CITY OF OCALA

HERITAGE HILLS
HYDROLOGIC AND HYDRAULIC STUDY

Prepared for:

City of Ocala
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Ocala, Florida 34470

Prepared by:

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July 2012

Tt#200-08508-12001

CERTIFICATION BY A REGISTERED PROFESSIONAL ENGINEER

PROJECT NAME: City of Ocala Heritage Hills Hydrologic and Hydraulic Study

✓ I hereby certify that the material and data contained in this document was prepared under the supervision and direction of the undersigned, whose seal as a registered professional engineer in the State of Florida is affixed below.

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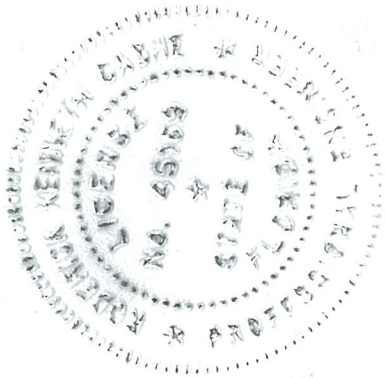

Date: 7 / 13 / 2012

Signature of Professional:

Florida Registration No.: 45,169

CITY OF OCALA, FLORIDA
HERITAGE HILLS
HYDROLOGIC AND HYDRAULIC STUDY

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HERITAGE HILLS
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EXECUTIVE SUMMARY

The Heritage Hills Subdivision is located in northeast Ocala as shown in Figure 1-1. The subdivision experienced major flooding on October 10, 2011. A major storm released 8.2 inches of rainfall within six (6) hours to eight (8) hours. This storm intensity is on the scale of a 100-year event when considering the short duration in which the rain fell. The drainage retention area that receives flow from this subdivision flooded above it's top of bank around 4:30 A.M. As many as 14 homes were overcome with flood water, six (6) of which had water rise above their finish floor elevations (FFEs). Through this report, the City of Ocala desires to develop a plan that will review the existing stormwater management facilities within the watershed and propose cost effective improvements that will address current drainage issues.

Tetra Tech has developed alternative solutions to alleviate future flooding in the Heritage Hill Subdivision in conjunction with a level of service (LOS) analysis. Tetra Tech visited the site to observe the impact of the flooding and had meetings with City staff to obtain documentation and understand how the stormwater management system in this area functions. The existing drainage system consists of a combination of retention ponds, a pumping station, a karst pond feature, a drainage well, and corresponding interconnected infrastructure.

To complete this study the following tasks were performed:

A. A geotechnical study to determine permeability rates for the various soil strata and estimates of normal water levels for the various retention areas.

B. An inspection of the existing wells in the Yum Yum retention pond and the FDOT Pond #9 retention area to assess their condition and anticipated serviceability.

C. Computer simulations analyzing the effects of various remedial alternatives including, but not limited to, constructing additional retention ponds, moving drainage wells, and redirecting the infrastructure between the ponds.

D. A cost-benefit analysis of the alternatives relating the increased LOS to cost and potential return frequency of the next event.

E. A preliminary design report to summarize the information and provide recommendations for the City.

Heritage Hills Pond Sub-Basin

School Sub-Basin

Nature Conservancy Pond Sub-Basin

Perry Swim School Sub-Basin

Heritage Hills Pond Sub-Basin

Yum Yum Pond Sub-Basin

North

South

FDOT Basin

City of Ocala

Area of Map Detail

Marion County

Source: City of Ocala 2009 Aerials

N

0 1,000 Feet

LEGEND

Heritage Hills Drainage Basin

FDOT Pond #9 Basin

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

AERIAL LOCATION MAP

TETRA TECH

FIGURE 1-1

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Several proposed improvements were analyzed as alternatives to potentially alleviate the flooding. The storms analyzed for this study include the October 2011 storm, mean annual, 10 year, 100 year, and the FEMA 100 year – 24 hours. In addition, the 25 year – 96 hour storm was modeled. The various alternatives predict a reduction in the number of FFEs that would flood for each of the storm events. However, due to the fact the residences are located within land-locked basins and the stormwater infrastructure, roads, and private residences were not constructed under today's standards, considerable capital costs will be necessary to raise the level of service (LOS) high enough to accommodate a FEMA 100-year storm without having flood levels rise above any FFEs.

The alternatives analyzed in this section include:

- Home purchasing program,
- Expanding the pond on the Nature Conservancy site,
- Rearranging the connectivity of the primary stormsewer line along NW 3rd Avenue,
- Lowering the top of the well casing in the Yum Yum pond,
- Restoring and lowering the existing FDOT shallow wells,
- Constructing a retention pond in the FDOT basin south of S.R. 40, and
- Constructing drainage wells in the Heritage Hills retention pond to replace the three (3) shallow wells in the FDOT Pond #9

A summary of the alternatives presented is provided below in Table 1. As shown, the alternatives 1 and 2 demonstrate significant positive improvements with a reasonable benefit to cost relationship. The Alternative 3 also demonstrates positive flood stage reductions; however, it is not as cost effective when considering the overall benefit. Another alternative that may be considered by the City in the future is the purchase of homes with the lowest FFEs. The purchase of the lowest two (2) to three (3) homes could significantly increase the level of service provided by the retention ponds and stormsewer systems in the study area. Funding to purchase homes may be available through FEMA if they qualify with their repetitive loss program.

Table 1

Summary of Alternatives

Alternative #	Description	Reduction in Number of Residences No Longer Predicted to Flood Heritage Hills Drainage Basin		Estimated Probable Cost
		October 2011 Storm	FEMA 100 Year 24 Hour	
Alternative 1	Home Purchasing Plan	30*	30	$3,100,000
Alternative 2	Expanded Nature Conservancy Pond	4	7	$760,000
Alternative 3	Route Flow from 3rd Ave into Yum Yum Pond	5	7	$600,000
Alternative 4	Lowering Yum Yum Well	0	0	$80,000
Alternative 5	Restore and Lower Existing FDOT Wells (3 wells)	1	1	$365,000
Alternative 6	Construct DRA South of S.R. 40	1	3	$260,000
Alternative 7	Relocate Drainage Wells into Heritage Hills Pond	5	10	$2.15 million

*Only six (6) homes flooded above their FFEs, however, 30 homes would be purchased as part of this alternative.

The costs for Alternatives 3 and 7 above should also include the cost for Alternative 2 since it is the most critical element required to obtain the maximum benefit to alleviate flooding in the study area.

The alternatives recommended for construction are Alternatives 2 and 3, which includes expanding the Nature Conservancy pond and improvements to the stormsewer system along NE 3rd Avenue. These improvements would significantly reduce the number of homes with FFEs below the flood elevation of the major storm in October of 2011 and the FEMA 100

year – 24 hour storm. FEMA FMGP cost-share funding would be available to assist the City with the capital to implement these improvements.

The home purchasing plan presents a viable alternative to greatly enhance the LOS in the Heritage Hills and Nature Conservancy basins. Although the results of the analysis indicate 30 homes with FFEs below the FEMA 100-year floodplain, this number could be substantially reduced if the retention ponds in the Heritage Hills and Nature Conservancy basins would be expanded into the areas in which homes are ultimately purchased. Determining the number of homes to purchase would be an iterative process to minimize the number targeted for purchase.

It is also recommended that measures are taken to improve conditions within the FDOT basin. Alternative 6, which involves construction of a pond south of S.R. 40, provides moderate improvements in the Heritage Hills and Nature Conservancy basins. Unlike Alternative 5, it also provides enough attenuation south of S.R. 40 to keep Pond #9 from flowing over its banks in the large storms. The City and FDOT would work out the details of covering the cost this expenditure.

To maximize the hydraulic connection between the three ponds (Heritage Hills, Yum Yum, and Nature Conservancy), a more detailed hydraulic analysis will be required prior to final design. This analysis would review the condition of each of the existing culverts for their condition compared to their life cycle; a comparison of their current capacity to the required capacity; the culvert sizing and connection, including smart boxes and variable weirs. This would allow the stormwater to most efficiently transfer between the ponds and maximize the use of all available storage and minimize the number of homes that could be inundated with flood water.

Lastly, measures should be taken to require the Fort King Middle School to attenuate the flow from its six acre drainage basin to predevelopment conditions. The flow from this area is a direct discharge into the Heritage Hills basin and has a significant impact on flood levels in this basin. The modeling results indicate that the impact of runoff from school basin causes as much as a 0.3 feet rise in the FEMA 100 year flood elevation within the Heritage Hills basin.

SECTION 1
INTRODUCTION

The Heritage Hills Subdivision is located in northeast Ocala, refer to Figure 1-1. It experienced major flooding on October 10, 2011. A major storm released 8.2 inches of rainfall within six (6) hours to eight (8) hours. This storm intensity is on the scale of a 100-year event when considering the short duration in which the rain fell. The drainage retention area that receives flow from this subdivision flooded above it's top of bank around 4:30 A.M. Six (6) homes were overcome with flood water several of which had water rise above their finish floor elevations (FFEs). Through this report, the City of Ocala desires to develop a plan that will review the existing stormwater management facilities within the watershed and propose cost effective improvements that will alleviate future flooding in this area.

Tetra Tech was hired by the City to conduct a hydrologic and hydraulic (H&H) analysis of the Heritage Hills stormwater system, including all areas contributing flow to develop solutions that would help alleviate flooding. Tetra Tech visited the site to observe the impact of the flooding and had a meeting with City staff to obtain documentation to help understand how the stormwater management system in this area functions. The existing drainage system contributing flow into the Heritage Hills subdivision retention system consists of retention ponds, a pumping station, drainage wells, and corresponding interconnected storm pipes and inlet structures.

Tetra Tech has developed alternative solutions to alleviate future flooding in the Heritage Hill Subdivision based on the alternatives in the consulting agreement with the City.

In order to accomplish this analysis the following tasks were performed:

A. A geotechnical study to determine permeability rates for the various soil strata and estimates of normal water levels for the various retention areas.

B. A study of the existing wells in the Heritage Hills Subdivision drainage basin to assess their condition and anticipated serviceability.

C. Computer simulations analyzing the effects of various remedial alternatives including but not limited to constructing additional retention ponds, moving drainage wells, and redirecting the infrastructure between the ponds.

D. A Cost-benefit analysis of the alternatives relating the increased LOS to cost and potential return frequency of the next event.

E. A Preliminary Design Report to summarize the information and provide recommendations for the City.

In this report, a discussion of the hydrology of the study area describing the topology, soils, land uses, flood plain and other aspects; the hydraulic analysis explaining how Tetra Tech calibrated the model and how the various alternatives were analyzed.

Heritage Hills Pond Sub-Basin

School Sub-Basin

Nature Conservancy Pond Sub-Basin

Perry Swim School Sub-Basin

Heritage Hills Pond Sub-Basin

Yum Yum Pond Sub-Basin

North

South

FDOT Basin

City of Ocala

Area of Map Detail

Marion County

Source: City of Ocala 2009 Aerials

N

0 1,000 Feet

LEGEND

Heritage Hills Drainage Basin

FDOT Pond #9 Basin

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

AERIAL LOCATION MAP

TETRA TECH

FIGURE 1-1

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SECTION 2
STUDY AREA DESCRIPTION AND HYDROLOGY

2.1 GENERAL

The study area includes the Heritage Hills drainage basin including all of the drainage retention areas that are interconnected through stormwater infrastructure. The terrain is comprised of typical Florida karst depressions that are landlocked with some of the depressions containing retention areas such as the Heritage Hills retention pond.

Topography for the overall Heritage Hills drainage basin was obtained from the City in the form of two (2) – foot contours. The soils in this area tend to have a sandy upper layer underlain by clayey sands and limestone formations. The Heritage Hills drainage basin has a variety of land uses including commercial, single and multifamily residential and State Road 40 right of way. Flows in this drainage basin are conveyed to the various retention areas through interconnected inlets, pipes, swales, drainage wells, and a stormwater pump station.

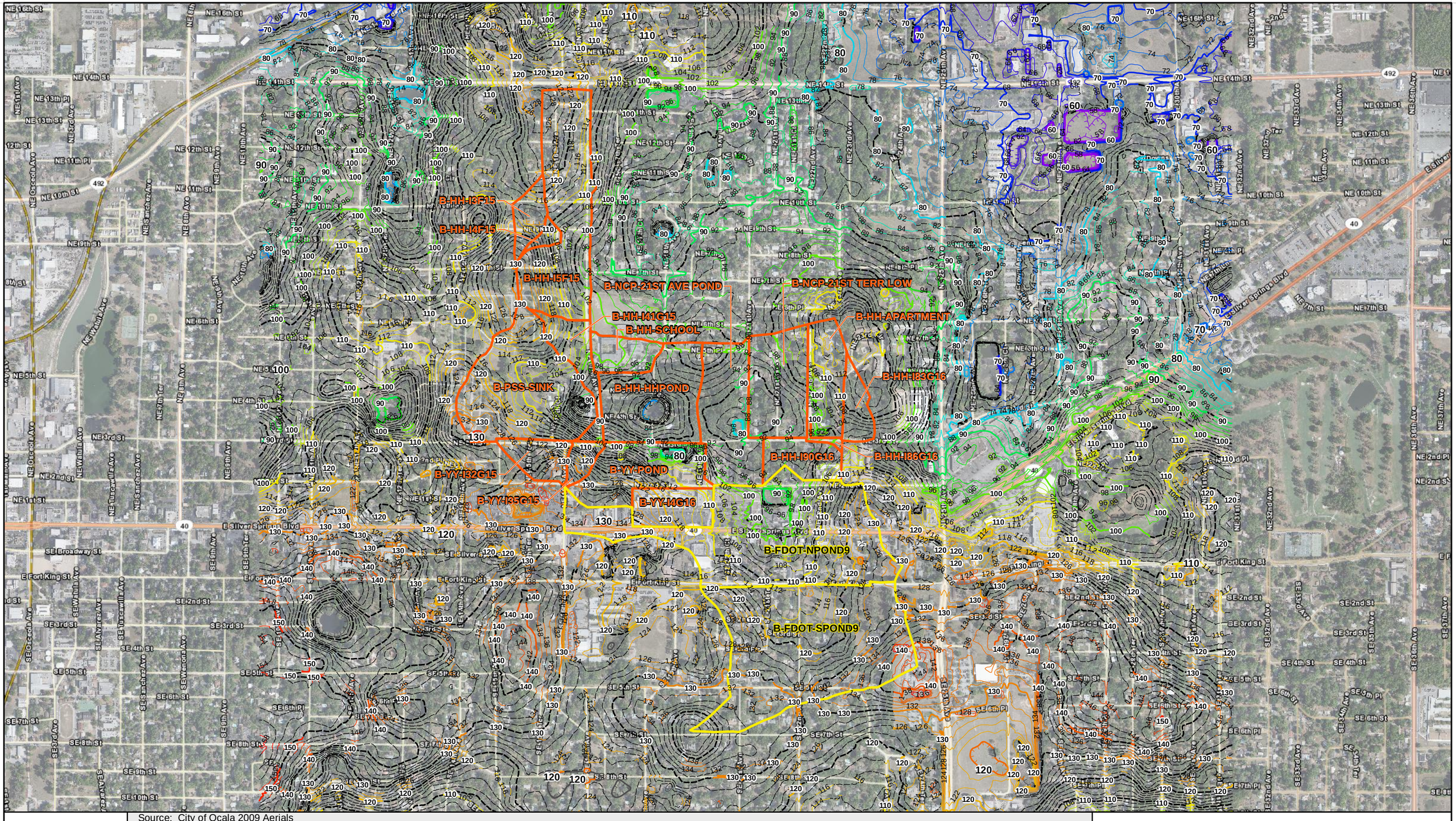
2.2 TOPOGRAPHY

Tetra Tech obtained topographic data for this site from the City. It contains two (2) – foot contours. Refer to Figure 2-1. The Heritage Hills drainage basin has moderate to mildly steep topographic relief which contributes to an increase in the flows that are ultimately discharged into the Heritage Hills retention pond. The topography ranges from an approximate elevation of 130-feet NAVD in the south part of the basin to 72-feet at the water surface in the landlocked depression at the bottom of the basin in the Heritage Hills retention area.

2.2.1 Basin Delineation

The Heritage Hills retention pond is located at the bottom of the Heritage Hills drainage basin. This drainage basin was divided into sub-basins utilizing the topographic contours and aerials and consists of the Heritage Hills Pond Sub-Basin, the Yum Yum Pond Sub-Basin, the Nature Conservancy Pond Sub-Basin, and the Perry Swim School Sub-Basin. The FDOT Pond #9 drainage basin was delineated utilizing the topographic contours and aerials. The sub-basins are depicted on Figure 2-1.

1) **The Heritage Hills Pond Sub-Basin** includes the portion that drains directly into the retention pond through overland flow and the portion that enters from the storm sewer on NE 17th Ave and NE 3rd St. Approximately 55.3 acres enters the retention pond



Source: City of Ocala 2009 Aerials

N

0 1,000 Feet

LEGEND

Heritage Hills Drainage Basin

FDOT Pond #9 Basin; B-FDOT-SPOND9

Contours Obscured

54' Elevations in NAVD88 158'

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

ELEVATION CONTOUR MAP

TETRA TECH

FIGURE 2-1

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from the northwest storm sewer system on NE 17th Ave, 23.4 acres enters it through overland flow, and an additional 26.0 acres directly contributes from the east through the storm sewer network along NE 3rd Street.

Areas draining into the Heritage Hills retention pond include the Yum Yum Pond through an overflow structure; the Nature Conservancy Retention Pond which dischargers through an overflow weir into the stormsewer system along NE 3rd St.; the FDOT Pond #9 which overflows into the Heritage Hills basin through a weir overflow structure that connects downstream to the stormsewer system along NE 3rd Street; and a retention pond at the apartment complex located at the intersection of NE 22nd Avenue and NE 3rd Street.

Also contributing to the Heritage Hills Basin is a 6.5 acre portion of Fort King Elementary School. This portion of the school consists of highly impervious uses that drain directly into the Heritage Hills retention pond without the use of an onsite pond to reduce the flow to predevelopment levels. The impact of the stormwater runoff from the middle school raises the 100 year flood level in the Heritage Hills Basin, approximately 0.3'. This impact is a result of the high percentage of impervious area in the Fort King Elementary School.

2) **The Yum Yum Pond Sub-Basin** receives flow from a commercial area between S.R. 40 and NE 2nd Street and an apartment complex located on the south side of the Yum Yum pond. The total basin area is approximately 34.5-acres. This basin generally drains from the southwest to the northeast where it ultimately discharges into the Yum Yum pond through drainage pipes connected to catch basins. The Yum Yum pond has an emergency overflow weir that discharges into the storm sewer system along NE 3rd Street that discharges into the Heritage Hills Pond.

3) **The Nature Conservancy Retention Pond Sub-Basin** receives surface water runoff from the portion of the upland preserve area that flows east into the NE 21st Avenue right-of-way eventually reaching the retention pond. Also, there is a low area between NE 21st Terrace and NE 21st Avenue that collects stormwater runoff along the rear of several homes. It fills up until it eventually flows between the homes at addresses 415, 405, and 313 NE 21st Avenue into a catch basin and culvert system that enters the retention pond. The Nature Conservancy Retention Pond has a drainage basin of 38.8 acres

4) **The Perry Swim School Pond Sub-Basin** includes a 35.0 acre area from Highland memorial Park and additional area west of NE 17th Ave. Stormwater enters a depression from overland flow. This basin is included in the Heritage Hills drainage basin because our analysis indicates that the water surface could exceed the top of the depression and enter the stormsewer system on NE 17th Avenue that discharges into the Heritage Hills Pond.

5) **The FDOT Pond #9 Basin** includes an area that drains approximately 3,500 feet of S.R. 40 right of way, commercial areas along the right of way; and a large residential area south of the S.R. 40 right of way. The storm sewer system extending from the S.R. 40 right of way connects to the retention pond located near the southwest corner of NE 2nd Ave and NE 22nd Avenue, which is approximately 123.8 acres. The emergency overflow from FDOT Pond #9 is connected to the infrastructure on NE 3rd Avenue via a culvert. Flows that exceed the capacity of the culvert enter the Nature Conservancy Pond via overland flow through the properties of the homes at addresses 2036, 2044, and 2102 NE 3rd Street

2.3 SOILS

Soils are classified into hydrologic soil groups (HSGs) by the National Resources Conservation Service (NRCS) Field Office Technical Guides to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting. The infiltration rate, which is controlled by surface conditions, represents the rate at which water enters the soil at the soil surface. Soil groups range from A to D with A soils having the highest infiltration rate and D soils having the lowest. A description of the soil types is provided below:

- **Group A** soils have a relatively high infiltration rate and therefore low runoff potential. They primarily consist of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
- **Group B** soils have moderate infiltration and consist of moderately deep and moderately well drained soils with fine to coarse textures.
- **Group C** soils have low infiltration rates with moderately fine to fine textures.
- **Group D** soils have poor infiltration rates and a high potential for runoff. They are characterized by high water tables with hard pan or clay layers near the surface and shallow soil over nearly impervious materials such as clay.
- **Groups A/D, B/D and C/D** soils are given for wet soils that can be adequately drained. The first letter applies to the drained and the second to the undrained

condition. Soils are assigned to dual groups of the depth to a permanent water table is the sole criteria for assigning a soil to hydrologic group D.

Figure 2-2 presents a map of the HSGs in the study area. HSGs A and B nearly completely cover the study area as shown in Tables 2-1 and 2-2.

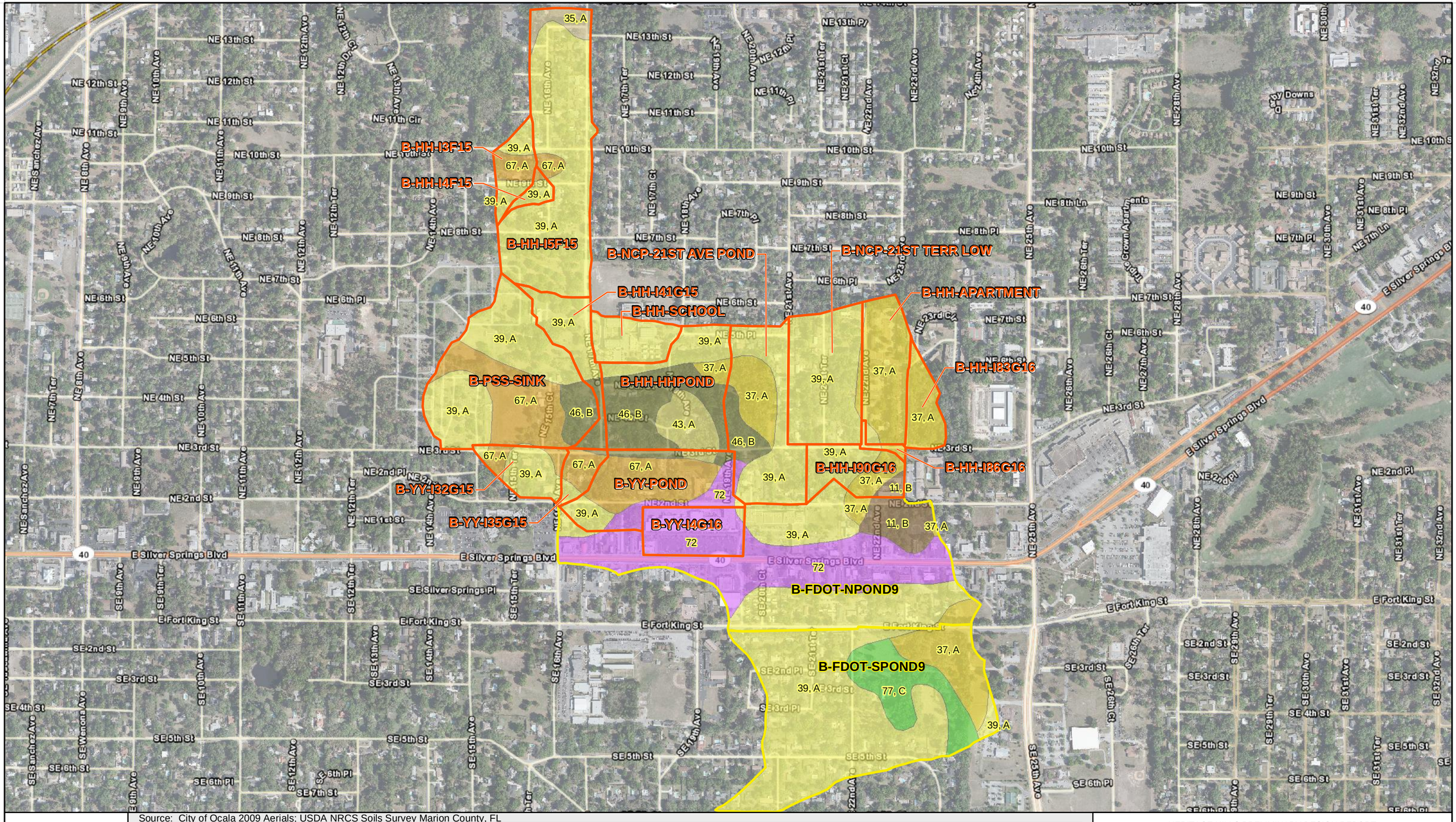
Table 2-1
Distribution of Soil Groups within the Heritage Hills Basin Area

SCS Soil Hydrologic Group	Area (Acres)	Percent of Total Area (%)
A	172.6	82.7%
B	22.8	10.9%
Urban Land (A)	13.2	6.4%
Totals	208.6	100.0%

Table 2-2
Distribution of Soil Groups within the FDOT Pond #9 Basin Area

SCS Soil Hydrologic Group	Area (Acres)	Percent of Total Area (%)
A	80.1	64.7%
B	5.4	4.4%
C	10.8	8.7%
Urban Land (A)	27.5	22.2%
Totals	123.8	100.0%

With the soil groups within the study area the potential for variability in runoff for a given HSG can vary greatly from factors such as rainfall intensity, and duration, total rainfall, soil moisture conditions, cover density, stage of growth, and temperature. These causes of variability are collectively called the antecedent moisture condition (AMC). AMC is divided into three classes: II for average conditions, I for dry conditions and III for wetter conditions. AMC condition II is the typical value utilized for a modeling project; however, the calibration process yielded the use of values between AMC I and II for this project.



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Feet

Source: City of Ocala 2009 Aerials; USDA NRCS Soils Survey Marion County, FL

LEGEND

Heritage Hills Drainage Basin

FDOT Pond #9 Basin

Heritage Hills Basin Soils

Hydro Group A

35, Gainesville, A

37, Hague, A

39, Hague, A

43, Arredondo, A

67, Sparr, A

Hydro Group B

11, Lochloosa, B

46, Lochloosa, B

Other

72, Urban land,

FDOT Pond #9 Basin Soils

Hydro Group A

37, Hague, A

39, Hague, A

Hydro Group B

11, Lochloosa, B

Hydro Group C

77, Zuber, C

Other

72, Urban land,

HERITAGE HILLS PRELIMINARY DESIGN REPORT

CITY OF OCALA

SOILS SURVEY MAP

TETRA TECH

FIGURE 2-2

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2.4 FLOOD PLAIN

According to FEMA mapping for the area as provided on the Flood Insurance Rate Maps (FIRM) 16% of the Heritage Hills drainage basin is in Zone AE or within the 1% annual chance flood, and 7% is within the 0.2% annual chance flood boundaries. The remaining 77% is identified as Zone X. The FIRM depicts that 2% of the FDOT Pond #9 drainage basin is in Zone AE, and 0.8% is within the 0.2% annual chance flood boundaries. The remaining 97% is identified as Zone X. Figure 2-3 provides the zone boundaries within the area.

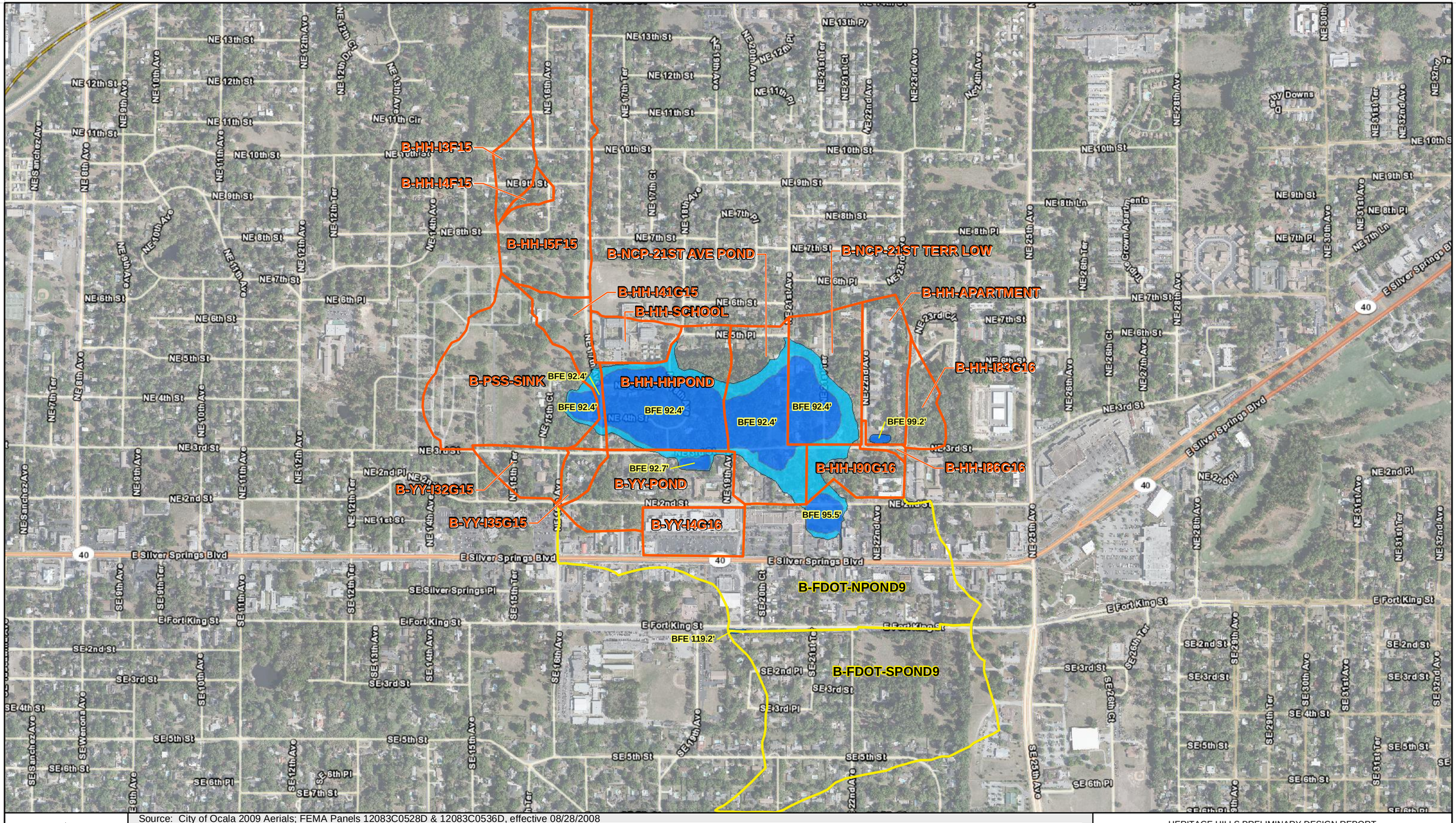
2.5 LAND USE

Figure 2-4 presents the St John's River Water Management District (SJRWMD) Land use for the Heritage Hills, and FDOT Pond #9 drainage basins. Table 2-3 and 2-4 below presents a breakout of the land uses.

Table 2-3

St. John's River Water Management District Land Uses
Heritage Hills Drainage Basin

Land Use/ Land Cover	FLUCCS Code	Area (Ac)	Percent (%)
Residential, low density - less than 2 dwelling units/acre	1100	0.08	0.1%
Residential, medium density - 2-5 dwelling units/acre	1200	96.78	46.4%
Residential, high density - 6 or more dwelling units/acre	1300	32.43	15.6%
Commercial and services	1400	20.69	9.9%
Cemeteries	1480	38.66	18.5%
Institutional	1700	2.15	1.0%
Parks and zoos	1850	12.03	5.77%
Upland mixed coniferous/hardwood	4340	4.24	2.03%
Lakes	5200	0.80	0.38%
Freshwater marshes	6410	0.74	0.36%



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Feet

Source: City of Ocala 2009 Aerials; FEMA Panels 12083C0528D & 12083C0536D, effective 08/28/2008

LEGEND

Heritage Hills Drainage Basin

FDOT Pond #9 Basin

Special Flood Hazard Areas

100-YEAR

Zone AE: Base Flood Elevations Determined.

OTHER FLOOD AREAS

Zone X: Areas of 0.2% annual chance flood.

OTHER AREAS

Zone X:

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT

CITY OF OCALA

FLOOD HAZARD MAP

TETRA TECH

FIGURE 2-3

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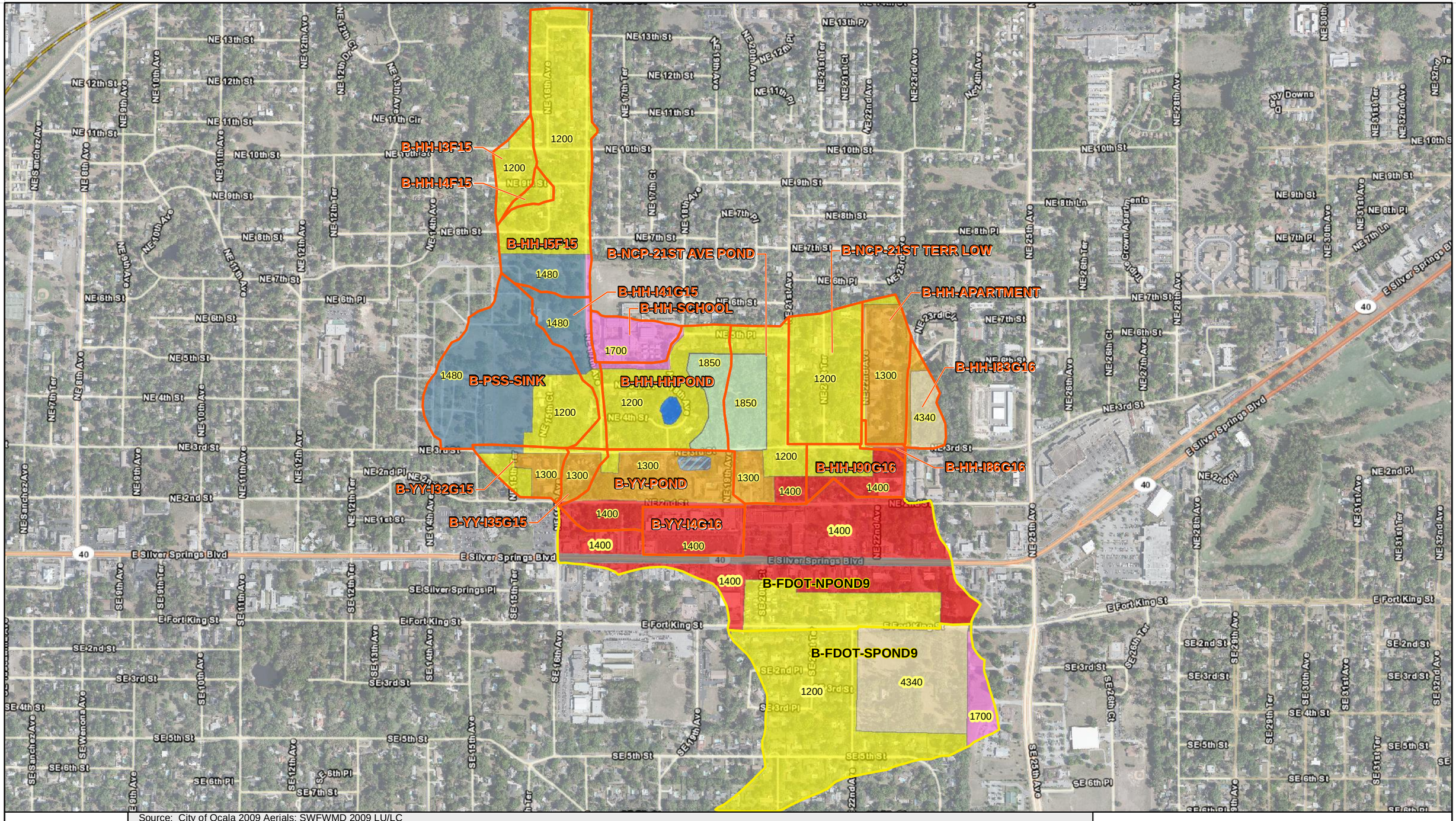

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Feet

Source: City of Ocala 2009 Aerials; SWFWMD 2009 LU/LC

LEGEND

Heritage Hills Drainage Basin

FDOT Pond #9 Basin

Heritage Hills Basin Land Use

- 1100: Residential, low density - < 2 DUs/acre
- 1200: Residential, medium density - 2-5 DUs/acre
- 1300: Residential, high density - 6+DUs/acre
- 1400: Commercial and services
- 1480: Cemeteries
- 1700: Institutional
- 1850: Parks and zoos
- 4340: Upland mixed coniferous/hardwood
- 5200: Lakes
- 6410: Freshwater marshes

FDOT Pond #9 Basin Land Use

- 1200: Residential, medium density - 2-5 DUs/acre
- 1400: Commercial and services
- 1700: Institutional
- 4340: Upland mixed coniferous/hardwood
- 8140: Roads and highways (divided 4-lanes with medians)

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

LAND USE / LAND COVER MAP

TETRA TECH

FIGURE 2-4

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Table 2-4

St. John's River Water Management District Land Uses
FDOT Pond #9 Drainage Basin

Land Use/Land Cover	FLUCCS Code	Area (Ac)	Percent (%)
Residential, medium density - 2-5 dwelling units/acre	1200	51.66	41.7%
Commercial and services	1400	41.50	33.5%
Institutional	1700	4.07	3.3%
Upland mixed coniferous/hardwood	4340	21.09	17.0%
Roads and highways (divided 4-lanes with medians)	8140	5.50	4.4%

2.6 WETLAND

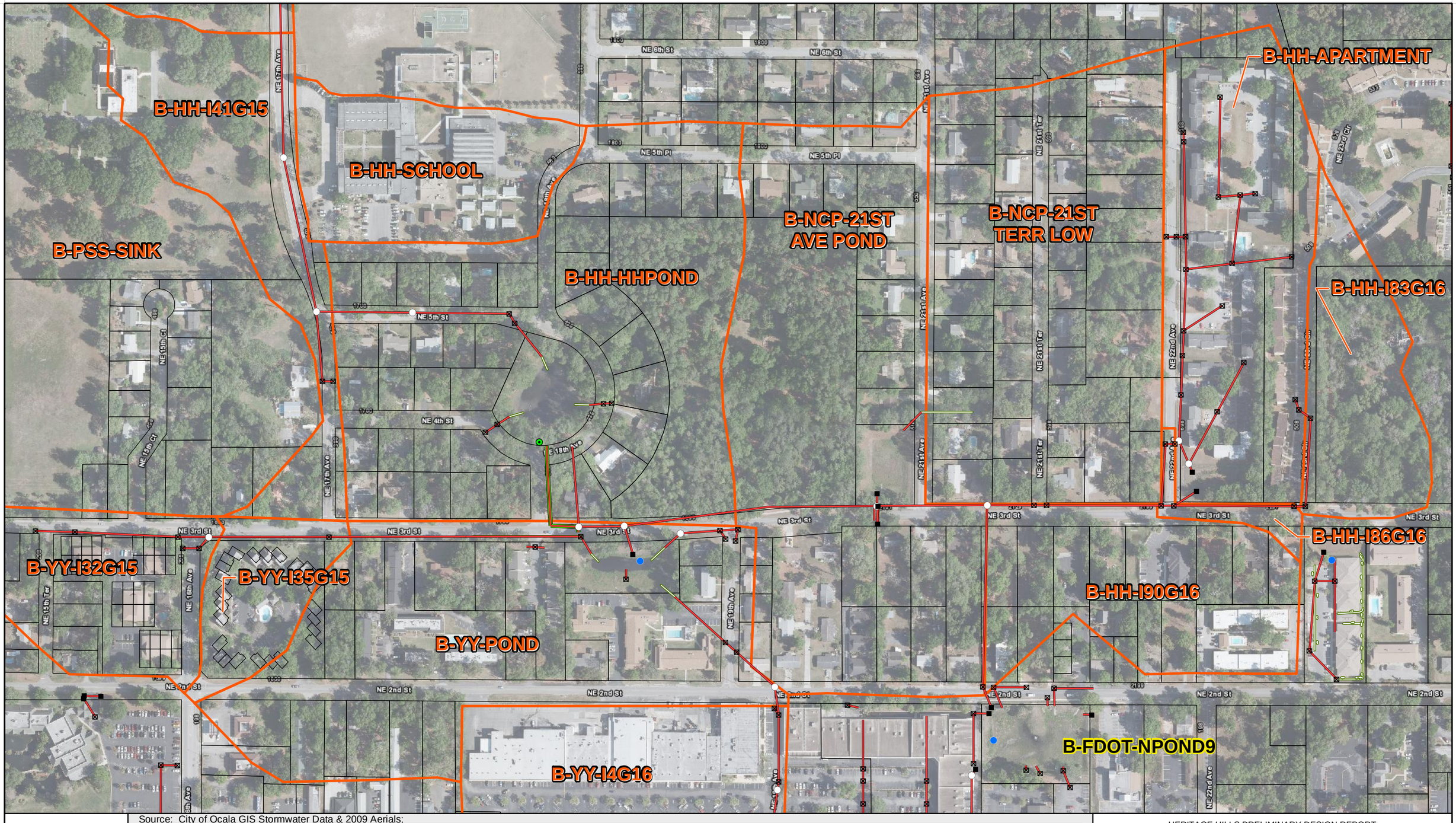
Figure 2-5 presents the wetlands within the Heritage Hills drainage basin as delineated by the SJRWMD's Land Use Cover. The only identified wetland is the Yum Yum pond drainage retention area of approximately 0.74 acres.

2.7 EXISTING STORMWATER INFRASTRUCTURE

The City of Ocala has general data available for the approximate location, size, and material of the current stormwater infrastructure within the Heritage Hills drainage basin and as a part of this project the City of Ocala staff conducted new field surveying efforts to collect elevation data for infrastructure located within public rights-of-ways, or within public easements. Figure 2-6 represents the infrastructure for the Heritage Hills drainage basin.

The Heritage Hills pond at the intersection of NE 4th St and NE 18th Ave has a 98.24 acre drainage area, the lowest calculated pond contour is 72 and the pond top of bank is 80, and an emergency pump station that pumps stormwater into the Yum Yum pond at a rate of 2,000-gpm, or 4.56-cfs.

The Yum Yum pond near the intersection of NE 3rd St and NE 18th Ave has a 34.47 acre drainage area, bottom elevation of 78 and a top of bank of 92, an 18-inch drainage well, and an



N

0 250

Feet

Source: City of Ocala GIS Stormwater Data & 2009 Aerials;

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin

Stormwater Structures

- Wells
- Mitered End Sections
- Pump Stations
- Storm_Inlets
- Storm Manholes
- Storm Force Main
- Pipes
- Swales

HERITAGE HILLS PRELIMINARY DESIGN REPORT
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EXISTING STORMWATER INFRASTRUCTURE MAP

TETRA TECH

FIGURE 2-6

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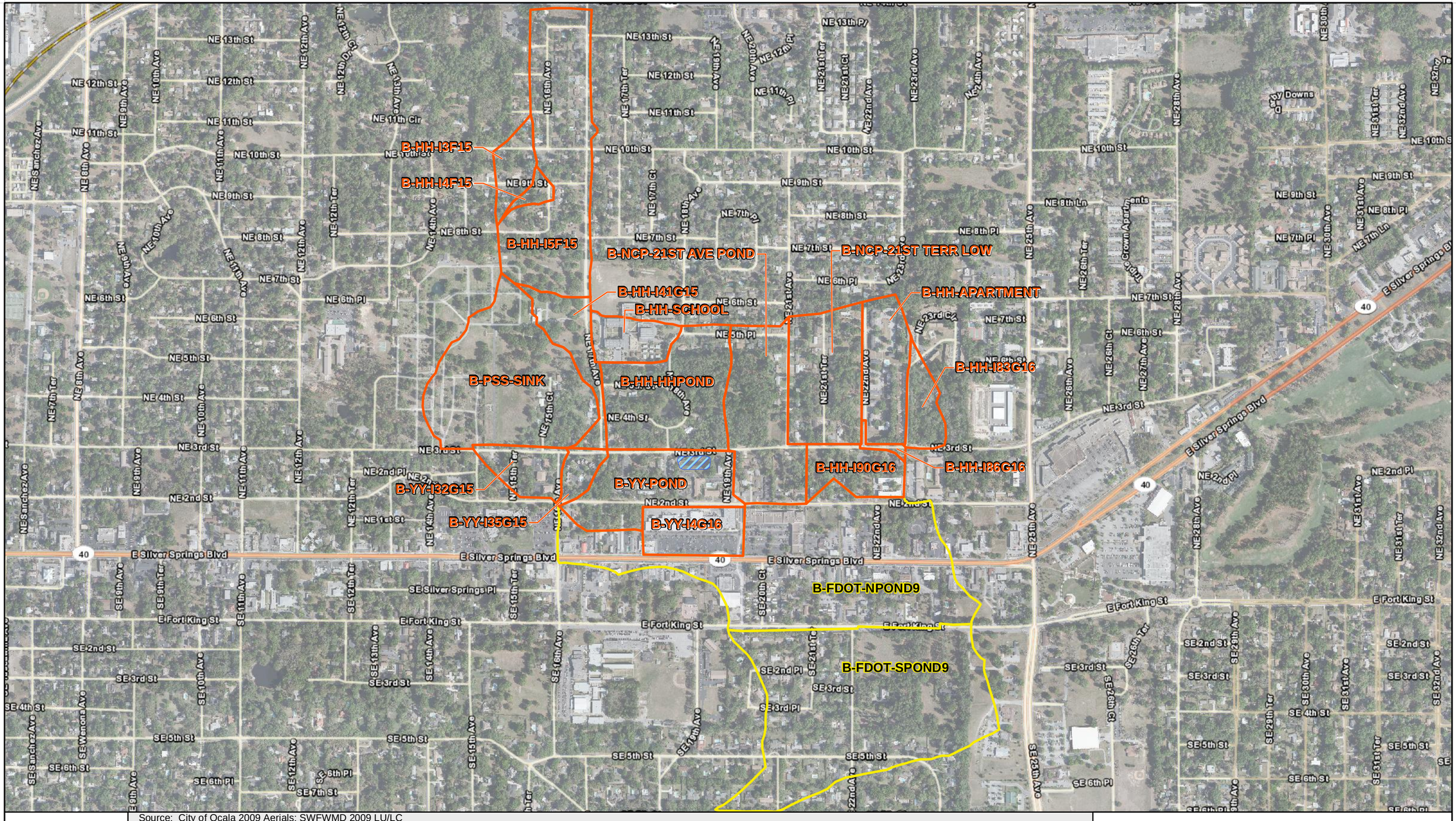

Source: City of Ocala 2009 Aerials; SWFWMD 2009 LU/LC

N

0 800

Feet

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- Wetlands

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

WETLANDS MAP

TETRA TECH

FIGURE 2-5

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emergency overflow structure that flows through a 15-inch reinforced concrete pipe (RCP) into the 30-inch RCP on NE 3rd Ave and eventually into Heritage Hills pond.

The Nature Conservancy pond on the corner of NE 21st Ave and NE 3rd St has a 38.79 acre drainage area, a bottom elevation of 78 and a top of bank of elevation 88, and an emergency overflow structure that flows through a 15-inch reinforced concrete pipe (RCP) into the 30-inch RCP on NE 3rd Ave and eventually into Heritage Hills pond.

Florida Department of Transportation (FDOT) Pond #9 has a 123.82 acre drainage area, a pond bottom elevation of 88 and top of bank of 96, four existing (4) drainage wells, and an emergency over flow structure. The drainage wells are sized accordingly: two 4-in diameter and two 16-in diameter wells, and the depths are listed in the Well Report in Appendix B. The overflow structure conveys flows from FDOT Pond #9 to the retention pond on the corner of NE 21st Avenue and NE 3rd Street through a 24-in reinforced concrete pipe (RCP).

2.8 PERMITS

A permit history search was conducted to obtain existing stormwater permits within the Heritage Hills drainage basin to determine what impact, if any, they may have on the stormwater infrastructure. All of existing approved or issued St. Johns River Water Management District (SJRWMD) and Florida Department of Environmental Protection (FDEP) Environmental Resource Permits (ERP) within the drainage basin area were collected. None of the permits were found to have adverse impacts to the public stormwater infrastructure.

SECTION 3
HYDRAULIC MODELING

3.1 GENERAL

A detailed hydrologic and hydraulic analysis was conducted for the Heritage Hills drainage basin. This analysis included the development of computer models to simulate the recent flooding from a major storm in October 2011 and several alternatives to determine the best cost effective solution to alleviate future flooding.

3.2 MODELING METHODOLOGY

The hydrologic and hydraulic models were conducted using the Interconnected Channel and Pond Routing (ICPR) software, version 3.10, Service Pack 8. ICPR was selected because of its ability to simulate rainfall events in unsteady conditions for complex and hydraulically interdependent stormwater ponds. The program has also been formally accepted by the Federal Emergency Management Agency (FEMA) as a numerical model for flood studies. ICPR predicts storm events through a two-step process. Step one is a hydrologic analysis of the runoff generated by the basin. ICPR has four methods to predict runoff; for this project the Soil Conservation Service (SCS) Unit Hydrograph method is utilized. The SCS Unit Hydrograph method simulates the peak flow from a peaking factor (typical values include 256, 323, or 484) and the volume of runoff from the curve number, which estimates the soil storage and infiltration for the basin. Step two involves the hydraulic routing of the predicted runoff through the interconnected pipes and structures within the drainage system. This involves the complex calculation of flow of between the inlets, pipes, weirs, drop structures, orifices, drainage wells, and stormwater ponds.

The model was used to simulate the 2-year, mean annual, 10-year, and 100-year storm events for a 24-hour duration using the Flmod hyetograph. The 100-year 24 hour (FEMA) and the 25-year-96-hour storm event, as predicted by the SJRWMD-96 hyetograph, were also modeled. For the purposes of this report, the FEMA based 100-year 24-hour storm is a storm event in which the starting water levels in storage areas, prior to running the standard 100-year storm, are set by first running the Mean Annual storm. Using the higher starting water surface elevations set by the Mean Annual storm, the 100-year 24-hour storm is then run to account for conditions where chronic rainfall may occur prior to the onset of a 100-year storm.

The elevations of the model inputs (stormwater ponds, pipe inverts, inlets, etc) are based on field survey data provided by the City and the two-foot topographic contours obtained from the City both of which are based on the North American Vertical Datum 1988 (NAVD 88).

The Natural Resource Conservation Service (NRCS) Curve Number (CN) method as described by Technical Release No. 55 (TR-55) – "Urban Hydrology for Small Watersheds" was used to estimate the CN and rainfall excess for each basin. The St. Johns River Water Management District (SJRWMD) Land Use maps and the NRCS soils data were used to establish which CNs to use for the various areas. Once a CN was established for each of the areas, a weighted CN was calculated for each basin. The CN's calculated by the TR-55 method represent a normal antecedent moisture condition (AMC II). The antecedent moisture for dry (AMC I) and wet (AMC III) conditions were calculated for comparison through the calibration process.

The peaking factor is used with the SCS Unit Hydrograph method to alter the shape of the hydrograph of an individual basin within a watershed. The peaking factors utilized by ICPR are 256, 323, and 484. As the peaking factor increases, the rising and falling limbs of the hydrograph become steeper and the peak rate of runoff increases, simulating less available surface storage within the basin. The 256 peaking factor represents a basin that is relatively flat and has significant surface storage, the 323 peaking factor represents a basin that has steeper topography and moderate surface storage, and the 484 peaking factor represents even steeper topography, or a fully developed basin with minimal surface storage. The peaking factors for the Heritage Hills basin were determined during calibration.

The time of concentrations for the unit hydrograph of each basin was calculated using the NRCS TR-55 procedure. The time of concentration is the time is takes water to travel from the hydraulically most distant point of the basin to the point of interest; in effect, it is the time to the peak of the runoff from the basin. The NRCS method estimates the time of concentration in three stages. The first stage is the sheet flow travel time, the second is the shallow concentrated flow travel time, and the final (if present) is the channel or pipe flow travel time. Each stage is calculated separately and added together as a cumulative flow time. The flow lengths were calculated from the 2-ft topography and the City storm sewer infrastructure.

The stormwater ponds were entered into the model as stage-area nodes. The surface areas of various two-foot contours were calculated using the two-foot topography provided by the City.

The initial stages of the ponds were set as the lowest known elevation observable from the two-foot topography. In addition, the starting water elevations were based on geotechnical data obtained near the storage areas in the Yum Yum, Heritage Hills and Conservancy basins. The warning stages were set as the lowest known finished floor elevation (FFE), or the top of bank of the pond when the lowest FFE was not known.

The storm sewer inventory data was gathered by the City's land surveyors. This storm sewer information provided the interconnectivity between each of the stormwater pond nodes and characterized all of the conveyance features that control flow within the Heritage Hills drainage basin (pipes, weirs, drainage wells, etc.). Invert elevations from this data were entered into the hydraulic model. In addition, typical pipe roughness and weir coefficients were obtained from this data and entered in the hydraulic routing data.

3.3 MODEL CALIBRATION

The model is calibrated based on the major storm event from October 2011 which released 8.2 inches of rain during a period of approximately six (6) to eight (8) hours, which is approximately a 100-year event for this duration. Successful calibration requires an accurate and reliable record of both rainfall and stage or flow data. In this case the rainfall data for the drainage basin is well documented by the local rain gauge. The event time is known based on telemetric data provided by the city which provides start and stop times for the pump station in the Heritage Hills retention pond., Also, the peak stages resulting from the flooding are known from surveyed elevations of FFE's that were overcome with flood water and water stains that remained on the side of these homes. All of the data necessary for adequate calibration was provided by the City.

The peak stages in the model were calibrated to two (2) known flood elevations from the October 2011 storm. The peak stage in the Heritage Hills pond was surveyed at an elevation of 86.12 feet (NAVD 88). The peak stage in the Nature Conservancy pond is estimated to be an elevation of approximately 90.0 feet (NAVD 88). This estimate considers that the high water marks on the homes along NE 21st Ave and NE 3rd Street had varying elevations that could be due to wave action from vehicles driving on NE 21st Avenue during the high water conditions. Based on the two-foot contour data, there is also a possibility that the somewhat higher flood elevations at the homes near 2036, 2044, and 2102 NE 3rd St. is attributable to the over-land flow movement of water from upstream that overtopped the banks of the FDOT #9 retention pond. The peak stages during this storm for the Yum Yum pond are not exactly known. However, it was estimated

from the debris line observed along the banks of the pond and the invert elevation at the pipe connection in the southeast corner of the pond. The maximum flood elevation for the FDOT Pond #9 is also not known. However, as indicated above, it appears that it may have overtopped its banks causing surface flow northwest into the Nature Conservancy retention pond.

The sensitivities of the peaking factors used in the model were evaluated utilizing the normal antecedent moisture condition (AMC II) and time of concentrations for the various values of 256, 323 and 484. The observed maximum stages were summarized and compared. The maximum stages did have a noticeable response to the use of the various peaking factors. 256 was a better fit for comparison to the calibration storm.

After the peaking factor was calibrated the model continued to predict higher than measured peak stages in the Heritage Hills Pond and Nature Conservancy Pond, therefore the CN was calibrated to adjust the volume of surface water runoff to help lower these stages to match closer to the known elevations. Several modeling iterations were conducted to methodically reduce the peak stages to calibrate to the October 2011 storm. Eventually a combination of dry AMC for the FDOT and Yum Yum basins, slightly dry for the Heritage Hills, and normal for the Nature Conservancy Pond was calculated to predict values within reason of the measured peak stages. The resulting model relatively accurately predicts the known peak elevation of the Heritage Hills pond and falls within an acceptable range for the ponds where the peak stage was estimated. Table 3.3-1 below summarizes the comparison.

Table 3.3-1
Heritage Hills Drainage Basin Calibration Comparison

Pond	Pond Top of Bank	Lowest Adjacent Roadway Crown	Estimated Stage October 2011 Storm (ft-NAVD 88)	Modeled Calibration Storm 8-Hour Event (ft-NAVD 88)
Heritage Hills Pond	82.9	83.0	86.12	86.61
Yum Yum Pond	92.5	92.8	92	91.78
Nature Conservancy Pond (NE 21st Ave)	87.5	88.9	90	89.77
FDOT Pond #9	95.0	95.0	95.5	95.88

3.4 MODEL RESULTS

The modeling results illustrate that the storage volumes provided in the existing retention ponds in the study area are inadequate to accommodate the runoff volumes during major storm events. As the retention areas in upstream basins - including Yum Yum, Nature Conservancy and FDOT Pond 9 – fill up, their overflow is routed downstream into the Heritage Hills retention area through stormsewer pipes and overland flow. The Heritage Hills retention area becomes overwhelmed with flow causing it to rise quicker than its stormwater pump station can pump stormwater uphill into the Yum Yum pond. This conditions is exacerbated by the intensity of the runoff from the middle school basin along the north side of the Heritage Hills basin. The high percentage of impervious area on the middle school site provides what amounts to a directly connected impervious area (DCIA). At elevation 84, the electrical components of the pump station become submerged, thereby shorting out the system causing the pumps to shut down. At this point, the flood levels in the Heritage Hills retention area continues to rise.

Similarly, the existing pond in the Nature Conservancy floods above its top of bank causing roads to flood and damage inside of residential homes. Figure 3-1 depicts the extents of the flooding of the October 2011 storm and the limits of flooding of the 100 year – 24 hour storm, as predicted by the calibrated model. Table 3.4-1 below summarizes the existing conditions for the drainage basins in the study area for the Mean Annual, 10, and 100 year – 24 hour storm events; and the 25 year – 96 hour storm.

Table 3.4-1
Existing Conditions Model Results (Stage shown in NAVD 88)

Storms modeled for review	Rainfall (in)	Heritage Hills Pond	Yum Yum Pond	Nature Conservancy Pond (NE 21st Ave)	FDOT Pond #9
Calibration Storm 8 hour event	8.2	86.61	91.78	89.77	95.88
Mean annual 24 hour event	4.30	75.44	87.16	83.67	92.99
10 year / 24 hour event	6.40	81.82	88.30	87.64	94.84
25 year / 96 hour event	11.75	89.64	92.62	90.24	96.13
100 year / 24 hour event	11.50	90.29	92.61	90.31	96.18
100 year / 24 hour event (FEMA)	11.50	90.80	92.69	90.80	96.23

The results show that four (4) residences flooded above their FFEs during the unnamed storm event in October of last year, which is consistent with the actual conditions in the Heritage Hills basin. Likewise, the results indicate the two (2) residences flooded above their FFEs in the Nature Conservancy Pond basin. As the size of the modeled storms increased, the number of homes flooding above their FFEs did as well. Specifically, for the Heritage Hills basin, the 25 year – 96 hour and 100-year – 24 hour storms resulted in 16 and 18 homes flooding above their FFEs, respectively. For the Nature Conservancy Pond basin, the 25 year – 96 hour and 100-year – 24 hour storms resulted in 7 homes flooding above their FFEs respectively. See Table 3.4-2 and Table 3.4-3 for a summary of the number of residences flooding as predicted by the existing conditions model.

Table 3.4-2
Existing Conditions Heritage Hills Summary of Residences Flooding

Storms modeled for review	Rainfall (in)	Existing Storm # Residences Flooding
Calibration Storm 8 hour event	8.20	4
Mean annual 24 hour event	4.30	0
10 year / 24 hour event	6.40	0
25 year / 96 hour event	11.75	16
100 year / 24 hour event	11.50	19
100 year / 24 hour event (FEMA)	11.50	22

Table 3.4-3
Existing Conditions Nature Conservancy Pond Summary of Residences Flooding

Storms modeled for review	Rainfall (in)	Existing Storm # Residences Flooding
Calibration Storm 8 hour event	8.20	2
Mean annual 24 hour event	4.30	0
10 year / 24 hour event	6.40	0
25 year / 96 hour event	11.75	7
100-year / 24 hour event	11.50	7
100-year / 24 hour event (FEMA)	11.50	9

Heritage Hills Pond Sub-Basin

School Sub-Basin

Nature Conservancy Pond Sub-Basin

Heritage Hills Pond Sub-Basin

Perry Swim School Sub-Basin

Yum Yum Pond Sub-Basin

FDOT Basin

Heritage Hills Pond

Nature Conservancy Pond

Apartment Pond

Yum Yum Pond

FDOT Pond #9

Source: City of Ocala 2009 Aerials; FEMA Panels 12083C0528D & 12083C0536D, effective 08/28/2008

N

0 250

Feet

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- 1717 88.78' Address Finished Floor Elevation
- Flow Directions
- Wells
- Extents of Flooding Predicted by Model for October 2011 Storm
- Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
- Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

EXISTING DRAINAGE CONDITIONS
OCTOBER 2011 CALIBRATION STORM

TETRA TECH

FIGURE 3-1

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SECTION 4
ALTERNATIVES ANALYSIS

4.1 GENERAL

The existing stormwater infrastructure in the study area was conducted to assess the number of homes that would flood above their FFEs during a major storm event in October of 2011, the 2, 10, 100 year – 24 hour, and 100 year – 24 hour (FEMA) and the 25 year – 96 hour design storms. The modeling predicts that the existing infrastructure is undersized and flooding of FFEs in residences in the Heritage Hills basin will likely continue.

Several proposed improvements were analyzed as alternatives to potentially alleviate the flooding. The storm events referenced above were evaluated. The alternatives analyzed predict a reduction in the number of FFEs that would flood for each of the storm events. However, due to the fact the residences are located within a land-locked basin, and neither the infrastructure (roads and drainage systems) or private homes were built adequately above the floodplain, considerable capital costs will be necessary for effective improvements that will eliminate flooding all together for the larger storms.

The alternatives analyzed in this section include:

- Home purchasing program,
- Expanding the pond on the Nature Conservancy site,
- Rearranging the connectivity of the primary stormsewer line along NW 3rd Avenue,
- Lowering the top of the well casing in the Yum Yum pond,
- Restoring and Lowering the Existing FDOT shallow wells,
- Constructing a retention pond in the FDOT basin south of S.R. 40, and
- Constructing drainage Wells in the Heritage Hills retention pond to replace the three (3) shallow wells in the FDOT Pond #9

In addition to these alternatives, an analysis was also conducted to assess the severity of flooding that would result if all of the drainage wells in this study failed. below is a description of the various alternatives listed above.

4.2 ALTERNATIVE 1 – HOME PURCHASING PLAN

One option for consideration by the City is to purchase homes with finish floor elevations (FFEs) that are below the FEMA 100-year floodplain elevation. It would be implemented in lieu of structural improvements requiring the preparation of construction drawings, permitting and construction. This alterative was analyzed independent of the other alternatives to estimate the number of homes that would have to be purchased to establish a flood level a service capable of accommodating the stormwater runoff from a FEMA 100-year/24-hour storm. The City provided an average price of $100,000 for a typical home in the Heritage Hills area.

Table 4.2-1
Number of Lots With Finish Floors Below FEMA 100 Year Storm

Basin Name	Number of Homes
Heritage Hills	21
Conservancy Pond	9
Total	30

A total of 30 homes have FFEs below the flood elevation of 90.8. Using the average home price of $100,000, the total purchase price for 30 homes is $3,000,000. The home located at 417 NE 18th Avenue has an FFE of 91.1 which is approximately 0.3 feet above the FEMA 100 year flood elevation. Purchasing the above referenced homes will leave this home isolated as the single remaining home on the looped section of NE 18th Avenue. Given the quantity of infrastructure that would have to be maintained for a single residence, the City may find it advisable to purchase all of the homes on NE 18th Avenue which would make the total purchase price $3,100,000.

4.3 ALTERNATIVE 2 – EXPAND NATURE CONSERVANCY POND

This alternative examined the effect of increasing the storage volume for of the retention pond in the Nature Conservancy site. The expansion from 1.0 acres at the top of bank to 3.1 acres quadruples the storage capacity from 6.0 acre-feet to 25.0 acre-feet. The results of the expansion are shown on Figure 4-2. This allows more water to be retained upstream of the Heritage Hills pond and results in lowering the peak stages of both ponds. Table 4.3-1 shows a summary of the resulting flood elevations from Alternative 2 compared to the existing conditions for the Heritage Hills retention pond, Table 4.3-2 is a summary for the Nature Conservancy Pond. Neither the Yum Yum Pond or the FDOT Pond #9 significantly improved from this alternative. Table 4.3-3

and Table 4.3-4 shows the impact of how this alternative could potentially reduce the number of residences subjected to flooding above their FFEs.

Table 4.3-1

Summary of Flood Elevations
Comparison of Alternative 2 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 2 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	86.61	85.65
Mean annual 24 hour event	4.30	75.44	75.44
10 year - 24 hour event	6.40	81.82	81.60
25 year - 96 hour event	11.75	89.64	88.64
100 year - 24 hour event	11.50	90.29	89.03
100 year - 24 hour event (FEMA)	11.50	90.80	90.04

Table 4.3-2

Summary of Flood Elevations
Comparison of Alternative 2 to the Existing Conditions
Expanded Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 2 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	89.77	85.74
Mean annual 24 hour event	4.30	83.67	79.02
10 year - 24 hour event	6.40	87.64	81.01
25 year - 96 hour event	11.75	90.24	89.30
100 year - 24 hour event	11.50	90.31	90.09
100 year - 24 hour event (FEMA)	11.50	90.80	90.13

Heritage Hills Pond Sub-Basin

School Sub-Basin

Nature Conservancy Pond Sub-Basin

Heritage Hills Pond Sub-Basin

Perry Swim School Sub-Basin

21 HOMES

9 HOMES

Yum Yum Pond Sub-Basin

FDOT Basin

Heritage Hills Pond

Nature Conservancy Pond

Apartment Pond

Yum Yum Pond

FDOT Pond #9

NE 6th St
NE 5th Pl
NE 5th St
NE 4th St
NE 3rd St
NE 2nd St
NE 17th Ave
NE 16th Ave
NE 16th Ct
NE 16th Ter
NE 18th Ave
NE 19th Ave
NE 21st Ave
NE 21st Ter
NE 22nd Ave
NE 23rd Cir

1705 91.39'
1715 90.33'
1727 89.22'
1733 89.84'
1743 90.22'
1753 89.82'
1706 89.22'
1716 87.86'
1732 86.47'
1748 86.4'
1754 86.47'
1705 89.36'
1717 88.78'
1727 85.78'
1737 84.38'
412 92.35'
423 90.75'
417 91.09'
411 87.7'
403 88.56'
321 86.49'
311 90.3'
310 85.96'
1706 93.53'
1716 90.99'
1726 88.12'
1736 85.14'
1725 94.25'
1735 92.47'
525 93.79'
516 94.35'
515 91.7'
506 92.18'
507 90.17'
508 93.8'
424 90.58'
429 87.68'
428 92.55'
414 90.05'
415 89.2'
416 90.63'
406 90.17'
405 90.01'
404 91.2'
413 93.7'
407 91.76'
313 88.97'
314 91.35'
313 92.91'
307 90.89'
2121 92.86'
2131 93.11'
2036 92.29'
2044 91.3'
2102 93.54'
2014 93.95'

Source: City of Ocala 2009 Aerials; FEMA Panels 12083C0528D & 12083C0536D, effective 08/28/2008

N

0 250
Feet

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- Homes to be Purchased
- 1717 88.78' Address Finished Floor Elevation
- Flow Directions
- Wells
- Extents of Flooding Predicted by Model for October 2011 Storm
- Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
- Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

ALTERNATIVE 1
HOME PURCHASING PLAN

TETRA TECH

FIGURE 4-1

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Heritage Hills Pond Sub-Basin

School Sub-Basin

Nature Conservancy Pond Sub-Basin

Heritage Hills Pond Sub-Basin

Perry Swim School Sub-Basin

Expanded Nature Conservancy Pond

Yum Yum Pond Sub-Basin

FDOT Basin

Heritage Hills Pond

Nature Conservancy Pond

Apartment Pond

Yum Yum Pond

FDOT Pond #9

525 93.79'
516 94.35'
515 91.7'
508 93.8'
507 90.17'
506 92.18'
428 92.55'
429 87.68'
424 90.58'
416 90.63'
415 89.2'
414 90.05'
413 93.7'
406 90.17'
407 91.76'
405 90.01'
404 91.2'
313 88.97'
314 91.35'
313 92.91'
307 90.89'
2121 92.86'
2131 93.11'
2036 92.29'
2044 91.3'
2102 93.54'
2014 93.95'
1705 91.39'
1715 90.33'
1727 89.22'
1733 89.84'
1743 90.22'
1753 89.82'
423 90.75'
417 91.09'
1706 89.22'
1716 87.86'
1732 86.47'
1748 86.4'
1754 86.47'
411 87.7'
1705 89.36'
1717 88.78'
1727 85.78'
1737 84.38'
403 88.56'
1706 93.53'
1716 90.99'
1726 88.12'
1736 85.14'
321 86.49'
1725 94.25'
1735 92.47'
310 85.96'
311 90.3'
412 92.35'

NE 6th St
NE 5th Pl
NE 5th St
NE 4th St
NE 3rd St
NE 2nd St
NE 17th Ave
NE 16th Ave
NE 15th Ave
NE 21st Ave
NE 22nd Ave
NE 23rd Cir
NE 15th Ct
NE 15th Ter
NE 16th Ter
NE 19th Ave
NE 18th Ave

Source: City of Ocala 2009 Aerials

N

0 250
Feet

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- 1717 88.78' Address Finished Floor Elevation
- Wells
- Existing Flow Directions
- New Flow Directions
- Extents of Flooding Predicted by Model for October 2011 Storm
- Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
- Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

ALTERNATIVE 2
EXPAND NATURE CONSERVANCY POND

TETRA TECH

FIGURE 4-2

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Table 4.3-3
Summary of Residences Flooding
Comparison of Alternative 2 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 2 # Residences Flooding
Calibration Storm 8 hour event	8.20	4	2
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	16	11
100 year - 24 hour event	11.50	19	13
100 year - 24 hour event (FEMA)	11.50	22	18

Table 4.3-4
Summary of Residences Flooding
Comparison of Alternative 2 to the Existing Conditions
Expanded Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 2 # Residences Flooding
Calibration Storm 8 hour event	8.20	2	0
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	7	2
100 year - 24 hour event	11.50	7	5
100 year - 24 hour event (FEMA)	11.50	9	5

This alternative achieves a significant reduction in peak stages which reduces the number of FFEs flooding in the Heritage Hills basin from four (4) to two (2) for the flood event of October 2011. The number of FFEs removed from flooding in the Nature Conservancy basin reduced from two (2) to none. The modeling results show that the 100 year - 24 hour storm improves conditions in the Heritage Hills basin. However, the impact of the number of FFEs removed from flooding diminishes when compared to the results from the October 2011 storm. Comparing the existing conditions model to the Alternative 2 shows that the number of FFEs reduces from 19 to 13 and

for the Heritage Hills basin and from seven (7) to five (5) for the Nature Conservancy pond for the 100 year - 24 hour storm.

Discussions with City staff indicate that funding may be available for the expansion of the Nature Conservancy pond as part of a surface water treatment facility and educational park. The expanded pond would help reduce the quantity of water discharged to the aquifer through the existing drainage wells.

The preliminary opinion of probable cost for Alternative 2, including design, permitting, bidding and construction is approximately $760,000. This includes estimates of the site costs for the future parking area to in the Nature Conservancy.

4.4 ALTERNATIVE 3 – ROUTE FLOW FROM 3RD AVE INTO YUM YUM

The third alternative builds on the effectiveness of the second alternative by also including proposed improvements to redirect existing stormsewer pipes along 3rd Avenue. In the existing conditions, the stormsewer pipes that flow west on 3rd Avenue discharge into the Heritage Hills retention pond. This alternative would redirect the stormsewer pipes to discharge instead into the Yum Yum pond. A smart box would be constructed in the Yum Yum pond to overflow initially into the expanded Nature Conservancy pond. Also it would divert the runoff from the Nature Conservancy basin, consisting of the area east of the intersection of NE18th Ave and 3rd St, into the Yum Yum pond, rather than flowing directly into the Heritage Hills pond.

By routing these flows into Yum Yum pond the use of the drainage well is maximized and the pumping requirements from the Heritage Hills retention area are minimized. A change to the existing conveyance regime will significantly reduce the flooding in the Heritage Hills pond. It minimally reduces the effectiveness that the expanded Nature Conservancy retention pond will have on its drainage basin. By rerouting flows from into the Yum Yum pond, it allows flood water to redistribute thereby removing some of the burden from the Heritage Hills pond. Figure 4-3 depicts the proposed changes to the stormsewer infrastructure and the maximum stages predicted by the model. Table 4.4-1 shows a summary of the resulting flood elevations compared to the existing conditions model for the Heritage Hills retention pond, Table 4.4-2 is a summary for the Nature Conservancy Pond. The FDOT Pond #9 does not receive an improvement from this alternative, and the Yum Yum Pond sees a marginal increase in peak stage, although it does not exceed the top of bank. Table 4.4-3 and Table 4.4-4 shows the impact of how this alternative could potentially reduce the number of residences subjected to flooding above their FFEs.

Heritage Hills Pond Sub-Basin

School Sub-Basin

Perry Swim School Sub-Basin

Nature Conservancy Pond Sub-Basin

Heritage Hills Pond Sub-Basin

Expanded Nature Conservancy Pond

Yum Yum Pond Sub-Basin

FDOT Basin

Heritage Hills Pond

Nature Conservancy Pond

Apartment Pond

Yum Yum Pond

FDOT Pond #9

412 92.35'

1705 91.39' | 1715 90.33' | 1727 89.22' | 1733 89.84' | 1743 90.22' | 1753 89.82'

1706 89.22' | 1716 87.86' | 1732 86.47' | 1748 86.4' | 1754 86.47'

1705 89.36' | 1717 88.78' | 1727 85.78' | 1737 84.38'

1706 93.53' | 1716 90.99' | 1726 88.12' | 1736 85.14'

1725 94.25' | 1735 92.47' | 310 85.96'

423 90.75' | 417 91.09' | 411 87.7' | 403 88.56' | 321 86.49' | 311 90.3'

516 94.35' | 506 92.18' | 424 90.58' | 414 90.05' | 406 90.17'

525 93.79' | 515 91.7' | 507 90.17' | 429 87.68' | 415 89.2' | 405 90.01' | 313 88.97' | 307 90.89'

508 93.8' | 428 92.55' | 416 90.63' | 404 91.2' | 314 91.35' | 2121 92.86'

413 93.7' | 407 91.76' | 313 92.91' | 2131 93.11'

2036 92.29' | 2044 91.3' | 2102 93.54' | 2014 93.95'

NE 6th St | NE 5th Pl | NE 5th St | NE 4th St | NE 3rd St | NE 2nd St

NE 17th Ave | NE 16th Ave | NE 16th Ter | NE 16th Ct | NE 17th Ct | NE 18th Ave | NE 19th Ave | NE 21st Ave | NE 21st Ter | NE 22nd Ave | NE 23rd Cir | NE 24th Ter

N

0 250

Feet

Source: City of Ocala 2009 Aerials

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- 1717 88.78' — Address, Finished Floor Elevation
- Existing Flow Directions
- Wells
- New Flow Directions
- Extents of Flooding Predicted by Model for October 2011 Storm
- Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
- Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT

CITY OF OCALA

ALTERNATIVE 3
EXPAND NATURE CONSERVANCY POND AND ROUTE FLOW FROM 3RD AVE INTO YUM YUM POND

TETRA TECH

FIGURE 4-3

P:\IER\08508\200-08508-12001\GIS\maps\BLAlt3F4-3.mxd [betty.morris 6/6/2012]

Table 4.4-1
Summary of Flood Elevations
Comparison of Alternative 3 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 3 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	86.61	82.78
Mean annual 24 hour event	4.30	75.44	74.27
10 year - 24 hour event	6.40	81.82	78.27
25 year - 96 hour event	11.75	89.64	86.19
100 year - 24 hour event	11.50	90.29	88.49
100 year - 24 hour event (FEMA)	11.50	90.80	89.30

Table 4.4-2
Summary of Flood Elevations
Comparison of Alternative 3 to the Existing Conditions
Expanded Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 3 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	89.77	88.99
Mean annual 24 hour event	4.30	83.67	79.04
10 year - 24 hour event	6.40	87.64	83.19
25 year - 96 hour event	11.75	90.24	90.15
100 year - 24 hour event	11.50	90.31	90.23
100 year - 24 hour event (FEMA)	11.50	90.80	90.27

Table 4.4-3
Summary of Residences Flooding
Comparison of Alternative 3 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 3 # Residences Flooding
Calibration Storm 8 hour event	8.20	4	0
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	16	2
100 year - 24 hour event	11.50	19	11
100 year - 24 hour event (FEMA)	11.50	22	15

Table 4.4-4
Summary of Residences Flooding
Comparison of Alternative 3 to the Existing Conditions
Expanded Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 3 # Residences Flooding
Calibration Storm 8 hour event	8.20	2	1
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	7	5
100 year - 24 hour event	11.50	7	7
100 year - 24 hour event (FEMA)	11.50	9	7

The estimated probable cost for Alternative 3 (including replacement of all of the culverts between the Nature Conservancy pond and Yum Yum pond with larger diameters) would be approximately $600,000.

4.5 ALTERNATIVE 4 – LOWERING YUM YUM DRAINAGE WELL CASING

The well in the Yum Yum pond presents an opportunity to effect its flow capacity. The top of the well extends several feet above the bottom of the pond. Lowering it would allow the discharge rate to increase due to an increase in the available hydraulic head. The existing pond bottom elevation is 78.0 feet while the existing top of the well casing is 86.6 feet. Any attempt to lower the well will require compensatory measures to be taken to offset potential reductions in the quality of the surface water released from the pond.

As a starting point, an analysis was conducted to assess the minimum volume of water quality treatment that would be required by FDEP regulations as if the developed areas in this basin were newly constructed. Using this volume, the minimum top-of-casing elevation was set at 85.0 feet. This lowers the casing elevation by 1.6 feet. As an added measure of water quality mitigation, the City proposes construction of a sand filter on the drainage well. Tables 4.5-1 and 4.5-2 summarize the flood elevations for the various storms. In addition, Tables 4.5-3 and 4.5-4 summarizes the impact that this alternative has on potentially reducing the number of FFEs that would be exceeded by rising flood water.

Table 4.5-1
Summary of Flood Elevations
Comparison of Alternative 4 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 4 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	86.61	86.60
Mean annual 24 hour event	4.30	75.44	75.44
10 year - 24 hour event	6.40	81.82	81.82
25 year - 96 hour event	11.75	89.64	89.59
100 year - 24 hour event	11.50	90.29	90.26
100 year - 24 hour event (FEMA)	11.50	90.80	90.76

Table 4.5-2
Summary of Flood Elevations
Comparison of Alternative 4 to the Existing Conditions
Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 4 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	89.77	89.76
Mean annual 24 hour event	4.30	83.67	83.67
10 year - 24 hour event	6.40	87.64	87.64
25 year - 96 hour event	11.75	90.24	90.23
100 year - 24 hour event	11.50	90.31	90.31
100 year - 24 hour event (FEMA)	11.50	90.80	90.76

Table 4.5-3
Summary of Residences Flooding
Comparison of Alternative 4 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 4 # Residences Flooding
Calibration Storm 8 hour event	8.20	4	4
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	16	16
100 year - 24 hour event	11.50	19	19
100 year - 24 hour event (FEMA)	11.50	22	22

Table 4.5-4
Summary of Residences Flooding
Comparison of Alternative 4 to the Existing Conditions
Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 4 # Residences Flooding
Calibration Storm 8 hour event	8.20	2	2
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	7	7
100 year - 24 hour event	11.50	7	7
100 year - 24 hour event (FEMA)	11.50	9	9

The results indicated that this alternative, which is run independent of the other alternatives, provides a marginal improvement in reducing the flood elevations in the Heritage Hills and Conservancy basins for the various storms. It doesn't reduce the number of homes with the FEMA 100-year floodplain above their FFEs. Although the flood level is reduced in the Yum Yum pond, the limitation on the depth of improvement for the Heritage Hills and Nature Conservancy retention areas is the rate at which flood water is pumped from the Heritage Hills pond. The capacity of the pumps would have to be increased in order to take advantage of the additional capacity in the Yum Yum drainage well. Figure 4-4 below provides a graphic depiction of the FEMA 100-year flood elevation. The estimated probable cost for Alternative 4 would be approximately $80,000.

Heritage Hills Pond Sub-Basin

School Sub-Basin

Nature Conservancy Pond Sub-Basin

Heritage Hills Pond Sub-Basin

Perry Swim School Sub-Basin

Yum Yum Pond Sub-Basin

FDOT Basin

Heritage Hills Pond

Nature Conservancy Pond

Apartment Pond

Yum Yum Pond

FDOT Pond #9

N

0 250

Feet

Source: City of Ocala 2009 Aerials; FEMA Panels 12083C0528D & 12083C0536D, effective 08/28/2008

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- 1717 88.78' Address Finished Floor Elevation
- Flow Directions
- Wells
- Extents of Flooding Predicted by Model for October 2011 Storm
- Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
- Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

ALTERNATIVE 4
LOWERING YUM YUM DRAINAGE WELL CASING

TETRA TECH

FIGURE 4-4

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4.6 ALTERNATIVE 5 – RESTORE AND LOWER EXISTING FDOT SHALLOW WELLS

This alternative involves the FDOT taking action to maintain the drainage wells in FDOT Pond No. 9. In addition, the tops of the three shallow wells are proposed to be lowered to provide additional discharge capacity for the FDOT pond. The shallow wells are lowered to match the top-of-casing elevation of the deep well in the FDOT pond since it is the controlling elevation at which stormwater runoff is discharged. Tables 4.6-1 and 4.6-2 summarize the flood elevations for the various storms. In addition, Tables 4.6-3 and 4.6-4 summarizes the impact that this alternative has on potentially reducing the number of FFEs that would be exceeded by rising flood water.

Table 4.6-1
Summary of Flood Elevations
Comparison of Alternative 5 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 5 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	86.61	86.46
Mean annual 24 hour event	4.30	75.44	75.44
10 year - 24 hour event	6.40	81.82	81.13
25 year - 96 hour event	11.75	89.64	89.44
100 year - 24 hour event	11.50	90.29	90.08
100 year - 24 hour event (FEMA)	11.50	90.80	90.59

Table 4.6-2
Summary of Flood Elevations
Comparison of Alternative 5 to the Existing Conditions
Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 5 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	89.77	89.56
Mean annual 24 hour event	4.30	83.67	83.67
10 year - 24 hour event	6.40	87.64	87.64
25 year - 96 hour event	11.75	90.24	90.20
100 year - 24 hour event	11.50	90.31	90.29
100 year - 24 hour event (FEMA)	11.50	90.80	90.59

Table 4.6-3
Summary of Residences Flooding
Comparison of Alternative 5 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 5 # Residences Flooding
Calibration Storm 8 hour event	8.20	4	5
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	16	16
100 year - 24 hour event	11.50	19	18
100 year - 24 hour event (FEMA)	11.50	22	21

Table 4.6-4
Summary of Residences Flooding
Comparison of Alternative 5 to the Existing Conditions
Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 5 # Residences Flooding
Calibration Storm 8 hour event	8.20	2	2
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	7	7
100 year - 24 hour event	11.50	7	7
100 year - 24 hour event (FEMA)	11.50	9	8

The benefit gained from this analysis is marginal for the FDOT Pond #9, the Heritage Hills retention area and the Nature Conservancy retention pond. Flood stages in the FDOT pond only reduced by approximately 0.1 feet for all of the storms except the 10 year storm for which the results show a 0.6 foot drop in the flood elevation. Similarly, the Heritage Hills retention area and the Nature Conservancy pond show approximately a 0.6 drop in the 10-year storm flood elevations.

These results all hinge on the actual increases in flow capacity that would result from the proposed improvements in this alternative. Theoretical values were used for the models in this report. Performance tests should ultimately be performed on all of the wells in this basin to obtain actual flow capacities of the wells.

Based on the results of this model, FDOT Pond #9 will continue to exceed its top of bank in the large storms including the 25-year/96-hour and 100-year storm events. The preliminary opinion of probable cost for this alternative is $365,000 when also taking into account the soft costs that will be necessary to obtain the required permits.

Heritage Hills Pond Sub-Basin

School Sub-Basin

Nature Conservancy Pond Sub-Basin

Heritage Hills Pond Sub-Basin

Perry Swim School Sub-Basin

Yum Yum Pond Sub-Basin

FDOT Basin

Heritage Hills Pond

Nature Conservancy Pond

Apartment Pond

Yum Yum Pond

FDOT Pond #9

1705 91.39'
1715 90.33'
1727 89.22'
1733 89.84'
1743 90.22'
1753 89.82'
1706 89.22'
1716 87.86'
1732 86.47'
1748 86.4'
1754 86.47'
1705 89.36'
1717 88.78'
1727 85.78'
1737 84.38'
1706 93.53'
1716 90.99'
1726 88.12'
1736 85.14'
1725 94.25'
1735 92.47'
310 85.96'
311 90.3'
321 86.49'
403 88.56'
411 87.7'
417 91.09'
423 90.75'
412 92.35'
525 93.79'
516 94.35'
515 91.7'
506 92.18'
507 90.17'
508 93.8'
424 90.58'
429 87.68'
428 92.55'
414 90.05'
415 89.2'
416 90.63'
406 90.17'
405 90.01'
404 91.2'
313 88.97'
314 91.35'
307 90.89'
2121 92.86'
413 93.7'
407 91.76'
313 92.91'
2131 93.11'
2036 92.29'
2044 91.3'
2102 93.54'
2014 93.95'

NE 6th St
NE 5th Pl
NE 5th St
NE 4th St
NE 3rd St
NE 2nd St
NE 17th Ave
NE 16th Ave
NE 15th Ct
NE 18th Ave
NE 19th Ave
NE 21st Ave
NE 21st Ter
NE 22nd Ave
NE 23rd Cir

N

0 250
Feet

Source: City of Ocala 2009 Aerials; FEMA Panels 12083C0528D & 12083C0536D, effective 08/28/2008

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- 1717 88.78' Address Finished Floor Elevation
- Flow Directions
- Wells
- Extents of Flooding Predicted by Model for October 2011 Storm
- Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
- Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

ALTERNATIVE 5
RESTORE AND LOWER CASING OF EXISTING FDOT SHALLOW WELLS

TETRA TECH

FIGURE 4-5

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4.7 ALTERNATIVE 6 – CONSTRUCT DRA ON SOUTH SIDE OF S.R. 40

The drainage basin for the FDOT Pond #9 is the largest of all of the basins with a significant portion of it located south of S.R. 40. As noted above in Alternative 5, the proposed improvements to maintain the wells and lower the shallow wells resulted in marginal reductions in the floodplain elevations. Also, the results indicate that the FDOT will continue to exceed its top of bank during the large storms. Alternative 6 is included in this analysis to assess what the impact would be on the FDOT if a pond was constructed south of S.R. 40 to capture and slow down the flows from this portion of the FDOT Pond #9 basin and remove some of the burden from FDOT Pond #9. Tables 4.7-1 and 4.7-2 summarize the flood elevations for the various storms. In addition, Tables 4.7-3 and 4.7-4 summarizes the impact that this alternative has on potentially reducing the number of FFEs that would be exceeded by rising flood water.

Table 4.7-1
Summary of Flood Elevations
Comparison of Alternative 6 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 6 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	86.61	86.39
Mean annual 24 hour event	4.30	75.44	75.44
10 year - 24 hour event	6.40	81.82	81.13
25 year - 96 hour event	11.75	89.64	89.36
100 year - 24 hour event	11.50	90.29	89.98
100 year - 24 hour event (FEMA)	11.50	90.80	90.26

Table 4.7-2
Summary of Flood Elevations
Comparison of Alternative 6 to the Existing Conditions
Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 6 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	89.77	89.32
Mean annual 24 hour event	4.30	83.67	83.67
10 year - 24 hour event	6.40	87.64	87.64
25 year - 96 hour event	11.75	90.24	90.11
100 year - 24 hour event	11.50	90.31	90.18
100 year - 24 hour event (FEMA)	11.50	90.80	90.26

Table 4.7-3
Summary of Residences Flooding
Comparison of Alternative 6 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 6 # Residences Flooding
Calibration Storm 8 hour event	8.20	4	4
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	16	16
100 year - 24 hour event	11.50	19	18
100 year - 24 hour event (FEMA)	11.50	22	19

Table 4.7-4
Summary of Residences Flooding
Comparison of Alternative 6 to the Existing Conditions
Nature Conservancy Pond

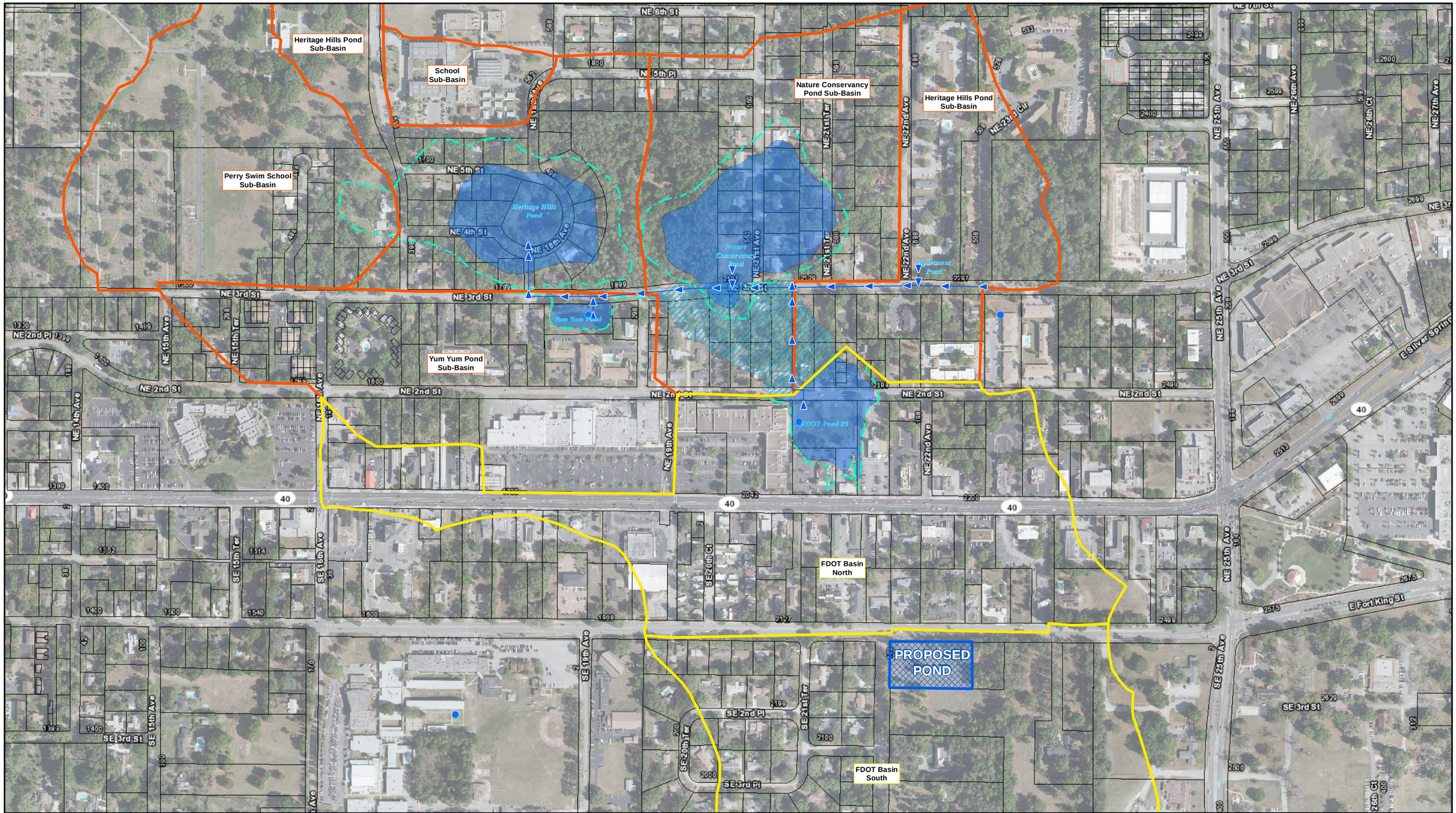
Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 6 # Residences Flooding
Calibration Storm 8 hour event	8.20	2	2
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	7	5
100 year - 24 hour event	11.50	7	7
100 year - 24 hour event (FEMA)	11.50	9	7

Similarly to the results in Alternative 5 above, this alternative has only a marginal impact on reducing the flood elevations in the Heritage Hills and the Nature Conservancy basins for the Mean Annual storm. However, the results indicate a more significant impact of reducing the flood elevation in these basins for the large storms including the major storm in October of 2011. Also, the results of this alternative indicate that flow over the top of bank of the FDOT pond would be eliminated for all of the modeled storms.

Tables 4.7-3 and 4.7-4 show that a low reduction in the number of homes with FFEs removed from below the FEMA 100-year floodplain.

The location of the pond is conceptually shown in an area that will require the purchase property. Refer to Figure 4-6 below. Records from the tax appraiser's Website indicate that most of the property located in the southeast corner of East fort King Street and east of SE 22nd Avenue is privately owned. The records show the City owning a small tract less than 0.5 acres within this block. The county owns the larger tracts of land south of East Fort King Street and west of SE 25th Avenue.

The preliminary opinion of probable cost for this alternative is $260,000.



N

0 420

Feet

Source: City of Ocala 2009 Aerials; FEMA Panels 12083C0528D & 12083C0536D, effective 08/28/2008

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- Flow Directions
- Wells
- 87.7 / 88.78' Extents of Flooding Predicted by Model for October 2011 Storm
- Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
- Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

ALTERNATIVE 6
CONSTRUCT DRA ON SOUTH SIDE OF S.R. 40

TETRA TECH

FIGURE 4-6

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4.8 ALTERNATIVE 7 - RELOCATE FDOT SHALLOW WELLS TO HERITAGE DRA

This alternative includes the effects of the expanded Nature Conservancy pond. In addition, the model predicted lower peak stages when the impact of the proposed improvements proposed in Alternative 2 were included. This alternative involves capping the three (3) shallower wells in FDOT Pond #9 and constructing three (3) wells of similar size and depths in the Heritage Hills pond as depicted on Figure 11.

In earlier discussions with the City, the idea was to consider relocating the well from the Yum Yum pond into the Heritage Hills pond. However, upon inspection of the drainage wells by Tetra Tech, the Hydrogeologists strongly recommend leaving the Yum Yum well in place. They're assessment shows that it is in good condition and, from City input on its apparent high flow capacity, there is no guarantee that similar conditions will exist in the Heritage Hills retention pond. Their recommendation is that if any wells are considered for transfer into the Yum Yum pond, they should be the less effective and shallower wells in the FDOT pond. The full report from the well inspection conducted by Tetra Tech is included in Appendix A.

For this model, the two (2) 4-inch and one (1) 18-inch drainage wells were moved from FDOT Pond #9 and installed in the Heritage Hills pond with an overflow elevation of 81.0 feet, or 1.9 feet below the top of bank. This change improved all conditions except the FDOT Pond #9 in which the stage increased. Therefore, any plans to remove any of the wells out of the FDOT Pond #9 will require additional upstream improvements to mitigate the slight increase in flood stage that would result if the three (3) wells are relocated. Ideally, the improvements to offset this effect would be constructed on the south side of S.R. 40. It could involve a retention pond or an exfiltration system along some of the City's public right of ways.

Table 4.8-1 shows a summary of the resulting flood elevations compared to the existing conditions for the Heritage Hills retention pond, Table 4.8-2 is a summary for the_Nature Conservancy Pond. The Yum Yum Pond is marginally affected by the improvements. However the FDOT Pond #9 stages higher and sends additional water downstream via overland flow between the residences that separate NE 2nd Ave and NE 3rd St. Table 4.8-3 and Table 4.8-4 shows the impact how this alternative could potentially reduce the number of residences subjected to flooding above their FFEs.

Table 4.8-1
Summary of Flood Elevations
Comparison of Alternative 7 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 7 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	86.61	82.12
Mean annual 24 hour event	4.30	75.44	74.27
10 year - 24 hour event	6.40	81.82	78.27
25 year - 96 hour event	11.75	89.64	84.70
100 year - 24 hour event	11.50	90.29	86.93
100 year - 24 hour event (FEMA)	11.50	90.80	87.83

Table 4.8-2
Summary of Flood Elevations
Comparison of Alternative 7 to the Existing Conditions
Expanded Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing Stage (ft-NAVD 88)	ALT 7 (ft-NAVD 88)
Calibration Storm 8 hour event	8.2	89.77	89.36
Mean annual 24 hour event	4.30	83.67	79.04
10 year - 24 hour event	6.40	87.64	83.30
25 year - 96 hour event	11.75	90.24	90.20
100 year - 24 hour event	11.50	90.31	90.28
100 year - 24 hour event (FEMA)	11.50	90.80	90.31

Table 4.8-3
Summary of Residences Flooding
Comparison of Alternative 7 to the Existing Conditions
Heritage Hills Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 7 # Residences Flooding
Calibration Storm 8 hour event	8.20	4	0
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	16	1
100 year - 24 hour event	11.50	19	8
100 year - 24 hour event (FEMA)	11.50	22	9

Table 4.8-4
Summary of Residences Flooding
Comparison of Alternative 7 to the Existing Conditions
Expanded Nature Conservancy Pond

Storms modeled for review	Rainfall (in)	Existing # Residences Flooding	ALT 7 # Residences Flooding
Calibration Storm 8 hour event	8.20	2	2
Mean annual 24 hour event	4.30	0	0
10 year - 24 hour event	6.40	0	0
25 year - 96 hour event	11.75	7	7
100 year - 24 hour event	11.50	7	7
100 year - 24 hour event (FEMA)	11.50	9	7

If a second retention pond in the FDOT basin is not practical then this alternative is not practical as it would exacerbate the conditions at the FDOT Pond #9.

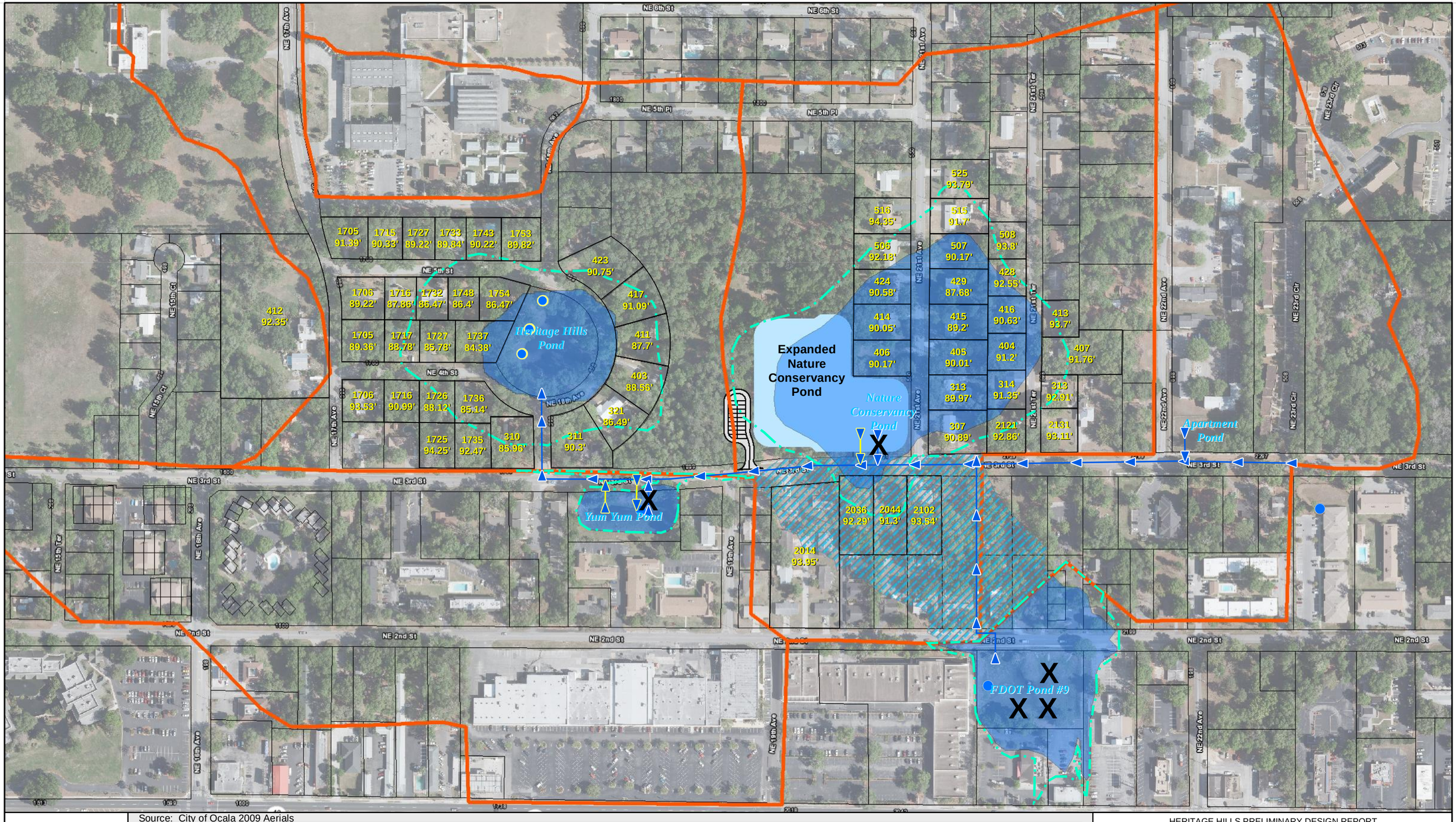
The estimated probable cost for this Alternative would be approximately $2.15 million. This cost does not include the cost to purchase a 1.5 acre property to excavate a pond to offset the effects of the slight rise in the FDOT Pond #9.

4.9 WORST CASE SCENARIO FOR FAILURE OF DRAINAGE WELLS

The City requested a prediction of the anticipated flooding that would happen if the drainage well in the Yum Yum pond, or the drainage wells in FDOT Pond #9, were to fail. The results of this scenario are summarized below in Table 4.9-1 and shown on Figures 4-8 and 4-9.

Table 4.9-1
Summary of Fail Alternatives

Fail #	Description	Flood Stage Increase	Estimated Number of Impacted Homes
Fail 1	Drainage Well in Yum Yum Pond Fails	0.42-feet to 0.55-feet	5
Fail 2	Drainage Wells in FDOT Pond #9 Fail	0.63-feet to 0.76-feet	7



N

0 250

Feet

Source: City of Ocala 2009 Aerials

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- 1717 88.78' Address / Finished Floor Elevation
- Existing Flow Directions
- Wells
- New Flow Directions
- New Drainage Well
- Extents of Flooding Predicted by Model for October 2011 Storm
- Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
- Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT

CITY OF OCALA

ALTERNATIVE 7 - EXPAND NATURE CONSERVANCY POND AND ROUTE FLOW FROM 3RD AVE INTO YUM YUM POND AND RELOCATE DRAINAGE WELLS INTO HERITAGE HILLS POND

TETRA TECH

FIGURE 4-7

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Heritage Hills Pond Sub-Basin

School Sub-Basin

Nature Conservancy Pond Sub-Basin

Heritage Hills Pond Sub-Basin

Perry Swim School Sub-Basin

Yum Yum Pond Sub-Basin

FDOT Basin

Heritage Hills Pond

Nature Conservancy Pond

Apartment Pond

Yum Yum Pond

FDOT Pond #9

1705 91.39'
1715 90.33'
1727 89.22'
1733 89.84'
1743 90.22'
1753 89.82'
423 90.75'
417 91.09'
411 87.7'
403 88.56'
321 86.49'
311 90.3'
310 85.96'
1725 94.25'
1735 92.47'
1706 93.53'
1716 90.99'
1726 88.12'
1736 85.14'
412 92.35'
1706 89.22'
1716 87.86'
1732 86.47'
1748 86.4'
1754 86.47'
1705 89.36'
1717 88.78'
1727 85.78'
1737 84.38'
525 93.79'
516 94.35'
515 91.7'
508 93.8'
506 92.18'
507 90.17'
428 92.55'
424 90.58'
429 87.68'
416 90.63'
414 90.05'
415 89.2'
413 93.7'
406 90.17'
405 90.01'
404 91.2'
407 91.76'
313 88.97'
314 91.35'
313 92.91'
307 90.89'
2121 92.86'
2131 93.11'
2036 92.29'
2044 91.3'
2102 93.54'
2014 93.95'

Source: City of Ocala 2009 Aerials

N

0 250
Feet

LEGEND

Heritage Hills Drainage Basin
FDOT Pond #9 Basin
1717 88.78' Address Finished Floor Elevation
Existing Flow Directions
Wells
Extents of Flooding Predicted by Model for October 2011 Storm
Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

FAIL 1
DRAINAGE WELLS IN YUM YUM POND FAIL

TETRA TECH

FIGURE 4-8

P:\IER\08508\200-08508-12001\GIS\maps\BLFail1F4-8.mxd [betty.morris 6/6/2012]

Heritage Hills Pond Sub-Basin

School Sub-Basin

Nature Conservancy Pond Sub-Basin

Heritage Hills Pond Sub-Basin

Perry Swim School Sub-Basin

Yum Yum Pond Sub-Basin

FDOT Basin

Heritage Hills Pond

Nature Conservancy Pond

Apartment Pond

Yum Yum Pond

FDOT Pond #9

1705 91.39'
1715 90.33'
1727 89.22'
1733 89.84'
1743 90.22'
1753 89.82'
1706 89.22'
1716 87.86'
1732 86.47'
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313 88.97'
314 91.35'
313 92.91'
307 90.89'
2121 92.86'
2131 93.11'
2036 92.29'
2044 91.3'
2102 93.54'
2014 93.95'

Source: City of Ocala 2009 Aerials

N

0 250
Feet

LEGEND

- Heritage Hills Drainage Basin
- FDOT Pond #9 Basin
- Address Finished Floor Elevation
- Existing Flow Directions
- Wells
- Extents of Flooding Predicted by Model for October 2011 Storm
- Extents of Flooding Predicted by Model 100 Year - 24 Hour Storm
- Maximum Extents of Overland Flow

Base Flood Elevations (BFE) in NAVD88

HERITAGE HILLS PRELIMINARY DESIGN REPORT
CITY OF OCALA

FAIL 2
DRAINAGE WELLS IN FDOT POND #9 FAIL

TETRA TECH

FIGURE 4-9

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4.10 ALTERNATIVES SUMMARY

A summary of the alternatives presented is provided below in Table 4.10-1. Itemized breakdowns of the probable costs are included in Appendix A. As shown, Alternatives 2 and 3 demonstrate significant positive improvements with a reasonable benefit to cost relationship. The final alternative also demonstrates positive flood stage reduction; however, is not as cost effective when considering the overall benefit. The home purchasing plan is a viable alternative considering the current status of home prices.

Furthermore, the number of homes targeted for purchase could be reduced if the Heritage Hills DRA could be expanded to replace homes that are purchased by the City. This would be an iterative process to minimize the number of homes that would have to be purchase by further lowering the FEMA 100-year flood elevation by expanding the Heritage Hills and the Nature Conservancy retention areas.

Table 4.10-1
Summary of Alternatives

Alternative #	Description	Reduction in Number of Residences No Longer Predicted to Flood Heritage Hills Drainage Basin		Estimated Probable Cost
		October 2011 Storm	FEMA 100 Year 24 Hour	
Alternative 1	Home Purchasing Plan	30*	30	$3,100,000
Alternative 2	Expanded Nature Conservancy Pond	4	7	$760,000
Alternative 3	Route Flow from 3rd Ave into Yum Yum Pond	5	7	$600,000
Alternative 4	Lowering Yum Yum Well	0	0	$80,000
Alternative 5	Restore and Lower Existing FDOT Wells	1	1	$365,000
Alternative 6	Construct DRA South of S.R. 40	1	3	$260,000
Alternative 7	Relocate Drainage Wells into Heritage Hills Pond	5	10	$2.15 million

*Only six (6) homes flooded above their FFEs, however, 30 homes would be purchased as part of this alterntive.

The costs for Alternatives 3 and 7 above should also include the cost for Alternative 2 since it is the most critical element required to obtain the maximum benefit to alleviate flooding in the study area.

SECTION 5

RECOMMENDATIONS

5.1 GENERAL

The results from the modeling and alternatives analysis indicate that the ultimate solution to alleviating flooding in the Heritage Hills Drainage Basin should involve the expansion of existing retention pond or ponds. In addition to improving the water quality of the water discharged into the drainage wells, the retention pond would serve to reduce the peak stage of the Heritage Hills retention pond and the Nature Conservancy retention pond. Also, a concerted effort should be made to require measures to be put in place to attenuate flows from the middle school property to predevelopment conditions.

5.2 RECOMMENDATIONS

The alternatives recommended for construction are Alternatives 2 and 3, which includes expanding the Nature Conservancy pond and improvements to the storm sewer system along NE 3rd Avenue. These improvements would significantly reduce the number of homes with FFEs below the flood elevation of the major storm in October of 2011 and the FEMA 100 year – 24 hour storm. FEMA FMGP cost-share funding may be available to assist the City with the capital to implement these improvements if the need can be demonstrated throught the application process.

The home purchasing plan presents a viable alternative to greatly enhance the LOS in the Heritage Hills and Nature Conservancy basins. Although the results of the analysis indicate 30 homes with FFEs below the FEMA 100-year floodplain, this number could be substantially reduced if the retention ponds in the Heritage Hills and Nature Conservancy basins would be expanded into the areas in which homes are ultimately purchased. It would be an interactive process to minimize the number of homes targeted for purchase.

It is also recommended that measures are taken to improve conditions within the FDOT basin. Alternative 6, which involves construction of a pond south of S.R. 40, provides moderate improvements in the Heritage Hills and Nature Conservancy basins. Unlike Alternative 5, it also provides enough attenuation south of S.R. 40 to keep Pond #9 from flowing over its banks in the large storms. The City and FDOT would work out the details of covering the cost of this expenditure.

To maximize the hydraulic connection between the three ponds (Heritage Hills, Yum Yum, and Nature Conservancy), a more detailed hydraulic analysis will be required prior to final design. This analysis would review the condition of each of the existing culverts for their condition compared to their life cycle; a comparison of their current capacity to the required capacity; the culvert sizing and connection, including smart boxes and variable weirs. This would allow the stormwater to most efficiently transfer between the ponds and maximize the use of all available storage and minimize the number of homes that could be inundated with flood water.