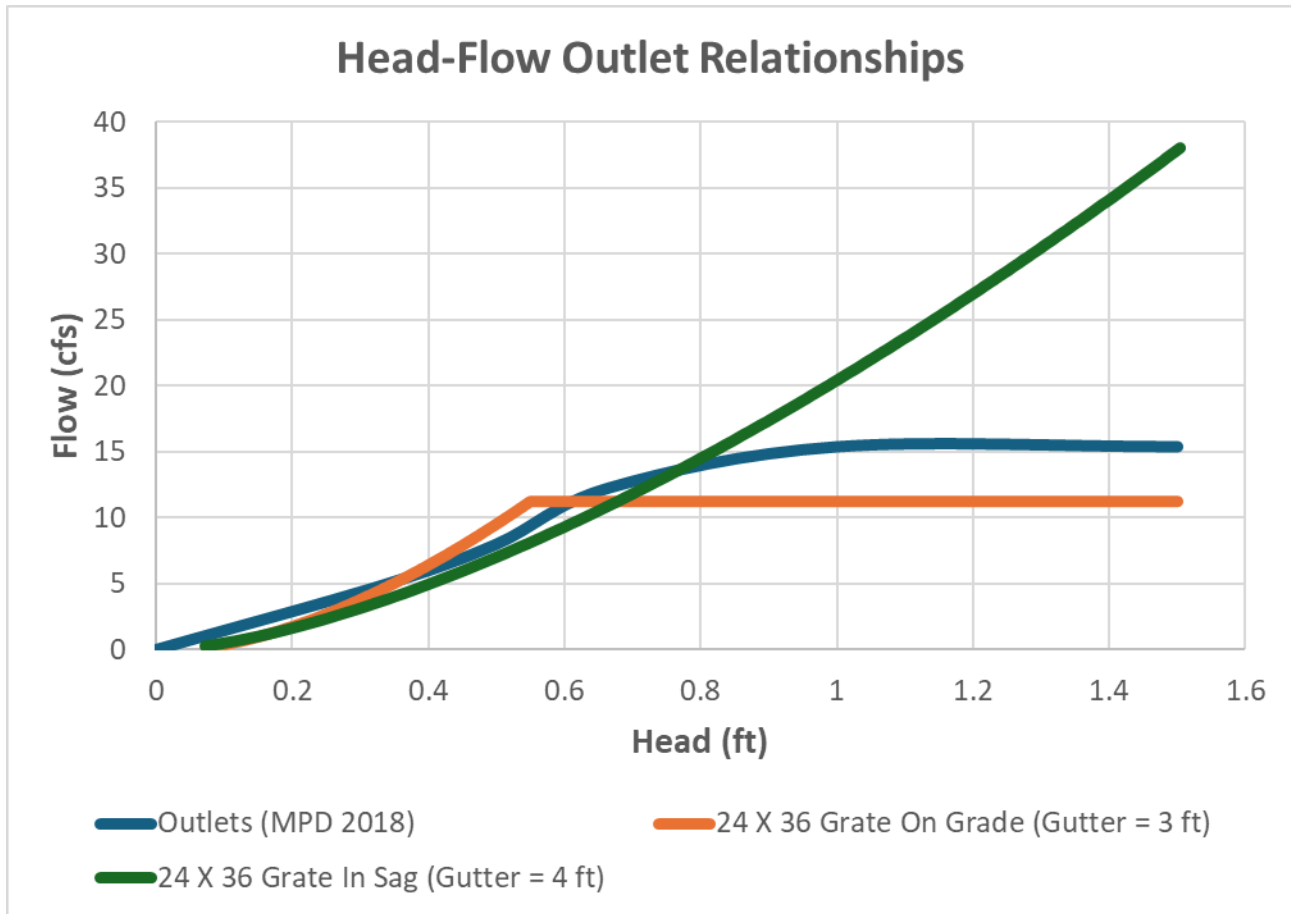


Figure 2-2. Updated head-flow relationships for inlets represented with dual drainage modeling in PCSWMM.

2.1.3 2D Mesh Representation

Updates to the representation to the 2D mesh were made to more accurately reflect the lake topography. As previously noted in the 2018 MPD, the resolution of the 2D mesh was discretized into two zones (**Figure 2-3**); a coarser scale (150 feet hexagons) was used for the center of the pond because of its generally uniform elevation (in the absence of bathymetric data), and a finer scale (50 feet hexagons) was used for the region around the banks to capture the topographic variation around the pond banks.

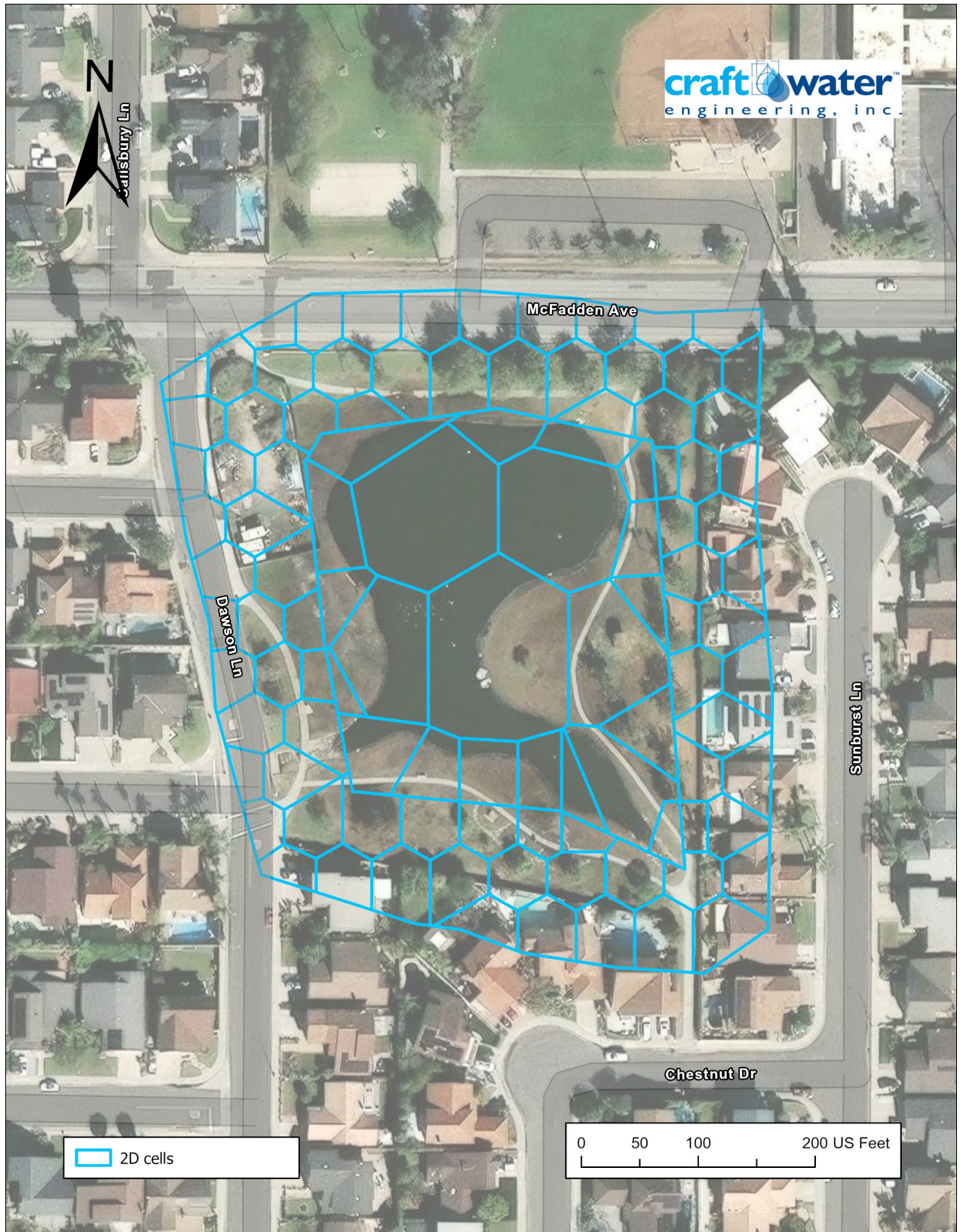


Figure 2-3. 2D mesh representation of Greer Park lake.

For the updates, the Manning’s n value for the pond banks were first changed to 0.026 to represent earthen conditions. The Manning’s n value for the lake itself was maintained at 0.001 to represent the impermeability of water. In addition, the connection between the 1D storm drain infrastructure components to the 2D mesh was updated to utilize side bottom orifices as opposed to direct connection to the 1D nodes as recommended by PCSWMM.

2.2 Existing Conditions

2.2.1 10-Year Design Storm

Table 2-2 and **Table 2-3** displays street flooding results predicted for the 10-year design storm (85% confidence depth equal to 2.90 inches) existing conditions within the Greer Park drainage network. The updated PCSWMM modeling suggests that 67% of nodes within the drainage network will have a water surface elevation above the curb height during a 10-year, 24-hour design storm event (previous MPD analysis suggested 42% of nodes).

Table 2-2. Street flooding results predicted for the 10-year design storm existing condition.

Maximum Street Flow Depth, 100-yr	Nodes (Count)	Nodes (%)
WSE Above Curb Height	8	67% ¹

1. Inclusive of all nodes in **Table 2-1** except for the lake nodes.

Table 2-3. Depth above curb height for nodes run under the 10-year design storm.

Node	Estimated Depth Above Curb Height (ft)
Chestnut Dr	
970 (24" X 36" Grate)	3.41
971 (10' Curb Inlet)	0.85
972 (24" X 36" Grate)	0.36
Dawson Ln	
928 (24" X 36" Grate)	1.66
929 (24" X 36" Grate)	15.98
930 (16' Curb Inlet)	-0.51
McFadden Ave	
823 (18" X 18" Grate)	5.10
896 (Manhole)	4.08
897 (12" X 12" Grate)	4.61
894 (Manhole)	-1.67
886 (Manhole)	-2.74
885 (Connection to 63" RCP)	-7.23

2.2.2 100-Year Design Storm

Table 2-4 and **Table 2-5** displays street flooding results predicted for the 100-year design storm (85% confidence depth equal to 5.88 inches) existing conditions within the Greer Park drainage network. The updated PCSWMM modeling suggests that 75% of nodes within the drainage network will have a water surface elevation above 1-foot behind the back-of-walk during a 100-year, 24-hour design storm event (previous MPD analysis suggested 75% of nodes). Overall, the updated analysis remains similar to the results obtained in the previous MPD.

Table 2-4. Street flooding results predicted for the 100-year design storm existing condition.

Maximum Street Flow Depth, 100-yr	Nodes (Count)	Nodes (%)
WSE Above 1-Foot Behind Back-of-Walk	9	75% ¹

1. Inclusive of all nodes in **Table 2-1** except for the lake nodes.

Table 2-5. Depth above 1 feet behind parkway for nodes run under the 100-year design storm.

Node	Estimated Depth Above 1 Feet Behind Parkway (ft)
Chestnut Dr	
970 (24" X 36" Grate)	12.11
971 (10' Curb Inlet)	1.82
972 (24" X 36" Grate)	1.20
Dawson Ln	
928 (24" X 36" Grate)	9.00
929 (24" X 36" Grate)	51.13
930 (16' Curb Inlet)	1.04
McFadden Ave	
823 (18" X 18" Grate)	21.60
896 (Manhole)	20.58
897 (12" X 12" Grate)	21.12
894 (Manhole)	-2.68
886 (Manhole)	-3.27
885 (Connection to 63" RCP)	-6.17

The updated PCSWMM modeling suggests that all nodes at arterial intersections within the Greer Park drainage network are meeting the criteria for street flow at arterial intersections during the 100-year, 24-hour design storm event (water surface elevation below driving lane in each direction).

Figure 2-4 shows the simulated flood volume associated with each node in the Greer Park drainage network. While the MPD 2018 did not show flooding at nodes along McFadden Ave, the updated PCSWMM modeling shows flooding at nodes along McFadden Ave, likely due to the updated modeled storm drain network invert elevations.

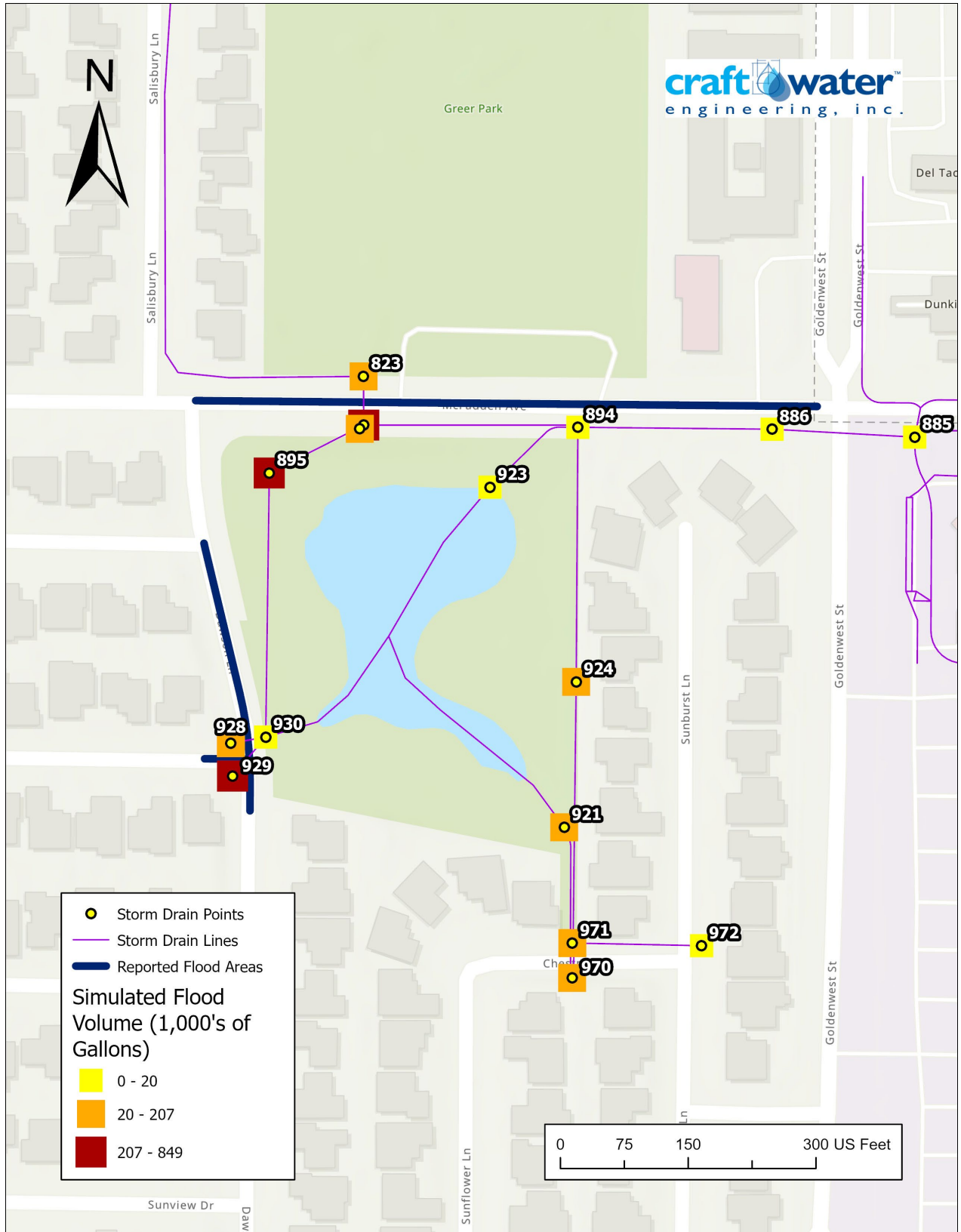


Figure 2-4. Simulated flood volume at each node for the 100-year design storm.

2.2.3 100-Year Flooding Extents

Previous analysis of flooding extents in the 2018 MPD were estimated based on the flooded volume from a 24-hour, 100-year storm and a ponded depth of one foot at each node in lieu of a complex 2D analysis. **Equation 2-1** was applied to calculate the flood radius. This radius was used to generate buffers at each node in GIS to geospatially estimate the extents of each flooded area. Generated buffers were then intersected with the Orange County Building Footprints GIS layer created on May 1, 2019 to determine the potential impact of flooding at each location.

$$Flood\ Radius\ (ft) = \sqrt{\frac{\left(\frac{(Flood\ Volume\ (MG) \times \left(\frac{1,000,000\ gal}{1\ MG} \right) \times \frac{1\ ft^3}{7.48052\ gal}}{(Ponding\ Depth)} \right)}{\pi}}$$

Equation 2-1. Flood radius calculations.

To represent more site-specific factors, an updated analysis was carried out to provide a potentially more precise estimate of the flooding extents around Greer Park. This analysis updated the ponding depth estimates using curb height data, which were approximated from Google Earth aerial imagery. Buffers were then created at each node in GIS and intersected with the Orange County Building Footprint layer. This approach aims to deliver a more accurate estimate of flooding extents by considering local infrastructure factors. The new analysis resulted in an **estimated 70 residential buildings being affected** during the 100-year design storm as seen in **Figure 2-5**.

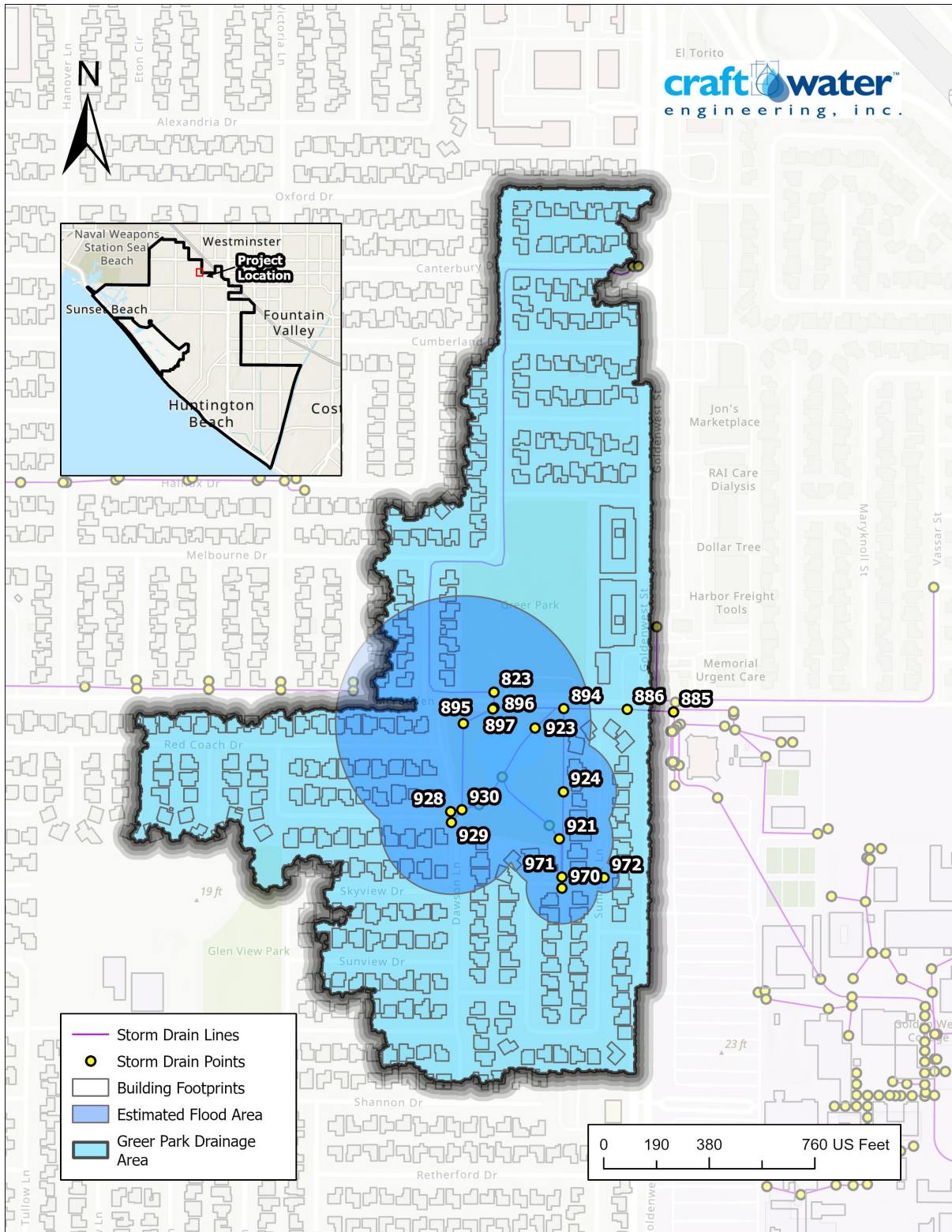


Figure 2-5. Map showing the flooding extents based on refined ponding depths at each node.

2.2.4 Greer Annex Lake Storage

The elevation of the berm was updated from 16.032 feet from the 2018 MPD to 15.247 feet. This updated elevation is based on the existing Greer Annex Lake as-built noting that the existing lake edge is located approximately at the 13’ contour line and updating the datum from NGVD 1929 to NAVD 1988 (2.247 feet per the NGS Coordinate Conversion and Transformation Tool).

The 2018 MPD estimated the current storage volume of Greer Park Pond to be 1.8 ac-ft according to the 2021 Priority Drainage Improvement Project Memo, and the 2021 Priority Drainage Improvement Project Memo noted an additional 12.72 ac-ft increase based on the 100-year, 24-hour design storm, resulting in approximately 14.5 ac-ft of storage capacity needed at the site. The calculations were performed by selecting all the 2D cells within the lake area (**Figure 2-3**) and summing the volume of water above the berm elevation. **This methodology is conservative as some of the 2D cells in Figure 2-3 fall outside of the actual lake area.**

2024 Update

As part of this project, as-built drawings of the Greer Annex Lake Rehabilitation project in 1992 from the City were referenced to calculate the existing lake capacity, given that the scope of work of this project does not include a bathymetric survey. Bluebeam Revu was used to perform takeoff calculations of the area of each contour, given the 1” = 20’ scale on the as-built drawing (**Figure 2-6**). The greatest depth of the lake is 4 feet per the as-built drawings.

Table 2-6. Takeoff calculations of existing lake capacity based on Greer Annex Lake Rehabilitation as-built drawings.

Contour (ft)	Approximate Area (ft ²)	Incremental Volume Between Contours(ac-ft)	Approximate Cumulative Volume (ac-ft)
13	59,479	1.17	2.84
12	42,680	0.91	1.67
11	36,314	0.58	0.76
10	13,938	0.19	0.19
9	2,202	N/A	N/A

Subsequently, the existing lake capacity was calculated using the trapezoidal prism volume method. This resulted in an estimated 2.84 ac-ft of volume within the lake. Given that the existing lake provides a habitat for fish from the California Department of Fish and Wildlife, it was determined that any proposed solutions that would require alteration of the existing lake maintain at least a permanent pool volume of 2.84 ac-ft.

Using the methodology from the 2018 MPD, the updated PCSWMM modeling indicated an additional 9.95 ac-ft increase in storage based on the 10-year, 24-hour design storm, resulting in approximately 12.79 ac-ft (9.95 ac-ft + 2.84 ac-ft) of storage capacity needed at the site. If using the 16.032 feet berm elevation, the additional capacity needed to capture the 10-year design storm would be 6.59 ac-ft. For the 100-year, 24-hour design storm, the updated PCSWMM modeling indicated an additional 20.37 ac-ft increase in storage, resulting in approximately 23.21 ac-ft (20.37 ac-ft + 2.84 ac-ft) of storage capacity needed at the site. If using the 16.032 feet berm elevation, the additional capacity needed to capture the 100-year design storm would be 16.36 ac-ft.

The subsequent section (**Section 3**) **evaluates the necessary storage and outflow rate based on the hydrographs of the incoming flows into the lake.**

3 STRUCTURAL CONTROL MEASURE OPTIMIZATION

The drainage area to Greer Park Lake is 40.8 acres, predominantly consisting of residential land uses (**Figure 3-1**).

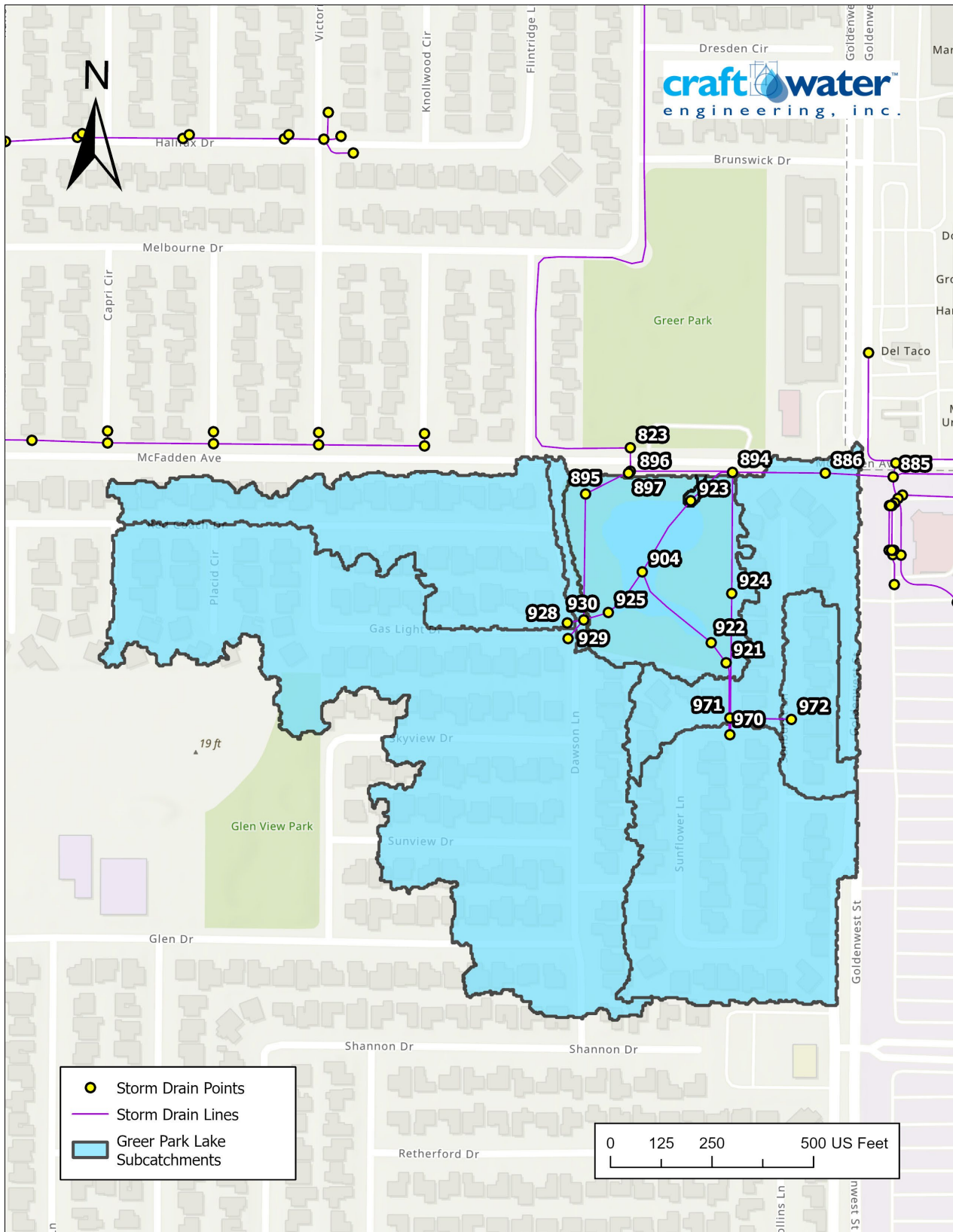


Figure 3-1. Subwatersheds draining to Greer Park South Lake.

The 100-year, 24-hour design storm (85% confidence depth of 5.88 inches) was simulated in PCSWMM for the area draining into Greer Park Lake. The resulting hydrograph is shown in **Figure 3-2**. The peak flow rate is 108 cfs while the 100-year, 24-hour design storm event volume is 17.11 ac-ft. As recommended in the previous section, a combination of storage and pumped outflow at Greer Park South lake is recommended to address the 100-year design storm.

It will be assumed that all drainage infrastructure into Greer Park South lake at the southwestern and southeastern corners of the lake will be retrofitted as part of this project to properly convey the 100-year design storm flows from the respective subcatchments into the lake, given that the existing drainage infrastructure is severely undersized.

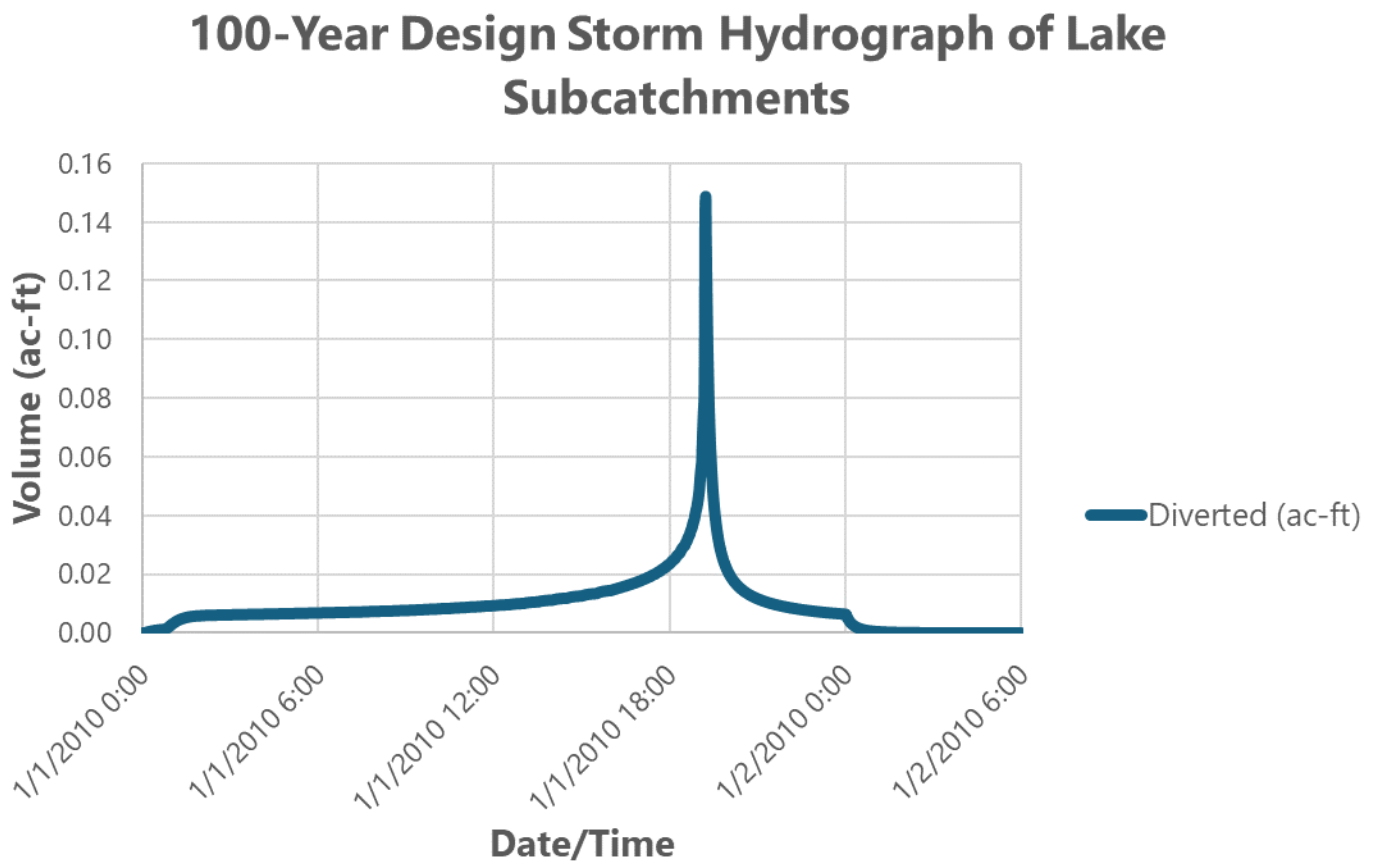


Figure 3-2. 100-year design storm hydrograph of subcatchments draining to Greer Park South Lake.

A Python model was developed to verify whether different combinations of storage sizes and pumping rates can fully capture the total runoff volume resulting from the 100-year, 24-hour design storm from all contributing subwatersheds. It was assumed that the peak flow of the design storm could be captured given upgrades to existing drainage infrastructure. Modeled storage sizes varied in 0.1 ac-ft increments between 0.1 ac-ft and 18 ac-ft while modeled pumping rates varied in 0.5 cfs increments between 0.5 cfs and 9.5 cfs. Each combination was tested to see whether it would be able to capture the entirety of the 100-year, 24-hour design storm hydrograph.

3.1 Results

As seen in **Figure 3-3**, the higher the pumping rate, the lower the storage capacity needed to retain the 100-year design storm.

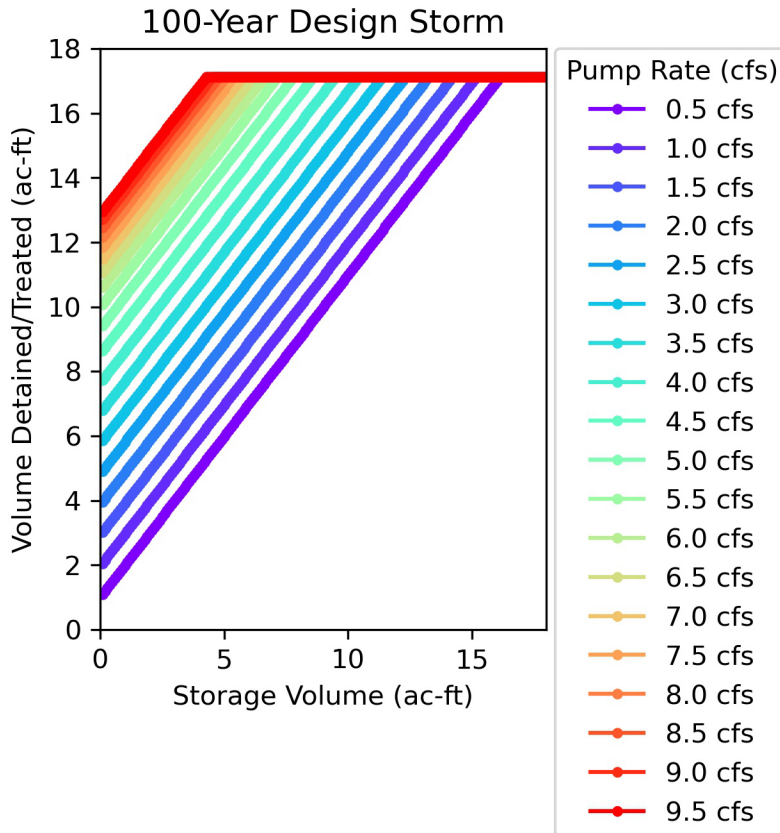


Figure 3-3. Storage volume vs. volume captured disaggregated by pumping rate.

Figure 3-4 displays a graph of the minimum storage size at each pumping rate to retain the 100-year design storm vs. estimated high-level planning costs (assuming subsurface tank costs to be conservative). The relationship between the minimum storage size and high-level planning costs is linear, indicating that the size of the storage tank is a primary driver of costs. Therefore, the smaller the storage tank size, the less expensive the project is likely to be.

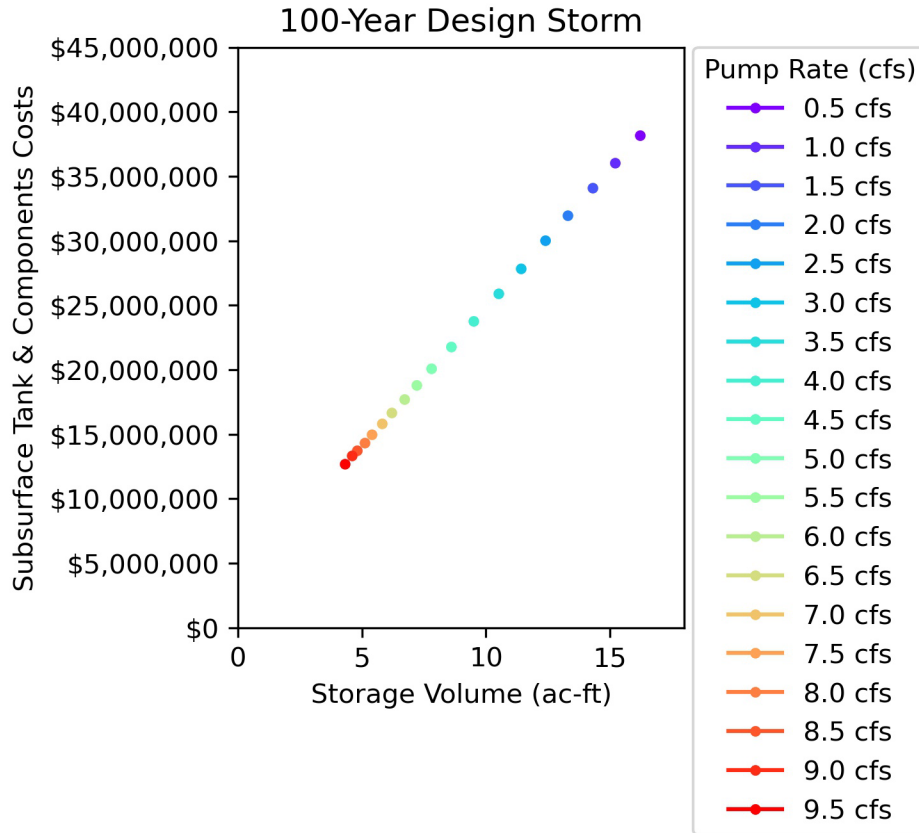


Figure 3-4. Graph of minimum storage size at each pumping rate vs. estimated high-level planning costs using cost functions derived from data collection of quotes/bids from similar projects in the region (assuming subsurface tank costs, which are significantly higher than surface excavation costs).

Table 3-1 is a tabular display of the information depicted in **Figure 3-4**.

Table 3-1. Minimum storage size at each pumping rate to capture the 100-year design storm and associated estimated high-level planning costs.

Pumping Rate (cfs)	Minimum Storage Size to Capture 100-Year Design Storm (ac-ft)	Planning-Level Cost Estimate
0.5	16.20	\$38,183,000
1.0	15.20	\$36,037,000
1.5	14.30	\$34,109,000
2.0	13.30	\$31,957,000
2.5	12.40	\$30,031,000
3.0	11.40	\$27,873,000
3.5	10.50	\$25,932,000
4.0	9.50	\$23,765,000
4.5	8.60	\$21,815,000
5.0	7.80	\$20,084,000
5.5	7.20	\$18,796,000
6.0	6.70	\$17,730,000
6.5	6.20	\$16,661,000
7.0	5.80	\$15,815,000
7.5	5.40	\$14,976,000
8.0	5.10	\$14,352,000
8.5	4.80	\$13,728,000
9.0	4.60	\$13,329,000
9.5	4.30	\$12,703,000

3.2 Sizing Recommendation

As depicted in **Table 3-1**, to minimize costs, **the minimum storage size of 4.30 ac-ft corresponding to a pumping rate of 9.5 cfs is recommended to be selected.** **Figure 3-5** displays the timeseries for the storage and pumped outflow to illustrate how the two would work in conjunction to store the 100-year design storm.

100-Year Design Storm Hydrograph of Lake Subcatchments with Lake Storage/Pump

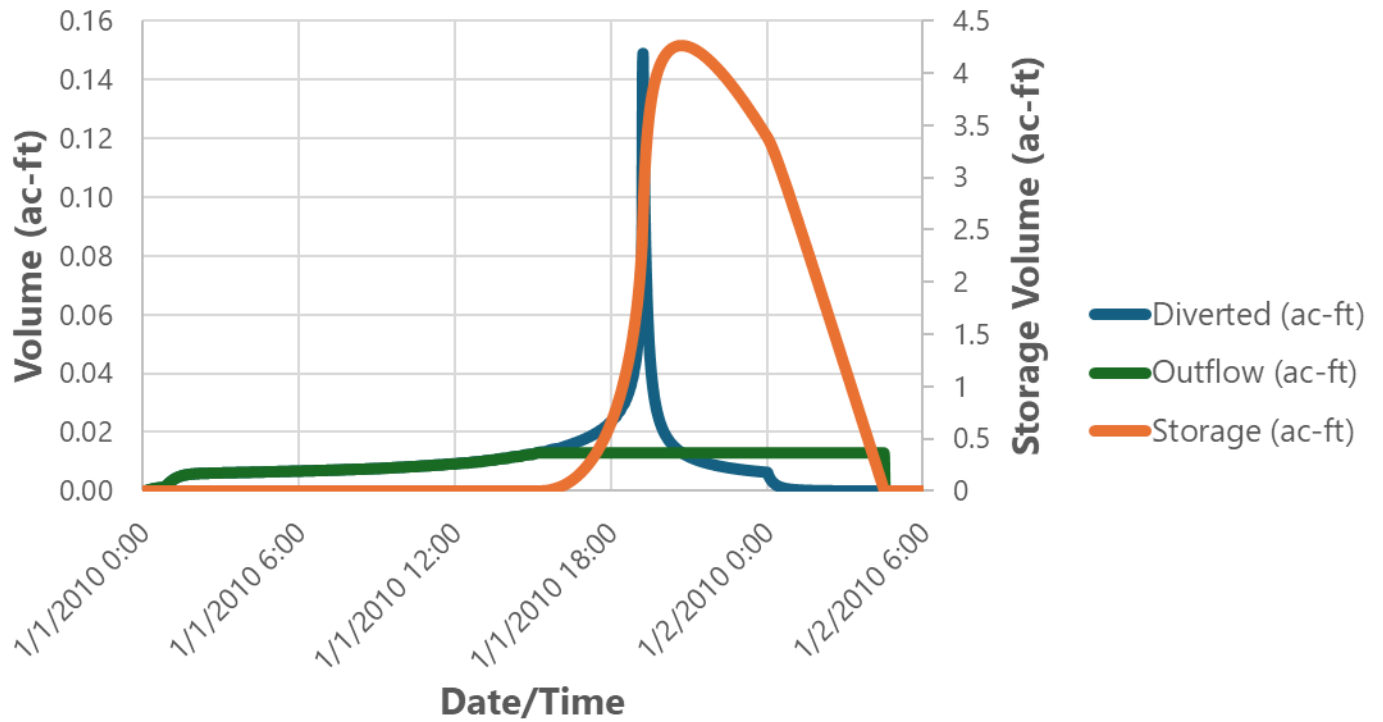


Figure 3-5. 100-year design storm hydrograph with storage (values on secondary axis) and pumped outflow timeseries.

3.2.1 Pump Station Footprint

As outlined in the previous section, City staff is seeking a permanent pumping solution to handle runoff from the 100-year design storm. Additionally, the City is in the process of constructing a sewer lift station at the northwest corner of Greer Park South (intersection of Dawson Ln and McFadden Ave), which will also include new sanitary sewer lines. The City sees this as an opportunity to convey wet weather flows into the sewer lift station, allowing them to be pumped into the City’s sewer system to progress towards both goals of 1) improving runoff water quality and 2) augmenting the region’s recycled water supply.

This feasibility study does not include formal mechanical calculations for pump sizing or plan development within its scope; therefore, rough approximations were made based on experience with designing similar-sized pump stations for regional water quality improvement projects in the nearby greater Los Angeles area. Because this is a critical flood control project for the City, it is recommended that a 2+2 configuration (two duty pumps and two backup pumps for 100% redundancy) and a backup generator is provided as part of this project. Per the McFadden Ave Sewer Lift Station plans provided by the City, the City is planning on installing a 30 kW generator in the Greer Park North parking lot. The generator equipment could potentially be upsized to additionally accommodate the power needs of the proposed stormwater pump station.

The footprint of a wet well and valve vault for a similar-sized pump station (7.84 cfs) of a project in the Greater Los Angeles area currently in the design phase was referenced (has 2+1 pump configuration with a low flow pump). The dimensions encompassing both the wet well and valve vault for that project is proposed to be 37'3" by 21'11". It is important to note that this does not include the footprint of an equipment pad if one is intended to be built. **For the purposes of the 10% design level layouts, a 45' by 45' footprint was assumed south of the proposed McFadden Ave Sewer Lift Station;** however, there appears to be more available space in the northwest corner of the park if needed to accommodate a bigger footprint, if determined necessary during the design phase.

4 ENGINEERING ANALYSIS

This section presents the engineering and design components recommended for the Greer Park South Flood Control project based on the preceding decision support modeling to capture flows from the 100-year, 24-hour design storm.

4.1 Utilities

Utility requests were sent out to utility purveyors who may potentially have utilities within the area surrounding Greer Park. Responses from the following utility purveyors were received and mapped within the concept layouts:

- Chevron
- Chevron Environmental
- Clear Channel Outdoor
- City of Huntington Beach
- Orange County Water District
- Southern California Edison
- City of Westminster

Responses from the following utility purveyors are pending:

- AT&T Distribution
- Cable Com LLC
- Crimson Pipeline LP
- MCI (Verizon Business)
- Plains All American Pipeline
- SoCal Gas Distribution
- Spectrum
- Frontier

A brief overview of the utilities present within the proposed three drainage improvement areas is outlined below, though it is not yet comprehensive. Utility conflicts with proposed alignments will be investigated further in future design phases.

Dawson Ln

- Water line owned by the City
- Sewer line owned by the City
- Underground electric lines owned by SCE

Chestnut Dr/Sunburst Ln

- Water line owned by the City
- Sewer line owned by the City
- Underground electric lines owned by SCE

McFadden Ave

- Water line owned by the City
- Proposed new sewer lines owned by the City built as part of the McFadden Ave Sewer Lift Station Replacement
- Proposed new electrical duct owned by the City to the new generator
- Overhead electric lines owned by SCE
- Underground electric lines owned by SCE
- Inactive petroleum line owned by Chevron Environmental Management Company

4.2 Drainage Improvements

To upsize or propose new drainage infrastructure to properly convey flows from the surrounding subcatchments into the lake as well as on McFadden Ave, Chapter 7 (Inlet Design) of the U.S. Department of Transportation Federal Highway Administration (FHWA)'s Hydraulic Engineering Circular (HEC) No. 22 4th edition (February 2024) was referenced. Inlet and pipe sizing calculations were performed using the Hydraulic Toolbox application using the Curb and Gutter Analysis and Channel Analysis calculators.

The results for each area draining to the lake (Dawson Ln and Chestnut Dr/Sunburst Ln) as well as McFadden Ave are shown in the below subsections.

4.2.1 Dawson Ln

Dawson Ln is considered a local street; therefore, per HEC-22 Table 5.1, the design spread should be 1/2 of the width of a driving lane. Given that this street is 40' wide from curb to curb with two driving lanes (approximately 20' each), the design spread should be 10' (essentially based on any flows that bypass the inlet). As it exists, the drainage infrastructure on Dawson Ln is severely undersized and does not have adequate pipe cover (approximately 1.2–1.5 feet), resulting in modeled flooding as well as anecdotal flooding reported along Dawson Ln.

To address this issue, several new catch basins with combination curb inlet and gutter grate on grade are proposed starting from past the intersection of Dawson Ln and Glen Dr to the existing lake inlet structure on the southwest end (**Table 4-1**). In addition, a new 36" reinforced concrete pipe (RCP) at a 0.5% slope is proposed along Dawson

Ln to convey flows captured from the inlets into the southwestern end of the lake. The invert of the 36” RCP is proposed to be approximately 8.94 feet (accounting for a 2.5’ pipe cover depth per County of Orange standards).

Table 4-1. New inlets and laterals proposed along Dawson Ln.

Location	Approximate Q100 (cfs)	Proposed Improvement
Dawson Ln near Glen Dr	4.2 cfs (intercept 3.4 cfs, bypass 0.8 cfs)	6’ curb inlet with 6’ X 2’ P-1-7/8 grate on grade 18” RCP lateral
Dawson Ln near Sunview Dr	6.3 cfs with 0.8 cfs upstream bypass (intercept 7.3 cfs, bypass 0.9 cfs)	10’ curb inlet with 10’ X 2’ P-1-7/8 grate on grade 24” RCP lateral
Dawson Ln near Skyview Dr	7.7 cfs with 0.9 cfs upstream bypass (intercept 7.6 cfs, bypass 0.9 cfs)	10’ curb inlet with 10’ X 2’ P-1-7/8 grate on grade 30” RCP lateral
Dawson Ln near Gas Light Dr	15.5 cfs with 0.9 cfs upstream bypass (intercept 15.4 cfs, bypass 1.1 cfs)	15’ curb inlet with 15’ X 2’ P-1-7/8 grate on grade 36” RCP lateral
Dawson Ln near Red Coach Dr	14 cfs (intercept 13.1 cfs, bypass 0.9 cfs)	15’ curb inlet with 15’ X 2’ P-1-7/8 grate on grade 24” RCP lateral

4.2.2 Chestnut Dr/Sunburst Ln

Both Chestnut Dr and Sunburst Ln are considered local streets; therefore, per HEC-22 Table 5.1, the design spread should be 1/2 of the width of a driving lane. Given that this street is 40’ wide from curb to curb with two driving lanes (approximately 20’ each), the design spread should be 10’ (essentially based on any flows that bypass the inlet). As it exists, the drainage infrastructure on Chestnut Dr/Sunburst Ln is severely undersized and does not have adequate pipe cover (approximately 1–1.5 feet), resulting in modeled flooding along Chestnut Dr/Sunburst Ln.

To address this issue, the three existing inlets are proposed to be upsized to catch basins with combination curb inlet and gutter grate in sag as shown in **Table 4-2**. In addition, the pipes are proposed to be upsized as shown in **Table 4-2** and the inverts are proposed to be lowered to accommodate a 2.5 feet pipe cover depth. The invert of the 5’ X 1’ RCB that conveys flows from this area to the southeastern end of the lake is proposed to be lowered to approximately 10.65 feet.

Table 4-2. Upsized inlets and laterals proposed along Chestnut Dr/Sunburst Ln.

Location	Approximate Q100 (cfs)	Proposed Improvement
Chestnut Dr (north curb)	9.08 cfs	12' curb inlet with 12' X 2' P-1-7/8 grate in sag
Chestnut Dr (south curb)	10.82 cfs	12' curb inlet with 12' X 2' P-1-7/8 grate in sag 18" RCP lateral
Sunburst Ln at intersection with Chestnut Dr (east curb)	15.71 cfs	12' curb inlet with 12' X 2' P-1-7/8 grate in sag 30" RCP lateral

4.2.3 McFadden Ave

Per recommendations based on the PCSWMM model, the existing 8" VCP and 18" RCP pipes along McFadden Ave between Salisbury Ln and Goldenwest Ave are proposed to be upsized to 6'X2' RCB. This proposed improvement differs from the 66" pipe MPD 2018 recommendation due to the following reasons:

1. Invert elevations for the Greer Park drainage area were only known for the existing 63" RCP near the intersection of McFadden Ave and Goldenwest Ave. Therefore, inverts for the pipes along McFadden Ave were unknown and assumed.
2. Once the invert elevations for the existing drainage network surrounding Greer Park were updated based on as-built drawings, it was found that a 66" pipe would result in the pipe sticking above the ground. Therefore, different iterations of smaller pipe sizes or box culverts with a higher slope were tested. It was found that a 6'X2' RCB to replace the 8" VCP and 12" RCP would result in a cover depth of nearly 44" at the most upstream invert, which meets minimum cover requirements of 30".

4.3 Alternatives Analysis

4.3.1 Recommended Alternative

The three alternatives considered for increasing the storage to accommodate the minimum 4.30 ac-ft flood control storage volume include:

1. **Expanding lake storage** through surface excavation only;
2. **Adding underground storage** to minimize disruptions to the existing lake; and,
3. **Combination of expanding lake storage and adding underground storage.**

After extensive discussions with the City, it was determined that installing subsurface tanks beneath the park would be cost prohibitive due to high groundwater levels. These conditions would require extensive dewatering efforts and necessitate a reinforced concrete design thick enough to counteract buoyant forces from the groundwater, significantly increasing project complexity and cost. Therefore, **the City decided to proceed with Alternative 1**, which proposes to increase the storage capacity to accommodate the necessary flood control

storage volume through surface excavation only (2.84 ac-ft existing within lake + 4.30 ac-ft flood control capacity through lake expansion = 7.14 ac-ft total minimum).

By expanding the lake into the currently underutilized areas along the park's edges, the lake could be re-graded to follow a standard detention pond design with slopes at a 3:1 ratio at minimum (horizontal to vertical). Expansion along the eastern edge was minimized since there is an existing lake treatment equipment building that may need to be rehabilitated to demolish and replace the existing lake treatment equipment housed within the building.

A 10% design was created to illustrate a concept of the recommended alternative as seen in **Attachment A**. The top of the detention pond would align at the existing top of the lake edge, which is at 15 feet. The detention pond is proposed to have a maximum depth of 9 feet; therefore, the elevation of the existing lake would be lowered to a 6 feet elevation to provide additional vertical relief for the southern drainage area, given the present lack of vertical relief. Given concerns about the high groundwater level seeping into the lake and the existing surface flooding, an additional 6-inch wall could be built around the lake edge to prevent flood water from overtopping the lake edge (not shown in **Attachment A**).

The drainage infrastructure in Dawson Ln would enter the southwest end of the detention pond via a pipe culvert headwall inlet at an invert elevation of 8.94 feet with Caltrans Class I rip rap immediately downstream to dissipate energy. Similarly, the drainage from Chestnut Dr would enter the southeast end of the detention pond via a box culvert wingwall inlet at an invert elevation of 10.65 feet with Caltrans Class I rip rap immediately downstream to dissipate energy. The permanent pool is proposed to be between the 6 foot and 9 foot proposed contour elevations, allowing for a volume of 3.60 ac-ft (greater than the minimum required of 2.84 ac-ft), and would be graded with a 3:1 ratio (horizontal to vertical). The flood control volume is proposed to be between the 9 foot and 15 foot proposed contour elevations, allowing for a volume of 6.80 ac-ft (greater than the minimum required of 4.30 ac-ft), and would be graded with a 5:1 ratio (horizontal to vertical). It is important to note that the volumes shown on the 10% plans greatly exceed the required minimum volume of 7.14 ac-ft and that the proposed grading of the lake should be discussed further with City staff in future design stages to accommodate any other constraints that may arise. However, this illustrates the site's capability for accommodating storage above the required amount if the City desires a smaller pump capacity. The lake is proposed to be lined with a bentonite clay pond liner to minimize seepage flows from the high groundwater table into the lake. This would be a more cost-effective solution than installing a thick concrete lake bottom.

Near the northwestern end of the lake, a pipe culvert headwall outlet structure would direct flows from the lake to a new flood control pump station, which would pump up to 9.5 cfs of flows into the upsized 6'X2' RCB along McFadden Ave. In addition, a connection can be made from the proposed flood control pump station to the McFadden Ave lift station currently undergoing construction to augment Orange County Water District's recycled water goals. City staff have noted challenges with dewatering during the construction of the sewer lift station due to high groundwater levels; therefore, future designs should incorporate measures to manage groundwater effectively. This may include implementing robust dewatering systems, waterproofing foundations, or considering alternative construction methods to mitigate potential groundwater-related issues that could impact project timelines and costs.

Littoral shelf plantings could be created along the lake perimeter where diverse aquatic plant communities can thrive and offer flood mitigation and water quality treatment benefits (discussed in **Section 6**).

4.4 Operations and Maintenance

4.4.1 Operations

While different elevations within the detention pond can be designated for specific purposes (such as a permanent pool for ecological benefits and flood storage for storm events), a real-time control (RTC) system can add flexibility and efficiency by dynamically managing water levels. Utilizing an RTC platform like OptiRTC, this system would continuously monitor variables such as incoming stormwater flow, pond levels, rainfall forecasts, and groundwater conditions to make real-time adjustments in response to changing conditions.

Operational Strategy and Workflow

Monitoring and Data Collection: Sensors placed within the detention pond and connected infrastructure gather real-time data on water levels, inflow/outflow rates, and local weather conditions. This information allows the RTC system to evaluate both immediate and forecasted scenarios.

Predictive Control for Preemptive Adjustments: With real-time data and weather forecasts, the RTC system anticipates high-flow events and can proactively lower pond levels by releasing water. For instance, prior to a forecasted storm, the system could begin a controlled release to the upsized storm drain on McFadden Ave. This preemptive action ensures there is enough capacity within the pond to manage the peak stormwater inflow, which is critical for flood control.

Dynamic Flow Management: During storm events, the RTC system adjusts in real time, prioritizing flood control by sending excess water to the storm drain to prevent overflow. Conversely, during dry weather or minor rainfall, the system can direct flows to the proposed sewer lift station, allowing Orange County Water District (OCWD) to treat the water for recycling. This flexibility helps balance flood management and recycled water goals based on actual conditions.

Adaptable Response to Unpredictable Changes: An RTC system offers adaptability that static infrastructure cannot. For example, if unpredicted increases in groundwater seepage raise the pond's water level, the system can recalibrate discharge to avoid overflow. This ensures the detention pond can handle unexpected conditions without manual intervention, maintaining the system's reliability under a variety of scenarios.

Post-Event Analysis and Optimization: After each significant weather event, the RTC system generates reports on discharge patterns, storage utilization, and flood control outcomes. These reports help operators understand how effectively the system managed the stormwater, identify areas for refinement, and optimize future performance based on observed seasonal trends or evolving groundwater conditions.

Practical Benefits of RTC in Stormwater Management

With RTC integration, the detention pond can maximize its operational flexibility, enabling it to efficiently serve flood control, water quality, and water recycling functions. By using real-time data and predictive algorithms, the system responds to storm events in a proactive, calculated way, reducing overflow risks and minimizing maintenance needs through automated control. This approach aligns with flood management requirements, supports OCWD's goals for recycled water augmentation, and provides a sustainable solution for handling the area's complex stormwater challenges.

In this way, the RTC system would help maintain optimal water levels within the detention pond, supporting both environmental and infrastructure objectives while providing adaptive, data-driven stormwater management.

4.4.2 Maintenance

In terms of maintenance requirements, it is anticipated that this alternative would require the following anticipated maintenance duties:

- Rip rap cleaning (quarterly);
- Wet well vacuuming (once before the wet season and twice during the wet season);
- Valve maintenance; and,
- Control panel inspection and maintenance.

4.5 Cost Estimate

Table 4-3 provides an estimate of the construction costs for the Greer Park South Flood Control Project, **which is currently estimated at nearly \$12,462,000**. The annual O&M costs are estimated at approximately \$72,000.

Table 4-4 provides an estimate of the soft costs for the Greer Park South Flood Control Project, **which is currently estimated at nearly \$3,056,000**.

Table 4-3. Estimated construction costs for Greer Park South.

Construction Costs Category	Cost
Miscellaneous (Mobilization/Demobilization & Traffic Control)	\$1,189,267
Drainage Infrastructure Improvements (Dawson Ln)	\$766,964
Drainage Infrastructure Improvements (Chestnut Dr/Sunburst Ln)	\$349,798
Drainage Infrastructure Improvements (McFadden Ave)	\$393,445
Greer Park South Detention Pond (7.14 AF) and Lake Treatment Equipment	\$2,255,014
Greer Park South Pump Station and Connection to McFadden Sewer Lift Station and Storm Drain	\$2,796,847
Greer Park South Site Amenities and Improvements	\$127,800
Electrical Service, Controls, and Instrumentation	\$655,000
Start-up, Testing, Prepare O&M Manuals, and Prepare Record Drawings	\$105,000
SUBTOTAL	\$8,639,134
25% Contingency	\$2,159,784
4% Escalation Per Year of Subtotal	\$1,663,194
TOTAL CONSTRUCTION COSTS	\$12,462,112

Table 4-4. Estimated soft costs for Greer Park South.

Soft Costs Category	Cost
Pre-Design, Design, and Construction Support (10%)	\$1,246,211
Community Outreach during Design	\$50,000
Environmental Planning and Permitting (1.5%)	\$186,932
Agency Project Management (2.5%)	\$311,553
Construction Management (10% of construction)	\$1,246,211
Construction Surveying	\$15,000
TOTAL SOFT COSTS	\$3,055,907

4.6 Schedule

The detailed proposed schedule for the Greer Park Flood Control project can be found in **Attachment C. Table 4-5** summarizes the major milestones.

Table 4-5. Schedule by phase.

Phase	Description	Start Date	Completion Date
Planning	Feasibility Study	03/2024	12/2024
Design	Final Design (30/60/90/100)	01/2026	03/2027
Design	Public Outreach and Education	02/2026	01/2027
Design	Agency Management	01/2026	03/2027
Construction	Contracting and Mobilization	05/2027	12/2027
Construction	Construction of Lake and Drainage Infrastructure	12/2027	04/2029
Construction	Construction Administration and Design Support	12/2027	10/2029
Construction	Agency Management (Construction)	12/2027	10/2029

5 ENVIRONMENTAL DOCUMENTATION AND PERMITTING

Evaluation of the environmental impacts of the project in accordance with the California Environmental Quality Act (CEQA) is required before construction. Past project experience has shown that the CEQA Initial Study most often identifies a Mitigated Negative Declaration for projects constructed in similar locations. The most significant impacts are temporary during the construction period and once construction is complete, will be gone entirely. Upon project completion, the project will ultimately provide a net benefit to flood control, water quality, and natural environment.

Once an Initial Study is completed, the appropriate environmental review will be determined. The CEQA Initial Study and associated Mitigated Negative Declaration are anticipated to take up to one year and will occur simultaneously with the design phase.

Other than CEQA, consultation with additional regulatory agencies and acquisition of permits is required before the project components can be constructed. **Table 5-1** summarizes the plan checks, regulatory permits, and approvals relevant to the recommended alternative.

Table 5-1. Listing of anticipated agency permits.

Agency	Permit	Rationale	Initial Steps
City of Huntington Beach Department of Public Works	---	City of Huntington Beach Department of Public Works is the property manager.	Contact Department of Public Works.
United States Army Corps of Engineers	Section 404 Permit	Potential discharge of dredged or fill material into waters of the United States (Greer Park Lake is considered an assessed waterbody on the 303(d) list).	Check with USACE if permit is needed and if so, file a permit.
California Department of Fish and Wildlife	Lake and Streambed Alteration Notification Form	Alteration of the existing lake	Submit the Lake or Streambed Alteration (LSA) Notification Form to CA DFW
State Water Resources Control Board	Construction General Permit	One or more acres of soil will be disturbed during construction.	Develop a Storm Water Pollution Prevention Plan (SWPPP).
Orange County Mosquito and Vector Control District	Notification Only	Standing water may be present within the subsurface storage galleries. In addition, the lake will be expanded.	Inform OCMVCD about the project details and areas where standing water may be present and prepare a list of mosquito abatement measures.
South Coast Air Quality Management District	Rule 403	Prevent, reduce, or mitigate fugitive dust emissions from construction activities.	Construction in the South Coast Air Basin must incorporate best available control measures included in Table 1 of Rule 403

6 NATURE-BASED SOLUTIONS ASSESSMENT

Littoral shelves within a detention pond offer significant flood control benefits by using strategically designed shallow, sloping areas with flood-tolerant vegetation to mitigate flood impacts. These would likely be created between the 9 feet to 15 feet contours (flood control storage volume as described in **Section 4.3.1**). These vegetated areas are transition zones that create extra storage capacity along the pond's edges, accommodating rising water levels during heavy rain events. By slowing down incoming water, the shelves help reduce the peak flow rate and decrease the risk of sudden overflow, effectively extending the pond's flood capacity while using natural materials and methods.

The vegetation on littoral shelves also stabilizes the pond banks and protects against erosion. As water levels fluctuate, the root systems of the plants anchor the soil, maintaining pond integrity even with changing water levels. Additionally, the shelves help filter out debris and sediment as water flows through, which reduces maintenance needs and helps maintain the detention pond's full capacity for flood storage.

Through these features, littoral shelves serve as natural buffers, reducing strain on the detention pond's engineered elements, adding flexibility to manage stormwater, and providing essential flood resilience.

To determine the type of flood-tolerant vegetation that would be grown on the littoral shelves for the detention pond, it will be essential to collaborate with various experts, including landscape architects, botanists, etc. in future design phases. Their combined expertise, detailed below, would ensure that the selected vegetation is not only flood-tolerant but also well-suited to the local environment, contributing to both flood control and ecological health.

- **Landscape Architect:** Designs the overall planting plan, ensuring vegetation is placed effectively for both flood control and aesthetic appeal, and integrates the natural systems with the surrounding environment.
- **Botanist or Ecologist:** Identifies native, flood-tolerant plant species suitable for the local conditions, focusing on biodiversity and long-term ecological health.

It will also be crucial to consider how selected plantings may attract new, unwanted species into the park. Many ducks thrive within the existing lake's ecosystem currently; however, the ducks are considered a nuisance to the nearby residents.

7 CONCLUSION AND NEXT STEPS

After evaluating three alternatives to increase storage for flood control at Greer Park Lake, the City chose to proceed with surface excavation expansion only, as subsurface tanks were found to be cost-prohibitive due to high groundwater levels. Expanding the lake's capacity through re-grading will achieve the required flood storage volume of 7.14 acre-feet while minimizing disruptions. The design incorporates a bentonite clay liner to prevent groundwater seepage and strategically placed inlets to manage drainage from nearby streets. The project also includes a proposed littoral shelf for aquatic vegetation, offering additional flood mitigation and water quality benefits. To enhance operational flexibility, a real-time control (RTC) system will monitor water levels and adjust flows proactively, balancing flood control, water recycling, and maintenance needs efficiently. The design anticipates quarterly rip rap cleaning, well vacuuming, and regular valve and control panel checks to ensure ongoing performance.

In terms of next steps, several technical analyses are needed to guide and further refine the design to ensure performance under varying conditions:

- **Sewer capacity analysis:** Assess the ability of downstream sewer infrastructure and identify optimal discharge windows during non-peak flow times to accept flows from the lake. This ensures that redirected flows from the lake are released when the sewer system has sufficient capacity, reducing the risk of overflow and maintaining efficient wastewater management.
- **Hydraulic analysis:** Model expected water surface elevations throughout the lake and connected stormwater infrastructure during the 100-year, 24-hour design storm, identifying any potential flooding risks and confirming that flow control measures can effectively manage peak storm events.
- **Geotechnical investigation:** Provide insight into the soil and groundwater conditions, informing excavation practices, liner selection, and foundation stability. Understanding the groundwater conditions is essential for developing measures to prevent seepage, buoyancy issues, and construction challenges, ensuring that the expanded detention pond maintains structural integrity over time.

These analyses, along with ongoing monitoring, will ensure the design is resilient, cost-effective, and prepared for real-time control integration to maximize flood mitigation benefits.