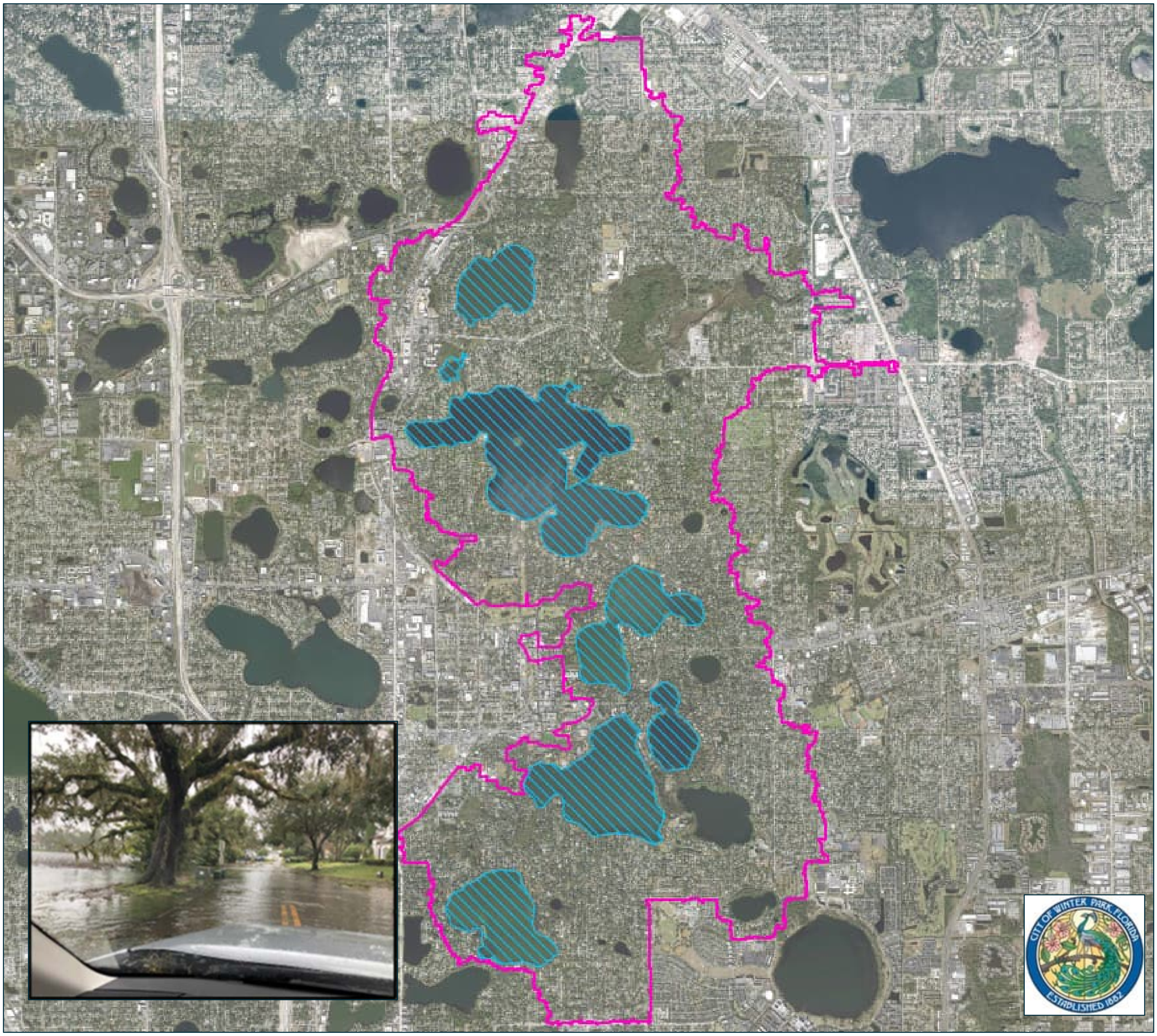

Winter Park Central Basin Stormwater Master Plan
Final Report

Prepared for:
The City of Winter Park

Date: December 2024

SINGHOFEN & ASSOCIATES INCORPORATED | halff

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Executive Summary

Introduction and Project Background

The City of Winter Park (CWP) experienced significant flooding during Hurricane Ian in 2022. The CWP subsequently initiated a series of flood control projects, one of which being this study, to prepare for future extreme storm events. This study is intended to establish a modeling tool that can be used to identify potential future flood risks and evaluate potential design alternatives to mitigate those risks.

The Focus Area of this report is referred to as the Central Basin which covers approximately 9 square miles within the Howell Creek Watershed, part of the larger Lake Jesup Basin. The Central Basin is regulated by the St. Johns River Water Management District (SJRWMD) as well as Seminole and Orange Counties. The majority of the Basin resides within Orange County but ultimately discharges into Howell Creek in Seminole County. The project location is presented in **Figure 1.1**, which shows the overall Study Area, Central Basin project area (i.e., Focus Area), and other key features in the vicinity.

The defining feature of the Central Basin is the Winter Park Chain of Lakes. The lake chain is comprised of seven (7) lakes including: Lake Virginia, Lake Osceola, Lake Maitland, Lake Mizell, Lake Nina, Lake Minnehaha, and Lake Sue. Six (6) of the lakes are connected by navigable canals; Lake Sue is connected but not navigable. The Chain of Lakes is part of a larger lake system, with numerous lakes upstream discharging into the Chain. The entire Chain discharges into Howell Creek through a control structure just downstream of Lake Maitland, at Howell Branch Rd (referred to as the Lake Maitland Control Structure). Flow is then conveyed through Howell Creek into Lake Howell before ultimately discharging into Lake Jesup. These drainage patterns are presented in **Figure 1.2**.

Data Collection and Site Investigation

As part of the data collection phase of the project, SAI-Halff obtained and reviewed a variety of data, including infrastructure information, GIS files, drainage models, environmental resource permit (ERP) documents from the SJRWMD, etc.

Additionally, field reconnaissance was conducted in December & January of 2023 & 2024. The purpose of the reconnaissance was to observe site conditions, as well as investigate areas with missing or suspect data.

Existing Conditions Analysis

Model Development

SAI-Halff developed a hydrologic and hydraulic (H&H) computer model using the StormWise program to simulate the rainfall runoff process of the existing drainage system. Rates and volumes of stormwater runoff were determined for nine (9) synthetic storm events, including five (5) 24-hour storms, two (2) 6-hour storms, and two (2) 96-hour storms. Hurricane Ian was also simulated and used to verify the model results were representative of observed flooding conditions during or after the hurricane.

The existing conditions model was created by reviewing and refining an area within an available Howell Creek watershed model, originally developed by CDM in 2011 (HC2011). In addition to the model updates made by SAI-Halff (CB2024), a model developed by Geosyntec in 2020 (CRA2020) for the Community Redevelopment Agency was also incorporated. The overall area updated by SAI-Halff is referred to as the Focus Area. A map depicting the extents of the HC2011, CRA2020, and CB2024 model areas is included as **Figure 3.1**.

Model results indicate structure flooding, as well as lot and street flooding, can occur at a number of locations within the City. The flood control design alternatives developed for this study, however, are focused on the closed-basin lakes within the focus area. Consequently, they were evaluated separately from the rest of the Central Basin.

Model Results: Closed-Basin Lakes

- Lake Knowles: Results indicate several streets may be inundated during extreme storm events, including Lake Knowles Cir., Temple Dr., and Via Salerno.
- Lake Sylvan: Results indicate lot flooding may occur during extreme storm events, but no street or structure flooding is expected.
- Lake Chelton: Results indicate no lot, street, or structure flooding is expected during extreme storm events. However, several well-established trees (live oaks) around the lake are at risk when they are inundated for extended periods of time.
- Lake Grace: Results indicate lot and structure flooding may occur during extreme storm events.
- Lake Forest: Results indicate lot flooding may occur during extreme storm events, but no street or structure flooding is expected.

Table 3.1 presents a comprehensive list of the maximum predicted stages and flood depths at key nodes within the Focus Area. Approximate floodplains were developed for each modeled storm event to demonstrate the predicted flood extents under existing conditions and are provided as **Figures 3.6a-3.6k**. Summaries of these results are discussed below.

Level of Service Analysis

A level of service (LOS) analysis was performed for buildings and roads to evaluate flooding during the synthetic storm events throughout the rest of the Central Basin. Building polygons, road centerlines, and the project terrain information were used as the basis of this analysis.

The number of structures and combined roadway lengths inundated during each storm event are listed below:

Storm Event	Number of Inundated Structures	Length of Inundated Road [ft]
2-Year 24-hour	0	7,425
10-Year 24-hour	2	23,950
25-Year 24-hour	15	37,375
100-Year 24-hour	64	51,300
500-Year 24-hour	125	86,675
10-Year 6-hour	2	31,275
25-Year 6-hour	16	42,500
25-Year 96-hour	36	44,600
100-Year 96-hour	89	70,650

The results of the LOS analysis, including the buildings and roads inundated during each storm event, are provided as **Figures 3.7a-3.7i**.

Model Calibration and Verification

Radar rainfall data (NEXRAD) were used to simulate Hurricane Ian. The simulated Ian results were compared with documented flood data at several locations throughout the Central Basin to facilitate calibration and help verify results of the model. These comparisons indicate the simulated Hurricane Ian results are generally consistent with observed conditions. While discrepancies were noted in the higher simulated peak stages, the discrepancy is consistent, with higher stages at all locations. Ultimately, this means the model overstates flood stages, producing more conservative results.

Design Development and Evaluation

SAI-Halff developed and evaluated flood control design alternatives at five (5) closed-basin lakes, including Lake Knowles, Lake Sylvan, Lake Chelton, Lake Grace, and Lake Forest.

Two (2) types of designs were evaluated: one using temporary pumps, the other using permanent gravity culvert outfalls. Temporary pumping options were not evaluated for Lake Chelton or Lake Sylvan, as the existing peak stages within the lakes are more than 2 ft below the determined LOS elevations. Global Standard Trash (GST) pumps offered by Global Pump were used to determine the pump requirements at the remaining lakes, as the CWP already has one (1) GST pump within its fleet (model: 6GST, rated for 3,000gpm). Meanwhile, gravity culvert outfalls were evaluated at all five (5) closed-basin lakes.

Summary tables comparing the design peak stages and anticipated flood depths to the existing conditions are included as **Tables 4.1** and **4.2,** respectively. A brief description of each design alternative and the estimated cost is presented below. Note, the cost ranges for some alternatives are based on the assumption that the CWP will utilize the 6GST pump currently within its fleet.

Design Alternative	Design Location	Design Description	Cost Estimate
Temporary Pumping Alternatives			
1a	Lake Knowles	Pump during storm	$182,000
1b	Lake Knowles	Pump prior to storm	$0 - $90,000
2a	Lakes Grace & Forest	Pump during storm	$90,000 - $180,000
2b	Lakes Grace & Forest	Pump prior to storm	$0 - $90,000
Gravity Culvert Outfall Alternatives			
3	Lake Knowles	Construct emergency outfall to Lake Maitland	$2,250,243
4	Lake Sylvan	Construct emergency outfall to Lake Mizell; outfall structure to include bleed down orifice	$1,117,971
5	Lake Chelton	Construct emergency outfall to Lake Sue; outfall structure to include bleed down orifice	$597,359
6	Lakes Grace & Forest	Construct emergency outfall from Lake Forest to Lake Grace, and from Lake Grace to Lake Sue; outfall structure within Lake Grace to include bleed down orifice	$2,394,517
7	Lake Grace	Construct emergency outfall from Lake Grace into Lake Sue; outfall structure to include bleed down orifice	$1,986,312
8	Lake Grace	Plug existing Phillips Place Retention Pond outfall into Lake Grace; construct new outfall from retention pond into Lake Forest	$237,989

Alternative 1a-b: Alternative 1 addresses street and lot flooding around Lake Knowles, which was observed during Hurricane Ian.

- Proposed Design: To achieve this, temporary pumps will be used to pump water from Lake Knowles into Lake Maitland, during or prior to the storm (1a and 1b, respectively), (**Figure 4.1**).
- Results: Both pump options meet the desired LOS (500-year, 24-hour) at Lake Knowles. Impacts to the maximum stages within Lake Maitland are negligible.
- Permitting and Construction Considerations: No permitting challenges are anticipated for this alternative, and no construction is proposed.

Alternative 2a-b: Alternative 2 addresses lot flooding and potential structure flooding around Lake Grace and Lake Forest, which was observed during Hurricane Ian.

- Proposed Design: To achieve this, temporary pumps will be used to pump water from Lake Grace and Lake Forest into Lake Sue, during or prior to the storm (2a and 2b, respectively), (**Figure 4.2**).
- Results: Both pump options meet the desired LOS (500-year, 24-hour) at Lake Grace and Lake Forest. Impacts to the maximum stages within Lake Sue are negligible.
- Permitting and Construction Considerations: No permitting challenges are anticipated for this alternative, and no construction is proposed.

Alternative 3: Alternative 3 addresses street and lot flooding around Lake Knowles, which was observed during Hurricane Ian.

- Proposed Design: To achieve this, an emergency gravity culvert outfall will be constructed to allow Lake Knowles to discharge into Lake Maitland during extreme storm events (**Figure 4.3**).
- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Knowles and impacts to the maximum stages within Lake Maitland are negligible.
- Permitting and Construction Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system might facilitate more pumping than might otherwise occur during emergency situations alone and could also pose water quality concerns. Construction challenges are also anticipated, as a segment of the outfall culvert traverses privately-owned land.

Alternative 4: Alternative 4 addresses lot flooding around Lake Sylvan, which was observed during Hurricane Ian.

- Proposed Design: To achieve this, a gravity culvert emergency outfall will be constructed to allow Lake Sylvan to discharge into Lake Mizell during extreme storm events. In addition, the outfall structure will include an orifice to allow Lake Sylvan to recover its available storage after a storm (**Figure 4.4**).
- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Sylvan, with the primary benefit of providing the lake with a bleed-down mechanism. Impacts to the maximum stages within Lake Mizell are negligible.
- Permitting and Construction Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system might facilitate more pumping than might otherwise occur during emergency situations alone and could also pose water quality concerns. Construction challenges are also anticipated, as a segment of the outfall culvert traverses privately-owned land.

Alternative 5: Alternative 5 inundation that threatens well-established tree (live oaks) around Lake Chelton, which was observed during Hurricane Ian.

- Proposed Design: To achieve this, a structural outfall will be constructed to allow Lake Chelton to discharge into Lake Sue during extreme storm events. In addition, the outfall structure will include an orifice to allow Lake Chelton to recover its available storage after a storm (**Figure 4.5**).
- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Chelton, with the primary benefit of providing the lake with a bleed-down mechanism. Impacts to the maximum stages within Lake Sue are negligible.
- Permitting and Construction Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system might facilitate more pumping than might otherwise occur during emergency situations alone and could also pose water quality concerns. Construction of this alternative is contained within City right-of-way.

Alternative 6: Alternative 6 addresses lot flooding and potential structure flooding around Lake Grace, and lot flooding around Lake Forest, which was observed during Hurricane Ian.

- Proposed Design: To achieve this, an emergency gravity culvert outfall will be constructed to allow Lake Forest to discharge into Lake Grace, and for Lake Grace to discharge into Lake Sue during extreme storm events. In addition, the outfall structure within Lake Grace will include an orifice to allow the lake to recover its available storage after a storm (**Figure 4.6**).
- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Grace, and achieves the benefit of providing the lake with a bleed-down mechanism. Impacts to maximum stages within Lake Forest are negligible; the outfall into Lake Grace only provides a benefit if the drainwell within Lake Forest fails. Impacts to the maximum stages within Lake Sue are negligible.
- Permitting and Construction Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system might facilitate more pumping than might otherwise occur during emergency situations alone and could also pose water quality concerns. Construction challenges are also anticipated, as a segment of the outfall culvert traverses privately-owned land.

Alternative 7: Alternative 7 addresses lot flooding and potential structure flooding around Lake Grace, which was observed during Hurricane Ian.

- Proposed Design: To achieve this, an emergency gravity culvert outfall will be constructed to allow Lake Grace to discharge into Lake Sue during extreme storm events. In addition, the outfall structure will include an orifice to allow Lake Grace to recover its available storage after a storm (**Figure 4.7**).
- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Grace. Impacts to the maximum stages within Lake Sue are negligible.
- Permitting and Construction Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system might facilitate more pumping than might otherwise occur during emergency situations alone and could also pose water quality concerns. Construction challenges are also anticipated, as a segment of the outfall culvert traverses privately-owned land.

Alternative 8: Alternative 8 addresses lot flooding and potential structure flooding around Lake Grace, which was observed during Hurricane Ian.

- Proposed Design: To achieve this, the Phillips Place retention pond outfall will be moved from Lake Grace to Lake Forest (**Figure 4.8**).
- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Knowles and impacts to the maximum stages within Lake Maitland are negligible.

- Permitting and Construction Considerations: Permitting challenges are anticipated for this alternative, as impervious area is being added to the Lake Forest basin, which may pose water quality concerns. Construction challenges are also anticipated, as a segment of the outfall culvert traverses privately-owned land.

Additional Design Alternatives: Additional alternatives were reviewed but were not fully developed due to feasibility concerns. Alternatives which modified the Lake Maitland control structure at Howell Branch Rd were reviewed. This included improving the conveyance of the control structure, as well as the use of an operable gate to lower the water levels in the Chain of Lakes prior to a storm. These alternatives are not generally favored by state regulatory agencies due to the wasting fresh water that could potentially be used to offset or supplement potable water uses. The CWP is taking steps to evaluate potential regional partnership projects and opportunities to use lake water more sustainably in cases like these. As a result, no modeling or cost estimates were developed for these alternatives.

Design Recommendation: The design alternatives were compared to each other on a lake-by-lake basis, based on construction costs and considerations, maintenance considerations, longevity, permitting feasibility, and effectiveness of design, as described below. The design alternatives at Lakes Chelton and Sylvan were not included in the ranking as only one (1) alternative was developed for each lake. **Table 4.9** presents the scoring and ranking of each design alternative as well as a description of the evaluation criteria and scoring method.

SAI-Halff recommends Design Alternatives 1b & 2b (Pump Option 2): temporary pumping prior to a storm at Lake Knowles, Lake Grace, and Lake Forest. Pump Option 2 meets the desired LOS at all three lakes, has the lowest cost, and requires no construction.

While Pump Option 1 meets the desired LOS, it has a higher cost and requires the pumps to operate during a storm, which may pose safety concerns. The gravity outfall alternatives also meet the desired LOS, but cost significantly more than Pump Option 2, and construction of the outfalls will cause significant interruption to the neighborhood.

Section 1

Introduction and Project Background

1.1 Background

The City of Winter Park (CWP) contracted with Singhofen-Halff (SAI-Halff) to develop a stormwater management master plan for the Central Basin. The CWP experienced significant flooding during Hurricane Ian in 2022; to prepare for future extreme storm events. The CWP subsequently initiated a series of flood control projects, one of which being this study, to prepare for future extreme storm events. This study is intended to establish a modeling tool that can be used to identify potential future flood risks and evaluate potential design alternatives to mitigate those risks.

Specifically, the objectives of this project, as defined by the CWP, include:

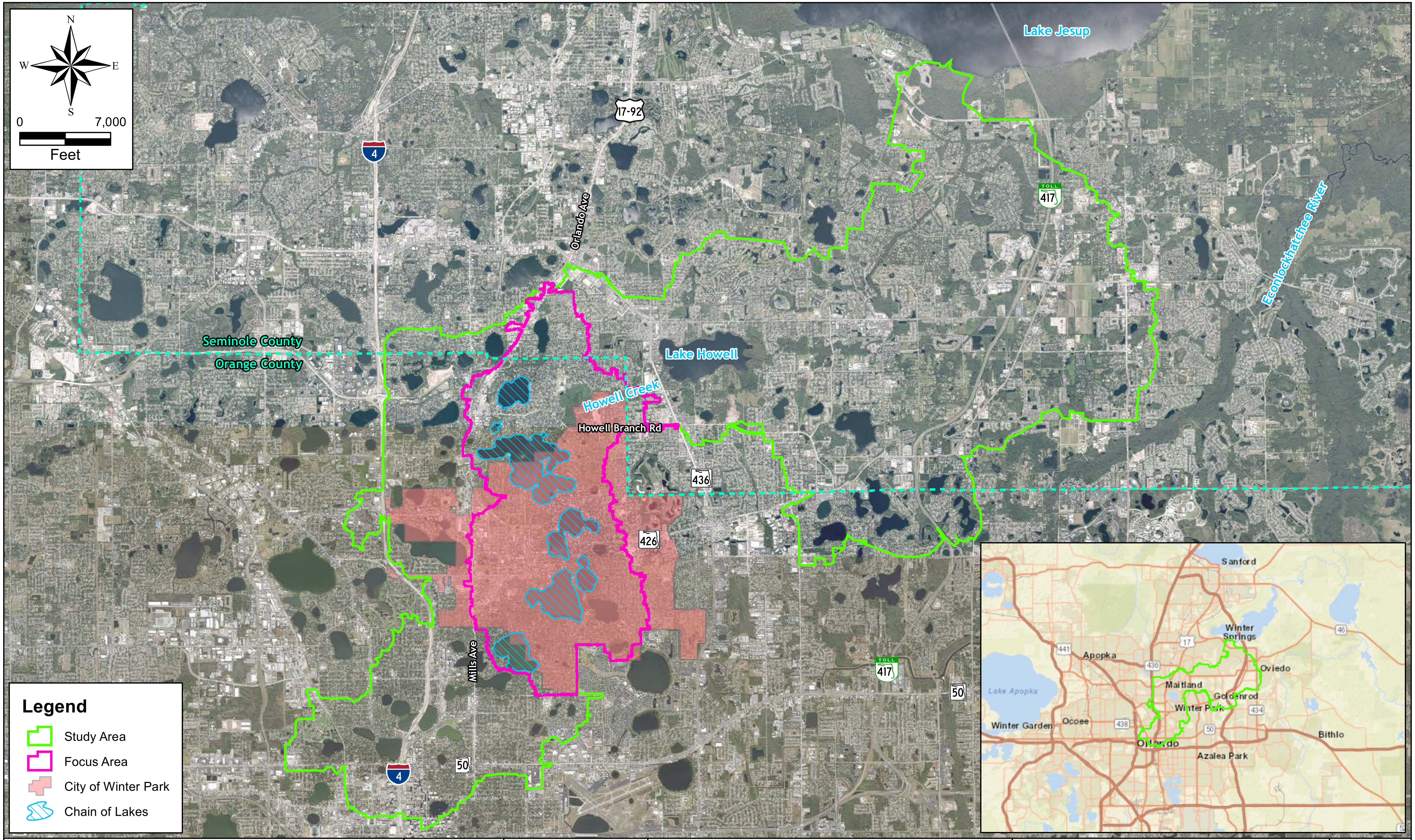
- Development of an existing conditions model for the Central Basin,
- Evaluation of current and future flood risks,
- Evaluation of the CWP's current level-of-service (LOS) for roadways and structures, and
- Development of conceptual design solutions to mitigate flooding. Specifically, conceptual design solutions evaluated establishing interconnections between several closed-basin lakes, including Lake Knowles, Lake Sylvan, Lake Chelton, Lake Grace, and Lake Forest.

1.2 Location

The Central Basin covers approximately 9 square miles within the Howell Creek Watershed, part of the larger Lake Jesup Basin. The Central Basin is regulated by the St. Johns River Water Management District (SJRWMD) as well as Seminole and Orange Counties. The majority of the basin resides within Orange County but ultimately discharges into Howell Creek in Seminole County. The project location is presented in **Figure 1.1**, which shows the overall Study Area, Central Basin project area (i.e., Focus Area), and other key features in the vicinity.

The defining feature of the Central Basin is the Winter Park Chain of Lakes. The lake chain is comprised of seven (7) lakes including: Lake Virginia, Lake Osceola, Lake Maitland, Lake Mizell, Lake Nina, Lake Minnehaha, and Lake Sue. Six (6) of the lakes are connected by navigable canals; Lake Sue is connected but not navigable. The Chain of Lakes is part of a larger lake system, with numerous lakes upstream discharging into the Chain. The entire Chain discharges into Howell Creek through a control structure just downstream of Lake Maitland, at Howell Branch Rd (referred to as the Lake Maitland Control Structure). Flow is then conveyed through Howell Creek into Lake Howell before ultimately discharging into Lake Jesup. These drainage patterns are presented in **Figure 1.2**.

The FEMA flood hazard zones mapped within the Focus Area are classified as mostly Zone AE and have corresponding base flood elevations (BFE). This includes the Chain of Lakes and most of the closed-basin lakes. Two (2) designated regulatory floodways are located within the Focus Area: the channel between Lake Sue and Lake Viginia; and Howell Creek, beginning just upstream of the Lake Maitland Control Structure and extending downstream past Lake Howell into Lake Jesup. Floodways prohibit encroachments (e.g., fill, new construction, substantial improvements) unless it is demonstrated that proposed encroachments will not result in any increase in flood levels during the occurrence of the base flood discharge. The extents of the FEMA flood hazard zones within the Focus Area are shown in **Figure 1.3**.



Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

LOCATION MAP

FIGURE: 1.1

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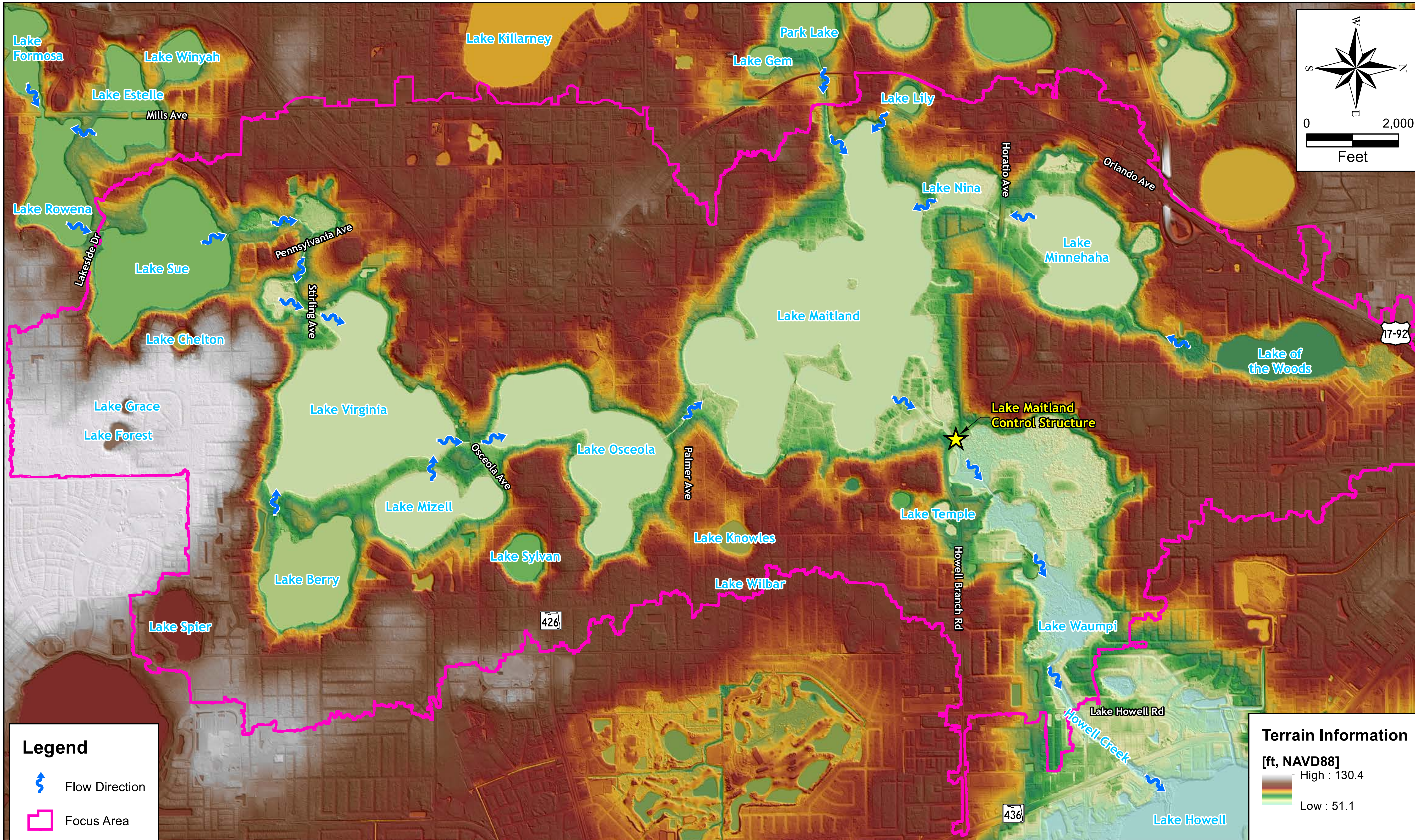

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Sources:
Terrain: USGS 2018

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING DRAINAGE PATTERNS

FIGURE: 1.2

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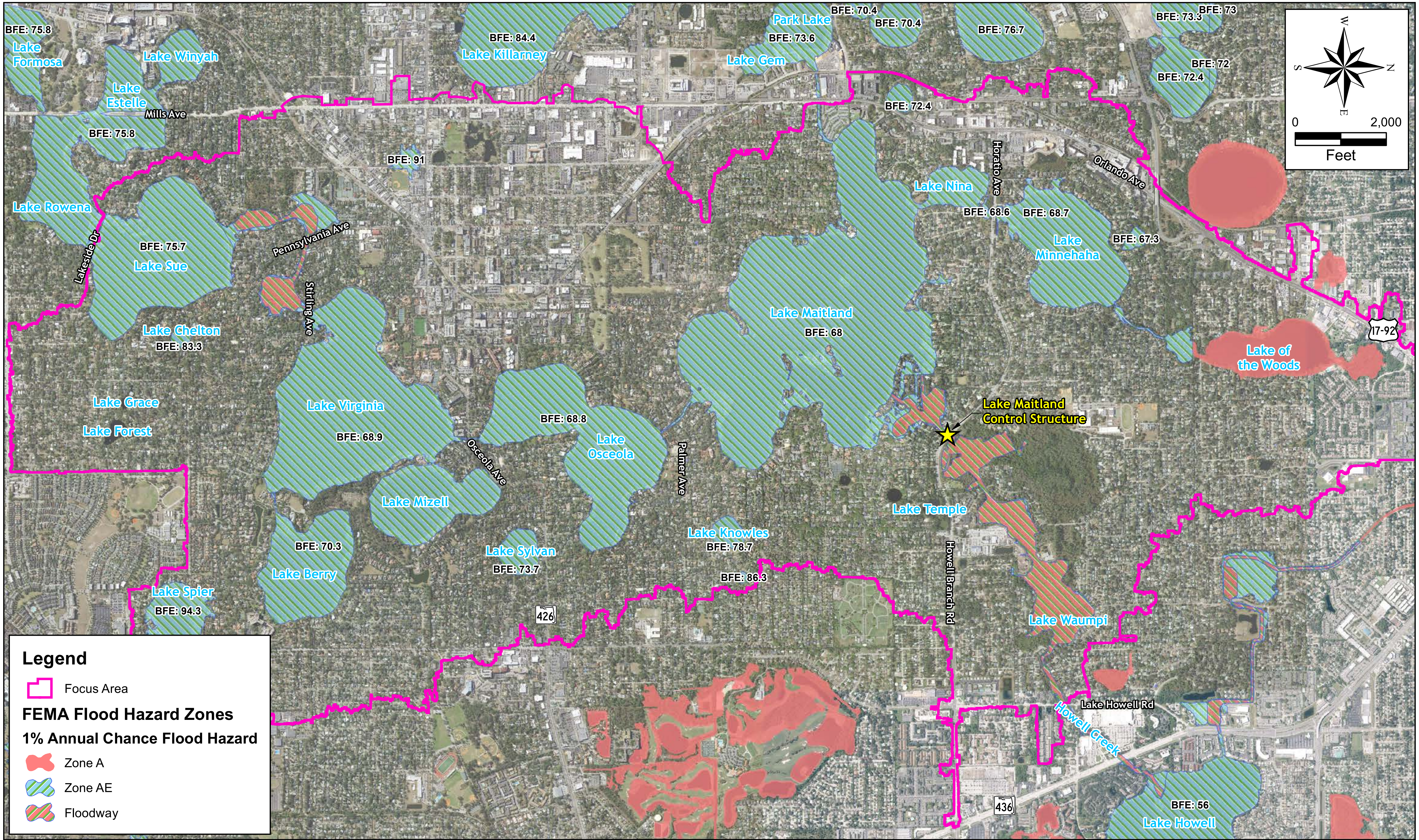

Legend

Focus Area

FEMA Flood Hazard Zones

1% Annual Chance Flood Hazard

- Zone A
- Zone AE
- Floodway

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Sources:
Aerials:
2018 Orange County
2018 Seminole County
FEMA: 2021

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

FEMA FLOOD HAZARD ZONES

FIGURE: 1.3

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Section 2

Data Collection and Site Investigation

2.1 Data Collection

As part of the data collection phase of the project, SAI-Halff obtained and reviewed a variety of data (e.g., infrastructure information, GIS files, drainage models), listed below.

- Howell Creek Basin Watershed Management Plan: Report, ICPR3 Model (CDM, 2007)
- Howell Creek Basin Watershed Management Plan Update: Report, ICPR3 Model, GIS data (CDM 2011)
- Maitland Chain of Lakes LOMR: Report, GIS data (CDM, 2012)
- Community Redevelopment Agency (CRA) Stormwater Master Plan: Report, ICPR4 Model, GIS data (Geosyntec, 2020)
- Infrastructure geodatabase (Orange County)
- 2018 LIDAR information (USGS)
- 2018 Orange and Seminole County Aerial Imagery
- Orange and Seminole County NRCS Soils information
- SJRWMD Landuse information
- Historic Water Surface Elevations (Watershed Atlas Program)

Additionally, environmental resource permit (ERP) documents were obtained from the SJRWMD. The ERP documents reviewed and cataloged by SAI-Halff and are presented in **Table 2.1**. Select information provided by the CWP is also listed in the table.

Table 2.1: Reference Documents

Document ID	Document Type	Document Date	Development	Permit Number	Source	Datum
WPCB_0002_CP	Construction Drawings	December 1998	The Preserve at Windsong Northeast	75939	SJRWMD	NGVD29
WPCB_0003_CP	Construction Drawings	December 1995	Phillips Place	46237	SJRWMD	NGVD29
WPCB_0005-01_CP	Construction Drawings	July 1995	Mead Garden Stormwater Retrofit & Pond Restoration	20716	SJRWMD	NGVD29
WPCB_0005_CP	Construction Drawings	July 1995	Mead Garden Stormwater Retrofit & Pond Restoration	20716	SJRWMD	NGVD29
WPCB_0010_CP	Construction Drawings	October 1999	Canal Wall Replacement	62696	SJRWMD	NGVD29
WPCB_0024_SD	Survey Data	November 2012	Maitland LOMR - Apx E Survey Data & Plans (CDM)	N/A	CWP	NGVD29
WPCB_0040_CP	Construction Drawings	March 2006	Knowles Place	103678	SJRWMD	NGVD29
WPCB_0041_CP	Construction Drawings	July 2000	Public Works Compound	65839	SJRWMD	NGVD29
WPCB_0042-01_CP	Construction Drawings	December 2007	Dommerich Elementary School	45392	SJRWMD	NGVD29
WPCB_0042-02_CP	Construction Drawings	December 2007	Dommerich Elementary School	45392	SJRWMD	NGVD29
WPCB_0044_RD	Survey Data	December 2009	Lake Howell Control Water Control Structure Replacement	119739	SJRWMD	NAVD88

WPCB_0045_RPT	Report	January 2009	Lake Howell Water Control Structure Replacement	119739	SJRWMD	NAVD88
WPCB_0046_CP	Construction Drawings	December 2009	Lake Howell Water Control Structure Replacement	119739	SJRWMD	NAVD88
WPCB_0050_CP	Construction Drawings	January 2011	Lake Howell Road Bridge Replacement	119739	SJRWMD	NAVD88
WPCB_0052_CP	Construction Drawings	November 1998	Lake Howell Road Townhomes	51668	SJRWMD	NGVD29
WPCB_0058-01_CP	Construction Drawings	September 2020	Lake of the Woods Retention Pond	162910	SJRWMD	NAVD88
WPCB_0059-01_SD	Survey Data	January 2017	Villa Tuscany; Formal Wetland Determination	148006	SJRWMD	NAVD88
WPCB_0061_RPT	Report	January 2021	Lake Forest Basin	N/A	CWP	NAVD88
WPCB_0057-01_CP	Construction Drawings	September 2005	Downtown Maitland Master Stormwater Facility	91505	SJRWMD	NGVD29

2.2 Field Reconnaissance and Site Observations

Field reconnaissance was conducted in December & January of 2023 & 2024. The purpose of the reconnaissance was to observe site conditions, as well as investigate areas with missing or suspect data.

Section 3

Existing Conditions Analysis

SAI-Halff developed a hydrologic and hydraulic (H&H) computer model to simulate the rainfall runoff process. Rates and volumes of stormwater runoff were determined for nine (9) synthetic storm events, which included five (5) 24-hour storms, two (2) 6-hour storms, and two (2) 96-hour storms. Hurricane Ian was also simulated and used to verify the model results were representative of observed flooding conditions during or after the hurricane. The specific storm events simulated are presented in **Section 3.3**. StormWise (Version 4.08.02), formerly known as ICPR4, was used for all H&H calculations. The resulting existing conditions stormwater model was used to identify locations and causes of current flooding and its extents within the project area.

3.1 Vertical Datum

All deliverables for this project are based on the NAVD88 vertical datum. Any data utilized for this project which were referenced to NGVD29 were converted to NAVD88. The following conversion factor was used as necessary for this project:

Elevation in NAVD88 = Elevation in NGVD29 – 0.98 ft

This conversion factor is the average conversion factor for the Howell Creek Watershed determined by FEMA for the FIS that was conducted in 2009.

3.2 Base Models

An existing stormwater model for the Howell Creek watershed was available in ICPR Version 3.02. This model is the FEMA-effective Howell Creek model and was developed by CDM Smith in 2011 (referred to herein as the HC2011 model). This model was converted to StormWise and was used as the starting point for developing the existing conditions stormwater model for the current study.

Based on the CWP limits and known flooding concerns within the Central Basin, SAI-Halff defined an area within the overall HC2011 model to review and refine to better evaluate drainage characteristics and system performance. Part of this refinement effort included incorporating the Community Redevelopment Agency (CRA) ICPR4 model, developed by Geosyntec in 2020 (referred to herein as the CRA2020 model). A small region within the CRA2020 model was modeled using two-dimensional surface flow (2D); SAI-Halff converted this 2D region to one-dimensional surface flow (1D). The 2D region was converted to 1D for consistency purposes. Beyond this conversion, the CRA2020 model was incorporated as-is, with limited exceptions.

The area of the HC2011 model that was reviewed and refined by SAI-Halff is referred to as the CB2024 model, while the combined CB2024 and CRA2020 refinement area is referred to as the Focus Area. The overall model area is referred to as the Study Area. H&H data outside of the Focus Area were left as-is from the HC2011 model, with limited exceptions. A map depicting the extents of the HC2011, CRA2020, and CB2024 model areas is included as **Figure 3.1**. To summarize:

- HC2011: Howell Creek FEMA effective model (CDM Smith 2011)
- CRA2020: Community Redevelopment Agency model (Geosyntec 2020)
- CB2024: Central Basin model (SAI-Halff 2024)
- Focus Area: Central Basin refinement area; includes CRA2020 and CB2024
- Study Area: Overall model area; includes CRA2020, CB2024, and as-is areas from HC2011

3.3 Hydrologic Data Development

The Focus Area is comprised of 325 basins, with 137 basins from SAI-Halff's refinement efforts and 188 basins from the CRA2020 model. A total of 224 basins outside of the Focus Area were taken as-is from the HC2011 model.

Basins within the Focus Area were delineated using infrastructure, construction plans, and USGS terrain data (LiDAR, 2018). **Figure 3.2** depicts the existing conditions nodal network within the overall study area, while **Figure 3.3** demonstrates the nodal network within the Focus Area.

StormWise manual basin features were used for hydrologic modeling in the Focus Area, including calculation of Green-Ampt parameters (GA) using the StormWise program. Basins taken from the HC2011 model were included as simple basins with weighted NRCS curve numbers (CN).

For consistency purposes, all manual basins within the model were recalculated using GA parameters. GA are dependent on the landuse and soil conditions within each basin. Landuse information was obtained from SJRWMD and updated as needed based on the 2018 aerials. Soils information was obtained from NRCS. Landuse and Soils maps are provided as **Figures 3.4** and **3.5**, respectively.

Rainfall volumes used for the synthetic storm events were based on NOAA Atlas-14 rainfall amounts; total rainfall volumes for each respective storm event are listed below:

Storm Event	Rainfall [in]
2-Year 24-hour	4.28
10-Year 24-hour	6.13
25-Year 24-hour	7.57
100-Year 24-hour	10.2
500-Year 24-hour	14.0
10-Year 6-hour	4.66
25-Year 6-hour	5.5
25-Year 96-hour	10.6
100-Year 96-hour	14.3

Hurricane Ian was simulated using hourly Next Generation Weather Radar (NEXRAD) rainfall data, obtained from the SJRWMD.

3.4 Hydraulic Data Development

Node and link data were developed based on field reconnaissance information, construction documents, and data provided by the CWP.

Stage/Area relationships were calculated at storage nodes representing low lying areas, wetlands, ponds, and lakes. Stage/Area relationships were derived from the delineated basins and LiDAR. Channel storage was excluded from these calculations to be consistent with recommendations of the StormWise program.

A total of 20 Time/Stage nodes were included in the mode. These nodes were used to represent conditions (i.e., water levels) at model boundaries such as Lake Jesup or groundwater. Percolation and drainwells were modeled with connections to these groundwater Time/Stage nodes. All data related to the percolation links, and most of the drainwells were taken as-is from their respective models. Several drainwells located within the CB2024 area were revised or added to the model.

Node initial conditions (i.e., initial water levels) outside of the Focus Area were taken as-is from the HC2011 model, with limited exceptions. A similar approach was taken within the Focus Area, with initial stages from the CRA2020 model taken as-is, with limited exceptions. For the remaining nodes within the Focus Area, initial stages were reviewed and revised based on best available data, such as seasonal high-water elevations (SHWE) where available. Historic water surface elevations (WSE) obtained from the Orange and Seminole County Water Atlases were also used to set initial stages for numerous lakes throughout the Central Basin, including the Chain of Lakes. These were based on the average WSE during the peak wet season (July to Sept.).

3.5 Existing Conditions Model Results

Model results indicate structure flooding, as well as lot and street flooding are expected throughout the CWP. The flood control design alternatives developed for this study are focused on the closed-basin lakes, consequently, they were evaluated separately from the rest of the Central Basin. As such, model results at the closed-basin lakes and the rest of the Central Basin are discussed separately; the closed-basins results are presented below, while results for the rest of the Central Basin are discussed in **Section 3.6**.

Closed-Basin Lakes

- Lake Knowles: Results indicate several streets are expected to be inundated during extreme storm events, including Lake Knowles Cir, Temple Dr, and Via Salerno. The basis of flooding was the lowest road crown elevation in the Lake Knowles basin (81.2-feet), obtained from terrain data along Lake Knowles Cir. With a peak stage of 82.7-feet during the 500-year, 24-hour storm, the depth of flooding is 18.0-inches.
- Lake Sylvan: Results indicate lots / yards are expected to flood during extreme storm events, but no street or structure flooding is expected. The basis of flooding was the lowest FFE in the Lake Sylvan basin (76.1-feet), obtained from the CWP. With a peak stage of 74.1-feet during the 500-year, 24-hour storm, the WSE within Lake Sylvan is 24.0-inches below the LOS elevation.
- Lake Chelton: Results indicate no lot, street, or structure flooding is expected during extreme storm events. The basis of flooding was the lowest road crown elevation in the Lake Chelton basin (87.1-feet), obtained via terrain data along Chelton Cir. With a peak stage of 84.2-feet during the 500-year, 24-hour storm, the WSE within Lake Chelton is 34.8-inches below the LOS elevation.
- Lake Grace: Results indicate lots /yards and structures are expected to flood during extreme storm events. The basis of flooding was the lowest FFE in the Lake Grace basin (104.5-feet), obtained from the CWP. With a peak stage of 104.6-feet during the 500-year, 24-hour storm, the depth of flooding is 1.2-inches.
- Lake Forest: Results indicate lots / yards are expected to flood during extreme storm events, but no street or structure flooding. The basis of flooding was the lowest FFE in the Lake Forest basin (105.0-feet), estimated via terrain data. With a peak stage of 104.7-feet during the 500-year, 24-hour storm, the WSE within Lake Forest is 3.6-inches below the LOS elevation.

Table 3.1 presents the maximum predicted stages and flood depths at key nodes within the Focus Area.

Approximate (i.e., Level pool) floodplains were developed for each modeled storm event to demonstrate the predicted flood extents under existing conditions and are provided as **Figures 3.6a-3.6k**.

The StormWise input data and results for the existing conditions model can be found in **Appendix E.**

3.6 Level of Service Analysis

An LOS analysis of buildings and roads was performed to evaluate flooding during the synthetic storm events throughout the Central Basin. The Focus Area and the CWP limits were used to determine which features to include in the analysis, though some buildings and roads outside of the CWP limits were included to provide a buffer. The LOS analysis methodology and the findings of the evaluation are presented below.

Building LOS

Building footprint polygons were obtained from Microsoft and served as the basis of the LOS analysis. The buildings were reviewed at a highlevel and certain inappropriate buildings were excluded from the analysis (e.g., boat houses). A total of 9,792 buildings were included in the analysis, which included a mix of residential, commercial, institutional, and recreational structures.

The FFEs were estimated using the building polygons and the project's terrain data. First, an average ground surface elevation (GSE) was calculated for the area within each building polygon. The FFE was then estimated based on an assumed distance (i.e., offset) above the average GSE. An offset of 1 ft was used, which is consistent with standard LOS methodology.

Estimated FFE = Building Average GSE + 1 ft

The estimated FFEs were compared to known FFEs from construction documents or provided by the CWP. The known FFEs were as much as ± 1 ft above/below the estimated FFEs, though the average difference was about + 0.1 ft. As such, the + 1 ft offset was considered reasonable.

The number of inundated structures during the various simulated storm events are listed below:

Storm Event	Number of Inundated Structures
2-Year 24-hour	0
10-Year 24-hour	2
25-Year 24-hour	15
100-Year 24-hour	64
500-Year 24-hour	125
10-Year 6-hour	2
25-Year 6-hour	16
25-Year 96-hour	36
100-Year 96-hour	89

The results of the LOS analysis, including the buildings and roads inundated during each storm event, are provided as **Figures 3.7a-3.7i**.

Building LOS Limitations: While considered to be a reasonable high-level LOS evaluation, there are several limitations to building LOS methodology to note.

- Inundation depths were not considered, meaning no differentiation was made between buildings inundated by several feet vs. tenths of an inch.
- The building use type (e.g., residential, commercial), and the building size were not considered in the analysis; all buildings were evaluated using the same methodology.
- Due to the high-level nature of the LOS analysis, certain inappropriate buildings (e.g., unimproved detached garage, sheds) may have inadvertently been included in analysis.

Roadway LOS

Road centerlines were obtained from the CWP and served as the basis of the LOS analysis. The centerlines in the vicinity of key project areas were revised as needed to align with road crowns as they appear on aerial imagery and terrain data. The road centerlines were then subdivided into 25 ft segments and each segment was related to a specific model node for evaluation. A total of 29,320 road segments were included in this analysis.

The GSE along each road crown segment was extracted to determine the minimum elevation for each segment. The minimum elevation was used to evaluate the entire 25 ft segment and served as the basis for determining road inundation. Roads were only considered to be inundated if the peak stage for the assigned node exceeded the road crown; inundation of only the curb/right-of-way did not flag the road segment as inundated.

The total length of inundated roads during each storm event are listed below:

Storm Event	Length of Inundated Road [ft]
2-Year 24-hour	7,425
10-Year 24-hour	23,950
25-Year 24-hour	37,375
100-Year 24-hour	51,300
500-Year 24-hour	86,675
10-Year 6-hour	31,275
25-Year 6-hour	42,500
25-Year 96-hour	44,600
100-Year 96-hour	70,650

The results of the LOS analysis, including the buildings and roads inundated during each storm event, are provided as **Figures 3.7a-3.7i**.

Road LOS Limitations: While considered to be a reasonable high-level LOS evaluation, there are several limitations to the roadway LOS methodology to note.

- Inundation depths were not considered, meaning no differentiation was made between roads inundated by several feet vs. tenths of an inch. Similarly, inundation durations were not considered (i.e., no differentiation between roads inundated for hours vs. minutes).
- Roadway types were not considered; For example, no differentiation was made between minor dead-end residential roads vs. major arterial roads.
- Several factors contribute to overestimation of the total inundated road lengths, including double counting at intersections where more than one road centerline intersects; and segments with a single point below the peak stage, flagging the entire 25 ft segment.
- While most of the road centerlines generally align with the road crown, some centerlines are offset from the road crown, or even from the roadway itself. In other instances, the centerline aligns with a raised median, resulting in road segment minimum elevations set higher than they should be.

3.7 Model Calibration and Verification

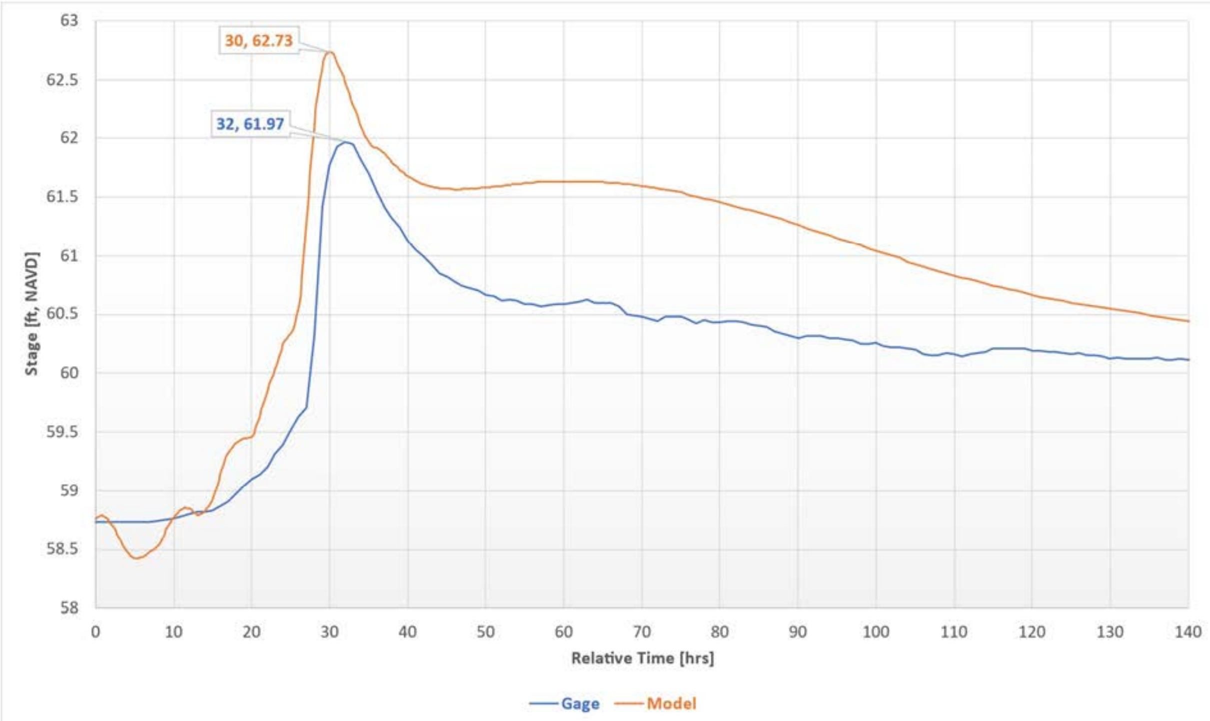
Radar rainfall (NEXRAD) data were used to simulate Hurricane Ian. The storm was used as the basis for model calibration and verification. Initial condition lake levels at the onset of the storm were not available. As a result, they were based on normal high water information as described previously. It should be noted that the storm occurred after a period of approximately 1-2 weeks during which little rain appears to have fallen on the Focus area. As a result, actual water levels in the lake system at the onset of the storm were likely lower than the levels used for the modeling due to continued surface discharges into Howell Creek and evaporation/evapotranspiration from the lake system over that time period. This would tend to lower actual water levels compared to simulated values and exaggerate the difference between them.

Hurricane Ian flood data were available at several locations throughout the Central Basin, including:

- A USGS gage within Howell Creek at Lake Howell Rd (gage: 02234308), downstream of the Chain of Lakes;
- Photographs of flooding during or after Ian at areas upstream of the Chain of Lakes and at a closed-basin lake, provided by the CWP; and
- Flood depth measurements taken during Ian, provided by a resident living adjacent to Lake Virginia.

The flood data at these locations were compared to Hurricane Ian simulation results to facilitate calibration and verification of the model. The comparisons at the various locations are presented below.

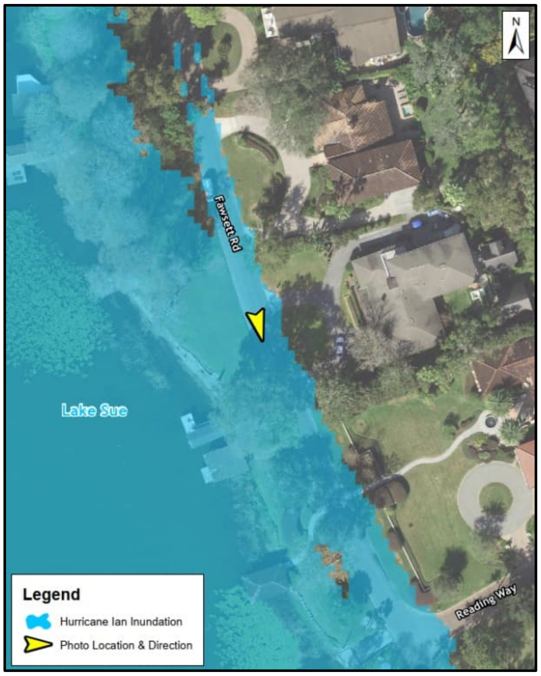
Exhibit 3.1: Hurricane Ian WSE Comparison – USGS Gage (ID: 02234308) vs. Model



- Time is relative to the start of Hurricane Ian (9/28/2022 at 12:00am)

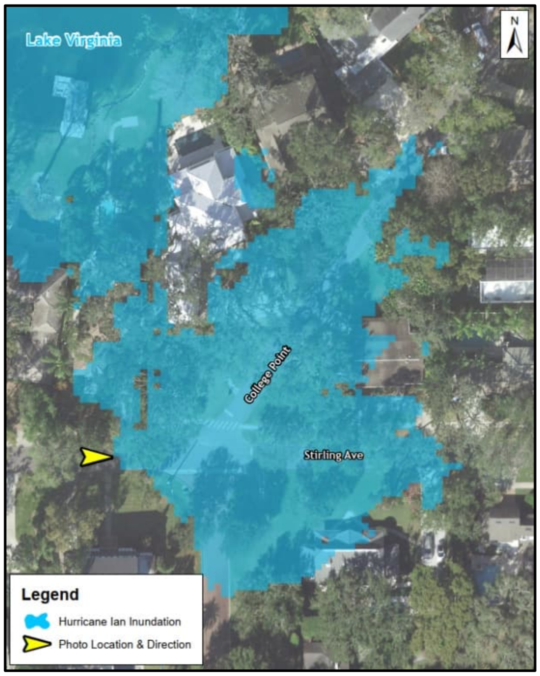
Location 1 – USGS Gage: A comparison between the gage WSEs and model stages (node: HC-0065) is presented in **Exhibit 3.1**. Model stages are shown to be higher than the gage data throughout the simulation, with the modeled peak stage about 0.76 ft higher than measured at the stream gage. However, the time to peak and drawdown characteristics generally align, suggesting reasonable correlation with the model. It should be noted that the location of the gage is downstream of the outfall from the chain of lakes and in an area that was modeled using data "as is" from the HC2011 model. It is uncertain how old the data in this area are or how accurately they reflect current conditions. Despite the modeled stages being slightly higher than measured at the gage in Howell Creek, water levels at the Lake Maitland outfall structure do not submerge the weir. Consequently, the creek has no effects on the chain of lakes and no further investigation was performed to identify causes of discrepancies at this location.

Exhibit 3.2: Fawsett Rd Along Lake Sue (9/29/22)



Location 2 – Fawsett Rd Flooding: **Exhibit 3.2** shows a comparison between photographed flooding along Fawsett Rd and the simulated area of inundation for Hurricane Ian. While a peak stage is not clearly identifiable within the photo, mapped inundation from the model results appear to cover much the same areas depicted in the photo, suggesting good correlation with the model.

Exhibit 3.3: Stirling Ave at College Point (9/29/22)



Location 3 – Stirling Ave Flooding: **Exhibit 3.3** shows a comparison of photographed flooding along Stirling Ave at College Point and the simulated Ian inundation area. Based on the photo, the water level was estimated at 68.8 ft although it appears flood stages may have been a bit higher during some point in the storm based on the presence of litter or debris along the curb in the lower right portion of the photo. The node at this location (LV-0160) had a simulated flood stage of 69.2 ft, about 0.4 ft above the photo-estimated water level. The modeled water level appears to be high enough to overtop the curb and create the litter line where the debris is found suggesting good correlation between simulated and observed conditions.

Exhibit 3.4: Temple Dr at Via Salerno Along Lake Knowles (9/29/22)

Location 4 – Temple Dr at Via Salerno: **Exhibit 3.4** shows a comparison between photographed flooding along Temple Dr to the simulated Ian inundation area. Based on the photo, as well as discussion with the CWP, the peak flood stage was estimated at 82.2 ft. The node at this location (L_Knowles) had a simulated flood stage of 82.7 ft, about 0.5 ft above the photo-estimated flood stage. While the model shows a slightly higher flood stage, it is still reasonably correlated with the observed conditions.

Location 5 – Flood Depth Measurements: Several flood depth measurements were taken at a residence adjacent to Lake Virginia at various times during Ian, with the depths relative to a surveyed elevation. This information was used by SAI-Halff to estimate the measured stages during Ian. The node at this location had a simulated peak flood stage of 69.2 ft, about 0.3 ft above the estimated flood stage. While the model shows a higher flood stage, it still suggests good correlation with the model.

Comparing the simulated Hurricane Ian results to the available flood data suggests a general agreement between the model and Hurricane Ian. While minor discrepancies were noted in simulated peak stages, the discrepancy is fairly consistent with generally elevated stages at points of interest. As mentioned, it is possible that actual water levels in the lake chain before the storm were lower than those used at the beginning of model simulations which would result elevated model peak stages. The CWP is embarking on a program to monitor lake levels on a more continuous basis which will help provide more accurate data for further validation of the model when another major storm event occurs in the future.

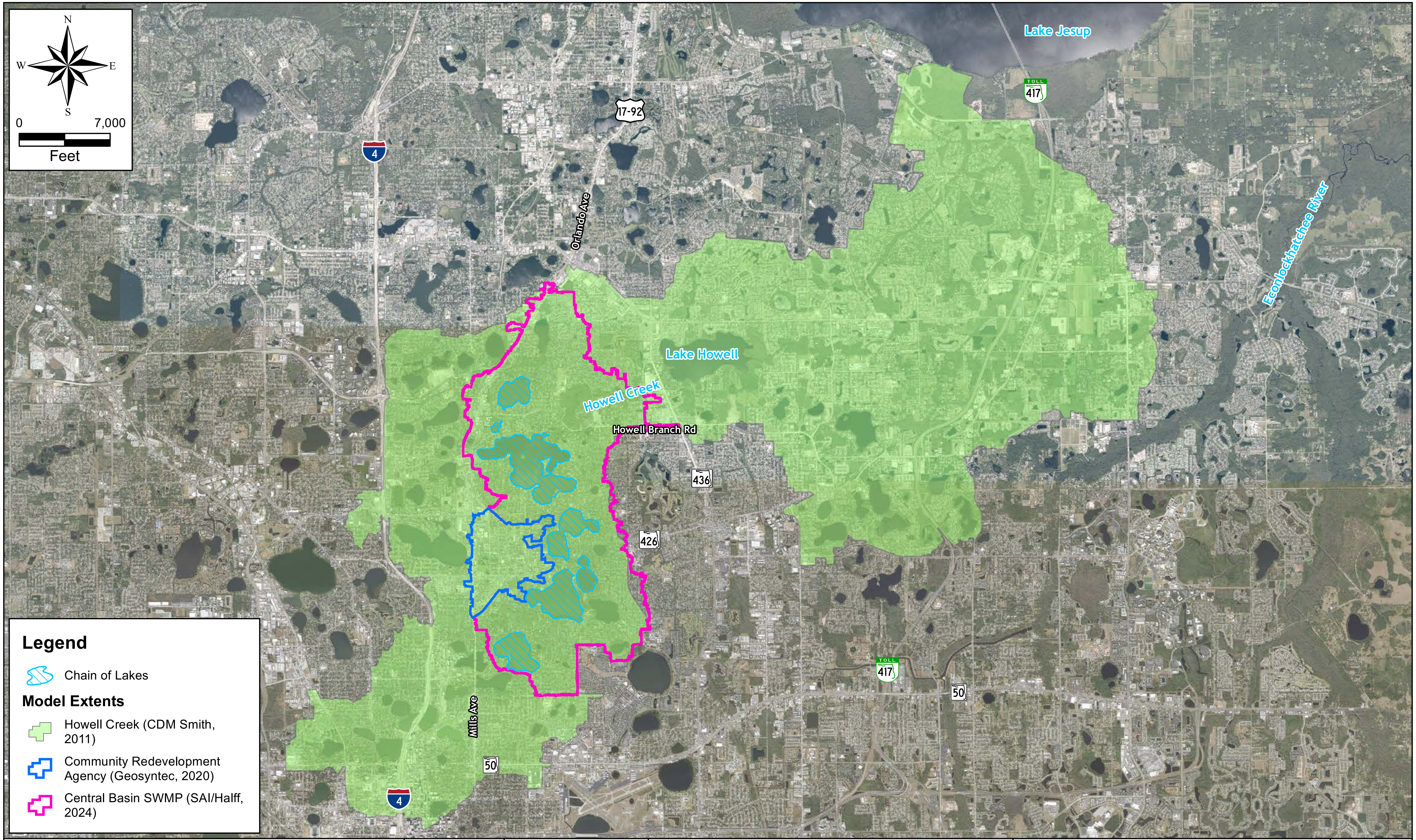
3.8 Ongoing Flood Control Projects

As discussed, the CWP experienced significant flooding during Hurricane Ian. To prepare for future storm events, the CWP subsequently initiated numerous flood control projects, one of which being this study. As of September 2024, several of these flood control projects have already been completed, with several others scheduled or in the planning phase. A brief description and status of these projects is presented in the table below. Meanwhile, the flood control design alternatives developed by SAI-Halff are presented in **Section 4**.

Project Status	Project Description
Completed	Outfall dredging in Lakes Maitland, Osceola, Berry, Knowles, Midget
	Dredging in the Venetian and Fern Canals
	Lake Knowles drainwell intake repair
	Dredging and stabilizing the 9th grade center pond
	Lake Sue Ave inlets
	Storm sewer pipe repair & lining - 456 Pointer Pl - Balmoral Rd - Pinetree Rd - 1129 Via Del Mar - 656 Interlachen Ave - Joeline Ct at Alexa Dr - 2631 Temple Dr
Planned or Scheduled	Howell Creek stabilization
	Palmer Ave at Old England Ave drainage improvements - Phase 1: Replace existing outfall pipe to Lake Maitland and retrofit with a new hydrodynamic separator for water quality improvements. Design complete, permit application in progress. - Phase 2: Three (3) new inlets and connecting pipes on Palmer Ave, between the intersections of Old England Ave and Lincoln Cir. - Phase 3: Seven (7) new inlets and connecting pipes on Palmer Ave, between the intersections of Old England Ave and Georgia Ave.
	Laurel Rd drainage improvements - Redesign of the existing conveyance and capture system to include new and additional inlets. A new outfall design is also being considered.
	Cherokee Ave inlet
	Storm sewer pipe repair & lining - Edgewater Ave from Sunset Dr to lake Knowles - Summerland Ave
	Stirling Bridge Replacement

Additionally, CWP Public Works is currently evaluating alternatives to purchase storm sewer camera equipment. This equipment would allow for improved infrastructure maintenance and repair through proper investigation of existing storm sewer systems.

The CWP has also adopted an Adaptive Flood Management Guide (October 2023), which outlines specific protocols and procedures for lake and flood management. This includes year-round procedures both during hurricane season and the off season. Procedures are also in place for activities before and after a major storm event, beginning seven (7) days prior to tropical activity impacting Central Florida. This document is included as **Appendix C.**



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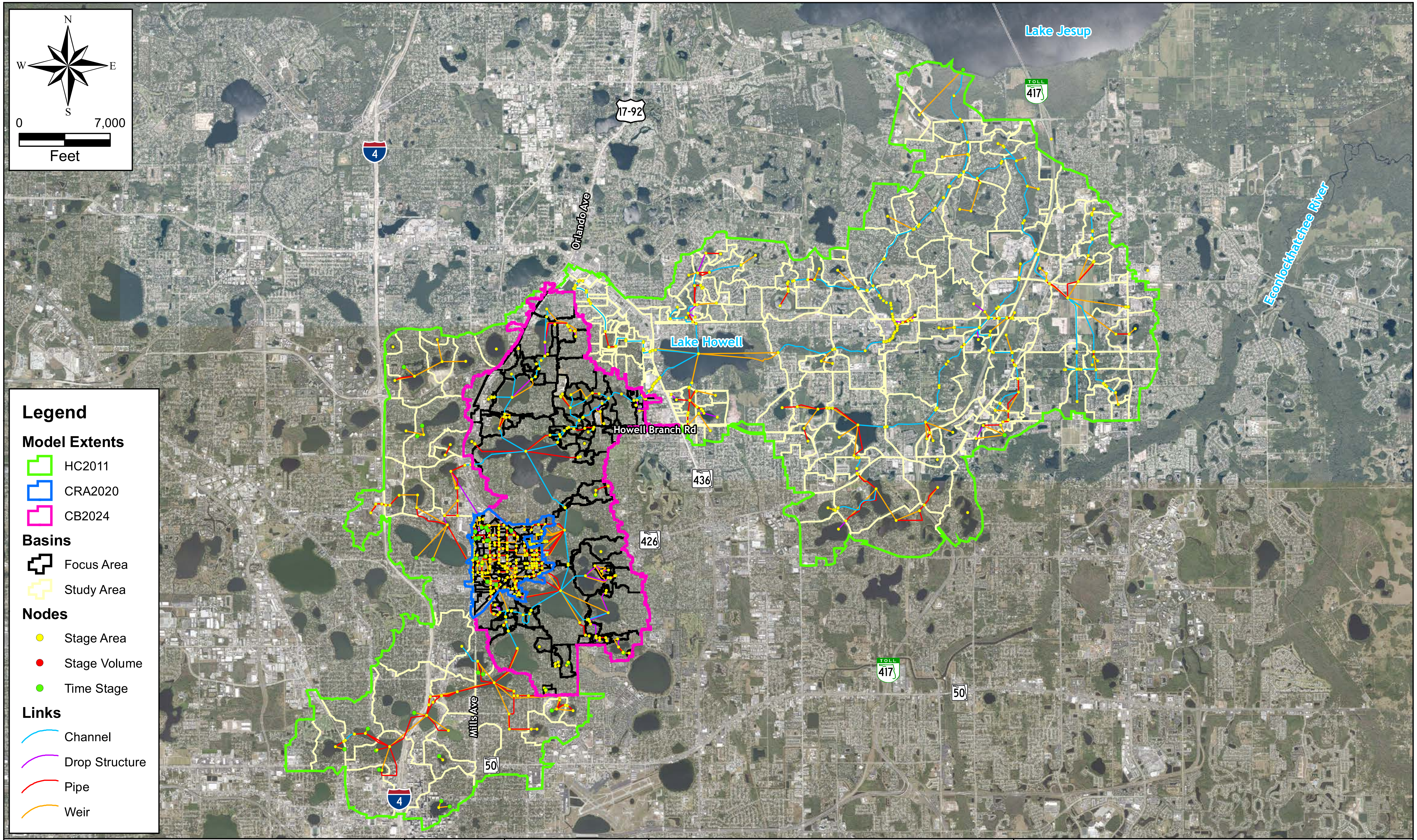
Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

MODEL EXTENTS MAP

FIGURE: 3.1

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\06_FinalReport\GIS\3.1_ModelExtents.mxd)
12/4/2024 -- 5:42:29 PM



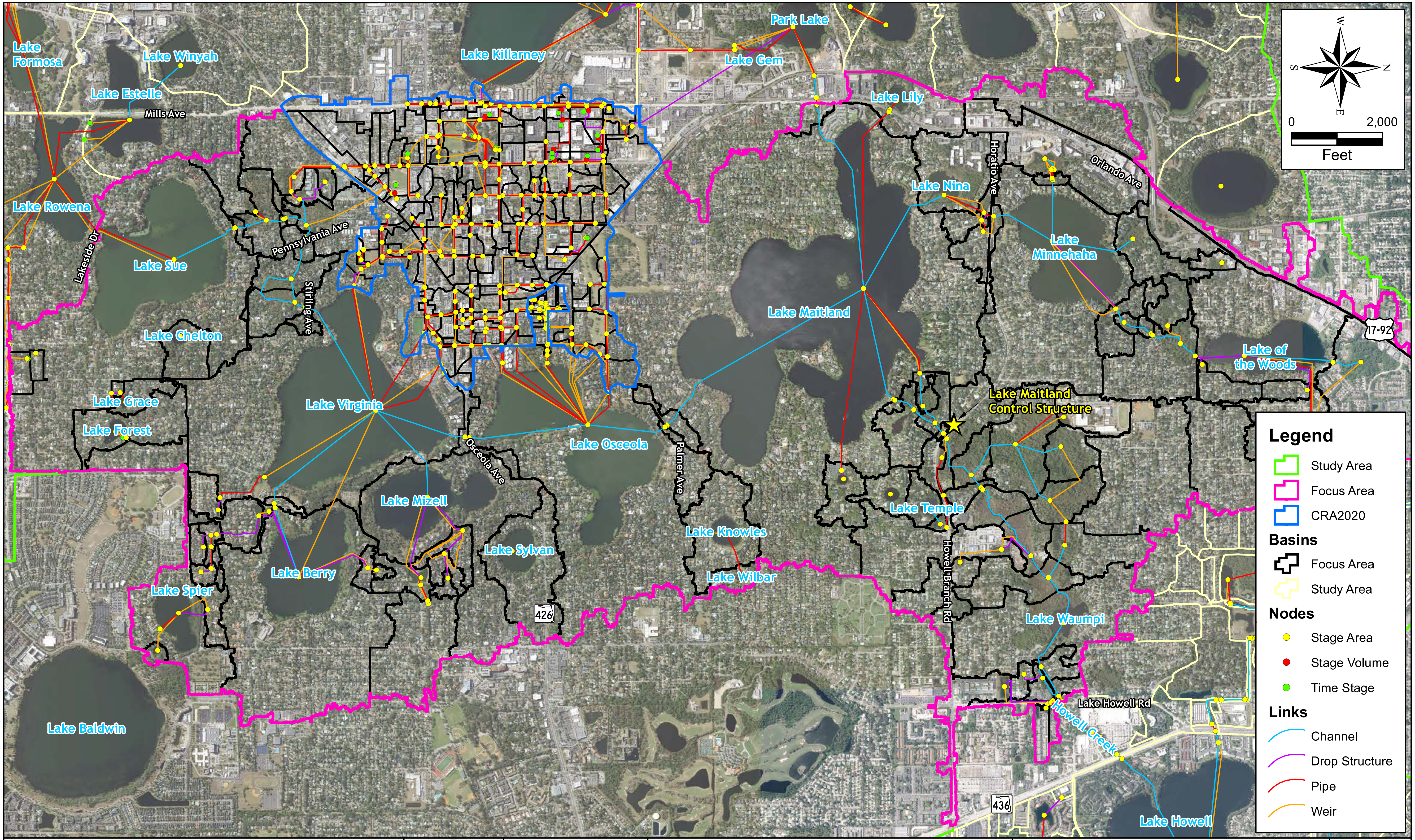
Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

MODEL NETWORK STUDY AREA

FIGURE: 3.2

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\05_DraftReport\3.2_ModelNetwork_StudyArea.mxd)
8/29/2024 -- 4:10:58 PM



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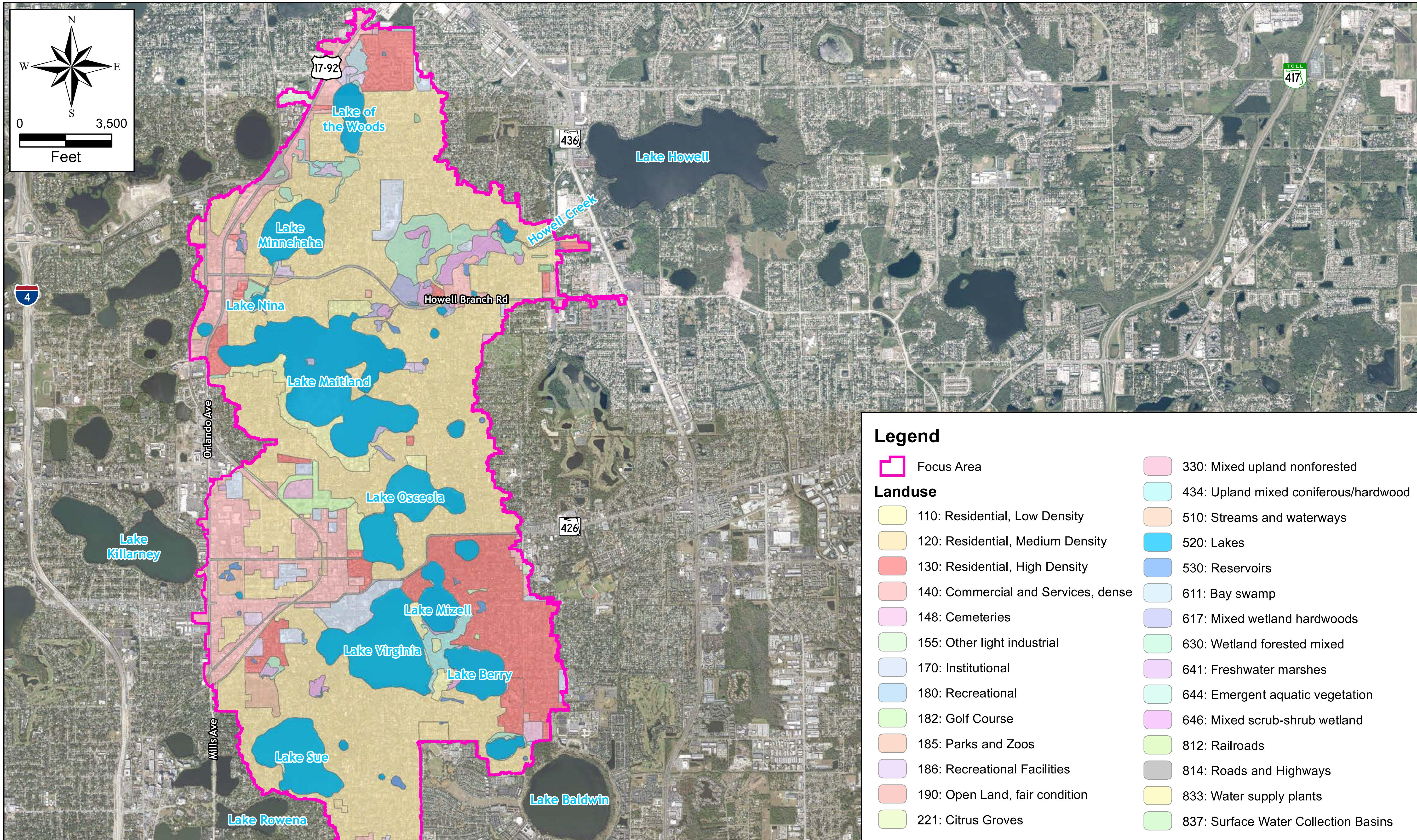
Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

MODEL NETWORK FOCUS AREA

FIGURE: 3.3

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\05_DraftReport\3.3_ModelNetwork_FocusArea.mxd)
8/29/2024 -- 4:07:47 PM



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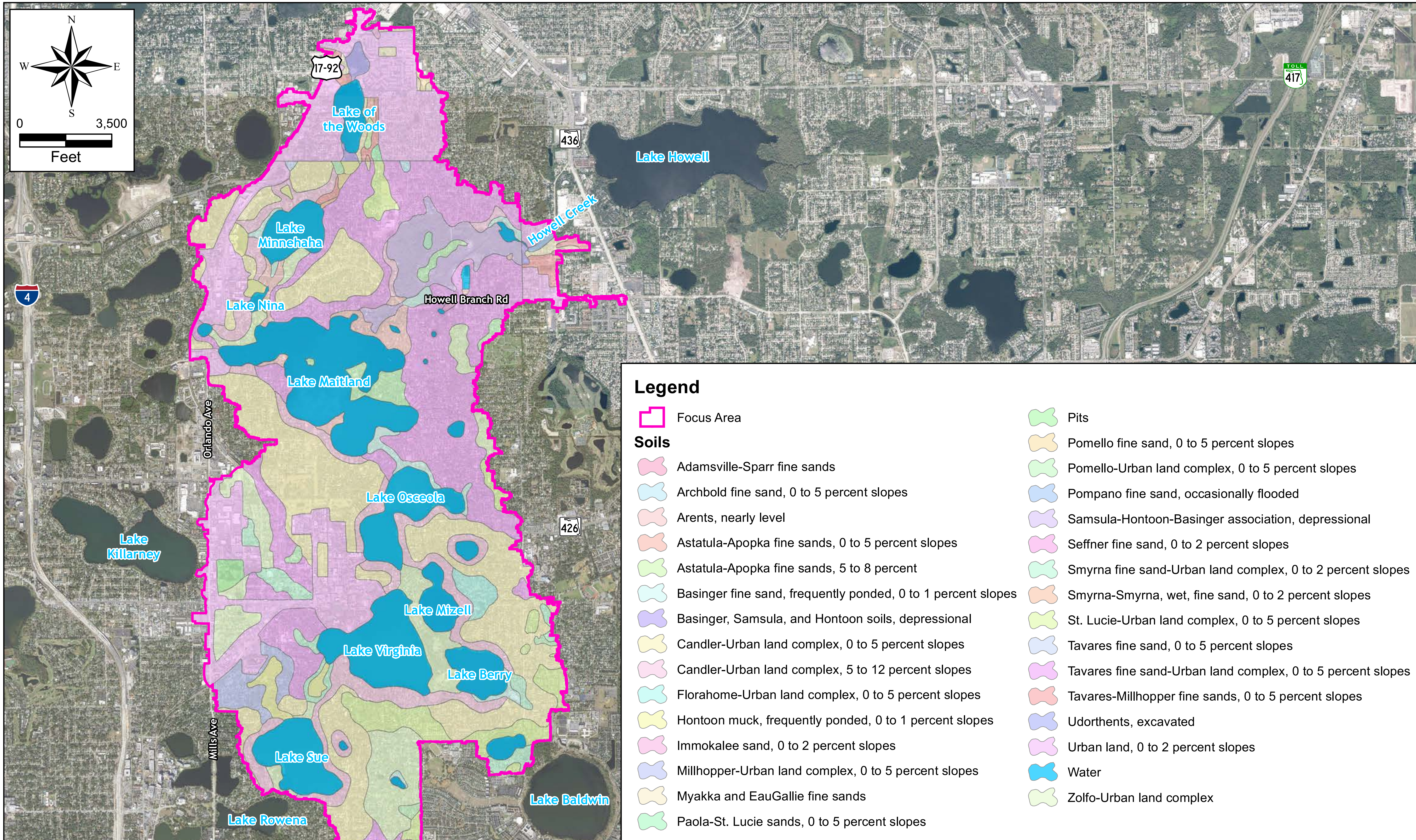
Sources:
Aerials:
2018 Orange County
2018 Seminole County
Landuse: 2009 SJRWMD

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

LANDUSE MAP

FIGURE: 3.4

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\05_DraftReport\3.4_Landuse.mxd)
8/29/2024 -- 4:12:47 PM



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Sources:
Aerials:
2018 Orange County
2018 Seminole County
Soils: 2023 NRCS

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

SOILS MAP

FIGURE: 3.5

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\05_DraftReport\3.5_Soils.mxd)
8/29/2024 -- 4:13:37 PM

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN
STORMWATER MASTER PLAN

EXISTING CONDITIONS
2-YEAR 24-HOUR INUNDATION MAP

FIGURE
3.6a

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS 10-YEAR 24-HOUR INUNDATION MAP

FIGURE 3.6b

SINGHOFEN & ASSOCIATES INCORPORATED / halff	Sources: Aerials: 2018 Orange County 2018 Seminole County	WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN	EXISTING CONDITIONS 25-YEAR 24-HOUR INUNDATION MAP	FIGURE 3.6c

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS 100-YEAR 24-HOUR INUNDATION MAP

FIGURE 3.6d

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\05_DraftReport\GIS\3.6_InundationMap.mxd)
9/5/2024 -- 3:11:50 PM

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS 500-YEAR 24-HOUR INUNDATION MAP

FIGURE 3.6e

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS 10-YEAR 6-HOUR INUNDATION MAP

FIGURE 3.6f

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS 25-YEAR 6-HOUR INUNDATION MAP

FIGURE 3.6g

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS 25-YEAR 96-HOUR INUNDATION MAP

FIGURE 3.6h

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS 100-YEAR 96-HOUR INUNDATION MAP

FIGURE 3.6i

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS HURRICANE IAN INUNDATION MAP

FIGURE 3.6j

Summary of LOS Analysis	
Number of Inundated Structures	0
Length of Inundated Roadway [ft]	7,425

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS
LEVEL OF SERVICE ANALYSIS
2-YEAR 24-HOUR

FIGURE
3.7a

Summary of LOS Analysis	
Number of Inundated Structures	2
Length of Inundated Roadway [ft]	23,950

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Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS LEVEL OF SERVICE ANALYSIS 10-YEAR 24-HOUR

FIGURE 3.7b

Summary of LOS Analysis	
Number of Inundated Structures	15
Length of Inundated Roadway [ft]	37,375

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CITY OF WINTER PARK FLORIDA ESTABLISHED 1887

Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS LEVEL OF SERVICE ANALYSIS 25-YEAR 24-HOUR

FIGURE 3.7c

Summary of LOS Analysis	
Number of Inundated Structures	64
Length of Inundated Roadway [ft]	51,300

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CITY OF WINTER PARK FLORIDA ESTABLISHED 1887

Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS LEVEL OF SERVICE ANALYSIS 100-YEAR 24-HOUR

FIGURE 3.7d

Summary of LOS Analysis	
Number of Inundated Structures	125
Length of Inundated Roadway [ft]	86,675

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CITY OF WINTER PARK FLORIDA ESTABLISHED 1882

Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS LEVEL OF SERVICE ANALYSIS 500-YEAR 24-HOUR

FIGURE 3.7e

Summary of LOS Analysis	
Number of Inundated Structures	2
Length of Inundated Roadway [ft]	31,275

SINGHOFEN & ASSOCIATES INCORPORATED | halff | CITY OF WINTER PARK FLORIDA ESTABLISHED 1887

Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS LEVEL OF SERVICE ANALYSIS 10-YEAR 6-HOUR

FIGURE 3.7f

Summary of LOS Analysis	
Number of Inundated Structures	16
Length of Inundated Roadway [ft]	42,500

SINGHOFEN & ASSOCIATES INCORPORATED | halff | City of Winter Park, Florida

Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS
LEVEL OF SERVICE ANALYSIS
25-YEAR 6-HOUR

FIGURE
3.7g

Summary of LOS Analysis	
Number of Inundated Structures	36
Length of Inundated Roadway [ft]	44,600

SINGHOFEN & ASSOCIATES INCORPORATED

halff

Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS LEVEL OF SERVICE ANALYSIS 25-YEAR 96-HOUR

FIGURE 3.7h

Summary of LOS Analysis	
Number of Inundated Structures	89
Length of Inundated Roadway [ft]	70,650

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CITY OF WINTER PARK FLORIDA ESTABLISHED 1887

Sources:
Aerials:
2018 Orange County
2018 Seminole County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

EXISTING CONDITIONS LEVEL OF SERVICE ANALYSIS 100-YEAR 96-HOUR

FIGURE 3.7i

Table 3.1 - Maximum Stages/Flood Depths: Existing Conditions

				2-Year, 24-Hour Storm Event		10-Year, 24-Hour Storm Event		25-Year, 24-Hour Storm Event		100-Year, 24-Hour Storm Event		500-Year, 24-Hour Storm Event		10-Year, 6-Hour Storm Event		25-Year, 6-Hour Storm Event		25-Year, 96-Hour Storm Event		100-Year, 96-Hour Storm Event		Hurricane Ian	
Node ID	**Location**	**Warn. Elev.**	**Warning Elevation Location**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**
L_Wilbar	Lake Wilbar; US Lake Knowles	87.20	Road EOP (DEM); Wilbar Cir	86.0	0.0	86.2	0.0	86.3	0.0	86.7	0.0	**87.3**	**1.2**	86.5	0.0	86.8	0.0	86.3	0.0	86.7	0.0	86.6	0.0
L_Knowles	Lake Knowles	81.20	Road Crown (DEM); Lake Knowles Cir	79.4	0.0	79.8	0.0	80.1	0.0	81.0	0.0	**82.7**	**18.0**	79.6	0.0	79.8	0.0	80.7	0.0	**82.3**	**13.2**	**82.7**	**18.0**
L_Maitland	Lake Maitland	66.20	Lowest FFE (LOS)	65.9	0.0	66.2	0.0	**66.4**	**2.4**	**67.0**	**9.6**	**67.9**	**20.4**	65.9	0.0	66.1	0.0	**67.0**	**9.6**	**67.8**	**19.2**	**67.8**	**19.2**
L_Sue	Lake Sue	75.00	Lowest FFE (LOS)	71.5	0.0	72.3	0.0	72.8	0.0	73.7	0.0	**75.2**	**2.4**	71.8	0.0	72.2	0.0	73.4	0.0	74.5	0.0	**75.2**	**2.4**
L_Forest	Lake Forest	105.00	Lowest FFE (DEM)	101.4	0.0	102.0	0.0	102.5	0.0	103.3	0.0	104.7	0.0	102.1	0.0	102.6	0.0	103.0	0.0	103.8	0.0	104.6	0.0
L_Grace	Lake Grace	104.50	Lowest FFE (CWP)	101.9	0.0	102.4	0.0	102.8	0.0	103.5	0.0	**104.6**	**1.2**	102.2	0.0	102.6	0.0	103.6	0.0	104.5	0.0	104.4	0.0
CB-1990	Phillips Place Retention Pond; Lake Grace System	111.70	Road Crown (DEM); Phillips Park Cir	109.5	0.0	109.6	0.0	109.8	0.0	110.1	0.0	110.8	0.0	109.7	0.0	109.9	0.0	110.1	0.0	110.3	0.0	109.8	0.0
CB-2000	Pond; Lake Forest System	106.80	Pond TOB (DEM)	106.4	0.0	106.6	0.0	106.7	0.0	106.8	0.0	**107.0**	**2.4**	**106.9**	**1.2**	**107.0**	**2.4**	106.7	0.0	**106.9**	**1.2**	106.4	0.0
L_Mizell	Lake Mizell	66.90	Lowest FFE (LOS)	66.2	0.0	66.7	0.0	**67.1**	**2.4**	**68.0**	**13.2**	**69.2**	**27.6**	66.3	0.0	66.6	0.0	**67.9**	**12.0**	**69.0**	**25.2**	**69.2**	**27.6**
L_Sylvan	Lake Sylvan	76.07	Lowest FFE (CWP)	72.0	0.0	72.4	0.0	72.6	0.0	73.2	0.0	74.1	0.0	72.1	0.0	72.3	0.0	73.3	0.0	74.2	0.0	74.2	0.0
L_Chelton	Lake Chelton	87.05	Road Crown (LOS)	82.3	0.0	82.7	0.0	83.0	0.0	83.5	0.0	84.2	0.0	82.4	0.0	82.7	0.0	83.6	0.0	84.3	0.0	84.3	0.0
HC-0030	Howell Creek; DS Lake Maitland CS	68.84	Road Crown (LOS)	62.0	0.0	62.6	0.0	62.9	0.0	63.5	0.0	64.6	0.0	62.6	0.0	63.0	0.0	63.4	0.0	64.5	0.0	64.7	0.0
HC-0025	Howell Creek; US Lake Maitland CS	69.50	Lowest FFE (LOS)	65.8	0.0	66.1	0.0	66.3	0.0	66.8	0.0	67.7	0.0	65.9	0.0	66.0	0.0	66.8	0.0	67.7	0.0	67.7	0.0
L_Berry	Lake Berry	74.70	Lowest FFE (LOS)	69.8	0.0	70.1	0.0	70.4	0.0	70.8	0.0	71.2	0.0	69.9	0.0	70.1	0.0	70.7	0.0	71.0	0.0	71.4	0.0
L_Virginia	Lake Virginia	66.80	Lowest FFE (LOS)	66.2	0.0	66.7	0.0	**67.1**	**3.6**	**68.0**	**14.4**	**69.2**	**28.8**	66.3	0.0	66.6	0.0	**67.9**	**13.2**	**69.0**	**26.4**	**69.2**	**28.8**
L_Nina	Lake Nina	67.30	Lowest FFE (LOS)	65.9	0.0	66.2	0.0	66.4	0.0	67.0	0.0	**67.9**	**7.2**	65.9	0.0	66.1	0.0	67.0	0.0	**67.8**	**6.0**	**67.9**	**7.2**
L_Waumpi	Lake Waumpi	65.50	Lowest FFE (LOS)	59.9	0.0	60.4	0.0	60.8	0.0	61.6	0.0	62.8	0.0	60.5	0.0	60.8	0.0	61.2	0.0	62.3	0.0	63.1	0.0
L_Osceola	Lake Osceola	68.90	Lowest FFE (LOS)	66.0	0.0	66.5	0.0	66.8	0.0	67.5	0.0	68.6	0.0	66.1	0.0	66.3	0.0	67.5	0.0	68.4	0.0	68.5	0.0
L_Minnehaha	Lake Minnehaha	67.80	Lowest FFE (LOS)	65.9	0.0	66.2	0.0	66.5	0.0	67.0	0.0	**67.9**	**1.2**	66.0	0.0	66.2	0.0	67.0	0.0	67.8	0.0	**67.9**	**1.2**

Table 3.1 - Maximum Stages/Flood Depths: Existing Conditions

				2-Year, 24-Hour Storm Event		10-Year, 24-Hour Storm Event		25-Year, 24-Hour Storm Event		100-Year, 24-Hour Storm Event		500-Year, 24-Hour Storm Event		10-Year, 6-Hour Storm Event		25-Year, 6-Hour Storm Event		25-Year, 96-Hour Storm Event		100-Year, 96-Hour Storm Event		Hurricane Ian	
Node ID	Location	Warn. Elev.	Warning Elevation Location	Stage [ft]	Flood Depth [in]	Stage [ft]	Flood Depth [in]	Stage [ft]	Flood Depth [in]	Stage [ft]	Flood Depth [in]	Stage [ft]	Flood Depth [in]	Stage [ft]	Flood Depth [in]	Stage [ft]	Flood Depth [in]	Stage [ft]	Flood Depth [in]	Stage [ft]	Flood Depth [in]	Stage [ft]	Flood Depth [in]
HC-0016	Howell Creek	67.26	Road Crown (LOS)	65.9	0.0	66.1	0.0	66.4	0.0	66.9	0.0	**67.8**	**6.5**	65.9	0.0	66.1	0.0	66.9	0.0	**67.8**	**6.5**	**67.8**	**6.5**
L_Temple	Lake Temple	79.10	Lowest FFE (LOS)	67.5	0.0	67.8	0.0	68.1	0.0	68.7	0.0	69.8	0.0	67.5	0.0	67.7	0.0	68.8	0.0	69.6	0.0	70.0	0.0
L_Lily	Lake Lily	77.80	Lowest FFE (LOS)	70.2	0.0	71.1	0.0	71.9	0.0	73.3	0.0	75.2	0.0	71.0	0.0	71.6	0.0	72.3	0.0	73.9	0.0	75.0	0.0
L_Tuscany	Lake Tuscany	81.20	Lowest FFE (LOS)	71.5	0.0	71.9	0.0	72.2	0.0	73.4	0.0	75.9	0.0	71.6	0.0	71.9	0.0	73.7	0.0	76.1	0.0	75.9	0.0
LM-0010	Venetian Canal; DS Palmer Ave	71.18	Road Crown (LOS)	66.0	0.0	66.4	0.0	67.0	0.0	67.5	0.0	68.5	0.0	66.1	0.0	66.3	0.0	67.5	0.0	68.4	0.0	68.5	0.0
L_Compton	Lake Compton	94.40	Lowest FFE (LOS)	90.8	0.0	91.6	0.0	92.2	0.0	93.1	0.0	94.2	0.0	91.0	0.0	91.3	0.0	93.3	0.0	94.2	0.0	94.3	0.0
L_Spier	Lake Spier	94.10	Lowest FFE (LOS)	90.4	0.0	90.7	0.0	90.9	0.0	91.4	0.0	92.0	0.0	90.5	0.0	90.6	0.0	91.2	0.0	91.8	0.0	92.2	0.0
HC-0020	Howell Creek	68.10	Lowest FFE (LOS)	65.8	0.0	66.1	0.0	66.3	0.0	66.8	0.0	67.8	0.0	65.9	0.0	66.0	0.0	66.8	0.0	67.7	0.0	67.7	0.0
HC-0015	Howell Creek	67.60	Lowest FFE (LOS)	65.8	0.0	66.1	0.0	66.4	0.0	66.9	0.0	**67.8**	**2.4**	65.9	0.0	66.0	0.0	66.9	0.0	**67.7**	**1.2**	**67.8**	**2.4**
HC-0018	Howell Creek	69.00	Lowest FFE (LOS)	65.8	0.0	66.1	0.0	66.4	0.0	66.9	0.0	67.8	0.0	65.9	0.0	66.1	0.0	66.9	0.0	67.7	0.0	67.8	0.0
HC-0010	Howell Creek	67.09	Road Crown (LOS)	65.8	0.0	66.1	0.0	66.4	0.0	66.9	0.0	**67.8**	**8.5**	65.9	0.0	66.1	0.0	66.9	0.0	**67.7**	**7.3**	**67.8**	**8.5**
LV-0145	Fern Canal; US Osceola Ave	68.40	Lowest FFE (LOS)	66.1	0.0	66.6	0.0	67.0	0.0	67.7	0.0	**68.9**	**6.0**	66.2	0.0	66.5	0.0	67.7	0.0	**68.7**	**3.6**	**68.8**	**4.8**
LO-0005	Venetian Canal; US Palmer Ave	82.99	Road Crown (LOS)	66.0	0.0	66.4	0.0	68.8	0.0	68.8	0.0	68.5	0.0	66.1	0.0	66.3	0.0	68.8	0.0	68.4	0.0	68.5	0.0
LB-0040	Pond; residential	86.90	Lowest FFE (LOS)	76.2	0.0	76.5	0.0	76.7	0.0	77.2	0.0	77.7	0.0	76.5	0.0	76.7	0.0	77.1	0.0	77.6	0.0	77.5	0.0
LM-0100	Pond; residential	81.90	Lowest FFE (LOS)	74.2	0.0	74.3	0.0	74.4	0.0	74.5	0.0	74.9	0.0	74.4	0.0	74.5	0.0	74.4	0.0	74.7	0.0	74.8	0.0
LM-0090	Pond; residential	87.50	Lowest FFE (LOS)	83.6	0.0	83.9	0.0	84.1	0.0	84.3	0.0	84.5	0.0	83.9	0.0	84.1	0.0	84.1	0.0	84.3	0.0	84.1	0.0
LM-0070	Pond; residential	84.28	Road Crown (LOS)	83.1	0.0	83.4	0.0	83.7	0.0	84.1	0.0	**84.6**	**3.8**	83.4	0.0	83.6	0.0	83.8	0.0	84.2	0.0	83.7	0.0
LM-0060	Pond; residential	78.30	Lowest FFE (LOS)	73.2	0.0	73.6	0.0	73.9	0.0	74.4	0.0	75.8	0.0	73.7	0.0	73.9	0.0	74.1	0.0	74.4	0.0	74.0	0.0
LM-0080	Pond; residential	88.82	Road Crown (LOS)	86.5	0.0	86.8	0.0	86.9	0.0	87.1	0.0	87.2	0.0	86.7	0.0	86.9	0.0	87.0	0.0	87.1	0.0	86.9	0.0
CB-1600	Channel; US Stirling Ave	70.05	Road Crown (DEM)	67.0	0.0	67.5	0.0	68.1	0.0	68.9	0.0	**70.5**	**5.4**	67.6	0.0	67.9	0.0	68.8	0.0	69.9	0.0	**70.5**	**5.4**
LV-0160	Channel; DS Stirling Ave	66.82	Road Crown (LOS)	66.8	0.0	**67.2**	**4.6**	**67.8**	**11.8**	**68.3**	**17.8**	**69.2**	**28.6**	**67.3**	**5.8**	**67.5**	**8.2**	**68.2**	**16.6**	**69.0**	**26.2**	**69.2**	**28.6**

Table 3.1 - Maximum Stages/Flood Depths: Existing Conditions

				2-Year, 24-Hour Storm Event		10-Year, 24-Hour Storm Event		25-Year, 24-Hour Storm Event		100-Year, 24-Hour Storm Event		500-Year, 24-Hour Storm Event		10-Year, 6-Hour Storm Event		25-Year, 6-Hour Storm Event		25-Year, 96-Hour Storm Event		100-Year, 96-Hour Storm Event		Hurricane Ian	
Node ID	**Location**	**Warn. Elev.**	**Warning Elevation Location**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**	**Stage [ft]**	**Flood Depth [in]**
LB-0020	Pond; residential	81.19	Road Crown (LOS)	77.1	0.0	77.3	0.0	77.5	0.0	77.8	0.0	78.4	0.0	77.3	0.0	77.5	0.0	77.8	0.0	78.0	0.0	77.6	0.0
LB-0030	Pond; residential	86.80	Lowest FFE (LOS)	83.0	0.0	83.1	0.0	83.2	0.0	83.2	0.0	83.3	0.0	83.1	0.0	83.2	0.0	83.2	0.0	83.3	0.0	83.1	0.0
LB-0090	Pond; residential	105.60	Lowest FFE (LOS)	98.8	0.0	99.5	0.0	100.0	0.0	100.6	0.0	101.0	0.0	99.4	0.0	99.8	0.0	100.1	0.0	100.7	0.0	100.9	0.0
LB-0070	Pond; residential	100.61	Road Crown (LOS)	99.0	0.0	99.6	0.0	99.8	0.0	99.9	0.0	100.1	0.0	99.2	0.0	99.6	0.0	99.9	0.0	100.1	0.0	100.0	0.0
LB-0075	Pond; residential	73.74	Road Crown (LOS)	71.7	0.0	71.9	0.0	72.1	0.0	72.2	0.0	72.3	0.0	72.1	0.0	72.1	0.0	72.1	0.0	72.2	0.0	72.1	0.0
LS-0015	Pond; residential	95.60	Lowest FFE (LOS)	93.8	0.0	94.0	0.0	94.2	0.0	94.6	0.0	95.1	0.0	94.3	0.0	94.6	0.0	94.3	0.0	94.7	0.0	93.8	0.0
LB-0065	Pond; residential	99.63	Road Crown (LOS)	96.4	0.0	96.8	0.0	96.8	0.0	96.9	0.0	97.3	0.0	96.6	0.0	96.8	0.0	96.9	0.0	97.3	0.0	96.9	0.0
LB-0045	Pond; residential	100.40	Lowest FFE (LOS)	95.8	0.0	95.8	0.0	96.0	0.0	96.2	0.0	96.7	0.0	95.8	0.0	96.0	0.0	96.2	0.0	96.6	0.0	96.4	0.0
CB-0610	Wetland	68.14	Road Crown (LOS)	64.0	0.0	64.2	0.0	64.3	0.0	64.4	0.0	64.6	0.0	64.3	0.0	64.4	0.0	64.3	0.0	64.5	0.0	64.6	0.0
CB-0400	Pond; residential	66.70	Lowest FFE (LOS)	64.0	0.0	64.6	0.0	65.1	0.0	66.1	0.0	**66.8**	**1.2**	65.0	0.0	65.5	0.0	65.6	0.0	66.6	0.0	66.0	0.0
CB-0300	Wetland	66.13	Road Crown (LOS)	62.0	0.0	62.1	0.0	62.2	0.0	62.3	0.0	62.8	0.0	62.3	0.0	62.4	0.0	62.2	0.0	62.3	0.0	63.1	0.0
CB-0615	Wetland	70.90	Lowest FFE (LOS)	66.0	0.0	66.1	0.0	66.2	0.0	66.2	0.0	66.4	0.0	66.2	0.0	66.2	0.0	66.2	0.0	66.4	0.0	66.4	0.0
CB-0620	Wetland	72.90	Lowest FFE (LOS)	64.7	0.0	64.9	0.0	64.9	0.0	65.1	0.0	65.2	0.0	64.8	0.0	64.9	0.0	65.0	0.0	65.1	0.0	65.0	0.0
CB-0600	Wetland	67.00	Lowest FFE (LOS)	63.1	0.0	63.3	0.0	63.4	0.0	63.6	0.0	64.2	0.0	63.4	0.0	63.5	0.0	63.5	0.0	64.0	0.0	64.5	0.0
CB-1000	Pond; residential	93.10	Lowest FFE (LOS)	89.3	0.0	91.4	0.0	91.8	0.0	92.3	0.0	92.6	0.0	91.1	0.0	91.6	0.0	92.2	0.0	92.5	0.0	92.5	0.0

All elevations are based on the NAVD88 vertical datum.

Stages above the warning elevation are highlighted in **red.**

Anticipated flood depths are shown in **red**.

Stages are shown rounded to the nearest tenth.

Section 4

Design Development and Evaluation

4.1 Design Conditions Model Development & Analysis

The existing conditions stormwater model was used as the basis for the design conditions model development effort. After discussion with CWP staff, SAI-Halff developed and evaluated flood control design alternatives at five (5) closed-basin lakes, including Lake Knowles, Lake Sylvan, Lake Chelton, Lake Grace, and Lake Forest. The objective of the design alternatives is to reduce or eliminate lot, street, and structure flooding around the closed-basin lakes, with a desired LOS of a 500-year 24-hour storm event (approximation of Hurricane Ian). An LOS elevation was determined for each lake and was set to either 0.5 ft below the lowest road crown or 1 ft below the lowest FFE, whichever was lower.

Two (2) types of designs were evaluated: one using temporary pumps, the other using permanent gravity culvert outfalls. Temporary pumping options were not evaluated for Lake Chelton or Lake Sylvan as the existing peak stages within the lakes are more than 2 ft below the determined LOS elevations. Global Standard Trash (GST) pumps offered by Global Pump were used to determine the pump requirements at the remaining lakes, as the CWP already has one (1) GST pump within its fleet (Model: 6GST, rated for 3,000gpm). Meanwhile, gravity culvert outfalls were evaluated at all five (5) closed-basin lakes.

Each design alternative includes a conceptual layout of the design solution, along with a construction cost estimate. Summary tables comparing the design peak stages and anticipated flood depths to the existing conditions are included as **Tables 4.1** and **4.2,** respectively. A brief description of each design alternative is presented below.

Design Alternative	Design Location	Design Description
Temporary Pumping Alternatives		
1a	Lake Knowles	Pump during storm
1b	Lake Knowles	Pump prior to storm
2a	Lakes Grace & Forest	Pump during storm
2b	Lakes Grace & Forest	Pump prior to storm
Gravity Culvert Outfall Alternatives		
3	Lake Knowles	Construct emergency outfall to Lake Maitland
4	Lake Sylvan	Construct emergency outfall to Lake Mizell; Outfall structure to include bleed down orifice
5	Lake Chelton	Construct emergency outfall to Lake Sue; Outfall structure to include bleed down orifice
6	Lakes Grace & Forest	Construct emergency outfall from Lake Forest to Lake Grace, and from Lake Grace to Lake Sue; Outfall structure within Lake Grace to include bleed down orifice
7	Lake Grace	Construct emergency outfall from Lake Grace into Lake Sue; Outfall structure to include bleed down orifice
8	Lake Grace	Plug existing Phillips Place Retention Pond outfall into Lake Grace; Construct new outfall from retention pond into Lake Forest

It should be noted that various design alternatives were grouped together and simulated within combined models to evaluate the cumulative impacts of implementing multiple alternatives. In total, five (5) design condition models were developed to evaluate the design alternatives. Specifically, Alternatives 1a & 2a, and 1b & 2b were each modeled together to represent the pumping during and prior to the storm, respectively. Alternatives 3, 4, 5, and 6 were simulated together to demonstrate that even if all designs are implemented, the impacts to the overall Chain of Lakes system are negligible. Alternatives 7 and 8 were each simulated independently. These groupings are reflected in the presentation of model results, and within the StormWise input reports.

Table 4.1 - Maximum Stages: Proposed Design Conditions vs. Existing Conditions

Temporary Pumping Alternatives

Alt 1a & 2a: Pump during storm at Lakes Knowles, Grace, and Forest
Alt 1b & 2b: Pump prior to storm at Lakes Knowles, Grace, and Forest

Gravity Culvert Outfall Alternatives

Alt 3-6: Construct outfalls at Lakes Knowles, Sylvan, Chelton, Grace, and Forest
Alt 7: Construct outfall at Lake Grace
Alt 8: Philips Place Retention Pond outfall redirected from Lake Grace to Lake Forest

				500-Year, 24-Hour Storm Event										
				Exist	Alt 1a & 2a		Alt 1b & 2b		Alt 3-6		Alt 7		Alt 8	
Node ID	Location	Warning Elevation	Warning Elevation Location	Stage [ft]	Stage [ft]	Diff (Alt - Ex) [in]	Stage [ft]	Diff (Alt - Ex) [in]	Stage [ft]	Diff (Alt - Ex) [in]	Stage [ft]	Diff (Alt - Ex) [in]	Stage [ft]	Diff (Alt - Ex) [in]
L_Wilbar	Lake Wilbar; US Lake Knowles	87.20	Road EOP (DEM); Wilbar Cir	**87.3**	**87.3**	0.0	**87.3**	0.0	**87.3**	0.0	**87.3**	0.0	**87.3**	0.0
L_Knowles	Lake Knowles	81.20	Road Crown (DEM); Lake Knowles Cir	**82.7**	80.5	-26.4	80.7	-24.0	81.2	-18.0	**82.7**	0.0	**82.7**	0.0
L_Maitland	Lake Maitland	66.20	Lowest FFE (LOS)	**67.9**	**67.9**	0.0	**67.9**	0.0	**67.9**	0.0	**67.9**	0.0	**67.9**	0.0
L_Sue	Lake Sue	75.00	Lowest FFE (LOS)	**75.2**	**75.3**	**1.2**	**75.2**	0.0	**75.3**	**1.2**	**75.3**	**1.2**	**75.2**	0.0
L_Forest	Lake Forest	105.00	Lowest FFE (DEM)	104.7	103.6	-13.2	103.9	-9.6	104.7	0.0	104.7	0.0	104.8	**1.2**
L_Grace	Lake Grace	104.50	Lowest FFE (CWP)	**104.6**	102.3	-27.6	103.3	-15.6	104.2	-4.8	104.1	-6.0	104.3	-3.6
CB-1990	Phillips Place Retention Pond; Lake Grace System	111.70	Road Crown (DEM); Phillips Park Cir	110.8	110.8	0.0	110.8	0.0	110.8	0.0	110.8	0.0	109.9	-10.8
CB-2000	Pond; Lake Forest System	106.80	Pond TOB (DEM)	**107.0**	**107.0**	0.0	**107.0**	0.0	**107.0**	0.0	**107.0**	0.0	**107.0**	0.0
L_Sylvan	Lake Sylvan	76.07	Lowest FFE (CWP)	74.1	74.1	0.0	74.1	0.0	74.0	-1.2	74.1	0.0	74.1	0.0
L_Chelton	Lake Chelton	87.05	Road Crown (LOS)	84.2	84.2	0.0	84.2	0.0	83.8	-4.8	84.2	0.0	84.2	0.0
L_Mizell	Lake Mizell	66.90	Lowest FFE (LOS)	**69.2**	**69.2**	0.0	**69.2**	0.0	**69.2**	0.0	**69.2**	0.0	**69.2**	0.0
HC-0030	Howell Creek; DS Lake Maitland CS	68.84	Road Crown (LOS)	64.6	64.6	0.0	64.6	0.0	64.6	0.0	64.6	0.0	64.6	0.0
HC-0025	Howell Creek; US Lake Maitland CS	69.50	Lowest FFE (LOS)	67.7	67.8	**1.2**	67.7	0.0	67.7	0.0	67.7	0.0	67.7	0.0
L_Virginia	Lake Virginia	66.80	Lowest FFE (LOS)	**69.2**	**69.2**	0.0	**69.2**	0.0	**69.2**	0.0	**69.2**	0.0	**69.2**	0.0
L_Osceola	Lake Osceola	68.90	Lowest FFE (LOS)	68.6	68.6	0.0	68.6	0.0	68.6	0.0	68.6	0.0	68.6	0.0

All elevations are based on the NAVD88 vertical datum.
Stages above the warning elevation are highlighted in **red.**
Differences shown in **red** indicate anticipated stage increases.
Stages are shown rounded to the nearest tenth.

Table 4.2 - Flood Depths: Proposed Design Conditions vs. Existing Conditions

Temporary Pumping Alternatives

Alt 1a & 2a: Pump during storm at Lakes Knowles, Grace, and Forest

Alt 1b & 2b: Pump prior to storm at Lakes Knowles, Grace, and Forest

Gravity Culvert Outfall Alternatives

Alt 3-6: Construct outfalls at Lakes Knowles, Sylvan, Chelton, Grace, and Forest

Alt 7: Construct outfall at Lake Grace

Alt 8: Philips Place Retention Pond outfall redirected from Lake Grace to Lake Forest

				500-Year, 24-Hour Storm Event					
				Exist	Alt 1a & 2a	Alt 1b & 2b	Alt 3-6	Alt 7	Alt 8
Node ID	Location	Warning Elevation	Warning Elevation Location	Flood Depth [in]	Flood Depth [in]	Flood Depth [in]	Flood Depth [in]	Flood Depth [in]	Flood Depth [in]
L_Wilbar	Lake Wilbar; US Lake Knowles	87.20	Road EOP (DEM); Wilbar Cir	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**
L_Knowles	Lake Knowles	81.20	Road Crown (DEM); Lake Knowles Cir	**18.0**	0.0	0.0	0.0	**18.0**	**18.0**
L_Maitland	Lake Maitland	66.20	Lowest FFE (LOS)	**20.4**	**20.4**	**20.4**	**20.4**	**20.4**	**20.4**
L_Sue	Lake Sue	75.00	Lowest FFE (LOS)	**2.4**	**3.6**	**2.4**	**3.6**	**3.6**	**2.4**
L_Forest	Lake Forest	105.00	Lowest FFE (DEM)	0.0	0.0	0.0	0.0	0.0	0.0
L_Grace	Lake Grace	104.50	Lowest FFE (CWP)	**1.2**	0.0	0.0	0.0	0.0	0.0
CB-1990	Phillips Place Retention Pond; Lake Grace System	111.70	Road Crown (DEM); Phillips Park Cir	0.0	0.0	0.0	0.0	0.0	0.0
CB-2000	Pond; Lake Forest System	106.80	Pond TOB (DEM)	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**
L_Sylvan	Lake Sylvan	76.07	Lowest FFE (CWP)	0.0	0.0	0.0	0.0	0.0	0.0
L_Chelton	Lake Chelton	87.05	Road Crown (LOS)	0.0	0.0	0.0	0.0	0.0	0.0
L_Mizell	Lake Mizell	66.90	Lowest FFE (LOS)	**27.6**	**27.6**	**27.6**	**27.6**	**27.6**	**27.6**
HC-0030	Howell Creek; DS Lake Maitland CS	68.84	Road Crown (LOS)	0.0	0.0	0.0	0.0	0.0	0.0
HC-0025	Howell Creek; US Lake Maitland CS	69.50	Lowest FFE (LOS)	0.0	0.0	0.0	0.0	0.0	0.0
L_Virginia	Lake Virginia	66.80	Lowest FFE (LOS)	**28.8**	**28.8**	**28.8**	**28.8**	**28.8**	**28.8**
L_Osceola	Lake Osceola	68.90	Lowest FFE (LOS)	0.0	0.0	0.0	0.0	0.0	0.0

All elevations are based on the NAVD88 vertical datum.

Values shown in **red** indicate anticipated flood depths.

4.2 Design Alternative 1a-b

Alternative 1 addresses street and lot flooding around Lake Knowles, which was observed during Hurricane Ian.

To achieve this, temporary pumps will be used to pump water from Lake Knowles into Lake Maitland. Two (2) temporary pumping options were evaluated and are presented below as Alternatives 1a and 1b.

Alternative 1a (*Pump Option 1*): Pumping occurs during a storm and continues operating thru the peak of the storm.

- Pump Requirements: This option requires an 8,800 gpm pump (model: 12GST) to operate for the duration of the storm.
- Results: Maximum stages during the 500-year, 24-hour storm event are reduced by about 26.4-inches within Lake Knowles.
- Permitting Considerations: Permitting challenges are not anticipated for this alternative, as pumping down lake levels is authorized during state of emergency declarations (Florida Statute 252.363).
- Cost: This option requires one (1) 12GST pump, with a quoted price of $182,000.

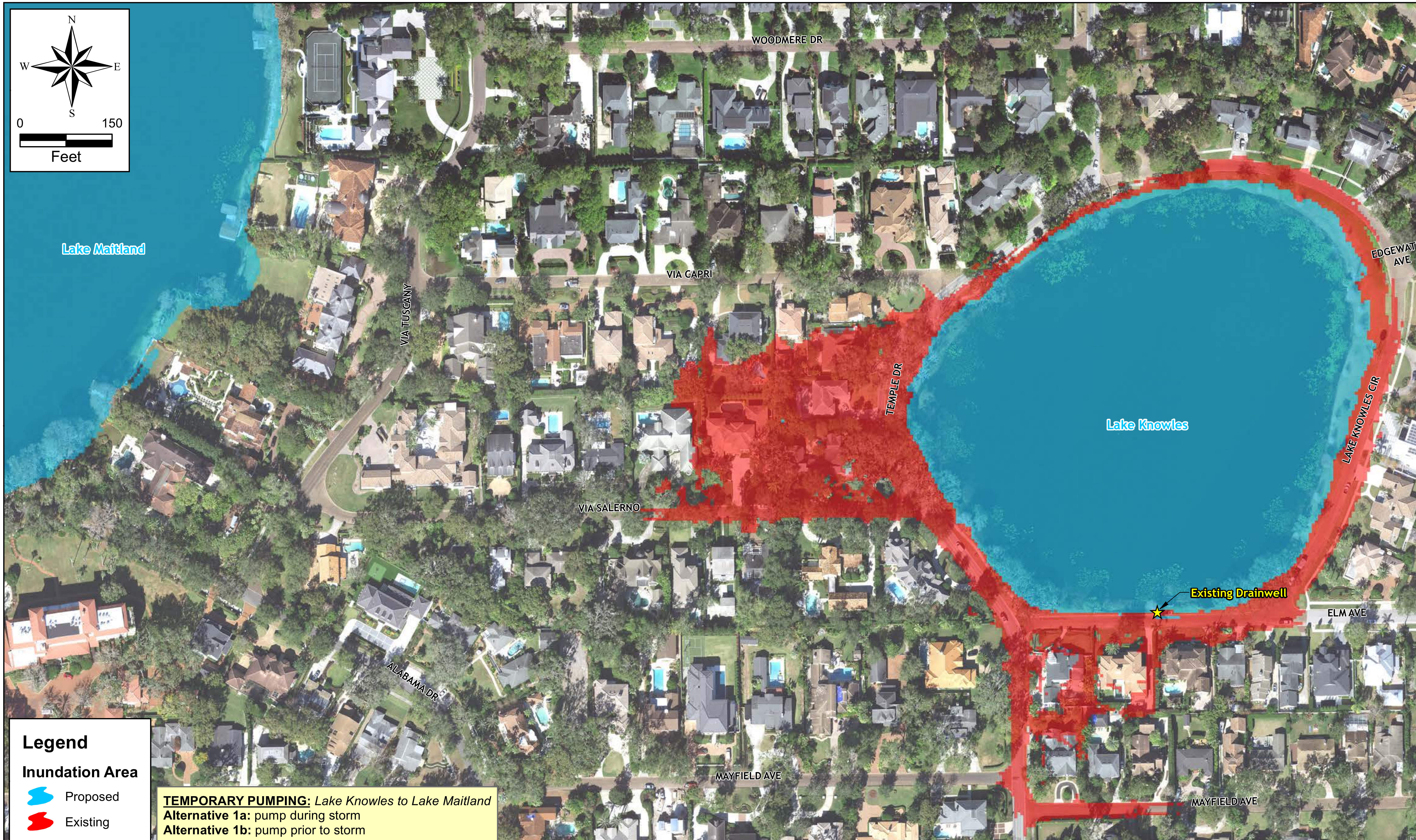
Alternative 1b (*Pump Option 2*): Pumping occurs prior to storm to lower the lake levels, increasing the available storage within the lake during the storm. No pumping occurs during storm.

- Pump Requirements: This option requires a 3,000gpm pump (model: 6GST) to operate for 45 hours prior to the storm to lower the lake level by 3.2 ft.
- Results: Maximum stages during the 500-year, 24-hour storm event are reduced by 24-inches within Lake Knowles.
- Permitting Considerations: Permitting challenges are not anticipated for this alternative, as pumping down lake levels is authorized during state of emergency declarations. However, lowering the lake level prior to a storm may pose environmental or water-use concerns and runs the risk over-pumping should the storm change path.
- Cost: This option requires one (1) 6GST pump, with a quoted price of $90,000. If the City utilizes the 6GST pump already within its fleet, there is no cost to implement this option.

Both pump options meet the desired LOS (500-year, 24-hour) at Lake Knowles. Impacts to the maximum stages within Lake Maitland are negligible.

Maximum stages and flood depths for this alternative are presented in **Table 4.1** and **4.2**, respectively. An inundation comparison map for this alternative is provided as **Figure 4.1**. Note, only one inundation map was provided, as the visual difference between Options 1 and 2 is negligible. The StormWise input data and results for Alternatives 1a and 1b can be found in **Appendix F.1** and **F.2**, respectively.

Pump specifications and pricing were obtained from Global Pump in July 2024. The pricing assumes the pumps are trailer mounted and include sound attenuation enclosures (SoundGuard). The costs per pump should be considered preliminary, as certain optional costs were not included (e.g., fuel tank extensions, hoses).



SINGHOFEN & ASSOCIATES INCORPORATED / halff	Sources: *Aerials: 2018 Orange County*	WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN	LAKE KNOWLES DESIGN ALTERNATIVE 1a & b 500-YEAR 24-HOUR INUNDATION MAP	FIGURE: 4.1

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\05_DraftReport\4.1_LakeKnowles_Alt1a-b.mxd)
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4.3 Design Alternative 2a-b

Alternative 2 addresses lot flooding and potential structure flooding around Lake Grace and Lake Forest, which was observed during Hurricane Ian.

To achieve this, temporary pumps will be used to pump water from Lake Grace and Lake Forest into Lake Sue. Two (2) temporary pumping options were evaluated and are presented below as Alternatives 2a and 2b.

Alternative 2a (*Pump Option 1*): Pumping occurs during storm and continues operating thru the peak of the storm.

- Pump Requirements: This option requires a 3,000gpm pump (model: 6GST) to operate within both lakes for the duration of the storm.
- Results: Maximum stages during the 500-year, 24-hour storm event are reduced by 27.6- and 13.2-inches within Lake Grace and Forest, respectively.
- Permitting Considerations: Permitting challenges are not anticipated for this alternative, as pumping down lake levels is authorized during state of emergency declarations (Florida Statute 252.363).
- Cost: This option requires two (2) 6GST pumps, with a total quoted price of $180,000. If the City utilizes the 6GST pump already within its fleet, the cost to implement this option is reduced to $90,000.

Alternative 2b (*Pump Option 2*): Pumping occurs prior to storm to lower the lake levels, increasing the available storage within the lakes during the storm. No pumping occurs during storm.

- Pump Requirements: This option requires a 3,000gpm pump (model: 6GST) within both lakes. The pump in Lake Grace would need to operate for four (4) hours prior to the storm to lower the lake level by 1.8 ft, while the pump in Lake Forest would need to operate for 10 hours to lower the lake level by 1.5 ft.
- Results: Maximum stages during the 500-year, 24-hour storm event are reduced by 15.6- and 9.6-inches within Lake Grace and Forest, respectively.
- Permitting Considerations: Permitting challenges are not anticipated for this alternative, as pumping down lake levels is authorized during state of emergency declarations. However, lowering the lake level prior to a storm may pose environmental or water-use concerns and runs the risk over-pumping should the storm change path.
- Cost: This option requires one (1) 6GST pump, with a quoted price of $90,000. If the City utilizes the 6GST pump already within its fleet, there is no cost to implement this option. While both lakes require a 6GST pump, the pumping in each lake can occur sequentially, thus requiring one (1) pump instead of two (2).

Both pump options meet the desired LOS (500-year, 24-hour) at Lake Grace and Lake Forest. Impacts to the maximum stages within Lake Sue are negligible.

Maximum stages and flood depths for this alternative are presented in **Table 4.1** and **4.2**, respectively. An inundation comparison map for this alternative is provided as **Figure 4.2**. Note, only one inundation map is provided, as the visual difference between Options 1 and 2 is negligible. The StormWise input data and results for Alternatives 2a and 2b can be found in **Appendix F.1** and **F.2**, respectively.

Pump specifications and pricing were obtained from Global Pump in July 2024. The pricing assumes the pumps are trailer mounted and include sound attenuation enclosures (SoundGuard). The costs per pump should be considered preliminary, as certain optional costs were not included (e.g., fuel tanks extensions, hoses).

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Sources:
Aerials: 2018 Orange County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

LAKES GRACE & FOREST DESIGN ALTERNATIVE 2a & b 500-YEAR 24-HOUR INUNDATION MAP

FIGURE: 4.2

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\05_DraftReport\4.2_LakesGrace-Forest_Alt2a-b.mxd)
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4.4 Design Alternative 3

Alternative 3 addresses street and lot flooding around Lake Knowles, which was observed during Hurricane Ian.

To achieve this, an emergency gravity culvert outfall will be constructed to allow Lake Knowles to discharge into Lake Maitland during extreme storm events. This includes installing an overflow structure within Lake Knowles, and 1,718-feet of 42" RCP along Temple Dr, Via Salerno, Via Tuscany, and Alabama Dr. Eight (8) manholes are included along the culvert run, with a headwall at the outfall within Lake Maitland. The outfall structure is designed to function only during extreme storm events. The components of this design can be seen in **Figure 4.3**.

- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Knowles. Model results indicate maximum stages during the 500-year, 24-hour storm event are reduced by 18.0-inches within Lake Knowles. Impacts to the maximum stages within Lake Maitland are negligible.

  Maximum stages and flood depths for this alternative are presented in **Table 4.1** and **4.2**, respectively. An inundation comparison for this alternative is provided within **Figure 4.3**.

- Permitting Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system may pose water quality concerns. As such, installing a treatment system may be required.
- Construction Considerations: Construction of this alternative would be mostly contained within City right-of-way; however, a segment of the outfall culvert traverses privately-owned land. As such, a drainage easement will need to be acquired. If this alternative is chosen, utilities will be located as part of the construction level survey and impacts to existing utilities will be minimized in the final design.
- Cost: The total cost of construction for this alternative is estimated to be $2,250,243. A detailed construction cost estimate is provided in **Table 4.3**. Note, the costs of installing a treatment system and acquiring a drainage easement are not included.

The StormWise input data and results for this alternative can be found in **Appendix F.3**.

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Sources:
Aerials: 2018 Orange County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

LAKE KNOWLES DESIGN ALTERNATIVE 3 500-YEAR 24-HOUR INUNDATION MAP

FIGURE: 4.3

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Table 4.3 Engineer's Opinion of Probable Cost

Design Alternative 3 - Lake Knowles

ITEM NO.	FDOT NO.	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	CONTRACT PRICE
1	101-1	MOBILIZATION (10% OF ITEMS 2 THRU 16)	1	LS	$ 205,000.00	$ 205,000.00
2	102-1	MAINTENANCE OF TRAFFIC	1	LS	$ 120,000.00	$ 120,000.00
3	104	PREVENTION, CONTROL, AND ABATEMENT OF EROSION AND WATER POLLUTION	1	LS	$ 48,000.00	$ 48,000.00
4	110-1-1	CLEARING & GRUBBING	1.1	AC	$ 66,799.76	$ 73,853.92
5	160-4	TYPE B STABILIZATION	3,736	SY	$ 8.77	$ 32,768.29
6	285-709	OPTIONAL BASE, BASE GROUP 09	3,827	SY	$ 50.14	$ 191,853.76
7	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	1,000	SY	$ 19.77	$ 19,770.00
8	425-1-581	INLETS, DT BOT, TYPE H, <10'	2	EA	$ 14,898.60	$ 29,797.20
9	425-2-71	MANHOLES, J-7, <10'	6	EA	$ 18,215.33	$ 109,291.97
10	425-2-72	MANHOLES, J-7, >10'	2	EA	$ 26,823.00	$ 53,646.00
11	430-175-142	PIPE CULVERT, OPT MATERIAL, ROUND, 42"S/CD	1,720	LF	$ 470.28	$ 808,881.60
12	430-542-100	STRAIGHT CONCRETE ENDWALLS, 42", SINGLE, 0 DEGREES, ROUND	1	EA	$ 17,448.00	$ 17,448.00
13	520-1-10	CONCRETE CURB & GUTTER, TYPE F	1,640	LF	$ 55.78	$ 91,472.64
14	522-2	CONCRETE SIDEWALK AND DRIVEWAYS, 6" THICK	400	SY	$ 116.84	$ 46,737.60
15	526-1-101	PAVERS, ARCHITECTURAL, REMOVE EXISTING AND REINSTALL	2,644	SY	$ 130.44	$ 344,941.33
16	570-1-2	PERFORMANCE TURF (SOD, MATCH EXISTING)	5,221	SY	$ 10.88	$ 56,780.55
					Total Estimated Construction Cost =	**$ 2,250,243.00**

General Notes:

1. Costs do not include construction administration.
2. Unit costs are from Florida Department of Transportation - From 2023/02/01 to 2024/01/31 (Statewide)
3. Lump Sum costs are engineer's estimate.

4.5 Design Alternative 4

Alternative 4 addresses lot flooding around Lake Sylvan, which was observed during Hurricane Ian.

To achieve this, an emergency gravity culvert outfall would be constructed to allow Lake Sylvan to discharge into Lake Mizell during extreme storm events. This includes installing a control structure within Lake Sylvan, and 1,050-feet of 18" RCP along Overlook Rd, Grove Terrace, and Osceola Ave. Six (6) manholes are included along the culvert, with a headwall at the outfall within Lake Mizell. The control structure will include an orifice to allow Lake Sylvan to recover its available storage after a storm. The weir component of the structure is designed to function only during extreme storm events. The components of this design can be seen in **Figure 4.4**.

- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Sylvan, with the primary benefit of providing the lake with a bleed-down mechanism. Model results indicate maximum stages during the 500-year, 24-hour storm event are reduced by 1.2-inches within Lake Sylvan. Impacts to the maximum stages within Lake Mizell are negligible.

  Maximum stages and flood depths for this alternative are presented in **Table 4.1** and **4.2**, respectively. An inundation comparison for this alternative is provided within **Figure 4.4**.

- Permitting Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system may pose water quality concerns. As such, installing a treatment system may be required.

- Construction Considerations: Construction of this alternative is mostly contained within City right-of-way, though a segment of the outfall culvert traverses thru privately-owned land. If this alternative is chosen, utilities will be located as part of the construction level survey and impacts to existing utilities will be minimized in the final design.

- Cost: The total cost of construction for this alternative is estimated to be $1,117,971. A detailed construction cost estimate is provided in **Table 4.4**. Note, the costs of installing a treatment system and acquiring a drainage easement are not included.

The StormWise input data and results for this alternative can be found in **Appendix F.3**.

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Sources:
Aerials: 2018 Orange County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

LAKE SYLVAN
DESIGN ALTERNATIVE 4
500-YEAR 24-HOUR INUNDATION MAP

FIGURE: 4.4

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Table 4.4 Engineer's Opinion of Probable Cost

Design Alternative 4 - Lake Sylvan

ITEM NO.	FDOT NO.	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	CONTRACT PRICE
1	101-1	MOBILIZATION (10% OF ITEMS 2 THRU 16)	1	LS	$ 102,000.00	$ 102,000.00
2	102-1	MAINTENANCE OF TRAFFIC	1	LS	$ 120,000.00	$ 120,000.00
3	104	PREVENTION, CONTROL, AND ABATEMENT OF EROSION AND WATER POLLUTION	1	LS	$ 48,000.00	$ 48,000.00
4	110-1-1	CLEARING & GRUBBING	0.6	AC	$ 66,799.76	$ 41,466.15
5	160-4	TYPE B STABILIZATION	1,777	SY	$ 8.77	$ 15,584.92
6	285-709	OPTIONAL BASE, BASE GROUP 09	1,820	SY	$ 50.14	$ 91,247.52
7	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	133	SY	$ 19.77	$ 2,636.00
8	425-1-521	INLETS, DT BOT, TYPE C,<10'	1	EA	$ 8,142.29	$ 8,142.29
9	425-2-71	MANHOLES, J-7, <10'	4	EA	$ 18,215.33	$ 72,861.31
10	425-2-72	MANHOLES, J-7, >10'	4	EA	$ 26,823.00	$ 107,292.00
11	430-175-118	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 18"S/CD	1,040	LF	$ 171.40	$ 178,251.84
12	430-518-100	STRAIGHT CONCRETE ENDWALLS, 18", SINGLE, 0 DEGREES, ROUND	1	EA	$ 5,759.88	$ 5,759.88
13	520-1-10	CONCRETE CURB & GUTTER, TYPE F	780	LF	$ 55.78	$ 43,505.28
14	522-2	CONCRETE SIDEWALK AND DRIVEWAYS, 6" THICK	300	SY	$ 116.84	$ 35,053.20
15	526-1-101	PAVERS, ARCHITECTURAL, REMOVE EXISTING AND REINSTALL	1,600	SY	$ 130.44	$ 208,704.00
16	570-1-2	PERFORMANCE TURF (SOD, MATCH EXISTING)	3,445	SY	$ 10.88	$ 37,466.55
					Total Estimated Construction Cost =	**$ 1,117,971.00**

General Notes:

1. Costs do not include construction administration.
2. Unit costs are from Florida Department of Transportation - From 2023/02/01 to 2024/01/31 (Statewide)
3. Lump Sum costs are engineer's estimate.

4.6 Design Alternative 5

Alternative 5 addresses inundation that threatens well-established trees (Live oaks) around Lake Chelton, which was observed during Hurricane Ian.

To achieve this, a structural outfall would be constructed to allow Lake Chelton to discharge into Lake Sue during extreme storm events. This includes installing a control structure within Lake Chelton, and 550-feet of 18" RCP along Chelton Cir, Dana Way, and Fawsett Rd. Three (3) manholes are included along the culvert, with a headwall at the outfall within Lake Sue. The control structure will include an orifice to allow Lake Chelton to recover its available storage after a storm. The weir component of the structure is designed to function only during extreme storm events. The components of this design can be seen in **Figure 4.5**.

- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Chelton, with the primary benefit of providing the lake with a bleed-down mechanism. Model results indicate maximum stages during the 500-year, 24-hour storm event are reduced by 4.8-inches within Lake Chelton. Impacts to the maximum stages within Lake Sue are negligible.

  Maximum stages and flood depths for this alternative are presented in **Table 4.1** and **4.2**, respectively. An inundation comparison for this alternative is provided within **Figure 4.5**.

- Permitting Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system may pose water quality concerns. As such, installing a treatment system may be required.

- Construction Considerations: Construction of this alternative is contained within City right-of-way. If this alternative is chosen, utilities will be located as part of the construction level survey and impacts to existing utilities will be minimized in the final design.

- Cost: The total cost of construction for this alternative is estimated to be $597,359. A detailed construction cost estimate is provided in **Table 4.5**. Note, the cost of installing a treatment is not included.

The StormWise input data and results for this alternative can be found in **Appendix F.3**.

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Sources:
Aerials: 2018 Orange County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

LAKE CHELTON DESIGN ALTERNATIVE 5 500-YEAR 24-HOUR INUNDATION MAP

FIGURE: 4.5

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Table 4.5 Engineer's Opinion of Probable Cost

Design Alternative 5 - Lake Chelton

ITEM NO.	FDOT NO.	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	CONTRACT PRICE
1	101-1	MOBILIZATION (10% OF ITEMS 2 THRU 14)	1	LS	$ 55,000.00	$ 55,000.00
2	102-1	MAINTENANCE OF TRAFFIC	1	LS	$ 90,000.00	$ 90,000.00
3	104	PREVENTION, CONTROL, AND ABATEMENT OF EROSION AND WATER POLLUTION	1	LS	$ 36,000.00	$ 36,000.00
4	110-1-1	CLEARING & GRUBBING	0.3	AC	$ 66,799.76	$ 21,929.22
5	160-4	TYPE B STABILIZATION	854	SY	$ 8.77	$ 7,492.75
6	285-709	OPTIONAL BASE, BASE GROUP 09	875	SY	$ 50.14	$ 43,869.00
7	425-1-521	INLETS, DT BOT, TYPE C,<10'	1	EA	$ 8,142.29	$ 8,142.29
8	425-2-71	MANHOLES, J-7, <10'	4	EA	$ 18,215.33	$ 72,861.31
9	430-175-118	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 18"S/CD	550	LF	$ 171.40	$ 94,267.80
10	430-518-100	STRAIGHT CONCRETE ENDWALLS, 18", SINGLE, 0 DEGREES, ROUND	1	EA	$ 5,759.88	$ 5,759.88
11	520-1-10	CONCRETE CURB & GUTTER, TYPE F	375	LF	$ 55.78	$ 20,916.00
12	522-2	CONCRETE SIDEWALK AND DRIVEWAYS, 6" THICK	100	SY	$ 116.84	$ 11,684.40
13	526-1-101	PAVERS, ARCHITECTURAL, REMOVE EXISTING AND REINSTALL	833	SY	$ 130.44	$ 108,700.00
14	570-1-2	PERFORMANCE TURF (SOD, MATCH EXISTING)	1,907	SY	$ 10.88	$ 20,736.45
					Total Estimated Construction Cost =	**$ 597,359.00**

General Notes:

1. Costs do not include construction administration.
2. Unit costs are from Florida Department of Transportation - From 2023/02/01 to 2024/01/31 (Statewide)
3. Lump Sum costs are engineer's estimate.

4.7 Design Alternative 6

Alternative 6 addresses lot flooding and potential structure flooding around Lake Grace, and lot flooding around Lake Forest, which was observed during Hurricane Ian.

To achieve this, an emergency gravity culvert outfall would be constructed to allow Lake Forest to discharge into Lake Grace, and for Lake Grace to discharge into Lake Sue during extreme storm events. Listed in a general upstream to downstream direction, the specific components of the improvements include:

1. Installing a control structure within Lake Forest. The weir component of the structure is designed to function only during events greater than or equivalent to the 500-year 24-hour storm.
2. Installing 300-feet of 36” RCP from Lake Forest to Lake Grace. One (1) manhole is included along this segment.
3. Installing a control structure within Lake Grace. The control structure will include an orifice to allow Lake Grace to recover its available storage after a storm. The weir component of the structure is designed to function only during events greater than or equivalent to the 500-year 24-hour storm.
4. Installing 1,075-feet of 36” RCP from the lake to an existing storm sewer system at the intersection of Fawsett Rd and Randall Rd. This segment traverses Phillips Park Ct, Winter Park Rd, and Fawsett Rd. Five (5) manholes are included along this segment.
5. Installing 820-feet of 36” RCP to upsize the pipe from the intersection of Fawsett Rd and Randall Rd to the outfall in Lake Sue. This segment traverses Fawsett Rd and the intersection with Forrest Rd. Seven (7) manholes and one (1) curb inlet are included along this segment.

The components of this design can be seen in **Figure 4.6**.

- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Grace, and achieves the benefit of providing the lake with a bleed-down mechanism. Model results indicate maximum stages during the 500-year, 24-hour storm event are reduced by 4.8-inches within Lake Grace. Impacts to maximum stages within Lake Forest are negligible; the outfall into Lake Grace only provides a benefit if the drainwell within Lake Forest fails. Impacts to the maximum stages within Lake Sue are negligible.

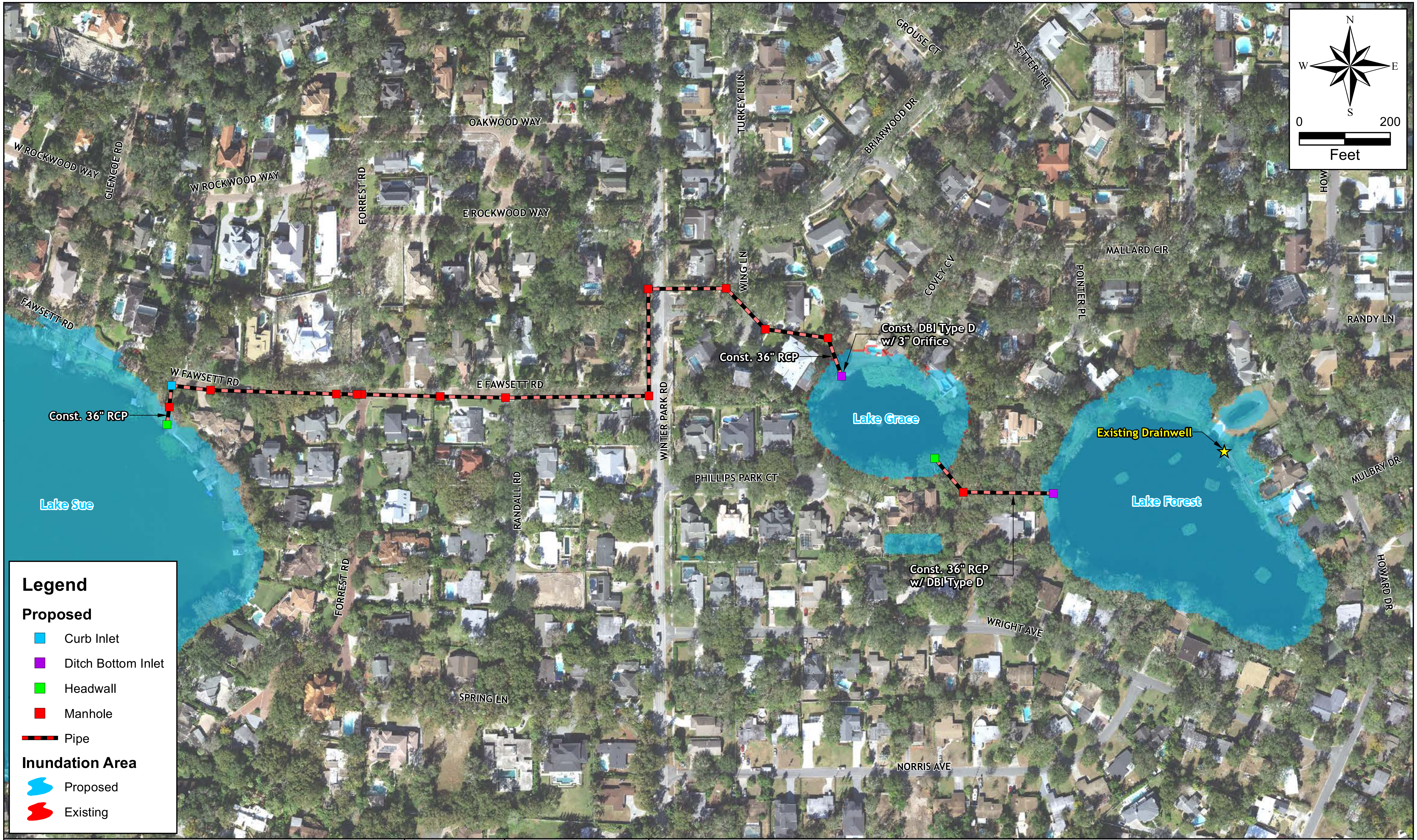
  Maximum stages and flood depths for this alternative are presented in **Table 4.1** and **4.2**, respectively. An inundation comparison for this alternative is provided within **Figure 4.6**.

- Permitting Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system may pose water quality concerns. As such, installing a treatment system may be required.

- Construction Considerations: Construction of this alternative is mostly contained within City right-of-way; however, portions of the proposed outfalls traverse privately-owned land. As such, a drainage easement will need to be acquired. If this alternative is chosen, utilities will be located as part of the construction level survey and impacts to existing utilities will be minimized in the final design.

- Cost: The total cost of construction for this alternative is estimated to be $2,394,517. A detailed construction cost estimate is provided in **Table 4.6**. Note, the costs of installing a treatment system and acquiring a drainage easement are not included.

The StormWise input data and results for this alternative can be found in **Appendix F.3**.



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Sources:
Aerials: 2018 Orange County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

LAKES GRACE & FOREST DESIGN ALTERNATIVE 6 500-YEAR 24-HOUR INUNDATION MAP

FIGURE: 4.6

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\05_DraftReport\4.6_LakesGrace-Forest_Alt6.mxd)
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Table 4.6 Engineer's Opinion of Probable Cost

Design Alternative 6 - Lakes Grace & Forest

ITEM NO.	FDOT NO.	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	CONTRACT PRICE
1	101-1	MOBILIZATION (10% OF ITEMS 2 THRU 17)	1	LS	$ 218,000.00	$ 218,000.00
2	102-1	MAINTENANCE OF TRAFFIC	1	LS	$ 135,000.00	$ 135,000.00
3	104	PREVENTION, CONTROL, AND ABATEMENT OF EROSION AND WATER POLLUTION	1	LS	$ 54,000.00	$ 54,000.00
4	110-1-1	CLEARING & GRUBBING	1.2	AC	$ 66,799.76	$ 78,462.12
5	160-4	TYPE B STABILIZATION	3,594	SY	$ 8.77	$ 31,529.49
6	285-709	OPTIONAL BASE, BASE GROUP 09	3,682	SY	$ 50.14	$ 184,600.75
7	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	1,178	SY	$ 19.77	$ 23,284.67
8	425-1-421	INLETS, CURB, TYPE J-2, <10'	1	EA	$ 17,532.04	$ 17,532.04
9	425-1-543	INLETS, DITCH BOTTOM, TYPE D, J BOT, <10'	2	EA	$ 17,863.63	$ 35,727.26
10	425-2-71	MANHOLES, J-7, <10'	8	EA	$ 18,215.33	$ 145,722.62
11	425-2-72	MANHOLES, J-7, >10'	6	EA	$ 26,823.00	$ 160,938.00
12	430-175-136	PIPE CULVERT, OPT MATERIAL, ROUND, 36"S/CD	2,195	LF	$ 359.72	$ 789,594.18
13	430-536-100	STRAIGHT CONCRETE ENDWALLS, 36", SINGLE, 0 DEGREES, ROUND	2	EA	$ 13,046.18	$ 26,092.37
14	520-1-10	CONCRETE CURB & GUTTER, TYPE F	1,578	LF	$ 55.78	$ 88,014.53
15	522-2	CONCRETE SIDEWALK AND DRIVEWAYS, 6" THICK	367	SY	$ 116.84	$ 42,842.80
16	526-1-101	PAVERS, ARCHITECTURAL, REMOVE EXISTING AND REINSTALL	2,333	SY	$ 130.44	$ 304,360.00
17	570-1-2	PERFORMANCE TURF (SOD, MATCH EXISTING)	5,408	SY	$ 10.88	$ 58,816.35
					Total Estimated Construction Cost =	**$ 2,394,517.00**

General Notes:

1. Costs do not include construction administration.
2. Unit costs are from Florida Department of Transportation - From 2023/02/01 to 2024/01/31 (Statewide)
3. Lump Sum costs are engineer's estimate.

4.8 Design Alternative 7

Alternative 7 addresses lot flooding and potential structure flooding around Lake Grace, which was observed during Hurricane Ian.

To achieve this, an emergency gravity culvert outfall would be constructed to allow Lake Grace to discharge into Lake Sue during extreme storm events. Listed in a general upstream to downstream direction, the specific components of the improvements include:

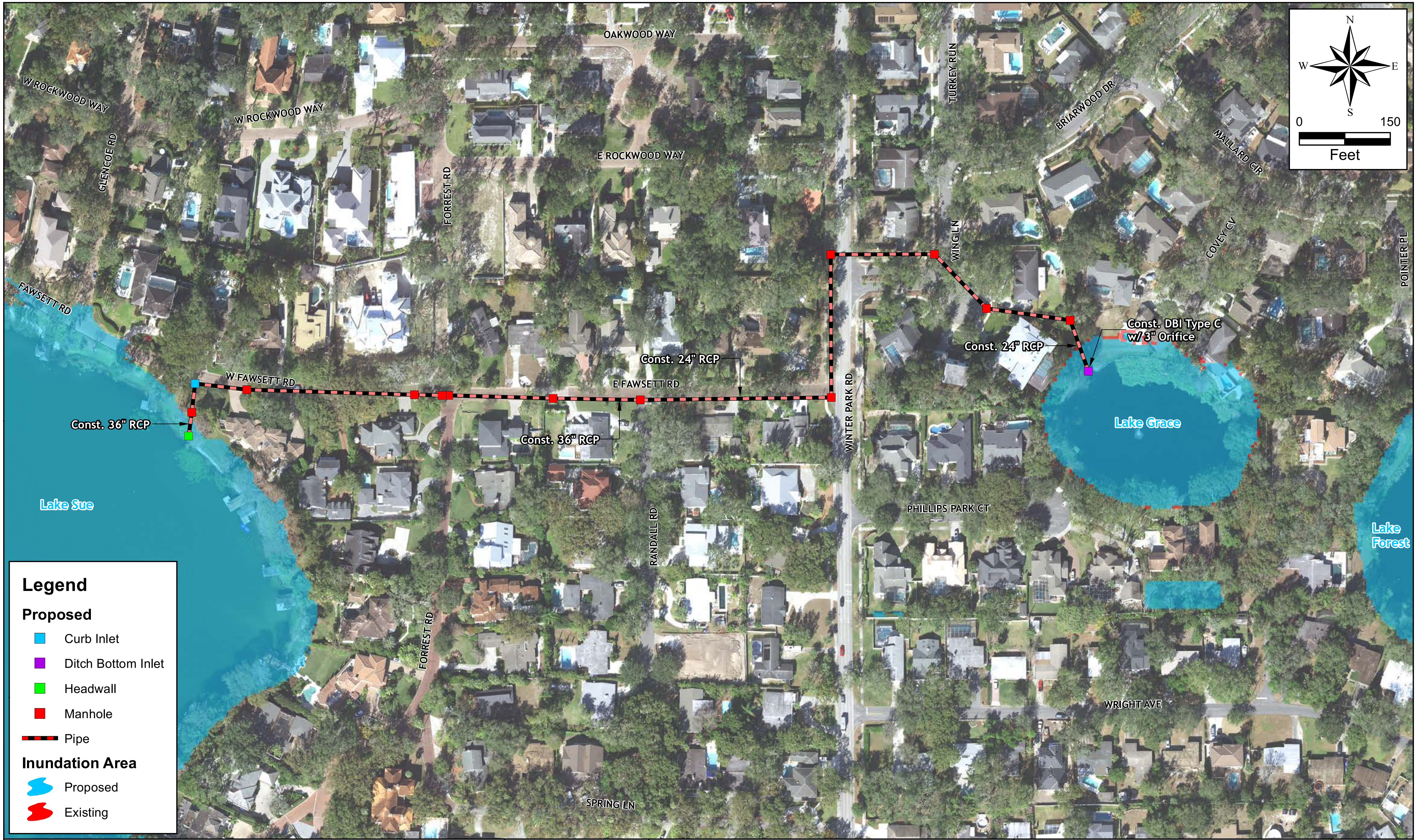
1. Installing a control structure within Lake Grace. The control structure will include an orifice to allow Lake Grace to recover its available storage after a storm. The weir component of the structure is designed to function only during storm events greater than or equivalent to the 500-year 24-hour.
2. Installing 1,075-feet of 18” RCP from the lake to an existing storm sewer system at the intersection of Fawsett Rd and Randall Rd. This segment traverses Phillips Park Ct, Winter Park Rd, and Fawsett Rd. Five (5) manholes are included along this segment.
3. Installing 820-feet of 36” RCP to upsize the pipe from the intersection of Fawsett Rd and Randall Rd to the outfall in Lake Sue. This segment traverses Fawsett Rd and the intersection with Forrest Rd. Seven (7) manholes and one (1) curb inlet are included along this segment.

The components of this design can be seen in **Figure 4.7**.

- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Grace. Model results indicate maximum stages during the 500-year, 24-hour storm event are reduced by 6.0-inches within Lake Grace. Impacts to the maximum stages within Lake Sue are negligible.

  Maximum stages and flood depths for this alternative are presented in **Table 4.1** and **4.2**, respectively. An inundation comparison for this alternative is provided within **Figure 4.7**.
- Permitting Considerations: Permitting challenges are anticipated for this alternative, as providing an outfall to a previously closed-basin system may pose water quality concerns. As such, installing a treatment system may be required.
- Construction Considerations: Construction of this alternative is mostly contained within City right-of-way. However, a portion of the proposed outfall passes through privately-owned land. As such, a drainage easement will need to be acquired. If this alternative is chosen, utilities will be located as part of the construction level survey and impacts to existing utilities will be minimized in the final design.
- Cost: The total cost of construction for this alternative is estimated to be $1,986,312. A detailed construction cost estimate is provided in **Table 4.7**. Note, the costs of installing a treatment system and acquiring a drainage easement are not included.

The StormWise input data and results for this alternative can be found in **Appendix F.4**.



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Sources:
Aerials: 2018 Orange County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

LAKE GRACE
DESIGN ALTERNATIVE 7
500-YEAR 24-HOUR INUNDATION MAP

FIGURE: 4.7

Map Document: (K:\CITY\WinterPark\CtrlBasinWMP\GIS\Figures\05_DraftReport\4.7_LakeGrace_Alt7.mxd)
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Table 4.7 Engineer's Opinion of Probable Cost

Design Alternative 7 - Lake Grace

ITEM NO.	FDOT NO.	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	CONTRACT PRICE
1	101-1	MOBILIZATION (10% OF ITEMS 2 THRU 18)	1	LS	$ 181,000.00	$ 181,000.00
2	102-1	MAINTENANCE OF TRAFFIC	1	LS	$ 120,000.00	$ 120,000.00
3	104	PREVENTION, CONTROL, AND ABATEMENT OF EROSION AND WATER POLLUTION	1	LS	$ 48,000.00	$ 48,000.00
4	110-1-1	CLEARING & GRUBBING	1.2	AC	$ 66,799.76	$ 78,462.12
5	160-4	TYPE B STABILIZATION	3,594	SY	$ 8.77	$ 31,529.49
6	285-709	OPTIONAL BASE, BASE GROUP 09	3,682	SY	$ 50.14	$ 184,600.75
7	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	1,178	SY	$ 19.77	$ 23,284.67
8	425-1-421	INLETS, CURB, TYPE J-2, <10'	1	EA	$ 17,532.04	$ 17,532.04
9	425-1-521	INLETS, DT BOT, TYPE C,<10'	1	EA	$ 8,142.29	$ 8,142.29
10	425-2-71	MANHOLES, J-7, <10'	8	EA	$ 18,215.33	$ 145,722.62
11	425-2-72	MANHOLES, J-7, >10'	5	EA	$ 26,823.00	$ 134,115.00
12	430-175-124	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 24"S/CD	1,075	LF	$ 197.09	$ 211,869.60
13	430-175-136	PIPE CULVERT, OPT MATERIAL, ROUND, 36"S/CD	820	LF	$ 359.72	$ 294,973.68
14	430-536-100	STRAIGHT CONCRETE ENDWALLS, 36", SINGLE, 0 DEGREES, ROUND	1	EA	$ 13,046.18	$ 13,046.18
15	520-1-10	CONCRETE CURB & GUTTER, TYPE F	1,578	LF	$ 55.78	$ 88,014.53
16	522-2	CONCRETE SIDEWALK AND DRIVEWAYS, 6" THICK	367	SY	$ 116.84	$ 42,842.80
17	526-1-101	PAVERS, ARCHITECTURAL, REMOVE EXISTING AND REINSTALL	2,333	SY	$ 130.44	$ 304,360.00
18	570-1-2	PERFORMANCE TURF (SOD, MATCH EXISTING)	5,408	SY	$ 10.88	$ 58,816.35
					Total Estimated Construction Cost =	**$ 1,986,312.00**

General Notes:

1. Costs do not include construction administration.
2. Unit costs are from Florida Department of Transportation - From 2023/02/01 to 2024/01/31 (Statewide)
3. Lump Sum costs are engineer's estimate.

4.9 Design Alternative 8

Alternative 8 addresses lot flooding and potential structure flooding around Lake Grace, which was observed during Hurricane Ian.

To achieve this, the Phillips Place retention pond outfall will be moved from Lake Grace to Lake Forest. This includes installing a control structure within the retention pond, and 295-feet of 18” RCP to Lake Forest, crossing West End Dr. Two (2) manholes are included along the culvert, with a headwall at the outfall within Lake Forest. The new control structure will include a weir to maintain the same control elevation as the existing outfall.

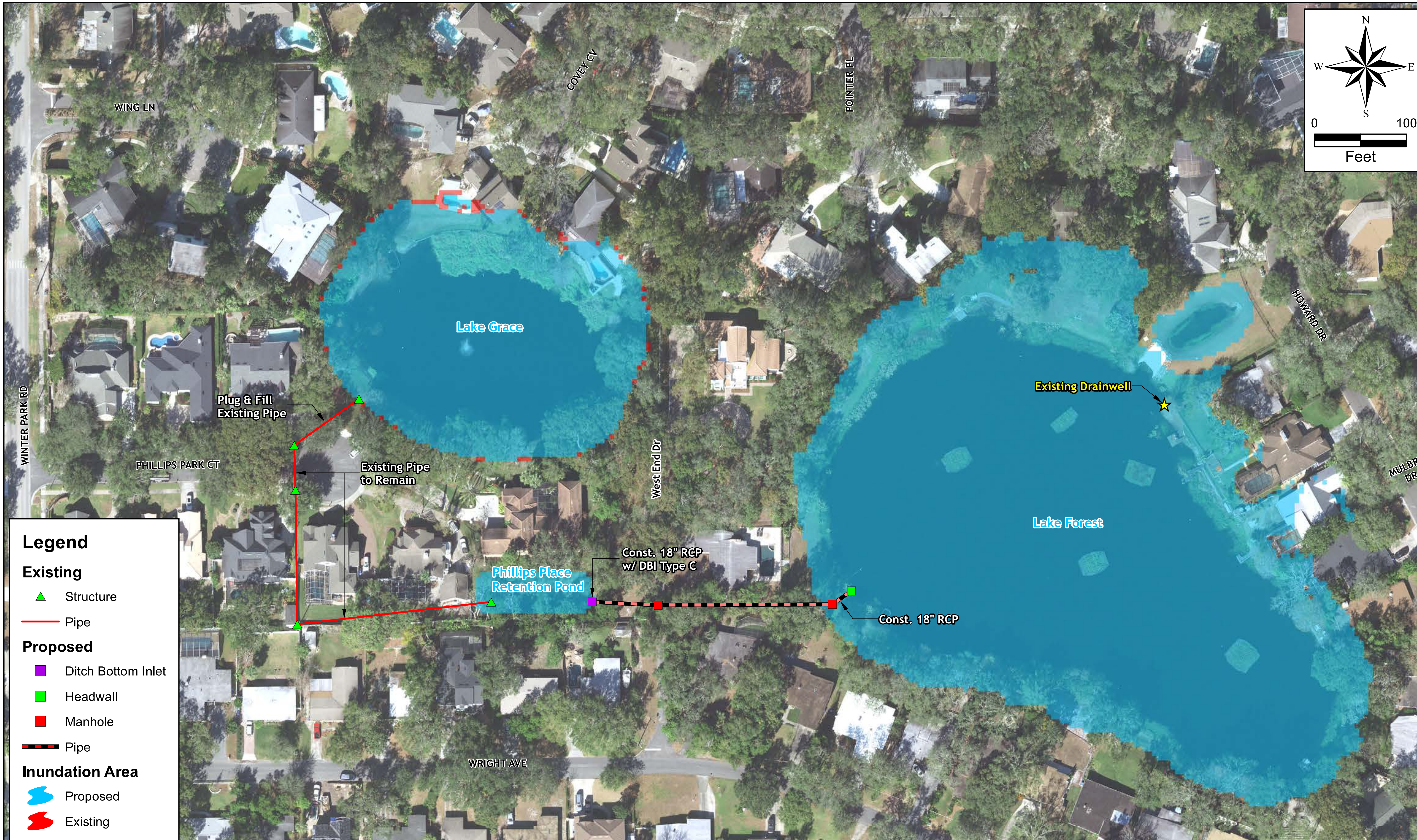
The components of this design can be seen in **Figure 4.8**.

- Results: This alternative meets the desired LOS (500-year, 24-hour) at Lake Grace. Model results indicate maximum stages during the 500-year, 24-hour storm event are reduced by 3.6-inches within Lake Grace. Maximum stages within Lake Forest are increased by 1.2-inches.

  Maximum stages and flood depths for this alternative are presented in **Table 4.1** and **4.2**, respectively. An inundation comparison for this alternative is provided within **Figure 4.8**.

- Permitting Considerations: Permitting challenges are anticipated for this alternative, as impervious area is being added to the Lake Forest basin, which may pose water quality concerns.
- Construction Considerations: Construction of this alternative is mostly on privately-owned land. As such, a drainage easement will need to be acquired. If this alternative is chosen, utilities will be located as part of the construction level survey and impacts to existing utilities will be minimized in the final design.
- Cost: The total cost of construction for this alternative is estimated to be $237,989. A detailed construction cost estimate is provided in **Table 4.8**. Note, the cost of acquiring a drainage easement is not included.

The StormWise input data and results for this alternative can be found in **Appendix F.5**.



Sources:
Aerials: 2018 Orange County

WINTER PARK CENTRAL BASIN STORMWATER MASTER PLAN

LAKE GRACE
DESIGN ALTERNATIVE 8
500-YEAR 24-HOUR INUNDATION MAP

FIGURE: 4.8

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Table 4.8 Engineer's Opinion of Probable Cost

Design Alternative 8 - Lake Grace

ITEM NO.	FDOT NO.	DESCRIPTION	EST. QTY.	UNIT	UNIT PRICE	CONTRACT PRICE
1	101-1	MOBILIZATION (10% OF ITEMS 2 THRU 13)	1	LS	$ 22,000.00	$ 22,000.00
2	102-1	MAINTENANCE OF TRAFFIC	1	LS	$ 75,000.00	$ 75,000.00
3	104	PREVENTION, CONTROL, AND ABATEMENT OF EROSION AND WATER POLLUTION	1	LS	$ 30,000.00	$ 30,000.00
4	110-1-1	CLEARING & GRUBBING	0.2	AC	$ 66,799.76	$ 10,121.18
5	160-4	TYPE B STABILIZATION	34	SY	$ 8.77	$ 299.71
6	285-709	OPTIONAL BASE, BASE GROUP 09	35	SY	$ 50.14	$ 1,754.76
7	334-1-13	SUPERPAVE ASPHALTIC CONC, TRAFFIC C	33	SY	$ 19.77	$ 659.00
8	425-1-521	INLETS, DT BOT, TYPE C,<10'	1	EA	$ 8,142.29	$ 8,142.29
9	425-2-61	MANHOLES, P-8, <10'	2	EA	$ 10,171.58	$ 20,343.17
10	430-175-118	PIPE CULVERT,OPTIONAL MATERIAL,ROUND, 18"S/CD	300	LF	$ 171.40	$ 51,418.80
11	430-518-100	STRAIGHT CONCRETE ENDWALLS, 18", SINGLE, 0 DEGREES, ROUND	1	EA	$ 5,759.88	$ 5,759.88
12	430-830	PIPE FILLING AND PLUGGING- PLACE OUT OF SERVICE	7	CY	$ 479.38	$ 3,355.63
13	570-1-2	PERFORMANCE TURF (SOD, MATCH EXISTING)	840	SY	$ 10.88	$ 9,135.00
					Total Estimated Construction Cost =	**$ 237,989.00**

General Notes:

1. Costs do not include construction administration.
2. Unit costs are from Florida Department of Transportation - From 2023/02/01 to 2024/01/31 (Statewide)
3. Lump Sum costs are engineer's estimate.

4.10 Additional Design Alternatives

Additional alternatives were reviewed but were not fully developed due to feasibility concerns. Alternatives which modified the Lake Maitland control structure at Howell Branch Rd were reviewed. This included improving the conveyance of the control structure, as well as the use of an operable gate to lower the water levels in the Chain of Lakes prior to a storm.

Improvements made to the outfall conveyance (e.g., wider overflow) would reduce stages throughout the Chain of Lakes upstream of the control structure. However, these improvements did not eliminate flooding, and caused adverse impacts in the regulatory floodway downstream of the structure.

Installing an operable gate has the potential to reduce peak stages and flows during extreme storm events, both upstream and downstream of the structure. However, lowering the lake levels in advance of a storm would require a detailed study of a variety of factors to determine potential impacts, including hydroperiod impacts, water quality considerations, recreational impacts, and lead and recovery times required for an approaching storm. Furthermore, with the control structure located at the downstream end of the Chain of Lakes system, and upstream of Howell Creek, numerous communities throughout the region could be potentially impacted by a design which modifies the control structure. Per the SJRWMD's feedback during a meeting between SAI-Halff, CWP, and SJRWMD staff (July 18, 2024), an operable structure could create a perception of adverse impacts downstream, even if modeling indicates no adverse impacts would be expected. Furthermore, release of freshwater to, what would ultimately be the Atlantic Ocean, are not generally favored by state regulatory agencies due to the wasting fresh water that could potentially be used to offset or supplement potable water uses. The CWP is taking steps to evaluate potential regional partnership projects and opportunities to use lake water more sustainably in cases like these.

No model or cost estimates were developed for these alternatives.

4.11 Design Recommendation

The design alternatives were compared to each other on a lake-by-lake basis, based on construction costs and considerations, maintenance considerations, longevity, permitting feasibility, and effectiveness of design, as described below. The design alternatives at Lakes Chelton and Sylvan were not included in the ranking as only one (1) alternative was developed for each lake.

Table 4.9 presents the scoring and ranking of each design alternative as well as a description of the evaluation criteria and scoring method.

- **Construction Costs**

  The design alternatives were evaluated and ranked based on total estimated construction costs, excluding land acquisition, design engineering, and permitting.

- **Construction Considerations**

  The design alternatives were evaluated and ranked based on any potential difficulties in constructing the project.

- **Maintenance Considerations**

  Maintenance criteria for the design alternatives were evaluated according to their need for continuing maintenance of the proposed system.

- **Longevity**

  Expected project useful life for each of the design alternatives evaluated.

- **Permitting**

  The design alternatives were evaluated and compared to each other in terms of anticipated ease of permitting the project through SJRWMD.

- **Effectiveness of Design**
  The design alternatives were evaluated and ranked based on the effectiveness of the design in reducing flooding.

SAI-Halff recommends Design Alternatives 1b & 2b (Pump Option 2): temporary pumping prior to a storm at Lake Knowles, Lake Grace, and Lake Forest. Pump Option 2 meets the desired LOS at all three lakes, has the lowest cost, and requires no construction.

While Pump Option 1 meets the desired LOS, it has a higher cost and requires the pumps to operate during a storm, which may pose safety concerns. The gravity outfall alternatives also meet the desired LOS, but cost significantly more than Pump Option 2, and construction of the outfalls will cause significant interruption to the neighborhood.

Table 4.9: Design Alternative Evaluation Matrix

	Design Alternative							
	Lake Knowles			Lakes Grace & Forest				
	1a	1b	3	2a	2b	6	7	8
Description	**Pump Option 1: pump during storm**	**Pump Option 2: pump prior to storm**	**Construct emergency outfall to Lake Maitland**	**Pump Option 1: pump during storm**	**Pump Option 2: pump prior to storm**	**Construct emergency outfall from Lake Forest to Lake Grace, and from Lake Grace to Lake Sue**	**Construct emergency outfall from Lake Grace into Lake Sue**	**Plug existing Phillips Place Retention Pond outfall into Lake Grace; Construct new outfall from retention pond into Lake Forest**
Estimated Cost	$182,000	$0 - $90,000	$2,250,243	$90,000 - $180,000	$0 - $90,000	$2,394,517	$1,986,312	$237,989
Cost	4	5	1	4	5	1	2	3
Construction Considerations	5	5	1	5	5	1	2	3
Maintenance Consideration	4	5	3	4	5	3	3	2
Longevity	4	4	5	4	4	5	5	2
Permitting Feasibility	5	4	4	5	4	3	3	3
Effectiveness of Design	5	5	5	5	5	4	4	3
Total Score	27	28	19	27	28	17	19	16
Rank	**2**	**1**	**3**	**2**	**1**	**4**	**3**	**5**

Evaluation Criteria:

Criteria	Description	Score = 1	Score = 5
Construction Cost	Comparison of total estimated construction costs excluding land acquisition, design engineering, and permitting	Highest Cost	Lowest Cost
Construction Considerations	Difficulty in constructing the project	Most Difficult	Least Difficult
Maintenance Considerations	Difficulty in maintaining the constructed project	Most Difficult	Least Difficult
Longevity	Expected lifetime of the constructed project	Shortest Lifespan	Longest Lifespan
Permitting Feasibility	Ease of permitting the project for construction	Most Difficult	Least Difficult
Effectiveness of Design	Effectiveness in addressing flooding issues	Least Effective	Most Effective