Preliminary Flood Assessment
Technical Memorandum
Royal Trails Flood Study

LAKE COUNTY
FLORIDA

Prepared for:
DEPARTMENT OF PUBLIC WORKS
LAKE COUNTY, FLORIDA

March 2009

Prepared by:
Inwood consulting engineers

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Royal Trails Flood Study

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Department of Public Works

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3000 Dovera Drive, Suite 200
Oviedo, FL 32765
p 407.971.8850 f 407.971.8955

Inwood consulting engineers

March 17, 2009 LAK-005-01

Mary Hamilton, Stormwater Project Manager
Lake County Public Works
437 Ardice Avenue
Eustis, Florida 32726

Re: Royal Trails Flood Study
Preliminary Flood Assessment Technical Memorandum
County PO # 20701804

Dear Ms. Hamilton,

Inwood Consulting Engineers, Inc. (Inwood) is pleased to submit two (2) copies of the Preliminary Flood Assessment Technical Memorandum for the Royal Trails Flood Study for the County's review. If you have any questions please do not hesitate to contact the undersigned below.

Inwood is pleased to provide our services to Lake County on this project. If you have any questions regarding the attached, please contact us at 407-971-8850.

Very truly yours,

INWOOD CONSULTING ENGINEERS, INC.

Thomas D. Amstadt, P.E.
Project Engineer

Mark W. Ellard, P.E.
Project Manager

Attachments:

Two (2) copies of Preliminary Flood Assessment Technical Memorandum

3000 Dovera Drive, Suite 200 Oviedo, FL 32765 p 407.971.8850 f 407.971.8955

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1.0 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION AND BACKGROUND

This Technical Memorandum presents the results of a floodplain study and level of service (LOS) assessment in the Royal Trails subdivision. Inwood Consulting Engineers, Inc. (Inwood) was tasked by Lake County Public Works to perform this study as one of the tasks of the Royal Trails Flood Study. The study as a whole includes the following tasks:

- **Public Involvement Plan (Submitted September 2007) –** The plan provided detailed approach and schedule for interfacing with the subdivision residents. Plan included evaluating opportunities for public education during the course of the project to comply with NPDES requirements.
- **Preliminary Project Evaluation Technical Memorandum (Submitted October 2008) –** Compilation of the data collection efforts, physical characteristics of the subdivision, and preliminary engineering analysis tasks performed. A copy of this report is included on the DVD.
- **Preliminary Flood Assessment Technical Memorandum (this report) –** Compilation and summary of results of flood and level of service (LOS) modeling to prioritize problem areas for deficiency correction.
- **Preliminary Pollutant Loading Analysis Technical Memorandum (Submitted concurrent with this report) –** Compilation and summary of results of pollutant loading modeling to prioritize problem areas for BMP implementation.
- **Preliminary Deficiency Correction Plan Technical Memorandum –** A summary report to provide recommendations for the most appropriate corrective action to address drainage problems, correct level of service deficiencies, and improve water quality.
- **Final Project Study Report –** Report will include a reiteration of the Preliminary Evaluation, Flood Assessment, Pollutant Loading Analysis, and Deficiency Correction Plan with final recommendations. Final version will reflect relevant permitability information obtained from the permit determination coordination with SJRWMD. Final Report will also include a summary of the Public Involvement efforts including copies of all public issue documents, presentations, meeting summaries, etc.

1.2 PURPOSE & GOALS

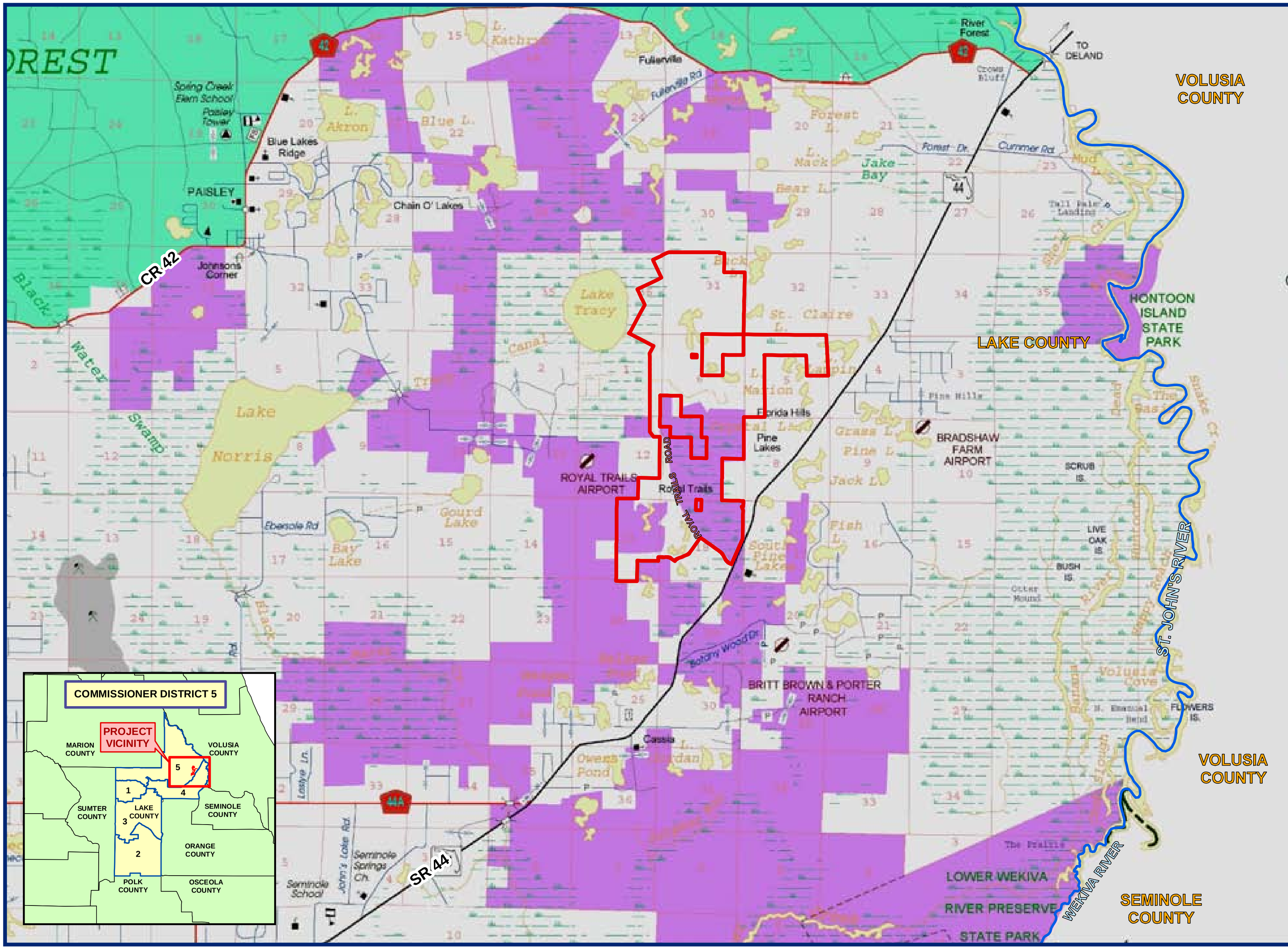
The purpose of this technical memorandum is to summarize efforts to:

- Establish 100-year floodplain elevations and extents within the Royal Trails subdivision; and
- Evaluate the LOS of drainage infrastructure and to identify LOS deficiencies in the subdivision.

The problem areas identified will be evaluated for potential corrective action as part of the Deficiency Correction Plan task of the project.

1.3 SITE LOCATION

The Royal Trails subdivision is located in northeastern unincorporated Lake County. Royal Trails is in section 36 of Township 17 South, Range 28 East, Section 31 of Township 17 South, Range 29 East, Sections 1,12,13,24, of Township 18 South, Range 28 East, Sections 4, 5, 6, 7, 18 of Township 18 South, Range 29 East. The subdivision is within the jurisdiction of the St. Johns River Water Management District (SJRWMD) and lies within the St. John's River Watershed. The subdivision is located within Lake County Commission District 5. Most of the subdivision lies within the Wekiva Protection Area. Royal Trails extends from west of SR 44 to east of Lake Tracy. The project vicinity is shown in Figure 1-1 and the project site is shown on Figure 1-2.



LAKE COUNTY FLORIDA

0 3,000 6,000 Feet

LEGEND

- ROYAL TRAILS SUBDIVISION
- LAKE COUNTY BOUNDARY

DATA SOURCES:

SUBDIVISION, ROADS, COMMMISIONER DISTRICTS: LAKE COUNTY, 2006

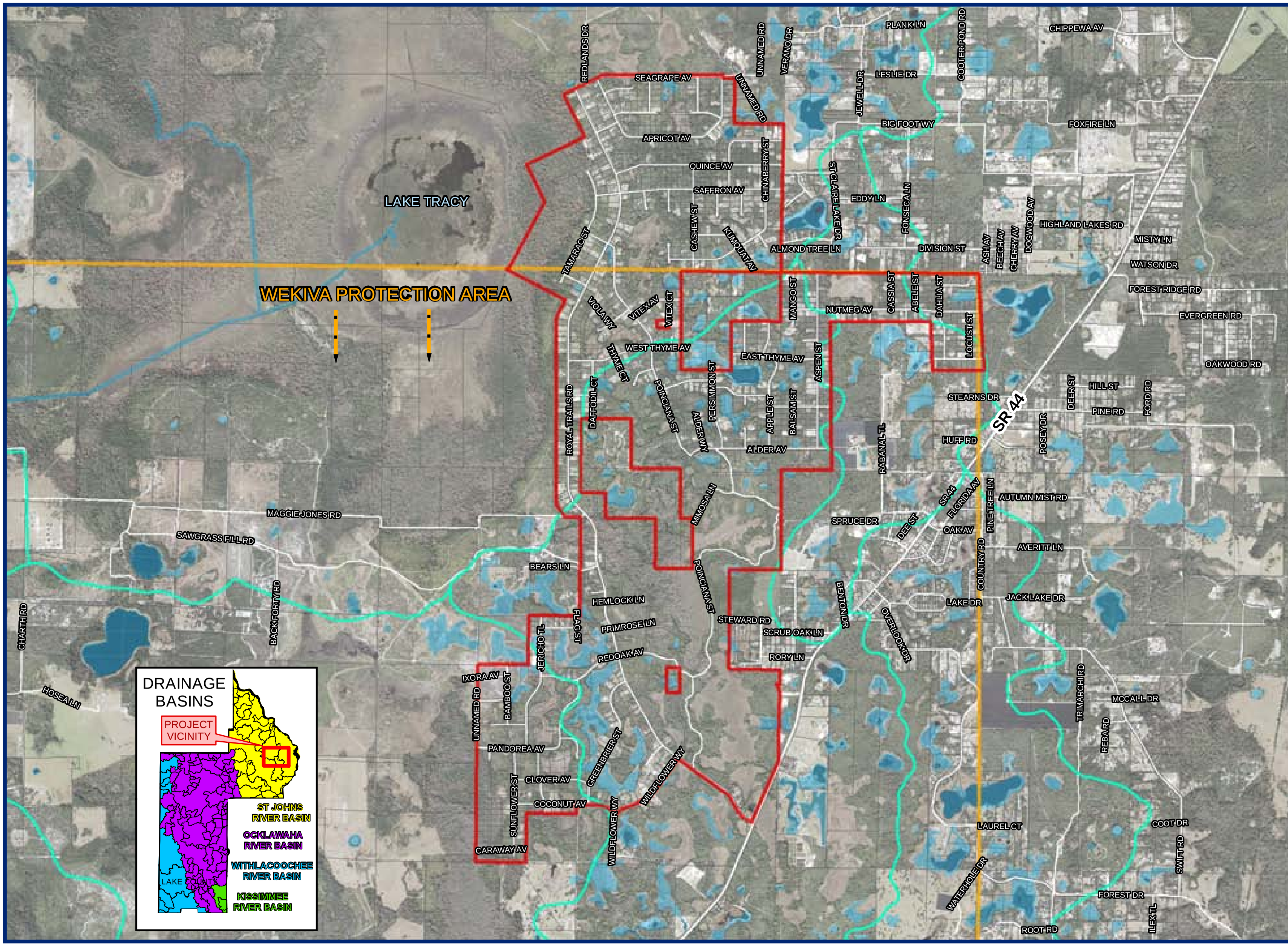
BACKGROUND MAP: FDOT HIGHWAY MAP, 2004

FIGURE 1-1

VICINITY MAP

Royal Trails Flood Study

Inwood consulting engineers



LAKE COUNTY FLORIDA

0 1,250 2,500 Feet

LEGEND
- ROYAL TRAILS SUBDIVISION
- WEKIVA PROTECTION AREA
- COUNTY DRAINAGE BASINS
- STREETS
- WATER BODIES
- ROYAL TRAILS PARCELS

DATA SOURCES:
SUBDIVISION: LAKE COUNTY, 2006
WEKIVA STUDY AREA: SJRWMD, 2005
PARCELS: LAKE COUNTY, 2008
BASINS: LAKE COUNTY, 1993
WATER BODIES: LAKE COUNTY, 2003
ROADS: LAKE COUNTY, 2004
AERIAL: LAKE COUNTY, 2008

FIGURE 1-2

SITE MAP

Royal Trails Flood Study

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2.0 DATA COLLECTION AND SITE CHARACTERISTICS

2.1 REVIEW OF MAINTENANCE REQUESTS

Maintenance requests and road maintenance history logs were obtained from Lake County Road Operations. The majority of maintenance requests were related to roadway structural issues. The approximate location and description of drainage and flooding related maintenance requests are shown on Figure 2-1. The road maintenance history logs provide a record of maintenance performed by the County in the subdivision, but no description of drainage related problems are included. Refer to the DVD included with this report for the maintenance requests and road maintenance logs for Royal Trails.

The flooding related maintenance requests will be compared to the hydrologic / hydraulic modeling results to aid in validating the model accuracy.

2.2 REVIEW OF AVAILABLE CONSTRUCTION PLANS AND PERTINENT DRAINAGE DATA

A drainage inventory survey was conducted by BCI in 2006. The inventory included data and photos for most of the culverts, drainage structures, and outfall ditches in the subdivision. The drainage inventory data included drainage structures details that were useful in the development of the hydraulic model for this study.

A Municipal Service Taxing Unit (MSTU) Project dated 1989 and associated drainage plans were obtained for the Royal Trails subdivision from Lake County. The project included an operation and maintenance plan for the Royal Trails drainage system and drainage plans that show the location of culverts, ditches, and drainage divides in the subdivision. The data was useful for confirming the designed drainage patterns of the subdivision.

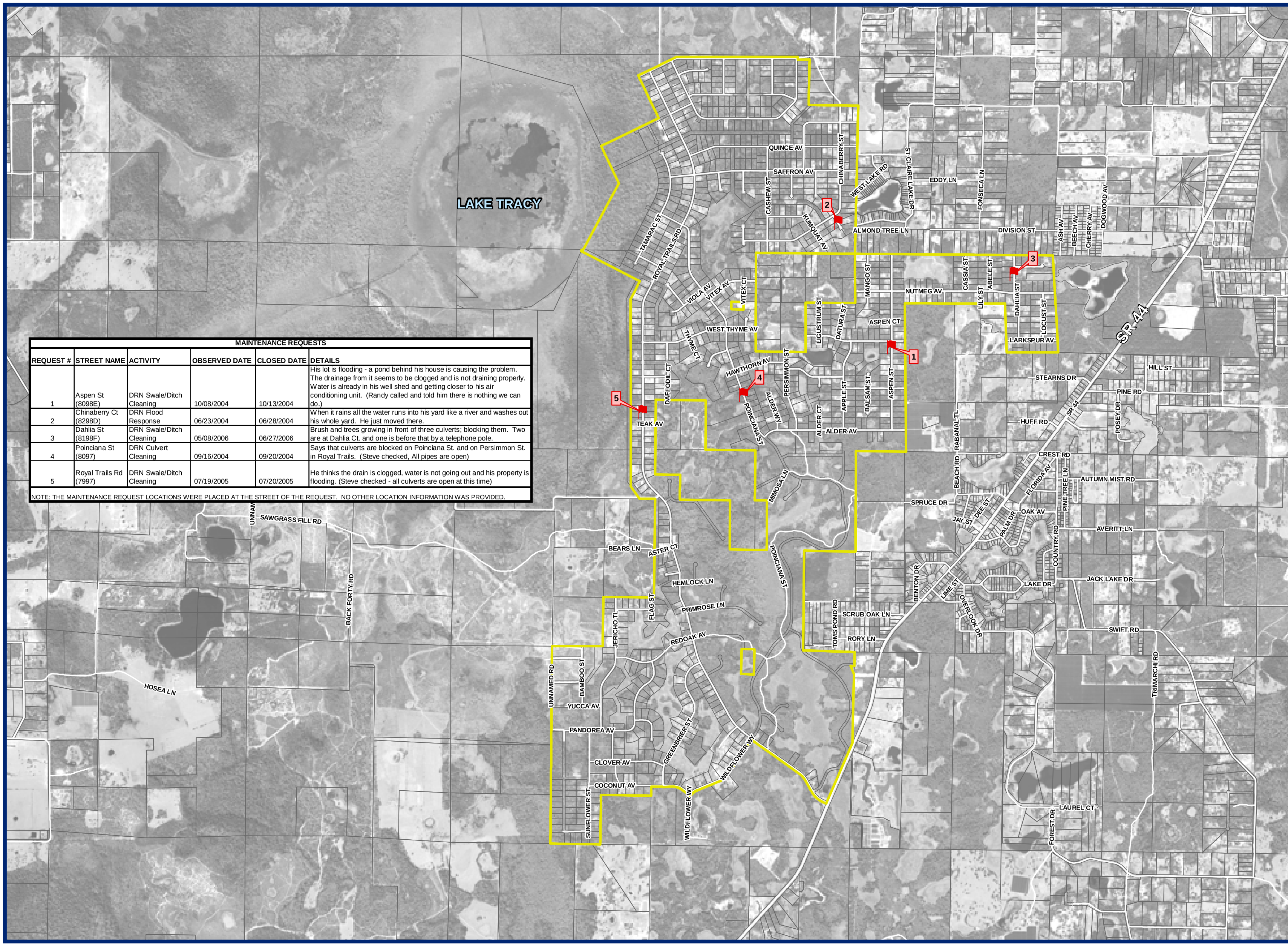
As-built plans dated 1954 were obtained for State Road 44 from the FDOT. Pertinent drainage data from the plans included culvert locations, size, material, and inverts that were referenced in the hydraulic model of this study.

The above referenced data is included on the DVD included with this report. The above referenced drainage infrastructure is shown on Exhibit 1.

2.3 FIELD INVESTIGATION

Inwood personnel visited the subdivision on October 3 and 4, 2007 to observe the condition of the roadside swales, culverts, outfall ditches, general lot grading, and elevation of each house relative to the road. The occupied parcels in the subdivision as of the date of the field investigation are shown on Figure 2-2.

Inwood personnel performed an additional site visit in February 2009 to obtain additional drainage structure details and confirm the existence of key drainage structures not included in the topographic survey. The existence of flash boards / risers in many of the control structures in the subdivision was investigated. The field investigation confirmed that the flash boards / risers in the majority of the control structures in the subdivision have been removed.



MAINTENANCE REQUESTS					
REQUEST #	STREET NAME	ACTIVITY	OBSERVED DATE	CLOSED DATE	DETAILS
1	Aspen St (8098E)	DRN Swale/Ditch Cleaning	10/08/2004	10/13/2004	His lot is flooding - a pond behind his house is causing the problem. The drainage from it seems to be clogged and is not draining properly. Water is already in his well shed and getting closer to his air conditioning unit. (Randy called and told him there is nothing we can do.)
2	Chinaberry Ct (8298D)	DRN Flood Response	06/23/2004	06/28/2004	When it rains all the water runs into his yard like a river and washes out his whole yard. He just moved there.
3	Dahlia St (8198F)	DRN Swale/Ditch Cleaning	05/08/2006	06/27/2006	Brush and trees growing in front of three culverts; blocking them. Two are at Dahlia Ct. and one is before that by a telephone pole.
4	Poinciana St (8097)	DRN Culvert Cleaning	09/16/2004	09/20/2004	Says that culverts are blocked on Poinciana St. and on Persimmon St. in Royal Trails. (Steve checked, All pipes are open)
5	Royal Trails Rd (7997)	DRN Swale/Ditch Cleaning	07/19/2005	07/20/2005	He thinks the drain is clogged, water is not going out and his property is flooding. (Steve checked - all culverts are open at this time)

NOTE: THE MAINTENANCE REQUEST LOCATIONS WERE PLACED AT THE STREET OF THE REQUEST. NO OTHER LOCATION INFORMATION WAS PROVIDED.

LAKE COUNTY
FLORIDA

N

0 1,250 2,500
Feet

LEGEND

- MAINTENANCE REQUESTS
- ROYAL TRAILS SUBDIVISION
- STREETS
- ROYAL TRAILS PARCELS

DATA SOURCES:
SUBDIVISION: LAKE COUNTY, 2006
PARCELS: LAKE COUNTY, 2008
ROADS: LAKE COUNTY, 2004
AERIAL: LAKE COUNTY, 2008
MAINTENANCE REQUESTS: LAKE COUNTY ROAD OPERATIONS, 2007

FIGURE 2-1

MAINTENANCE REQUESTS MAP

Royal Trails Flood Study

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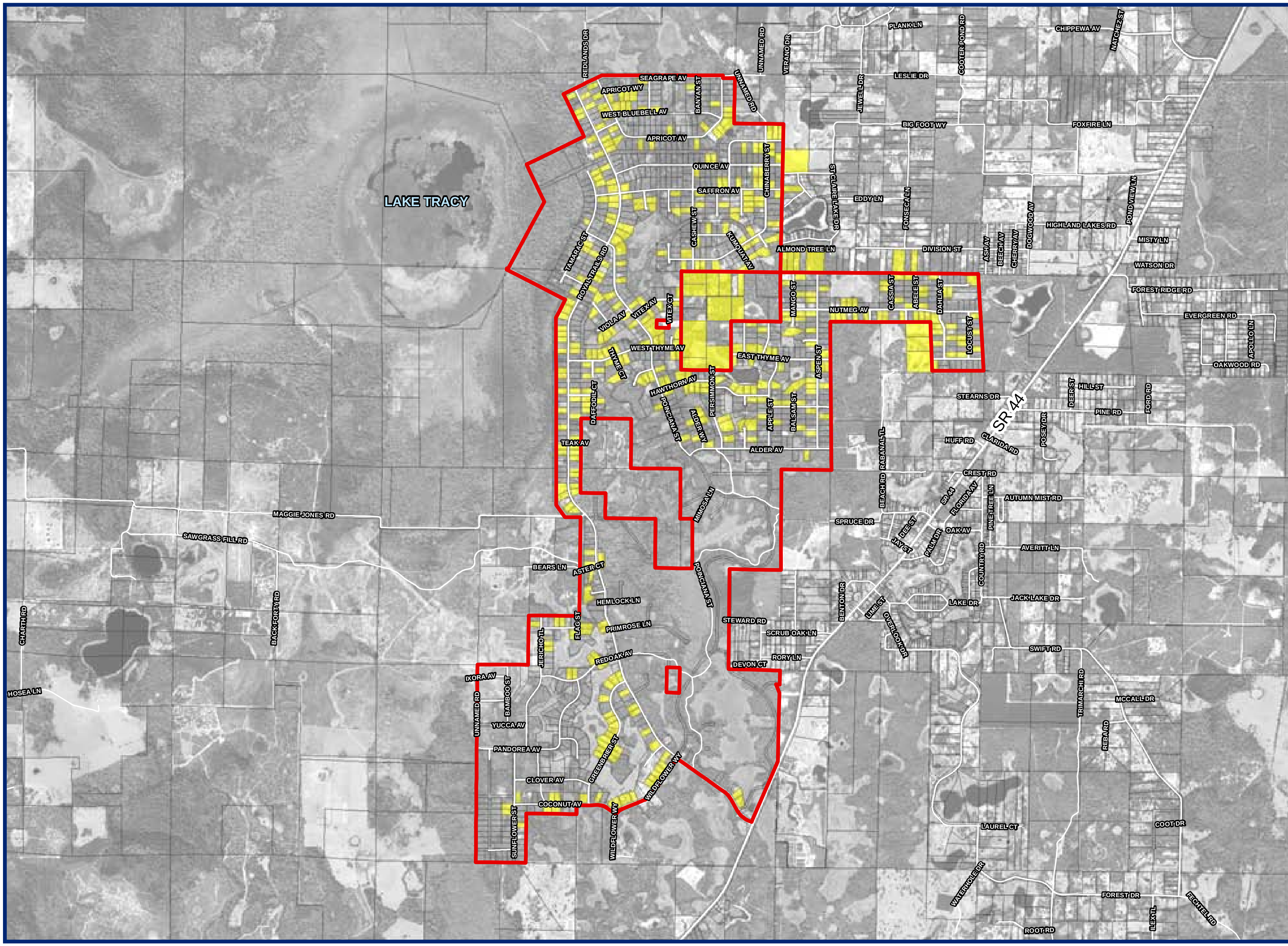

LAKE COUNTY FLORIDA

NOTE:
OCCUPIED PARCELS BASED ON OCTOBER 2007 FIELD OBSERVATIONS.

DATA SOURCES:
SUBDIVISION: LAKE COUNTY, 2006
PARCELS: LAKE COUNTY, 2008
ROADS: LAKE COUNTY, 2004
AERIAL: LAKE COUNTY, 2008

FIGURE 2-2

OCCUPIED PARCELS MAP

Royal Trails Flood Study

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2.4 FOLLOW UP INTERVIEWS WITH RESIDENTS

Follow up interviews with some of the subdivision residents were performed in February and March 2009. The residents were chosen for follow up based on comments received at the public meeting held on November 8th, 2007 or other comments received via emails or fax. The interviews conducted with the residents are summarized below:

- ***39915 Greenbrier Street*** – Resident attended the November 2007 public meeting where he mentioned he could provide information that may be useful for the study. A follow up interview occurred at his home on February 26th, 2009. The resident has never had flooding problems in the almost 30 years he has lived in the subdivision. However, the resident did mention that he has seen several houses flood or nearly flood that were built in areas that were formerly wetlands or lakes. He provided several aerial maps, topographic maps, engineering reports, photos and correspondence relevant to the drainage system at Royal Trails. He also provided aerial photos of the lakes in the subdivision prior to construction of the ditches that appear to show the water level of the lakes much higher than they are now. This information was scanned and is included on the DVD with this report. He believes that the construction of the ditches and the removal of the risers in the ditch control structures have significantly reduced the water level of the lakes and wetlands in the subdivision. He would like to see the lake levels in the subdivision restored to pre-ditch construction levels.
- ***30116 Viola Avenue*** – Resident reported flooding at her home after the 2004 hurricanes at the November 8th, 2007 public meeting. He mentioned during a follow up phone conversation on February 26th, 2009 that the property flooded during Tropical Storm Fay (in August 2008) and that flooding problems have occurred after other heavy rain events. During a field visit at the subject residence also on February 26th, 2009 a black line was shown that had been spray painted on the cinder blocks under the house to indicate the level that the flood water had reached in 2004. Photos of the property are shown below.

Photo of property looking southwest

Photo of space under residence and black line indicating flood water level.

- ***42302 West Cashew Ct*** – Resident reported prolonged yard flooding at the property after the 2004 hurricanes on a comment form from November 2007. During a field visit to the property on February 26th, 2009 the resident mentioned that the flood water had reached the wooden steps in front of the house and would have gotten higher if they had not pumped water from the property. The resident also mentioned that the County built ditch blocks in swale along Cashew Court to divert runoff from the street away from their property. The resident has also built a small berm along the side of the property to block water from coming into the property and brought in fill to raise the driveway. Flooding on the property also occurred during Tropical Storm Fay, but did not last as long as the flooding in 2004. Photos of the property are shown below.

Photo of property looking east

Photo of West Cashew Court swale looking north.

Photos property flooding after Hurricane Frances. (Provided by resident)

Photo of property after Tropical Storm Fay. (Provided by resident)

- ***41513 Aspen St*** – Resident reported flooding at the home after the 2004 hurricanes at the November 8th, 2007 public meeting and provided photos of flooding. It was indicated on a comment form that the flooding lasted for almost two years in 2004 and 2005. Attempts to contact the resident for a follow up visit were unsuccessful. Photos of the property are shown below.

Photo looking south at property.

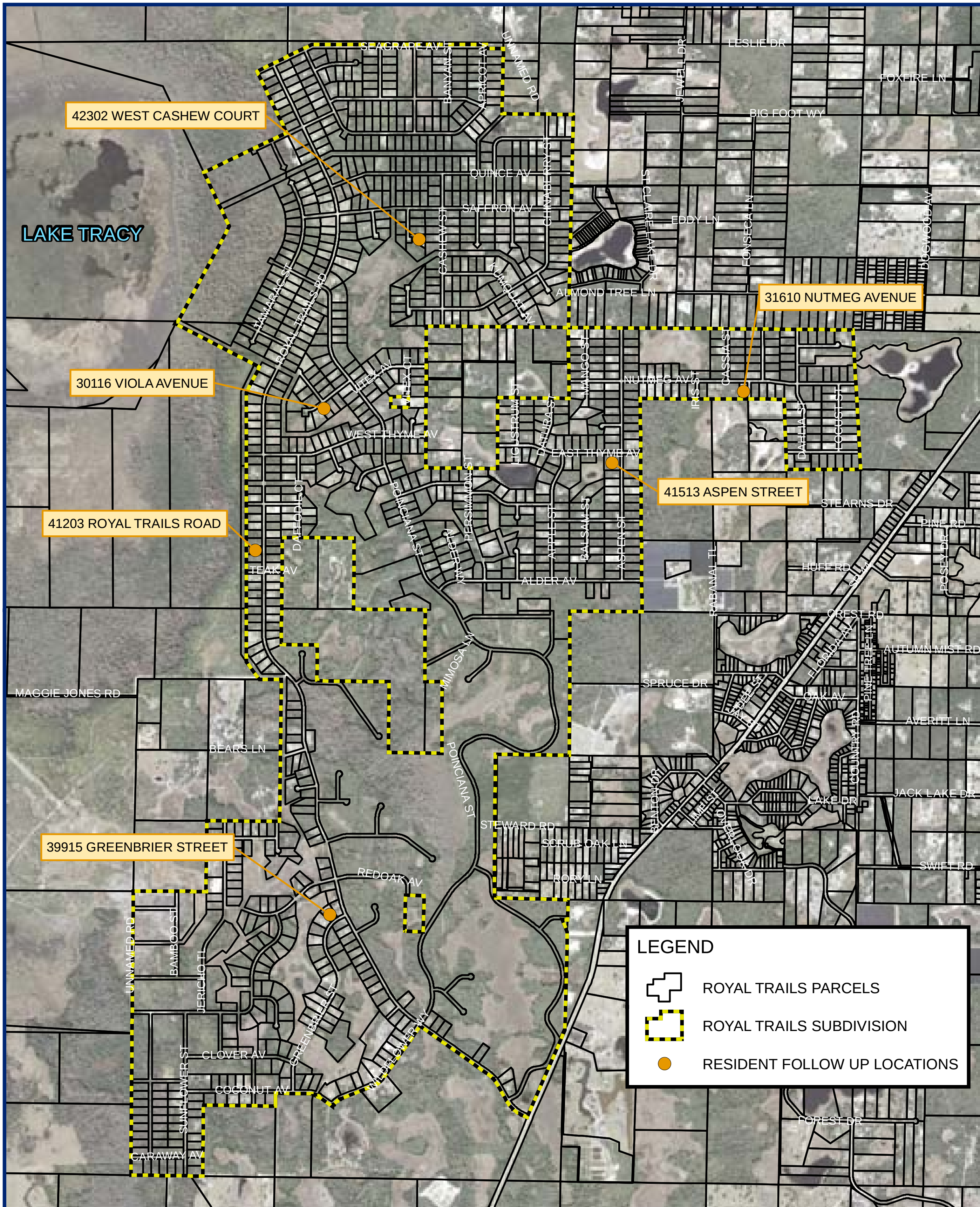
Photo looking south at flooding at property. (Provided by resident)

Photo looking southwest at property.

Photo looking west at flooding at property. (Provided by resident)

- ***31610 Nutmeg Avenue*** – Resident contacted the County by email concerning the project. The resident mentioned he has not seen flooding at his property. He is concerned with how changes to the floodplains may affect his insurance and property value. He was also concerned about maintenance in the subdivision (roadside swale grading).
- ***41203 Royal Trails Road*** – Resident attended the November 2007 public meeting. The resident mentioned he has never seen any flooding on his property. He is interested in seeing the results of this study but had no further comments.

The information obtained from the residents during the follow up interviews will be used for verification and validation of the hydrologic / hydraulic modeling. Refer to Section 8 - Verification and Validation Data for more details. See Figure 2-3 for a map of the locations of the residents who were contacted for follow up interviews.



LAKE COUNTY FLORIDA

DATA SOURCES:
SUBDIVISION: LAKE COUNTY, 2006
PARCELS: LAKE COUNTY, 2008
ROADS: LAKE COUNTY, 2004
AERIAL: LAKE COUNTY, 2008

N

0 1,250 2,500

Feet

FIGURE 2-3
FOLLOW UP INTERVIEWS WITH RESIDENTS MAP

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Royal Trails Flood Study

2.4 DRAINAGE FEATURE SURVEY

Geodata Consultants, Inc. performed a topographic drainage elevation survey in the subdivision in March 2008. The culverts, side-drains, driveway tops, finished floor elevations, and ditch cross-sections in the subdivision were surveyed. Geotechnical boring locations as well as seasonal high water elevation (SHWE) nails were also surveyed. Refer to the DVD included with this report for the topographic survey.

The topographic survey data had the following applications for use in hydrological / hydraulic model development:

- Model pipe links referenced the survey for inverts, size, and material data.
- Model channel links referenced the surveyed cross sections to define the geometry for irregular channels.
- Surveyed finished floor elevations were used for informational purposes when determining the flooding elevation of structures

2.6 ENVIRONMENTAL ASSESSMENT REPORT

Lotspeich and Associates, Inc. performed a preliminary ecological assessment to support the efforts of this study. The services performed by Lotspeich included but were not limited to a review of existing ecological data, an ecological site assessment, wetlands assessment, and determination of wetland SHWE's. Refer to the DVD included with this report for the ecological assessment.

Several of the SHWE's established in the ecological assessment were utilized to set initial stages and boundary conditions in the hydraulic model.

2.7 GEOTECHNICAL ENGINEERING REPORT

Devo Engineering performed a preliminary geotechnical engineering evaluation to support the efforts of this study. The services performed by Devo Engineering included but were not limited to drilling soil borings at various locations in the subdivision to determine general soil and groundwater parameters and a geotechnical investigation of soil and water table conditions within isolated pond and wetland areas. Refer to the DVD included with this report for the geotechnical engineering report.

The geotechnical engineering evaluation had the following applications for use in the hydrological / hydraulic model development:

- The Seasonal High Water Table (SHWT) information was used to estimate the groundwater table at each node for use in percolation links in the model.
- Vertical infiltration rate information from falling head permeameter tests and double ring infiltrometer tests performed at several locations in the subdivision was used to estimate the hydraulic conductivity at each node for use in percolation links in the model.

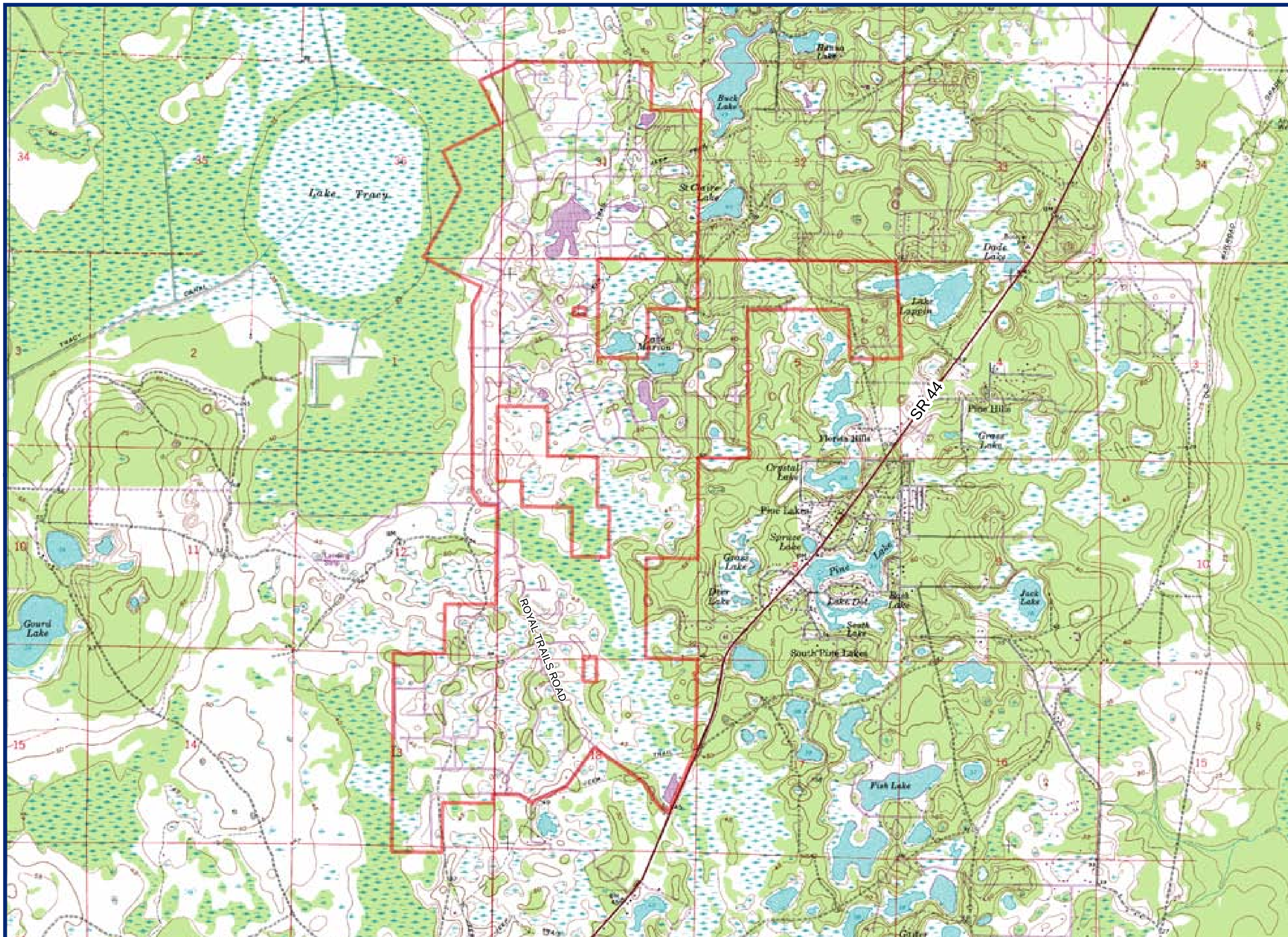
2.8 TOPOGRAPHY

Based on LIDAR data obtained by Lake County in 2008, elevations in the subdivision range from approximately 33' near Lake Tracy to 78' on the northeast side of the subdivision. The topography of the western side of the subdivision generally slopes west toward Lake Tracy. Also, ditches can be seen in the topography which would convey runoff from many of the depressions in the subdivision toward Lake Tracy. The topography of the northeast section of the subdivision appears to slope toward internal depression areas. The topography of the southeast section of the subdivision appears to slope toward a large wetland area on the northeast side of the Royal Trails Road. Five foot contours are shown on the USGS based topographical map on Figure 2-4. One foot digital contours based from the 2008 LIDAR are shown on Figure 2-5.

The topographic data was used while building hydrologic / hydraulic model to establish drainage divides for the model subbasins, time of concentration flow paths, node stage-area data, and irregular cross-section data for overland weirs.

2.9 INFRASTRUCTURE

Based on field observations, the topographic drainage survey performed by Geodata in 2008, and the drainage inventory performed by BCI in 2006, the drainage infrastructure in the subdivision consists of roadside swale drainage and driveway side-drains to roadway culverts that discharge to depressional areas. Several of the depressional areas discharge to upland-cut ditches which flow northwest to Lake Tracy. Many of the ditches have control structures which were designed to detain runoff in the ditch prior to discharging downstream. Some of the wetlands on the southwest side of the subdivision discharge southwest eventually flowing to Blackwater Creek. Most of the depressions in the eastern portion of the watershed appear to be landlocked with no controlled outfall. The drainage infrastructure is shown on Exhibit 1.



LAKE COUNTY
FLORIDA

0 1,250 2,500
Feet

LEGEND

ROYAL TRAILS SUBDIVISION

NOTE: CONTOURS REFERENCED TO NGVD29 DATUM

DATA SOURCES:
SUBDIVISION: LAKE COUNTY, 2006
ROADS: LAKE COUNTY, 2006
USGS: QUAD MAP, 1962
(PHOTO REVISED 1988)

FIGURE 2-4

USGS TOPOGRAPHIC MAP

Royal Trails Flood Study

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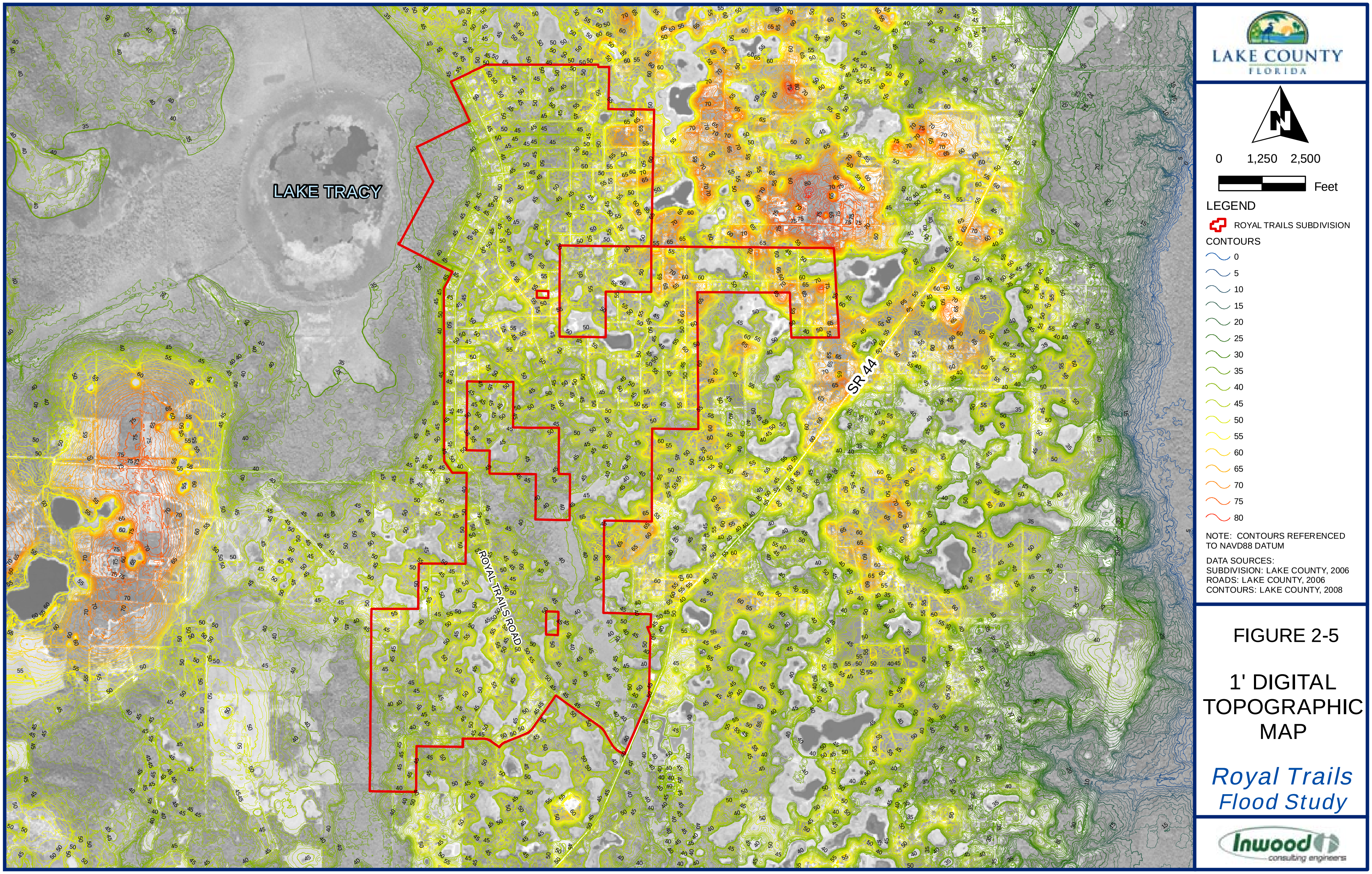


FIGURE 2-5

1' DIGITAL TOPOGRAPHIC MAP

Royal Trails Flood Study

2.10 SOILS

Soils data were obtained from the Southwest Florida Water Management District (SWFWMD) for use in this study. The SWFWMD data not only provides soil characteristics based on USDA-NRCS Soil Survey data, but also included additional soils data useful for Green-Ampt method runoff calculations from the NRCS SSURGO and University of Florida IFAS databases. Based on the soils data, the soils in the study area consist of approximately 41% well drained hydrologic group A mostly in the eastern portions of the study area, less than 1% moderately well drained hydrologic group B, 16% moderate to poorly drained hydrologic group C, 14% poorly drained hydrologic soil group A/D, 25% poorly drained hydrologic group B/D, 2% poorly drained hydrologic soil group D soils, and 2% water scattered throughout the study area. The soils data was used to calculate the Green-Ampt runoff parameters of the subbasins in the hydrologic model. The soils in the study area are shown on Figure 2-6.

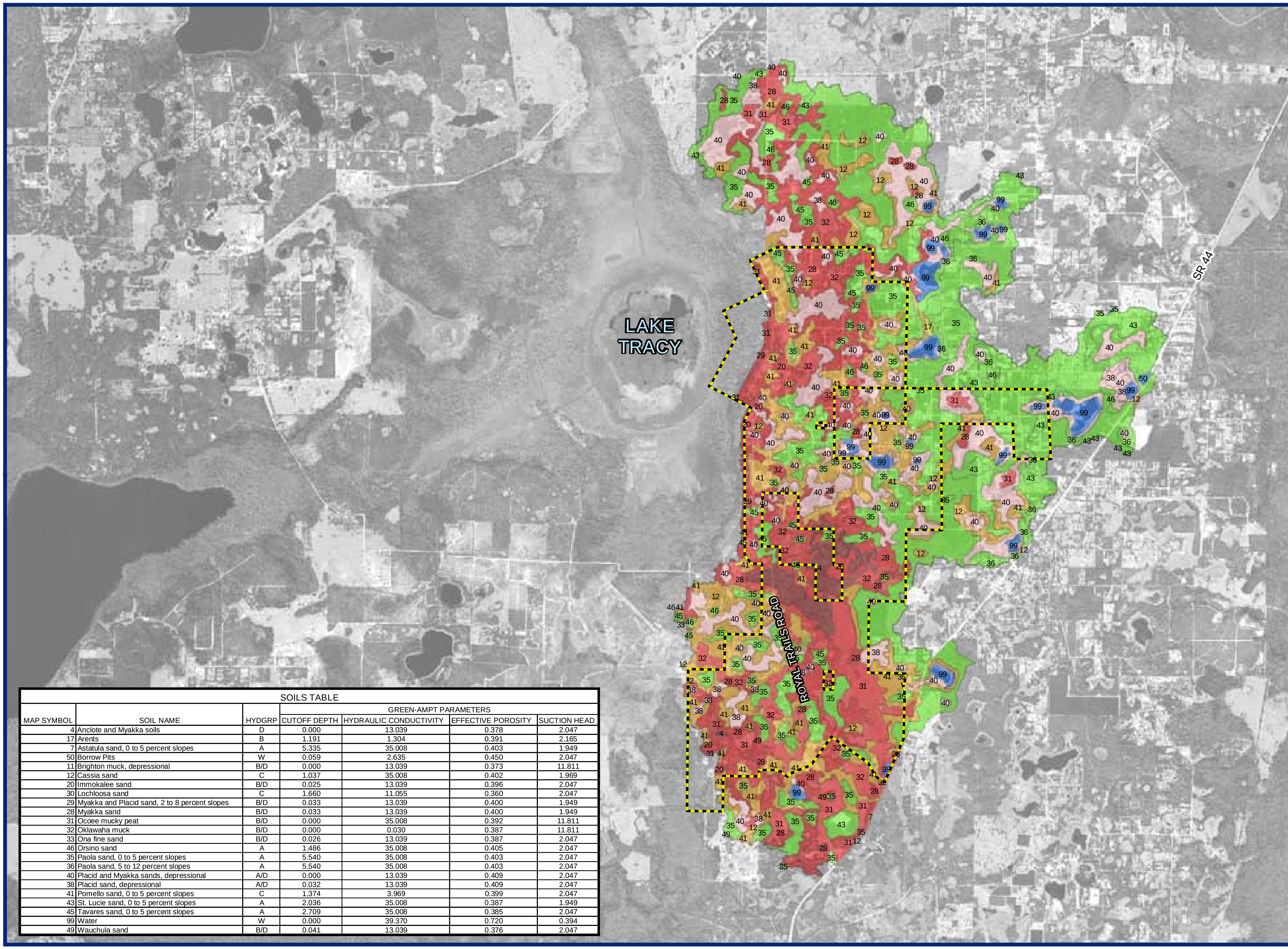
2.11 LAND USE

Based on the SJRWMD land use layer updated in 2004, the land use in the subdivision generally consists of low-density residential, upland forests, rangeland, and wetlands. The land use layer was modified for purposes of this study and DCIA and non-DCIA percentages were estimated for each land use type in the study area based on observations from the 2008 Aerials and updated parcels data. The land uses in the study area are shown on Figure 2-7. The land use designations, DCIA, and non-DCIA percentages were used to calculate Green-Ampt runoff parameters of the subbasins in the hydrologic model.

2.12 FEMA FLOODPLAINS

Based on review of FEMA Flood Insurance Rate Maps (July, 2002) and Flood Insurance Study (July, 2002), several areas within the subdivision are within a 'Zone A' designation. 'Zone A' is a 100-year flood hazard area where base flood elevations have not been determined. Since 'Zone A' designations do not have a particular elevation referenced with them, it is difficult to make sound decisions regarding finished floor elevations for structures in close proximity. Most of the area in the subdivision is within a 'Zone X' designation. 'Zone X' indicates it is in an area determined to be outside the 500-year floodplain. The existing FEMA floodplains are shown on Figure 2-8. Scans of FEMA Flood Insurance Rate Maps (FIRMS) are included on the DVD.

Several residents in the subdivision have requested that FEMA determine if their property can be removed from the 'Zone A' flood zone. Each resident has received a Letter of Map Amendment (LOMA) which removes the resident's structure and/or property from the 'Zone A' flood zone. The location of the residents who have received a LOMA from FEMA is shown on Figure 2-8. Copies of the LOMA's are included on the DVD submitted with this report.



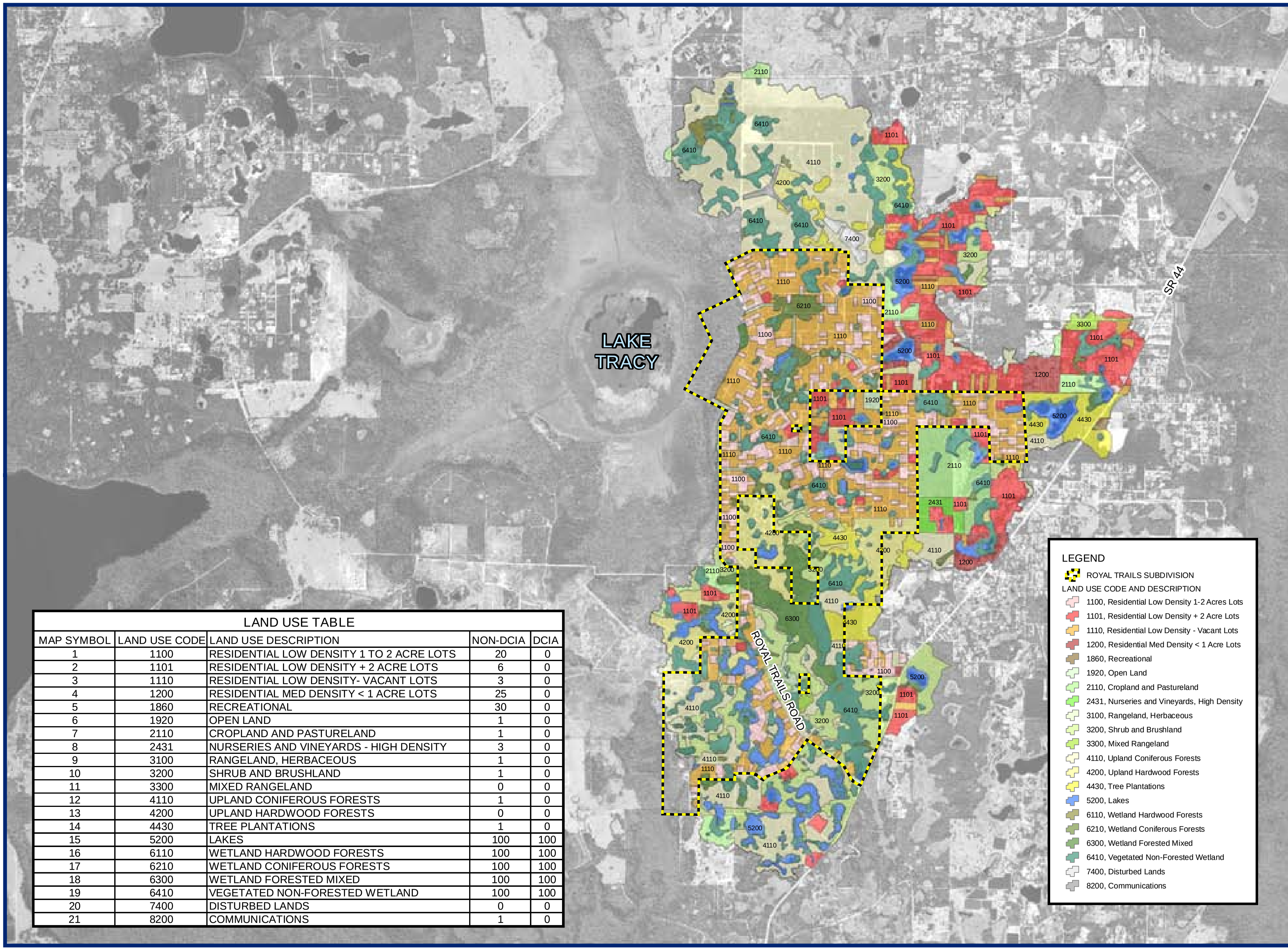
SOILS TABLE

MAP SYMBOL	SOIL NAME	HYDGRP	GREEN-AMPT PARAMETERS CUTOFF DEPTH	HYDRAULIC CONDUCTIVITY	EFFECTIVE POROSITY	SUCTION HEAD
4	Anclote and Myakka soils	D	0.000	13.039	0.378	2.047
17	Arents	B	1.191	1.304	0.391	2.165
7	Astatula sand, 0 to 5 percent slopes	A	5.335	35.008	0.403	1.949
50	Borrow Pits	W	0.059	2.635	0.450	2.047
11	Brighton muck, depressional	B/D	0.000	13.039	0.373	11.811
12	Cassia sand	C	1.037	35.008	0.402	1.969
20	Immokalee sand	B/D	0.025	13.039	0.396	2.047
30	Lochloosa sand	C	1.660	11.055	0.360	2.047
29	Myakka and Placid sand, 2 to 8 percent slopes	B/D	0.033	13.039	0.400	1.949
28	Myakka sand	B/D	0.033	13.039	0.400	1.949
31	Ocoee mucky peat	B/D	0.000	35.008	0.392	11.811
32	Oklawaha muck	B/D	0.000	0.030	0.387	11.811
33	Ona fine sand	B/D	0.026	13.039	0.387	2.047
46	Orsino sand	A	1.486	35.008	0.405	2.047
35	Paola sand, 0 to 5 percent slopes	A	5.540	35.008	0.403	2.047
36	Paola sand, 5 to 12 percent slopes	A	5.540	35.008	0.403	2.047
40	Placid and Myakka sands, depressional	A/D	0.000	13.039	0.409	2.047
38	Placid sand, depressional	A/D	0.032	13.039	0.409	2.047
41	Pomello sand, 0 to 5 percent slopes	C	1.374	3.969	0.399	2.047
43	St. Lucie sand, 0 to 5 percent slopes	A	2.036	35.008	0.387	1.949
45	Tavares sand, 0 to 5 percent slopes	A	2.709	35.008	0.385	2.047
99	Water	W	0.000	39.370	0.720	0.394
49	Wauchula sand	B/D	0.041	13.039	0.376	2.047

FIGURE 2-6

SOILS MAP

Royal Trails Flood Study



LAND USE TABLE

MAP SYMBOL	LAND USE CODE	LAND USE DESCRIPTION	NON-DCIA	DCIA
1	1100	RESIDENTIAL LOW DENSITY 1 TO 2 ACRE LOTS	20	0
2	1101	RESIDENTIAL LOW DENSITY + 2 ACRE LOTS	6	0
3	1110	RESIDENTIAL LOW DENSITY- VACANT LOTS	3	0
4	1200	RESIDENTIAL MED DENSITY < 1 ACRE LOTS	25	0
5	1860	RECREATIONAL	30	0
6	1920	OPEN LAND	1	0
7	2110	CROPLAND AND PASTURELAND	1	0
8	2431	NURSERIES AND VINEYARDS - HIGH DENSITY	3	0
9	3100	RANGELAND, HERBACEOUS	1	0
10	3200	SHRUB AND BRUSHLAND	1	0
11	3300	MIXED RANGELAND	0	0
12	4110	UPLAND CONIFEROUS FORESTS	1	0
13	4200	UPLAND HARDWOOD FORESTS	0	0
14	4430	TREE PLANTATIONS	1	0
15	5200	LAKES	100	100
16	6110	WETLAND HARDWOOD FORESTS	100	100
17	6210	WETLAND CONIFEROUS FORESTS	100	100
18	6300	WETLAND FORESTED MIXED	100	100
19	6410	VEGETATED NON-FORESTED WETLAND	100	100
20	7400	DISTURBED LANDS	0	0
21	8200	COMMUNICATIONS	1	0

LAKE COUNTY FLORIDA

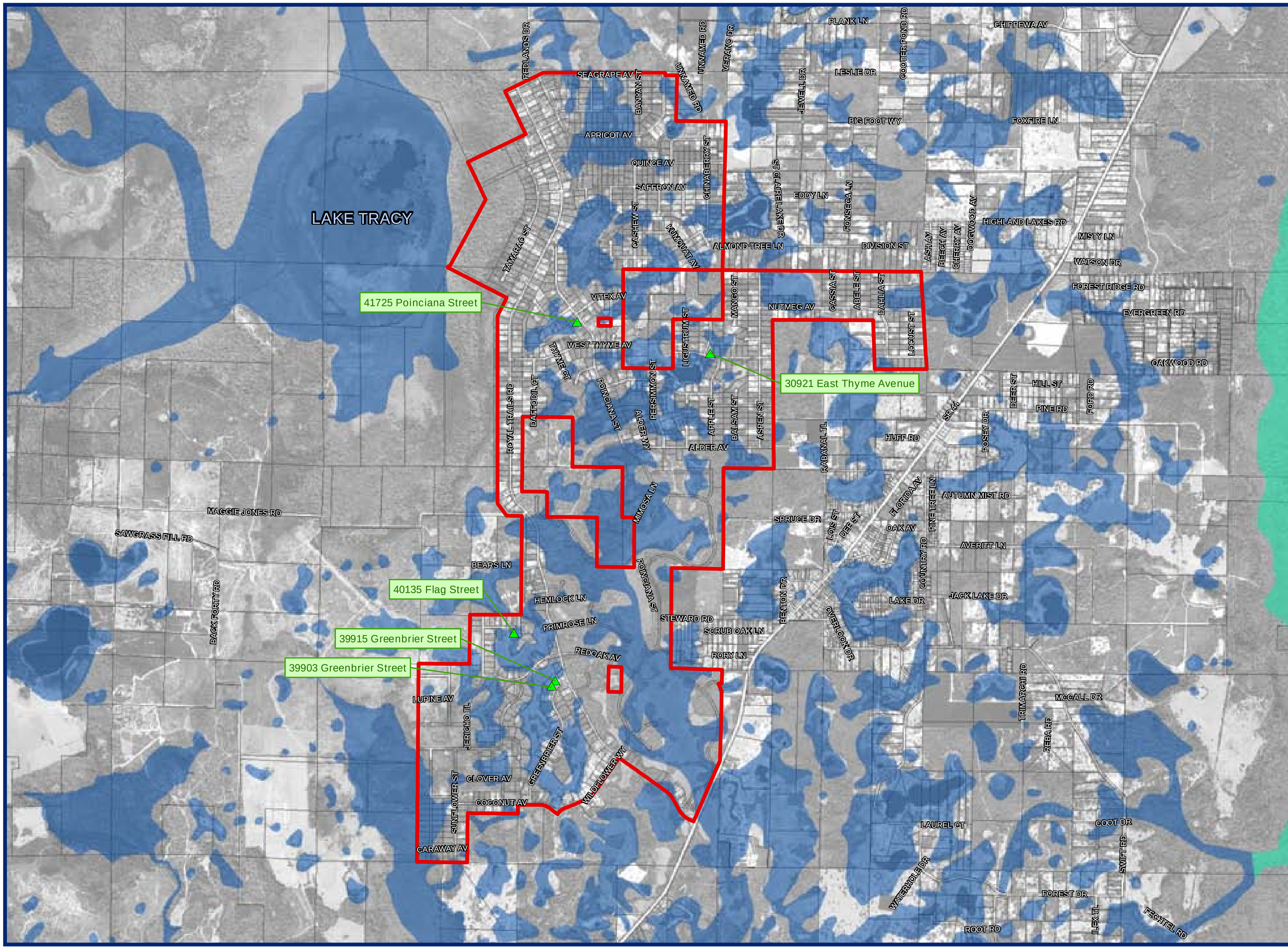
DATA SOURCES:
SUBDIVISION: LAKE COUNTY, 2006
ROADS: LAKE COUNTY, 2006
LAND USE: SJRWMD, 2004 BASED ON FDOT FLORIDA LAND USE COVER AND FORMS CLASSIFICATION SYSTEM (FLUCFCS)

FIGURE 2-7

LAND USE MAP

Royal Trails Flood Study

Inwood consulting engineers



LAKE COUNTY
FLORIDA

0 1,250 2,500 Feet

LEGEND
ROYAL TRAILS SUBDIVISION
PARCELS
LOMA LOCATIONS
FLOOD ZONE
A
AE

NOTE: THE LOMA LOCATIONS INDICATE THE RESIDENT HAS RECEIVED A LETTER OF MAP AMENDMENT (LOMA) WHICH REMOVES THE RESIDENT'S STRUCTURE AND / OR PROPERTY FROM THE 'ZONE A' FLOOD ZONE.

DATA SOURCES:
SUBDIVISION: LAKE COUNTY, 2006
ROADS: LAKE COUNTY, 2006
PARCELS: LAKE COUNTY, 2008
FLOODPLAINS: FEMA, 2002

FIGURE 2-8

FEMA FLOODPLAIN MAP

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3.0 DIGITAL TOPOGRAPHICAL INFORMATION DATA DEVELOPMENT

Digital topographic information (DTI) was used to create a digital topographic model (DTM) for use in this study. A DTM is a continuous surface created from the DTI data that are interpreted into a surface of topographic information. The GIS tools that perform various analysis tasks during the hydrologic / hydraulic modeling parameterization process require some form of DTM as input. The process for generating the DTM used in this study is discussed below.

3.1 TOPOGRAPHICAL DATA SOURCES

Digital topographic data for this project was available from two sources. First, LIDAR data was provided in LAS file format by Lake County. Second, surveyed cross-sections at several locations in the outfall ditches in the subdivision were provided by subconsultant Geodata. Both data sources reference the NAVD88 vertical datum.

3.2 DIGITAL TOPOGRAPHIC DATA PREPARATION

Some preparation of the raw topographic data was necessary prior to creating a DTM for surface runoff characterization. The steps taken to prepare the data for use in a DTM were:

- Breaklines were developed for the outfall ditches in the subdivision by connecting the surveyed top of bank, bottom of bank, and ditch centerline points along the length of the ditch with polylines in ArcGIS;
- The surveyed elevations were added to the breakline vertices to create 3D breaklines of the ditches;
- The LAS files were converted to multipoint features; and
- The multipoint vertices within the ditches were removed where breaklines were defined to avoid data conflicts with the breaklines.

3.3 TERRAIN DEVELOPMENT

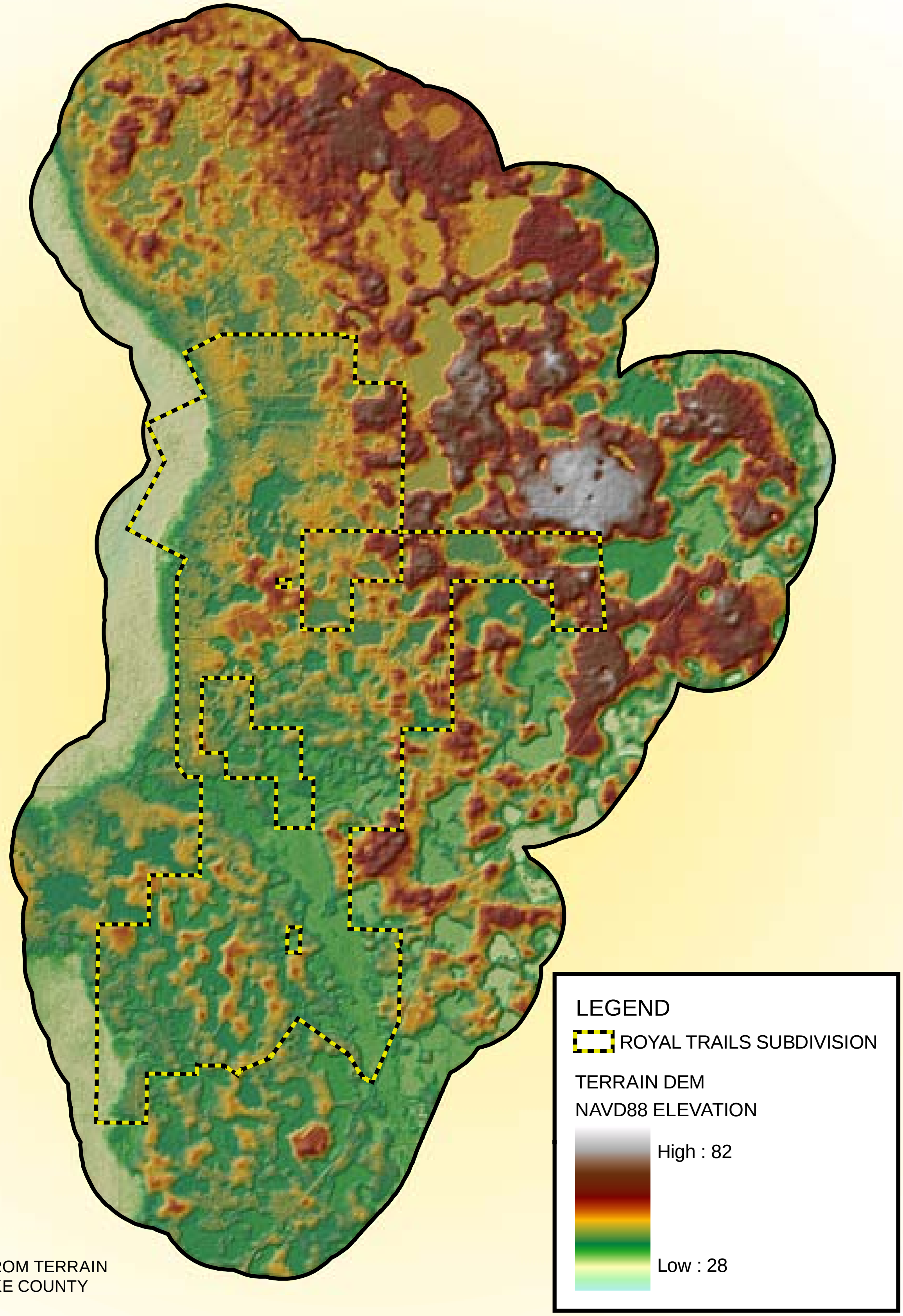
The DTM surface generated from the digital topographic features prepared for this project is an ESRI ArcGIS Terrain. A terrain is a TIN-based surface built from features in a geodatabase. Rules are set for the Terrain that controls how each feature will be used to define the Terrain surface. Terrains allow the user to define multiple resolutions depending on the scale which improve display performance. The general steps for generating the terrain for this project were:

- The multipoint features were added to the terrain as mass points; and
- The breaklines were added to the terrain as hard lines.

3.4 RASTER BASED DIGITAL ELEVATION MODEL (DEM) DEVELOPMENT

A raster based DEM was then generated from the terrain. The raster DEM was utilized to perform analysis tasks such as watershed delineation, model network generation, time of concentration flow path generation, stage-area takeoffs, and irregular cross-section extraction using GIS tools. The raster DEM created from the terrain for this project is comprised of 5' cells each with unique elevation values.

The raster DEM generated from the terrain is shown on Figure 3-1.



NOTE:
DEM GENERATED FROM TERRAIN CREATED FROM LAKE COUNTY 2008 LIDAR DATA.

LAKE COUNTY FLORIDA

DATA SOURCES:
SUBDIVISION: LAKE COUNTY, 2006

0 2,000 4,000 Feet

FIGURE 3-1
TERRAIN DEM MAP

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4.0 HYDROLOGICAL DATA DEVELOPMENT

4.1 SUBBASIN DELINEATION

In order to assess the impacts of stormwater runoff in the subdivision, the study area was divided into discrete subbasin areas which represent a discrete contributing area to a point of interest (pond, wetland, culvert, ditch, etc.). Subbasin delineation was conducted using the raster DEM developed for the project to determine boundaries between subbasins. GIS based 3D and Spatial Analyst tools were used to process the topographical data to delineate preliminary subbasin boundaries. Manual refinement was conducted to produce subbasins suitable for use in the floodplain analysis and level of service analysis. The subbasin delineation is shown in detail on Exhibit 2 and in general on Figure 4-1.

The subbasins in the study area were each assigned an outfall group based on the ultimate discharge location from the subbasin. The four groups to which the subbasins were assigned are Lake Tracy, Blackwater Creek Wetland, State Road 44 Wetland, and Landlocked. The delineated subbasins and their assigned outfall groups are shown on Figure 4-1.

Several large areas that are outside of the subdivision were included in the overall subbasin delineation. Although the project focus is within the subdivision, these areas were included because it was determined that if flood stages in these areas were to overtop they would contribute runoff towards the subdivision rather than away.

4.2 GREEN-AMPT PARAMETER DEVELOPMENT

The Green-Ampt method of calculating rainfall excess applied to SCS unit hydrographs was used for this project. This method was chosen over the traditional SCS curve number method to provide a more detailed accounting of infiltration of runoff during storm events, particularly in areas with deep sandy hydrologic group 'A' soils. The soils parameters required for the Green-Ampt method were obtained from SWFWMD and were applied in accordance with the document *"Determination of Green-Ampt Parameters for Hydrology Computations in ICPR, SWFWMD August 2008".* Parameter values derived from this source are considered reasonable for use in the model analysis. Parameters used include:

- Hydraulic Conductivity (SSURGO) – safety factor of 2 used per SWFWMD guidance.
- Soil Storage and porosity (IFAS database)
- Effective Porosity = 0.90 X soil porosity
- Cutoff Depth = (soil storage) / (effective porosity)
- Suction Head = soil suction values from literature
- Site specific % impervious and % directly connected impervious area (DCIA) values.

See Figure 2-5 for a table of the Green-Ampt parameters used in the model for each soil type in the study area. See Figure 2-6 for a table of the % impervious and %DCIA values used in the model for each land use type in the study area.

Each subbasin was divided into sub-areas based on unique land use and soil types by intersecting the land use and soils with the subbasins using GIS geoprocessing tools. Each sub-area with unique Green-Ampt parameters was assigned to the associated subbasin and input into ICPR for runoff hydrograph calculation using standard SCS unit hydrographs.

4.3 TIME OF CONCENTRATION

An additional input parameter of the SCS Unit Hydrograph Method is the subbasin time of concentration. The time of concentration (Tc) represents the amount of time it takes for a particle of water to travel from the hydraulically most distant point in the drainage basin to its outlet. The Tc is computed by summing all the travel times for consecutive flow components (sheet flow, shallow concentrated flow, channel flow) of the subbasin conveyance system. The Tc flow paths are shown on Exhibit 2.

The time of concentration flow paths in this study were automatically generated using the raster DEM and GIS tools. The flow paths were then manually refined and split into the appropriate flow components. The Tc calculation data is included on the DVD.

4.4 HYDROGRAPH PEAKING FACTOR

The SCS Unit Hydrograph Method requires a unit hydrograph peak attenuation factor be specified. The selection of a unit hydrograph peaking factor depends on the geographical area and local conditions. The peak rate factor (K) was consistently applied over the project study area to account for average slope, storage, drainage conditions, and predominant land uses present. A value of 323 was used which is an intermediate peak rate factor representing watersheds with moderate surface storage in some locations due to depressional areas, mild slopes and/or lack of existing drainage features.

4.5 RAINFALL DISTRIBUTION AND DEPTH

To implement the SCS Unit Hydrograph Method, a rainfall distribution must be specified for the desired storm event as a function of time for the subbasin's unit hydrograph. Standard SCS or St. Johns River Water Management District (SJRWMD) rainfall distributions are commonly used in this region of Florida if no local distribution has been established. This study uses the SCS II – Florida Modified distribution for the 24 hour storms and the SJRWMD 96-hour distribution for the 96-hour storm in the model.

The 100-year / 96-hour and 100-year / 24-hour storm events were used to analyze floodplain elevations for this study. The rainfall depth used when applying the unit hydrograph procedure to model these storm events was 14.7 and 11.3 inches respectively. Additionally, the Mean Annual, 10-year, and 25-year 24-hour storm events were modeled for general model refinement purposes and for assessing level of service (LOS) of infrastructure in the study area. The rainfall depths used for these storm events was 4.3, 6.6, and 8.4 inches respectively. The rainfall depths used in this study were referenced from SJRWMD rainfall isopluvial maps. Figure

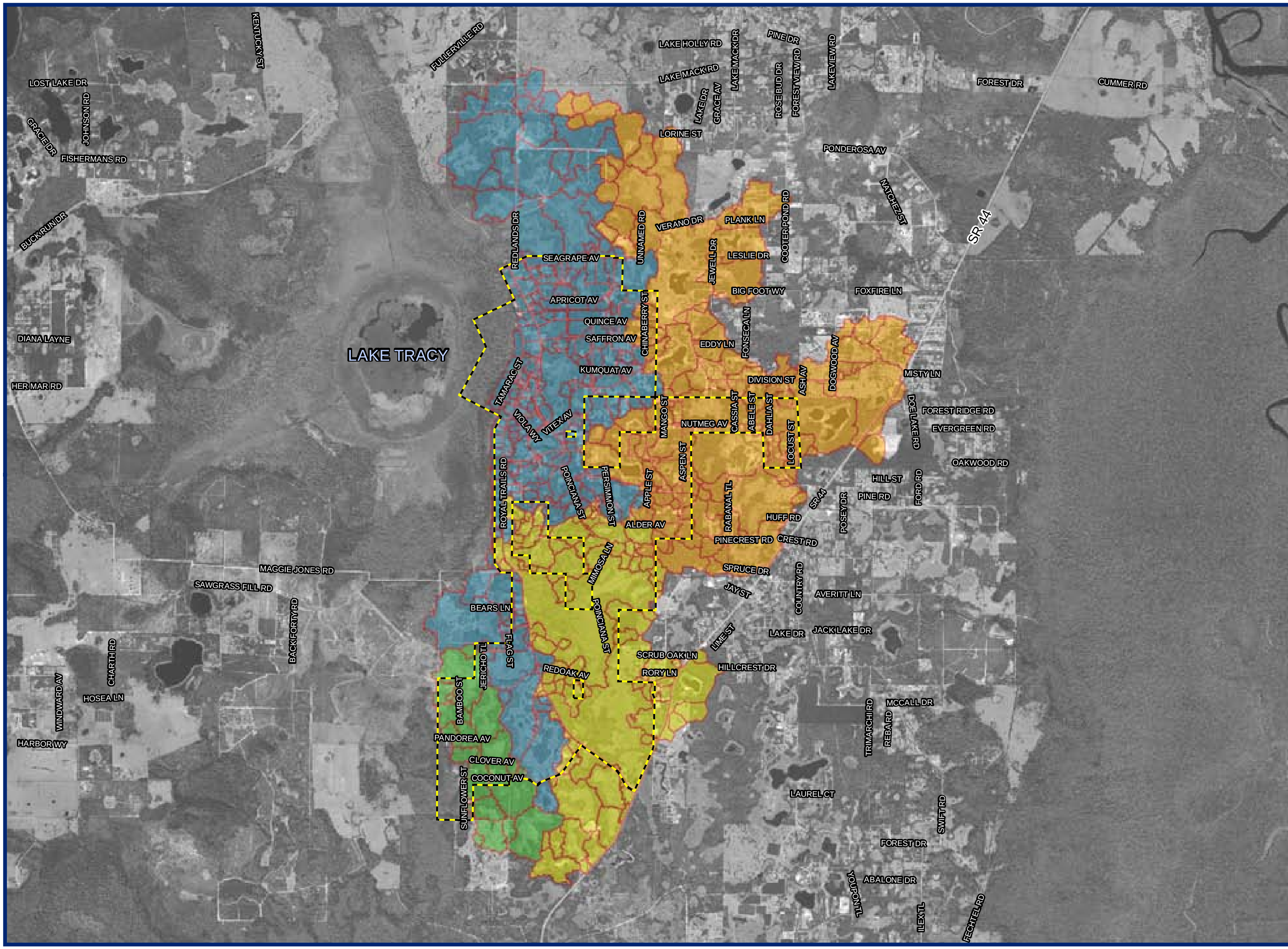

FIGURE 4-1

SUBBASIN OUTFALL MAP

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5.0 HYDROLOGICAL / HYDRAULIC MODEL DATA DEVELOPMENT

5.1 DESCRIPTION OF HYDROLOGICAL / HYDRAULIC COMPUTER MODEL

The Interconnected Channel and Pond Routing computer model (ICPR, Version 3.1, Service Pack 3, PercPack™ Plug-in) was used as the primary engineering modeling tool for the project.

ICPR was used for the hydrological simulation of rainfall and runoff and the hydraulic routing of the runoff on the land surface and subsurface. ICPR uses a node–link representation of real world conditions. Using the site characteristics and the SCS runoff method (or others), ICPR calculates rainfall rates, soil infiltration rates, and available storage capacity, for discrete storm events. This in turn models a runoff hydrograph that can be applied to an area of hydraulic interest within the study area. The calculated runoff can then be hydrodynamically routed through any number of surface and/or subsurface conveyance structures to evaluate their effectiveness in conveying stormwater.

ICPR can model natural (irregular) channels, prismatic channels, in-line ponds and other storage entities, including the accommodation of overbank flooding. Various control structures can also be simulated including pipes, culverts, drop structures, weirs, orifices, etc. The program can also accommodate the simulation of time dependent tailwater conditions and the effects of submerged and reverse flows. Model output includes detailed stage, storage, and flow data representations versus time for all nodes and links.

The ICPR PercPack™ plug-in provides additional functionality that allows the model to simulate groundwater infiltration. The plug-in has the ability to simulate vertical infiltration through a fixed or varied ground surface area as well as horizontal infiltration mounding analysis.

The model used to represent the study area included 539 subbasins, 559 nodes (junctions), and 1816 links (reaches) including 120 pipes, 90 channels, 1486 weirs, 20 drop structures, and 100 percolation links. These model components are described below in the following subsections. The model node-link representation is summarized diagrammatically on Exhibit 3.

5.1.1 Subbasins

The model uses subbasins to provide the hydrologic parameters used to generate the runoff volume routed in the hydraulic portion of the model. Using the Green-Ampt rainfall excess calculations and SCS Runoff Hydrograph Method, each basin is assigned the appropriately determined Green-Ampt parameters, time of concentration, and unit hydrograph peaking factor to simulate the runoff from the represented area. Each basin translates a hydrograph to one specific assigned node.

5.1.2 Nodes

The model calculates peak flood stages in nodes. The following types of nodes were used:

- *Stage-storage nodes:* These types of nodes were used to model surface depressions, ponds, and other areas where runoff collected. Stage-area takeoffs were obtained from the DTM. These nodes were also used to represent specific points of interest along extended conveyance paths or at upstream and downstream ends of culverts where stage information was desired. In this case, the nodes were generally assigned little or no area in order to not double-count the storage taken into account in the conveyance feature in the model. Also, areas within defined channel conveyance areas were excluded from the stage area calculations.

- *Time-stage nodes:* These nodes were used as boundary conditions to account for flow leaving the model area. The rational for the time-stage relationships established for each of the time-stage nodes in the model is discussed briefly below:
    - *TB0001* – This node was fixed at the Seasonal High Water Elevation (SHWE) established in the project environmental assessment report for the wetland around Lake Tracy.
    - *TB0002* - This node was fixed at the Seasonal High Water Elevation (SHWE) established in the project environmental assessment report for the wetland southwest of the subdivision.
    - *TB0003* – This node represents a wetland area southeast of State Road 44. The wetland area is connected to the subdivision by two culverts under State Road 44. Data was not available to determine an appropriate fixed seasonal high stage, so a tailwater approximation was developed for modeling purposes. The elevations in this node were increased from the approximate elevation of a stain line observed on the culverts under State Road 44 (assumed to be representative of high water conditions) at the beginning of the model simulation to the elevation of the top of the culvert at the time of apparent peak flow through the culvert. The node elevation then remained fixed at the top of the culvert for the rest of the model simulation.
    - *TB9999* – This node is an arbitrary elevation boundary node used to account for high stage "pop-off" flow to the adjacent areas north and east of the study area. The node is also used to receive infiltration flow from the percolation links in the model (i.e., representing the groundwater aquifer).

Initial Stage Rationale: Each node was assigned an initial stage based on apparent lowest ground surface in dry depressional areas or wet season average free water surface in wet areas. These were generally obtained from the DTM or in some specific cases taken from SHWE data available from the project Environmental Assessment Report. In many cases pipe or channel inverts were referenced which were lower than the apparent bottom elevation from the DTM. In these cases, the initial stages were adjusted to accurately reflect the inverts where dry initial conditions would be expected.

5.1.3 Links

The model analyzed flow in links allowing the evaluation of conveyance effectiveness between nodes. Entrance/exit/bend/transition head losses were incorporated where appropriate. The following types of links were used:

Pipes: These links were used to represent the various pipe and culvert sections included in the model. Pipe inverts were referenced from the survey performed by Geodata 2008 in March 2008, State Road 44 plans, or were estimated from the DTM if not included in the survey. Roughness coefficients (Manning's n) were varied based on material as follows:

Corrugated Metal Pipe (CMP)	0.024
Reinforced Concrete Pipe (RCP)	0.012

Pipe loss coefficients were applied on a pipe specific basis. These included entrance, and exit losses. These values were assigned based on literature values, or default values were used where exact conditions were uncertain. In general, the values were applied as follows:

Entrance Losses – a representative average value of 0.5 was used for all pipes

Exit Losses – for discharge from a channel or pipe into a static water body 1 was used

For submerged inlet face conditions, end treatment designations were also assigned for pipes based on standard FHWA values. Where exact end treatment geometry was uncertain, typical values were used by default (i.e., square-edges headwall for pipes, elliptical inlet face for mitered end sections, etc.).

Channels: These links were used to represent long runs of the upland-cut ditches in the subdivision. Nodes were placed at each significant change in direction, or slope, or geometry. Channel inverts were estimated based on the surveyed channel cross-sections and pipe inverts where available and on the project DTM where survey data was not available.

For the channels, location-specific irregular cross-section data was extracted from the project DTM. The DTM in most of the channel areas is based on the surveyed cross-sections which were incorporated into the DTM during terrain development. Therefore, the cross-section data extracted from the DTM for the channels is considered adequate for the purposes of this model.

Manning's n values were assigned to the channel cross-sections based on literature. The Manning's n values were chosen based on the observed condition of the channels in the field. Typically the channels are more heavily vegetated at the top of bank and on the side slopes than on the bottom. Manning's n values were typically varied across the channel cross-sections as follows:

Overbank channel areas	0.08
Channel side slope areas	0.06
Bottom of the channel	0.04

Default eddy losses were accounted for in each channel section as well as some other minor losses (exit, bend, etc.) where applicable.

In ICPR, runoff volume is accounted for within the channel based on the assigned cross-sectional geometry. Overbank flood storage was taken into account in the stage-area values for the nodes associated with the channel links. Care was taken to exclude the defined channel cross-sectional areas when extracting node stage-area data so as not to double count available flood storage.

Weirs: Weirs were used to represent outflow weirs at ponds, inlet characteristics to some outfall structures, and to represent overtopping of roadways, or overland flow. The specific geometry of the weir was input into the model. In general, horizontal weirs were used to model flat inlet structures and ditch bottom inlets. Vertical weirs were used to model control structure slots and bleeders along with true weir structures (sharp or broad crested) and overtopping situations. Where complex multi-level weirs are present, two or more separate model weirs were used to account for outflow. In the case of overtopping, irregular wide flat vertical weirs derived from the DTM were used to account for cross-node flow of runoff around other links and between roadway depressional areas.

Each weir was assigned a specific weir coefficient based on its configuration. Weir coefficients were applied as follows:

Overland / Saddle Flow	2.6
Overtopping Roadway	2.8
Sharp Crested Weir (typically pond outfall)	3.2

For weirs associated with outfall structures, regular geometric cross-sectional properties (i.e., trapezoidal, triangular, etc.) were used. For the vast majority of weirs representing overland flow and/or overtopping, location-specific irregular cross-section data was extracted from the project DTM. The extracted weir cross-section data were reviewed and manually adjusted where necessary to insure proper length and invert were represented. These extracted cross-sections were considered a reasonable approximation as best available information where no survey data exists. It should be recognized that vegetation can typically obscure finer details of flow lines when derived from a LiDAR based topographical surface.

Drop Structures: These links were used to simulate inlet-to-pipe in series combinations. Typically, the application for these was in the flashboard control structures at road crossings along the outfall ditches or ditch bottom inlets where an outlet structure with weir/orifice characteristics is followed by a pipe to the next model node. The weir portion of the drop structure was set up as described under weirs, while the pipe section set up similar to pipes described above.

Percolation Links: Percolation links were used to represent infiltration into the ground at several nodes in the model where flow from the percolation link would potentially significantly affect stages in the node. Percolation links were added to 100 nodes in the model that met the following criteria:

- The average SHWT indicated by the geotechnical data was below the ground surface and less than 5% of the contributing area to the node had an apparent SHWT within 2' of the surface;
- Based on the results of the 100-year / 24 and 96 hour model simulations without percolation links, enough runoff occurred in the node contributing area to cause stages in the node to increase significantly above the node initial stage (i.e., if little or no runoff was generated, no percolation link was added); and
- Stages in the node would potentially impact floodplain elevations or the LOS assessment in the subdivision.

The following procedures were utilized to develop the percolation link parameters for ICPR:

- *Water Table Elevation (ft)* – A SHWT terrain surface was interpreted from the project geotechnical borings data within the subdivision. This data was supplemented with lake level data for areas outside the subdivision to create a continuous terrain SHWT surface for the entire study area in GIS. Elevations from this surface were used as the groundwater table elevations in the percolation links in the model.

- *Vertical and Horizontal Hydraulic Conductivity (ft/day)* – A vertical hydraulic conductivity terrain surface was interpreted from the project geotechnical testing data (falling head permeameter and double ring infiltrometer) in GIS. Vertical hydraulic conductivities were extracted from the surface at percolation link locations and input into the model. A factor of safety of two was applied to the vertical hydraulic conductivity. A factor of 1.5 was then applied to the vertical hydraulic conductivity to calculate the horizontal hydraulic conductivity used in the percolation links.

- *Effective Porosity and Suction Head* – The effective porosity was calculated as 0.9 times the porosity referenced from the soils data provided by SWFWMD. The suction head was referenced from the soils data provided by SWFWMD. These parameter values were based on GIS weighted averages in areas with multiple soil types.

- *Horizontal Infiltration* – 50 foot and 450 foot percolation ring buffers for horizontal infiltration were used. These were recommended as reasonable values per the ICPR PercPack™ Manual). Radial interference of adjacent percolation areas was taken into account when calculating the perimeter lengths used for the horizontal mounding calculation so as not to over count horizontal infiltration capacity.

- *Vertical Percolation Surface Area* – DCIA areas for each percolation link were created to avoid double-counting percolation area when Green-ampt rainfall excess calculations. This was done so as to not take into account Green-Ampt runoff infiltration where it is being taken into account in the hydraulics of the model through percolation as an outfall.

- *Annual Recharge Rate* – Set to zero for the single event modeling performed for this study.

- *Layer Thickness* – Calculated as the difference between the generated SHWT surface and surface elevation terrain.

Design Versus Observed Conditions: The intention of the model is to assess the performance of the drainage infrastructure in design / maintained conditions. Therefore, no siltation, obstruction, damage, etc. was taken into account in the model links. The one exception is where it was observed that the flashboards / risers had been removed from a control structure, the model drop structure link was edited to represent the observed condition. In this specific case modeling the observed condition was deemed appropriate because these structures have apparently operated without flashboards / risers for a long time.

6.0 FLOODPLAIN MAPPING

This section summarizes the results of the existing conditions floodplain prediction model. Included are discussions of the modeled 100-year flood elevations with comparisons to existing FEMA 100-year flood elevations. Details of the model development methodology and assumptions are summarized in Sections 4 and 5. Associated reference documentation and model data referenced in this section are included in the Technical Support Data Notebook (TSDN) which is included on the DVD included with this report.

6.1 MODEL RESULTS AND FLOODPLAIN DELINEATION

Floodplain Delineation: Pooling floodplain extents were delineated based on model stage results and the project terrain data. GIS raster analysis tools were used to facilitate this process. These areas were considered to be inundated by 100-year flooding based on modeling and have a base flood elevation (BFE) corresponding to a typical Zone AE designation used by FEMA FIRMs.

Additionally, transitional floodplains were added at locations where stormwater is predicted to overtop a depression area and flow down to an adjacent depression. This was to provide an indication of an overland flow flood hazard. Transitional floodplains are only shown where the upstream node elevation was greater than 0.5' above the overtopping weir invert. Engineering judgment was used to determine the width of the transitional flood zones.

Although the model extends out beyond the subdivision boundary, floodplains were only delineated in areas that are within or intersect the subdivision boundary. The full ICPR model results are on the DVD included with this report.

Floodplain Model Results: Results from the 100 year 24 hour and 96 hour (1% annual probability) storm events were compared. Whichever produced a higher peak stage in the model node was used for estimation of floodplains for this analysis. The 100 year 96 hour event produced a higher peak stage than the 24 hour in all but 7 model nodes. On average, the difference in stage between the 100 year events was small, roughly 0.2 feet. The only exceptions were landlocked nodes where the peak stage of the 96 hour event was as much as 2.3 higher than the 24 hour event due to higher volume of runoff produced for the 96 hour event.

In general, the floodplains decreased slightly in overall acreage in the subdivision when compared to the FEMA 2002 floodplain delineation. The 100-year floodplain area from the FEMA 2002 delineation is 1120 compared to 1055 acres from the floodplains delineated for this study. Primarily, differences in floodplain extent and location are attributed to the limited topographical data and modeling detail that was apparently used in previous FEMA mapping efforts in comparison to the detailed modeling efforts conducted under this study. Accordingly, the floodplain results from the current study are considered a more reasonable representation of 100 year flood hazards. The modeled floodplains are shown on Exhibit 4.

Additionally, floodplain structure impacts appear to have decreased slightly when compared to the 2002 FEMA floodplain delineation. The FEMA floodplain delineation shows 64 apparent structure impacts compared to only 12 apparent structure impacts from the floodplains delineated for this study. Individual structure impacts are discussed in the LOS assessment section.

7.0 LEVEL OF SERVICE ASSESSMENT

7.1 STORMWATER LEVEL OF SERVICE CRITERIA

An important component of this study is to establish peak flood stages under existing conditions for several design storms, this allows a comparison of the performance of the particular stormwater management facility to regulatory criteria for the protection of residents, properties, and infrastructure.

A flooding level of service (LOS) is criteria by which infrastructure related flooding problems can be assessed for potential deficiencies. Alternatives for flood control improvements can then be evaluated and developed to improve stormwater management. The LOS criteria also can aid in prioritization of facility improvements under operation and maintenance activities. The criteria are typically tied to a specific design storm event, which would result in a runoff volume that must be accommodated by the stormwater facility.

Based on a review of the Lake County Stormwater Management criteria, the LOS standards considered applicable for the stormwater facilities assessed in this project are summarized on Table 7-1.

Table 7-1

Criteria for Flood Study LOS Assessment Modeling

FLOODING LEVEL OF SERVICE (LOS) STANDARDS / DESIGN CRITERIA			
Facility	Storm Frequency and Duration	Physical Elevation Reference	Example in Royal Trails Project Area
Local Roads (within a development)	10 year / 24 hour	Crown of the Road	Roads Inside Subdivision
Evacuation Route	100 year / 24 hour	Crown of the Road	State Road 44
Habitable Structure	100 year / 24 hour or 100 year / 96 hour	Structure Flooding Elevation	Houses Inside Subdivision

7.2 LOS RESULTS SUMMARY

Based on the modeled peak stage elevations, several LOS failures occur in the subdivision. Based on a comparison between road and structure flooding elevations and modeled node peak stages, road LOS criteria failures appear to occur at 39 nodes and structure LOS failures appear to occur at 8 nodes. The structure and road flooding elevations compared to the modeled node maximum elevations for the applicable LOS storm event are tabulated on table 7-2.

Further investigation of the GIS spatial data shows that several separate nodes were showing apparent flooding of the same road section and in some cases several structures were apparently flooded based on the results at one node. Therefore, the number of individual failed road and structure LOS locations is 22 and 12 respectively. In addition to structure flooding, 12 instances of apparent property impacts from yard flooding that would inhibit access to and from the structure were also identified. The failed structure and roadway LOS locations are shown on Exhibit 5. The full model results can be found on the DVD included with this report.

TABLE 7-2
MODEL NODE MAX RESULTS SUMMARY AND LEVEL OF SERVICE (LOS) ASSESSMENT

	ROADWAY OVERTOPPING			STRUCTURE IMPACTS						
MODEL NODE NAME*	ROAD FLOODING ELEVATION**	10 YR / 24 HOUR MAX STAGE (FEET)	APPARENT ROAD FLOODING LOS (PASS/ FAIL)	STRUCTURE FLOODING ELEVATION (INTERPRETED FROM TERRAIN, FEET)	100 YR / 24 HOUR MAX STAGE (FEET)	100 YR / 96 HOUR MAX STAGE (FEET)	HIGHEST 100 YR MAX STAGE COMPARISON (24-HOUR OR 96-HOUR)	100 YR MAX STAGE (FEET) USED FOR LOS	APPARENT STRUCTURE FLOODING LOS FROM TERRAIN (PASS/FAIL)	STRUCTURE SURVEYED FINISHED FLOOR REFERENCE ELEVATION (FT)***
NA0080	52.23	49.77	PASS	58.9	50.33	50.69	96-HOUR	50.69	PASS	59.48
NA0110	51.61	49.45	PASS	55.8	50.10	50.50	96-HOUR	50.50	PASS	55.94
NA0120	--	48.68	--	--	48.68	48.68	96-HOUR	48.68	--	N/A
NA0130	52.55	51.20	PASS	50.2	51.68	51.86	96-HOUR	51.86	**FAIL**	52.69
NA0140	58.70	56.25	PASS	--	56.25	56.25	96-HOUR	56.25	PASS	N/A
NA0150	53.50	51.40	PASS	55.8	51.84	51.88	96-HOUR	51.88	PASS	55.94
NA0160	52.90	49.99	PASS	55.8	50.15	50.50	96-HOUR	50.50	PASS	55.94
NA0170	54.09	52.12	PASS	65.3	53.30	53.76	96-HOUR	53.76	PASS	65.89
NA0180	52.55	52.12	PASS	52.8	52.71	52.97	96-HOUR	52.97	**FAIL**	55.73
NA0190	55.70	53.74	PASS	--	55.01	55.43	96-HOUR	55.43	PASS	N/A
NA0200	55.70	54.87	PASS	60.0	55.53	55.65	96-HOUR	55.65	PASS	60.80
NA0210	59.27	56.96	PASS	66.2	56.96	56.96	96-HOUR	56.96	PASS	59.64
NA0220	58.73	56.35	PASS	--	56.35	56.35	96-HOUR	56.35	PASS	N/A
NA0230	52.53	50.23	PASS	53.1	52.08	52.97	96-HOUR	52.97	PASS	54.59
NA0240	52.53	52.58	**FAIL**	57.5	52.71	52.97	96-HOUR	52.97	PASS	58.33
NA0250	52.73	52.09	PASS	54.2	52.83	52.90	96-HOUR	52.90	PASS	54.22
NA0260	52.13	49.79	PASS	--	50.94	51.34	96-HOUR	51.34	PASS	N/A
NA0270	52.13	50.38	PASS	65.2	50.69	50.78	96-HOUR	50.78	PASS	59.64
NA0280	52.92	50.40	PASS	53.5	50.49	50.52	96-HOUR	50.52	PASS	51.01
NA0290	49.74	49.51	PASS	53.2	50.04	50.10	96-HOUR	50.10	PASS	53.75
NA0295	50.33	49.23	PASS	54.9	49.41	49.41	96-HOUR	49.41	PASS	55.57
NA0380	47.25	46.73	PASS	--	47.74	47.86	96-HOUR	47.86	PASS	N/A
NA0390	49.09	46.38	PASS	--	47.25	47.57	96-HOUR	47.57	PASS	N/A
NA0400	49.33	46.46	PASS	--	47.73	48.54	96-HOUR	48.54	PASS	N/A
NA0405	--	39.03	--	--	39.20	39.31	96-HOUR	39.31	--	N/A
NA0410	47.49	46.56	PASS	49.3	47.63	47.67	96-HOUR	47.67	PASS	49.82
NA0415	--	39.14	--	--	39.23	39.31	96-HOUR	39.31	--	N/A
NA0420	47.27	47.25	PASS	49.1	47.80	47.84	96-HOUR	47.84	PASS	49.50
NA0425	--	41.08	--	--	41.25	41.30	96-HOUR	41.30	--	N/A
NA0430	47.27	45.81	PASS	50.2	47.80	47.84	96-HOUR	47.84	PASS	50.31
NA0440	48.73	47.60	PASS	50.6	47.94	48.25	96-HOUR	48.25	PASS	51.26
NA0450	49.97	47.50	PASS	50.5	47.83	47.93	96-HOUR	47.93	PASS	51.23
NA0460	50.24	48.22	PASS	52.8	48.31	48.38	96-HOUR	48.38	PASS	53.03
NA0470	47.25	47.39	**FAIL**	51.5	47.74	47.86	96-HOUR	47.86	PASS	52.12
NA0480	48.39	47.39	PASS	51.7	47.83	47.93	96-HOUR	47.93	PASS	52.06
NA0490	48.12	47.67	PASS	51.7	47.92	47.98	96-HOUR	47.98	PASS	52.06
NA0500	48.23	48.11	PASS	50.6	48.37	48.43	96-HOUR	48.43	PASS	41.49
NA0510	48.14	46.83	PASS	--	47.92	48.24	96-HOUR	48.24	PASS	N/A
NA0520	48.14	44.50	PASS	47.4	45.42	45.71	96-HOUR	45.71	PASS	50.80
NA0810	48.90	49.11	**FAIL**	53.6	49.72	49.84	96-HOUR	49.84	PASS	54.26
NA0820	52.37	52.11	PASS	--	52.55	52.60	96-HOUR	52.60	PASS	N/A
NA0840	47.76	47.97	**FAIL**	--	48.21	48.32	96-HOUR	48.32	PASS	N/A
NA0870	48.69	47.11	PASS	--	48.52	48.70	96-HOUR	48.70	PASS	N/A
NA0880	49.17	48.51	PASS	--	49.06	49.28	96-HOUR	49.28	PASS	N/A
NA0890	49.17	48.51	PASS	55.4	48.84	48.89	96-HOUR	48.89	PASS	55.52
NA0900	48.74	47.19	PASS	55.4	48.83	48.87	96-HOUR	48.87	PASS	55.52
NA0910	48.74	46.23	PASS	51.0	48.16	48.30	96-HOUR	48.30	PASS	50.48
NA0920	47.76	47.10	PASS	--	48.16	48.30	96-HOUR	48.30	PASS	N/A
NA0930	--	47.10	--	49.8	48.16	48.30	96-HOUR	48.30	--	50.44
NA0940	47.79	47.75	PASS	49.8	48.07	48.16	96-HOUR	48.16	PASS	50.44
NA0950	48.17	47.61	PASS	50.6	47.84	47.87	96-HOUR	47.87	PASS	41.49
NA0960	--	48.75	--	--	49.32	49.40	96-HOUR	49.40	--	N/A
NA0970	--	48.92	--	53.7	49.18	49.27	96-HOUR	49.27	--	N/A
NA0980	49.28	48.92	PASS	50.2	49.17	49.27	96-HOUR	49.27	PASS	N/A
NA0990	--	46.72	--	56.5	47.49	48.02	96-HOUR	48.02	--	N/A
NA1000	49.65	48.55	PASS	50.5	48.89	49.00	96-HOUR	49.00	PASS	N/A
NA1010	--	49.24	--	--	49.43	49.50	96-HOUR	49.50	--	N/A
NA1020	50.94	49.24	PASS	57.6	49.43	49.50	96-HOUR	49.50	PASS	57.81

TABLE 7-2
MODEL NODE MAX RESULTS SUMMARY AND LEVEL OF SERVICE (LOS) ASSESSMENT

	ROADWAY OVERTOPPING			STRUCTURE IMPACTS						
MODEL NODE NAME*	ROAD FLOODING ELEVATION**	10 YR / 24 HOUR MAX STAGE (FEET)	APPARENT ROAD FLOODING LOS (PASS/ FAIL)	STRUCTURE FLOODING ELEVATION (INTERPRETED FROM TERRAIN, FEET)	100 YR / 24 HOUR MAX STAGE (FEET)	100 YR / 96 HOUR MAX STAGE (FEET)	HIGHEST 100 YR MAX STAGE COMPARISON (24-HOUR OR 96-HOUR)	100 YR MAX STAGE (FEET) USED FOR LOS	APPARENT STRUCTURE FLOODING LOS FROM TERRAIN (PASS/FAIL)	STRUCTURE SURVEYED FINISHED FLOOR REFERENCE ELEVATION (FT)***
NA1030	54.96	50.77	PASS	57.0	51.71	51.88	96-HOUR	51.88	PASS	59.31
NA1040	48.99	48.54	PASS	--	49.09	49.09	96-HOUR	49.09	PASS	N/A
NA1041	48.99	48.53	PASS	--	49.08	49.07	24-HOUR	49.08	PASS	N/A
NA1050	49.07	48.54	PASS	52.2	49.10	49.10	96-HOUR	49.10	PASS	N/A
NA1060	49.47	47.54	PASS	50.9	48.55	49.04	96-HOUR	49.04	PASS	N/A
NA1070	48.99	48.01	PASS	51.6	48.06	48.07	96-HOUR	48.07	PASS	51.80
NA1080	49.47	45.12	PASS	52.4	46.76	47.16	96-HOUR	47.16	PASS	47.40
NA1090	48.60	45.41	PASS	51.6	46.77	47.16	96-HOUR	47.16	PASS	51.80
NA1100	--	45.12	--	--	46.76	47.16	96-HOUR	47.16	--	N/A
NA1110	49.74	47.09	PASS	51.2	47.26	47.35	96-HOUR	47.35	PASS	51.71
NA1120	48.60	47.34	PASS	--	48.53	48.77	96-HOUR	48.77	PASS	N/A
NA1130	--	47.94	--	51.9	48.96	49.02	96-HOUR	49.02	--	N/A
NA1140	49.28	49.48	**FAIL**	--	49.62	49.66	96-HOUR	49.66	PASS	N/A
NA1150	48.99	47.85	PASS	50.8	49.11	49.15	96-HOUR	49.15	PASS	55.77
NA1160	48.79	48.25	PASS	--	48.44	48.47	96-HOUR	48.47	PASS	N/A
NA1170	--	47.10	--	58.5	47.74	48.15	96-HOUR	48.15	--	59.23
NA1180	48.08	46.31	PASS	50.5	47.15	47.35	96-HOUR	47.35	PASS	N/A
NA1190	48.24	47.73	PASS	--	48.30	48.34	96-HOUR	48.34	PASS	N/A
NA1200	47.10	46.30	PASS	49.4	47.12	47.25	96-HOUR	47.25	PASS	49.41
NA1210	--	45.58	--	52.4	46.76	47.16	96-HOUR	47.16	--	47.43
NA1220	--	45.37	--	52.4	46.76	47.15	96-HOUR	47.15	--	47.43
NA1230	47.07	46.24	PASS	50.1	46.85	47.14	96-HOUR	47.14	PASS	49.59
NA1235	47.07	46.15	PASS	49.8	46.35	46.41	96-HOUR	46.41	PASS	49.87
NA1240	47.65	45.84	PASS	49.4	46.55	46.90	96-HOUR	46.90	PASS	49.41
NA1250	47.21	45.75	PASS	49.3	46.15	46.50	96-HOUR	46.50	PASS	49.48
NA1260	--	45.69	--	50.6	46.07	46.42	96-HOUR	46.42	--	50.61
NA1265	--	46.30	--	--	46.92	47.00	96-HOUR	47.00	--	N/A
NA1270	--	45.41	--	--	45.74	45.91	96-HOUR	45.91	--	N/A
NA1275	--	37.97	--	--	38.32	38.42	96-HOUR	38.42	--	N/A
NA1280	--	45.41	--	47.1	45.68	45.77	96-HOUR	45.77	--	47.18
NA1285	45.63	45.71	**FAIL**	48.3	45.79	45.81	96-HOUR	45.81	PASS	48.43
NA1290	45.33	45.40	**FAIL**	47.1	45.65	45.71	96-HOUR	45.71	PASS	47.18
NA1295	--	40.40	--	--	40.49	40.50	96-HOUR	40.50	--	N/A
NA1300	44.24	44.45	**FAIL**	49.7	44.51	44.55	96-HOUR	44.55	PASS	49.87
NA1305	--	38.73	--	--	38.79	38.84	96-HOUR	38.84	--	N/A
NA1310	--	44.45	--	--	44.51	44.55	96-HOUR	44.55	--	N/A
NA1320	43.73	43.96	**FAIL**	44.9	44.02	44.03	96-HOUR	44.03	PASS	45.35
NA1325	--	36.82	--	--	36.83	36.83	96-HOUR	36.83	--	N/A
NA1330	43.85	43.55	PASS	45.3	43.68	43.70	96-HOUR	43.70	PASS	45.66
NA1340	47.98	46.04	PASS	48.9	47.82	48.10	96-HOUR	48.10	PASS	49.29
NA1350	48.32	47.54	PASS	48.9	47.87	48.14	96-HOUR	48.14	PASS	49.29
NA1360	46.46	45.06	PASS	50.2	46.07	46.54	96-HOUR	46.54	PASS	50.53
NA1370	49.17	47.69	PASS	51.4	48.55	48.86	96-HOUR	48.86	PASS	N/A
NA1380	46.92	45.07	PASS	--	46.43	47.04	96-HOUR	47.04	PASS	N/A
NA1390	--	46.78	--	50.5	46.88	46.91	96-HOUR	46.91	--	50.61
NA1395	52.91	51.11	PASS	58.2	51.37	51.21	24-HOUR	51.37	PASS	59.05
NA1400	52.90	50.03	PASS	58.2	50.32	50.38	96-HOUR	50.38	PASS	59.05
NA1410	--	48.67	--	--	49.40	49.66	96-HOUR	49.66	--	N/A
NA1420	--	48.30	--	--	48.83	49.02	96-HOUR	49.02	--	N/A
NA1424	52.82	49.37	PASS	--	49.52	49.53	96-HOUR	49.53	PASS	N/A
NA1425	42.96	47.14	**FAIL**	--	48.45	48.60	96-HOUR	48.60	PASS	N/A
NA1430	51.64	47.14	PASS	48.5	48.45	48.59	96-HOUR	48.59	**FAIL**	49.57
NA1440	55.66	47.14	PASS	52.0	48.45	48.59	96-HOUR	48.59	PASS	N/A
NA1450	--	47.14	--	52.9	48.45	48.59	96-HOUR	48.59	--	N/A
NA1460	50.19	47.12	PASS	52.7	48.42	48.57	96-HOUR	48.57	PASS	53.33
NA1465	49.56	49.38	PASS	51.5	49.70	49.69	24-HOUR	49.70	PASS	52.08
NA1470	48.93	47.12	PASS	49.5	48.42	48.57	96-HOUR	48.57	PASS	51.05
NA1475	48.79	47.11	PASS	49.5	48.42	48.57	96-HOUR	48.57	PASS	51.05

TABLE 7-2
MODEL NODE MAX RESULTS SUMMARY AND LEVEL OF SERVICE (LOS) ASSESSMENT

	ROADWAY OVERTOPPING			STRUCTURE IMPACTS						
MODEL NODE NAME*	ROAD FLOODING ELEVATION**	10 YR / 24 HOUR MAX STAGE (FEET)	APPARENT ROAD FLOODING LOS (PASS/ FAIL)	STRUCTURE FLOODING ELEVATION (INTERPRETED FROM TERRAIN, FEET)	100 YR / 24 HOUR MAX STAGE (FEET)	100 YR / 96 HOUR MAX STAGE (FEET)	HIGHEST 100 YR MAX STAGE COMPARISON (24-HOUR OR 96-HOUR)	100 YR MAX STAGE (FEET) USED FOR LOS	APPARENT STRUCTURE FLOODING LOS FROM TERRAIN (PASS/FAIL)	STRUCTURE SURVEYED FINISHED FLOOR REFERENCE ELEVATION (FT)***
NA1480	48.93	45.19	PASS	51.1	46.77	47.16	96-HOUR	47.16	PASS	51.52
NA1490	--	45.12	--	--	46.76	47.16	96-HOUR	47.16	--	N/A
NA1500	--	45.12	--	--	46.76	47.16	96-HOUR	47.16	--	N/A
NA1505	48.35	47.85	PASS	48.8	47.99	47.98	24-HOUR	47.99	PASS	50.24
NA1510	48.35	45.12	PASS	--	46.76	47.16	96-HOUR	47.16	PASS	N/A
NA1520	48.31	45.09	PASS	49.7	46.75	47.15	96-HOUR	47.15	PASS	51.02
NA1530	48.32	45.07	PASS	--	46.75	47.15	96-HOUR	47.15	PASS	N/A
NA1535	48.31	44.68	PASS	--	46.06	46.54	96-HOUR	46.54	PASS	N/A
NA1540	48.31	44.65	PASS	--	46.06	46.54	96-HOUR	46.54	PASS	N/A
NA1545	48.39	47.63	PASS	--	47.76	47.77	96-HOUR	47.77	PASS	N/A
NA1546	52.22	49.87	PASS	--	50.46	50.58	96-HOUR	50.58	PASS	N/A
NA1550	47.26	44.64	PASS	--	46.06	46.54	96-HOUR	46.54	PASS	N/A
NA1555	47.67	48.06	**FAIL**	51.1	48.35	48.36	96-HOUR	48.36	PASS	50.57
NA1556	47.22	44.47	PASS	--	45.42	45.72	96-HOUR	45.72	PASS	N/A
NA1557	48.32	47.97	PASS	50.1	48.26	48.27	96-HOUR	48.27	PASS	50.57
NA1560	--	44.47	--	--	45.41	45.71	96-HOUR	45.71	--	N/A
NA1565	47.22	47.50	**FAIL**	--	47.75	47.76	96-HOUR	47.76	PASS	N/A
NA1570	--	44.31	--	--	45.33	45.67	96-HOUR	45.67	--	N/A
NA1575	47.67	44.83	PASS	52.1	45.42	45.71	96-HOUR	45.71	PASS	52.31
NA1580	--	43.99	--	--	45.17	45.55	96-HOUR	45.55	--	N/A
NA1585	47.40	45.17	PASS	--	45.33	45.67	96-HOUR	45.67	PASS	N/A
NA1590	--	43.79	--	49.8	45.08	45.47	96-HOUR	45.47	--	50.07
NA1595	46.46	44.69	PASS	--	45.41	45.71	96-HOUR	45.71	PASS	N/A
NA1600	47.61	43.68	PASS	49.8	45.02	45.42	96-HOUR	45.42	PASS	50.07
NA1605	47.61	41.59	PASS	47.1	42.00	42.11	96-HOUR	42.11	PASS	47.20
NA1607	--	40.97	--	--	41.22	41.28	96-HOUR	41.28	--	N/A
NA1609	--	37.19	--	--	37.54	37.59	96-HOUR	37.59	--	N/A
NA1610	52.91	47.29	PASS	53.5	47.73	47.95	96-HOUR	47.95	PASS	51.01
NA1615	--	49.42	--	--	50.89	50.97	96-HOUR	50.97	--	N/A
NA1620	--	45.21	--	--	45.78	45.99	96-HOUR	45.99	--	N/A
NA1624	49.74	46.60	PASS	52.7	46.71	46.83	96-HOUR	46.83	PASS	53.09
NA1625	50.12	45.78	PASS	52.7	46.19	46.27	96-HOUR	46.27	PASS	53.09
NA1630	--	44.93	--	--	45.47	45.76	96-HOUR	45.76	--	N/A
NA1640	--	44.50	--	52.5	45.43	45.72	96-HOUR	45.72	--	52.73
NA1650	48.55	44.49	PASS	52.3	45.42	45.72	96-HOUR	45.72	PASS	52.73
NA1660	--	44.47	--	--	45.42	45.71	96-HOUR	45.71	--	N/A
NA1670	48.17	46.23	PASS	50.8	48.16	48.30	96-HOUR	48.30	PASS	51.17
NA1680	--	46.18	--	50.8	48.16	48.30	96-HOUR	48.30	--	51.17
NA1690	48.11	46.12	PASS	--	48.15	48.29	96-HOUR	48.29	PASS	N/A
NA1695	48.11	44.48	PASS	--	45.42	45.72	96-HOUR	45.72	PASS	N/A
NA1700	48.17	44.48	PASS	--	45.42	45.72	96-HOUR	45.72	PASS	N/A
NA1710	48.84	47.89	PASS	--	48.23	48.18	24-HOUR	48.23	PASS	N/A
NB0100	42.82	41.93	PASS	--	42.87	43.26	96-HOUR	43.26	PASS	N/A
NB0110	44.99	43.32	PASS	--	45.02	45.08	96-HOUR	45.08	PASS	N/A
NB0120	46.19	42.07	PASS	--	42.87	43.26	96-HOUR	43.26	PASS	N/A
NB0130	49.31	43.27	PASS	46.5	44.23	44.57	96-HOUR	44.57	PASS	N/A
NB0135	50.51	44.78	PASS	--	44.95	44.99	96-HOUR	44.99	PASS	N/A
NB0140	49.56	43.95	PASS	--	44.70	45.21	96-HOUR	45.21	PASS	N/A
NB0150	44.08	43.38	PASS	49.2	43.85	43.97	96-HOUR	43.97	PASS	49.36
NB0160	46.19	43.59	PASS	--	43.98	44.16	96-HOUR	44.16	PASS	N/A
NB0170	44.08	44.04	PASS	48.3	44.40	44.45	96-HOUR	44.45	PASS	48.32
NB0180	47.01	44.59	PASS	47.7	45.25	45.68	96-HOUR	45.68	PASS	47.97
NB0190	45.93	43.85	PASS	49.6	44.46	44.66	96-HOUR	44.66	PASS	49.57
NB0200	--	44.21	--	--	45.13	45.74	96-HOUR	45.74	--	N/A
NB0210	44.46	43.45	PASS	--	44.59	44.72	96-HOUR	44.72	PASS	N/A
NB0220	45.18	44.76	PASS	--	45.24	45.46	96-HOUR	45.46	PASS	N/A
NB0230	45.18	44.76	PASS	47.1	45.38	45.50	96-HOUR	45.50	PASS	N/A
NB0240	44.65	44.01	PASS	46.8	44.55	44.73	96-HOUR	44.73	PASS	44.88

TABLE 7-2
MODEL NODE MAX RESULTS SUMMARY AND LEVEL OF SERVICE (LOS) ASSESSMENT

	ROADWAY OVERTOPPING			STRUCTURE IMPACTS						
MODEL NODE NAME*	ROAD FLOODING ELEVATION**	10 YR / 24 HOUR MAX STAGE (FEET)	APPARENT ROAD FLOODING LOS (PASS/ FAIL)	STRUCTURE FLOODING ELEVATION (INTERPRETED FROM TERRAIN, FEET)	100 YR / 24 HOUR MAX STAGE (FEET)	100 YR / 96 HOUR MAX STAGE (FEET)	HIGHEST 100 YR MAX STAGE COMPARISON (24-HOUR OR 96-HOUR)	100 YR MAX STAGE (FEET) USED FOR LOS	APPARENT STRUCTURE FLOODING LOS FROM TERRAIN (PASS/FAIL)	STRUCTURE SURVEYED FINISHED FLOOR REFERENCE ELEVATION (FT)***
NB0250	48.86	47.66	PASS	54.1	47.66	47.66	96-HOUR	47.66	PASS	54.48
NB0260	45.88	43.74	PASS	49.6	44.27	44.47	96-HOUR	44.47	PASS	50.02
NB0270	48.39	46.82	PASS	50.7	46.93	46.99	96-HOUR	46.99	PASS	51.14
NB0280	49.73	47.04	PASS	52.8	47.23	47.26	96-HOUR	47.26	PASS	53.14
NB0290	53.73	46.72	PASS	50.4	47.40	47.49	96-HOUR	47.49	PASS	47.67
NB0300	47.21	46.72	PASS	50.4	47.40	47.49	96-HOUR	47.49	PASS	47.67
NB0310	47.86	46.57	PASS	--	46.62	46.63	96-HOUR	46.63	PASS	N/A
NB0320	47.01	46.93	PASS	54.2	46.99	47.00	96-HOUR	47.00	PASS	N/A
NB0330	45.88	45.08	PASS	--	45.77	45.87	96-HOUR	45.87	PASS	N/A
NB0340	46.08	44.43	PASS	--	44.69	44.83	96-HOUR	44.83	PASS	N/A
NB0350	42.82	42.17	PASS	45.8	42.54	43.04	96-HOUR	43.04	PASS	46.39
NB0370	44.11	41.97	PASS	45.2	42.91	43.19	96-HOUR	43.19	PASS	N/A
NB0380	50.92	42.90	PASS	44.0	44.60	45.37	96-HOUR	45.37	**FAIL**	N/A
NB0390	45.17	40.36	PASS	43.7	42.88	43.19	96-HOUR	43.19	PASS	N/A
NB0400	42.10	42.17	**FAIL**	44.7	42.54	43.04	96-HOUR	43.04	PASS	N/A
NB0420	--	42.55	--	--	42.77	42.82	96-HOUR	42.82	--	N/A
NB0430	--	43.46	--	46.1	44.29	44.38	96-HOUR	44.38	--	N/A
NB0440	--	42.54	--	--	42.75	42.80	96-HOUR	42.80	--	N/A
NB0450	46.53	42.17	PASS	47.2	42.54	43.04	96-HOUR	43.04	PASS	N/A
NB0460	--	44.86	--	--	44.87	44.88	96-HOUR	44.88	--	N/A
NB0470	--	43.23	--	--	43.49	43.56	96-HOUR	43.56	--	N/A
NB0480	--	43.17	--	--	43.39	43.47	96-HOUR	43.47	--	N/A
NB0490	46.29	43.23	PASS	--	43.50	43.57	96-HOUR	43.57	PASS	N/A
NB0500	--	43.79	--	--	44.09	44.08	24-HOUR	44.09	--	N/A
NB0505	47.01	45.71	PASS	--	45.83	45.84	96-HOUR	45.84	PASS	N/A
NB0510	--	44.45	--	--	44.55	44.55	96-HOUR	44.55	--	N/A
NB0520	42.79	43.80	**FAIL**	--	44.11	44.11	96-HOUR	44.11	PASS	N/A
NB0530	--	43.45	--	--	43.52	43.52	96-HOUR	43.52	--	N/A
NB0540	47.28	44.70	PASS	--	45.28	45.64	96-HOUR	45.64	PASS	N/A
NB0550	42.68	42.17	PASS	46.3	42.54	43.04	96-HOUR	43.04	PASS	46.31
NB0555	--	42.27	--	--	42.63	43.03	96-HOUR	43.03	--	N/A
NB0560	--	42.75	--	--	43.69	43.81	96-HOUR	43.81	--	N/A
NB0570	--	42.65	--	--	42.65	42.65	96-HOUR	42.65	--	N/A
NB0580	--	40.32	--	--	40.79	41.08	96-HOUR	41.08	--	N/A
NB0590	44.40	46.58	**FAIL**	--	46.91	47.04	96-HOUR	47.04	PASS	N/A
NB0600	45.97	46.62	**FAIL**	--	46.89	47.01	96-HOUR	47.01	PASS	N/A
NB0610	48.22	46.61	PASS	--	46.90	47.03	96-HOUR	47.03	PASS	N/A
NB0620	46.30	43.52	PASS	49.3	43.94	44.20	96-HOUR	44.20	PASS	49.30
NB0630	44.80	44.94	**FAIL**	--	45.09	45.25	96-HOUR	45.25	PASS	N/A
NB0640	47.77	44.23	PASS	--	46.31	46.93	96-HOUR	46.93	PASS	N/A
NB0650	47.35	46.10	PASS	53.4	46.36	46.93	96-HOUR	46.93	PASS	55.04
NB0660	46.84	45.05	PASS	49.9	46.31	46.93	96-HOUR	46.93	PASS	50.17
NB0670	44.86	44.22	PASS	49.9	45.13	45.43	96-HOUR	45.43	PASS	50.17
NB0685	47.55	47.28	PASS	--	47.44	47.57	96-HOUR	47.57	PASS	N/A
NB0690	--	44.47	--	--	44.51	44.51	96-HOUR	44.51	--	N/A
NB0710	--	43.81	--	50.7	44.09	44.20	96-HOUR	44.20	--	N/A
NB0715	47.27	47.27	**FAIL**	--	47.35	47.37	96-HOUR	47.37	PASS	N/A
NB0720	46.16	44.34	PASS	--	46.08	46.95	96-HOUR	46.95	PASS	N/A
NB0730	45.22	45.02	PASS	48.4	45.43	45.46	96-HOUR	45.46	PASS	48.72
NB0760	44.08	43.69	PASS	--	44.06	44.13	96-HOUR	44.13	PASS	N/A
NB0770	41.60	42.17	**FAIL**	--	42.54	43.04	96-HOUR	43.04	PASS	N/A
NB0780	41.31	42.17	**FAIL**	--	42.54	43.04	96-HOUR	43.04	PASS	N/A
NB0790	42.93	43.93	**FAIL**	--	44.11	44.19	96-HOUR	44.19	PASS	N/A
NB0800	42.66	42.17	PASS	--	42.56	43.04	96-HOUR	43.04	PASS	N/A
NB0810	43.34	43.18	PASS	--	43.79	43.89	96-HOUR	43.89	PASS	N/A
NB0820	43.73	44.51	**FAIL**	--	44.63	44.66	96-HOUR	44.66	PASS	N/A
NB0830	--	42.52	--	--	42.71	43.04	96-HOUR	43.04	--	N/A
NB0840	--	42.17	--	--	42.54	43.04	96-HOUR	43.04	--	N/A

TABLE 7-2
MODEL NODE MAX RESULTS SUMMARY AND LEVEL OF SERVICE (LOS) ASSESSMENT

	ROADWAY OVERTOPPING			STRUCTURE IMPACTS						
MODEL NODE NAME*	ROAD FLOODING ELEVATION**	10 YR / 24 HOUR MAX STAGE (FEET)	APPARENT ROAD FLOODING LOS (PASS/ FAIL)	STRUCTURE FLOODING ELEVATION (INTERPRETED FROM TERRAIN, FEET)	100 YR / 24 HOUR MAX STAGE (FEET)	100 YR / 96 HOUR MAX STAGE (FEET)	HIGHEST 100 YR MAX STAGE COMPARISON (24-HOUR OR 96-HOUR)	100 YR MAX STAGE (FEET) USED FOR LOS	APPARENT STRUCTURE FLOODING LOS FROM TERRAIN (PASS/FAIL)	STRUCTURE SURVEYED FINISHED FLOOR REFERENCE ELEVATION (FT)***
NB0850	--	42.22	--	--	42.54	43.04	96-HOUR	43.04	--	N/A
NB0860	--	43.02	--	--	43.13	43.13	96-HOUR	43.13	--	N/A
NB0870	--	42.50	--	--	42.92	43.12	96-HOUR	43.12	--	N/A
NB0880	--	42.49	--	--	42.90	43.09	96-HOUR	43.09	--	N/A
NB0890	--	43.55	--	--	44.72	44.94	96-HOUR	44.94	--	N/A
NB0900	--	43.74	--	--	44.72	44.94	96-HOUR	44.94	--	N/A
NB0910	--	45.86	--	--	46.51	46.94	96-HOUR	46.94	--	N/A
NB0920	52.11	45.86	PASS	--	46.51	46.94	96-HOUR	46.94	PASS	N/A
NB0930	44.66	45.86	**FAIL**	46.5	46.51	46.94	96-HOUR	46.94	**FAIL**	51.11
NB0940	--	45.86	--	--	46.51	46.94	96-HOUR	46.94	--	N/A
NB0950	--	42.87	--	--	43.68	44.19	96-HOUR	44.19	--	N/A
NB0960	--	44.87	--	--	45.10	45.19	96-HOUR	45.19	--	N/A
NB0970	--	44.87	--	--	45.11	45.20	96-HOUR	45.20	--	N/A
NB0980	--	44.87	--	--	45.12	45.22	96-HOUR	45.22	--	N/A
NB0990	46.36	44.87	PASS	--	45.13	45.24	96-HOUR	45.24	PASS	N/A
NB1000	44.66	45.86	**FAIL**	50.3	46.51	46.94	96-HOUR	46.94	PASS	51.65
NB1010	47.59	45.29	PASS	54.5	45.51	46.24	96-HOUR	46.24	PASS	54.55
NB1015	51.00	50.02	PASS	--	50.02	50.02	96-HOUR	50.02	PASS	N/A
NB1020	47.59	43.70	PASS	49.6	45.29	46.24	96-HOUR	46.24	PASS	50.66
NB1025	--	45.31	--	49.6	46.78	47.62	96-HOUR	47.62	--	50.66
NB1030	46.39	44.94	PASS	50.4	45.15	45.24	96-HOUR	45.24	PASS	50.80
NB1040	46.36	44.87	PASS	--	45.14	45.29	96-HOUR	45.29	PASS	N/A
NB1050	44.22	44.48	**FAIL**	--	44.74	44.85	96-HOUR	44.85	PASS	N/A
NB1060	44.50	44.64	**FAIL**	49.7	44.74	44.85	96-HOUR	44.85	PASS	50.05
NB1070	44.22	44.48	**FAIL**	47.4	44.74	44.85	96-HOUR	44.85	PASS	47.72
NB1080	--	45.74	--	47.4	45.84	45.87	96-HOUR	45.87	--	47.72
NB1090	--	45.75	--	48.1	45.86	45.89	96-HOUR	45.89	--	49.31
NB1100	--	46.95	--	--	47.09	47.12	96-HOUR	47.12	--	N/A
NB1110	--	45.93	--	--	46.11	46.14	96-HOUR	46.14	--	N/A
NB1120	44.79	44.14	PASS	--	44.76	45.01	96-HOUR	45.01	PASS	N/A
NB1130	44.79	44.10	PASS	--	44.34	44.67	96-HOUR	44.67	PASS	N/A
NB1140	--	45.80	--	--	46.39	46.47	96-HOUR	46.47	--	N/A
NB1150	--	44.88	--	--	45.23	45.32	96-HOUR	45.32	--	N/A
NB1160	--	46.36	--	--	46.53	46.59	96-HOUR	46.59	--	N/A
NB1170	--	44.71	--	54.4	45.32	45.48	96-HOUR	45.48	--	56.44
NB1180	--	45.11	--	--	45.95	46.24	96-HOUR	46.24	--	N/A
NB1190	--	44.47	--	--	45.82	45.87	96-HOUR	45.87	--	N/A
NB1200	54.01	51.41	PASS	63.3	52.14	52.33	96-HOUR	52.33	PASS	63.81
NB1205	59.48	57.55	PASS	62.8	57.55	57.55	96-HOUR	57.55	PASS	62.86
NB1210	52.03	49.72	PASS	55.8	49.72	49.72	96-HOUR	49.72	PASS	56.10
NB1215	50.60	48.88	PASS	63.5	48.93	48.93	96-HOUR	48.93	PASS	63.78
NB1220	51.14	49.46	PASS	59.5	49.46	49.46	96-HOUR	49.46	PASS	N/A
NB1230	55.50	48.69	PASS	59.2	50.32	50.79	96-HOUR	50.79	PASS	59.69
NB1240	48.45	47.21	PASS	59.4	48.74	49.43	96-HOUR	49.43	PASS	59.69
NB1250	48.55	47.21	PASS	49.8	48.74	49.43	96-HOUR	49.43	PASS	51.29
NB1260	48.57	47.21	PASS	50.4	48.74	49.43	96-HOUR	49.43	PASS	51.37
NB1270	--	49.08	--	--	50.70	51.03	96-HOUR	51.03	--	N/A
NB1280	47.12	47.55	**FAIL**	--	48.25	48.74	96-HOUR	48.74	PASS	N/A
NB1290	48.45	47.21	PASS	58.6	48.74	49.43	96-HOUR	49.43	PASS	59.29
NB1300	49.31	47.55	PASS	54.1	48.25	48.74	96-HOUR	48.74	PASS	53.59
NB1310	47.88	47.44	PASS	49.9	48.25	48.74	96-HOUR	48.74	PASS	N/A
NB1320	47.12	47.55	**FAIL**	--	48.25	48.74	96-HOUR	48.74	PASS	N/A
NB1330	48.53	47.55	PASS	51.8	48.25	48.74	96-HOUR	48.74	PASS	51.77
NB1335	49.18	47.55	PASS	51.3	48.25	48.74	96-HOUR	48.74	PASS	52.08
NB1340	50.60	47.44	PASS	45.5	48.25	48.74	96-HOUR	48.74	**FAIL**	48.37
NB1350	48.44	47.44	PASS	50.1	48.25	48.74	96-HOUR	48.74	PASS	N/A
NB1360	48.66	47.44	PASS	52.3	48.25	48.74	96-HOUR	48.74	PASS	52.76
NB1370	48.44	47.44	PASS	--	48.25	48.74	96-HOUR	48.74	PASS	N/A

TABLE 7-2
MODEL NODE MAX RESULTS SUMMARY AND LEVEL OF SERVICE (LOS) ASSESSMENT

	ROADWAY OVERTOPPING			STRUCTURE IMPACTS						
MODEL NODE NAME*	ROAD FLOODING ELEVATION**	10 YR / 24 HOUR MAX STAGE (FEET)	APPARENT ROAD FLOODING LOS (PASS/ FAIL)	STRUCTURE FLOODING ELEVATION (INTERPRETED FROM TERRAIN, FEET)	100 YR / 24 HOUR MAX STAGE (FEET)	100 YR / 96 HOUR MAX STAGE (FEET)	HIGHEST 100 YR MAX STAGE COMPARISON (24-HOUR OR 96-HOUR)	100 YR MAX STAGE (FEET) USED FOR LOS	APPARENT STRUCTURE FLOODING LOS FROM TERRAIN (PASS/FAIL)	STRUCTURE SURVEYED FINISHED FLOOR REFERENCE ELEVATION (FT)***
NB1380	49.72	48.66	PASS	53.3	49.26	49.46	96-HOUR	49.46	PASS	53.42
NB1390	49.51	46.57	PASS	--	47.51	48.13	96-HOUR	48.13	PASS	N/A
NB1400	58.12	56.88	PASS	64.6	56.94	56.96	96-HOUR	56.96	PASS	64.87
NB1405	53.21	48.11	PASS	55.5	48.86	49.46	96-HOUR	49.46	PASS	55.92
NB1410	53.73	47.49	PASS	61.3	48.86	49.67	96-HOUR	49.67	PASS	62.53
NB1420	50.62	47.15	PASS	55.7	48.33	49.07	96-HOUR	49.07	PASS	58.53
NB1430	50.50	47.33	PASS	66.2	48.86	49.46	96-HOUR	49.46	PASS	66.83
NB1440	48.49	47.96	PASS	54.1	48.68	48.72	96-HOUR	48.72	PASS	56.16
NB1450	48.49	47.86	PASS	48.4	48.15	48.23	96-HOUR	48.23	PASS	50.41
NB1455	49.25	48.38	PASS	50.5	49.35	49.41	96-HOUR	49.41	PASS	53.76
NB1456	49.25	47.20	PASS	50.6	49.27	49.34	96-HOUR	49.34	PASS	48.82
NB1460	48.95	47.22	PASS	53.4	49.12	49.16	96-HOUR	49.16	PASS	53.76
NB1470	48.95	46.39	PASS	49.6	47.51	48.13	96-HOUR	48.13	PASS	50.89
NB1480	46.76	46.53	PASS	52.4	47.20	47.29	96-HOUR	47.29	PASS	51.98
NB1485	46.76	46.53	PASS	49.7	47.20	47.29	96-HOUR	47.29	PASS	49.84
NB1490	47.11	45.84	PASS	50.3	46.21	46.56	96-HOUR	46.56	PASS	50.89
NB1500	47.11	43.62	PASS	50.1	44.53	44.82	96-HOUR	44.82	PASS	50.30
NB1510	48.49	47.26	PASS	53.0	47.93	48.38	96-HOUR	48.38	PASS	53.17
NB1520	49.33	48.00	PASS	53.9	48.53	48.69	96-HOUR	48.69	PASS	48.24
NB1530	49.61	48.00	PASS	54.4	48.53	48.69	96-HOUR	48.69	PASS	48.24
NB1540	54.68	51.38	PASS	57.0	51.38	51.38	96-HOUR	51.38	PASS	59.31
NB1550	55.48	53.60	PASS	58.3	53.60	53.60	96-HOUR	53.60	PASS	58.94
NB1560	54.78	52.09	PASS	--	52.09	52.09	96-HOUR	52.09	PASS	N/A
NB1570	49.61	47.24	PASS	--	48.53	48.69	96-HOUR	48.69	PASS	N/A
NB1580	49.33	48.00	PASS	55.4	48.45	48.48	96-HOUR	48.48	PASS	49.86
NB1590	49.48	43.15	PASS	55.4	44.30	44.67	96-HOUR	44.67	PASS	49.86
NB1600	51.55	46.97	PASS	53.4	47.99	48.67	96-HOUR	48.67	PASS	N/A
NB1610	51.24	48.71	PASS	54.3	48.71	48.71	96-HOUR	48.71	PASS	54.76
NB1620	48.42	46.60	PASS	51.8	47.08	47.58	96-HOUR	47.58	PASS	52.53
NB1630	46.86	44.99	PASS	49.7	47.01	47.08	96-HOUR	47.08	PASS	49.66
NB1640	--	47.72	--	49.6	47.85	47.89	96-HOUR	47.89	--	49.66
NB1650	47.31	47.11	PASS	--	47.30	47.36	96-HOUR	47.36	PASS	N/A
NB1660	52.38	47.63	PASS	50.1	48.24	48.35	96-HOUR	48.35	PASS	50.91
NB1665	47.81	47.79	PASS	--	47.99	48.02	96-HOUR	48.02	PASS	N/A
NB1670	--	48.42	--	52.3	48.55	48.58	96-HOUR	48.58	--	52.60
NB1680	47.56	47.66	**FAIL**	48.9	47.74	47.76	96-HOUR	47.76	PASS	51.25
NB1690	46.33	44.42	PASS	47.6	45.28	45.38	96-HOUR	45.38	PASS	48.54
NB1700	45.14	41.06	PASS	--	41.11	41.11	96-HOUR	41.11	PASS	N/A
NB1710	--	43.84	--	--	43.89	43.89	96-HOUR	43.89	--	N/A
NB1730	45.45	43.60	PASS	50.0	44.53	44.82	96-HOUR	44.82	PASS	50.30
NB1740	45.45	43.39	PASS	50.5	44.47	44.78	96-HOUR	44.78	PASS	51.81
NB1750	--	43.38	--	--	44.47	44.78	96-HOUR	44.78	--	N/A
NB1760	--	43.37	--	52.8	44.47	44.78	96-HOUR	44.78	--	52.93
NB1770	48.49	43.37	PASS	49.6	44.47	44.78	96-HOUR	44.78	PASS	49.84
NB1780	50.11	43.36	PASS	50.8	44.47	44.78	96-HOUR	44.78	PASS	N/A
NB1790	45.39	43.35	PASS	52.3	44.46	44.78	96-HOUR	44.78	PASS	52.48
NB1795	45.39	43.13	PASS	49.8	44.29	44.66	96-HOUR	44.66	PASS	50.70
NB1800	45.34	43.13	PASS	49.8	44.29	44.66	96-HOUR	44.66	PASS	50.70
NB1810	--	43.12	--	--	44.29	44.66	96-HOUR	44.66	--	N/A
NB1820	--	43.06	--	--	44.27	44.64	96-HOUR	44.64	--	N/A
NB1825	--	45.39	--	--	45.48	45.50	96-HOUR	45.50	--	N/A
NB1830	--	43.04	--	--	44.26	44.64	96-HOUR	44.64	--	N/A
NB1835	--	45.73	--	--	45.90	45.97	96-HOUR	45.97	--	N/A
NB1840	--	42.96	--	52.2	44.24	44.63	96-HOUR	44.63	--	52.59
NB1845	--	44.74	--	--	44.86	44.89	96-HOUR	44.89	--	N/A
NB1850	50.25	42.94	PASS	50.6	44.24	44.63	96-HOUR	44.63	PASS	51.03
NB1855	--	43.61	--	--	44.25	44.64	96-HOUR	44.64	--	N/A
NB1860	--	42.90	--	--	44.22	44.62	96-HOUR	44.62	--	N/A

TABLE 7-2
MODEL NODE MAX RESULTS SUMMARY AND LEVEL OF SERVICE (LOS) ASSESSMENT

	ROADWAY OVERTOPPING			STRUCTURE IMPACTS							
MODEL NODE NAME*	ROAD FLOODING ELEVATION**	10 YR / 24 HOUR MAX STAGE (FEET)	APPARENT ROAD FLOODING LOS (PASS/ FAIL)	STRUCTURE FLOODING ELEVATION (INTERPRETED FROM TERRAIN, FEET)	100 YR / 24 HOUR MAX STAGE (FEET)	100 YR / 96 HOUR MAX STAGE (FEET)	HIGHEST 100 YR MAX STAGE COMPARISON (24-HOUR OR 96-HOUR)	100 YR MAX STAGE (FEET) USED FOR LOS	APPARENT STRUCTURE FLOODING LOS FROM TERRAIN (PASS/FAIL)	STRUCTURE SURVEYED FINISHED FLOOR REFERENCE ELEVATION (FT)***
NB1865	46.93	46.24	PASS	50.8	46.50	46.58	96-HOUR	46.58	PASS	50.94
NB1870	47.48	42.72	PASS	49.4	44.16	44.57	96-HOUR	44.57	PASS	49.16
NB1875	--	46.69	--	--	47.24	47.31	96-HOUR	47.31	--	N/A
NB1880	--	45.86	--	--	46.71	46.80	96-HOUR	46.80	--	N/A
NB1890	--	45.89	--	--	46.01	46.02	96-HOUR	46.02	--	N/A
NB1900	46.85	45.98	PASS	49.6	46.85	46.95	96-HOUR	46.95	PASS	49.74
NB1910	47.15	45.51	PASS	49.2	47.26	47.34	96-HOUR	47.34	PASS	50.28
NB1930	47.85	43.85	PASS	46.4	44.82	45.17	96-HOUR	45.17	PASS	49.46
NB1940	46.86	43.85	PASS	48.6	44.82	45.17	96-HOUR	45.17	PASS	48.72
NB1945	47.81	47.78	PASS	--	47.96	47.99	96-HOUR	47.99	PASS	N/A
NB1950	--	43.85	--	--	44.82	45.17	96-HOUR	45.17	--	50.14
NB1960	--	43.84	--	--	44.78	45.14	96-HOUR	45.14	--	N/A
NB1965	48.09	44.82	PASS	49.4	44.87	45.11	96-HOUR	45.11	PASS	49.42
NB1970	--	43.84	--	--	44.75	45.12	96-HOUR	45.12	--	N/A
NB1975	46.17	45.21	PASS	48.6	46.18	46.26	96-HOUR	46.26	PASS	50.14
NB1980	--	43.84	--	49.2	44.74	45.11	96-HOUR	45.11	--	49.42
NB1990	47.65	43.79	PASS	49.6	44.73	45.10	96-HOUR	45.10	PASS	N/A
NB1995	46.35	44.90	PASS	--	45.56	45.60	96-HOUR	45.60	PASS	N/A
NB2000	46.17	43.68	PASS	49.6	44.70	45.08	96-HOUR	45.08	PASS	N/A
NB2050	45.08	45.24	**FAIL**	47.9	45.29	45.29	96-HOUR	45.29	PASS	48.41
NB2080	47.10	46.31	PASS	46.5	46.60	46.58	24-HOUR	46.60	**FAIL**	46.96
NB2800	48.10	42.91	PASS	50.0	43.92	44.19	96-HOUR	44.19	PASS	N/A
NB2810	--	42.89	--	50.4	43.90	44.16	96-HOUR	44.16	--	N/A
NB2820	--	42.87	--	--	43.87	44.14	96-HOUR	44.14	--	N/A
NB2825	47.88	42.33	PASS	--	43.04	43.15	96-HOUR	43.15	PASS	N/A
NB2830	47.88	42.31	PASS	--	43.00	43.10	96-HOUR	43.10	PASS	N/A
NB2840	--	42.30	--	--	42.98	43.08	96-HOUR	43.08	--	N/A
NB2850	42.68	42.30	PASS	46.2	42.97	43.06	96-HOUR	43.06	PASS	46.42
NB2860	42.80	42.28	PASS	--	42.94	43.03	96-HOUR	43.03	PASS	N/A
NB2865	46.85	42.24	PASS	--	42.92	43.01	96-HOUR	43.01	PASS	N/A
NB2870	46.85	42.23	PASS	--	42.92	43.01	96-HOUR	43.01	PASS	N/A
NB2880	46.86	42.21	PASS	--	42.91	43.00	96-HOUR	43.00	PASS	N/A
NB2890	--	42.21	--	--	42.91	43.00	96-HOUR	43.00	--	N/A
NB2900	--	42.20	--	--	42.91	43.00	96-HOUR	43.00	--	N/A
NB2930	46.87	42.16	PASS	--	42.89	42.98	96-HOUR	42.98	PASS	N/A
NB2935	--	45.44	--	--	46.62	46.85	96-HOUR	46.85	--	N/A
NB2940	--	42.14	--	--	42.87	42.97	96-HOUR	42.97	--	N/A
NB2955	46.85	43.10	PASS	45.9	43.55	43.64	96-HOUR	43.64	PASS	46.28
NB2960	--	42.10	--	--	42.81	42.91	96-HOUR	42.91	--	N/A
NB2965	47.48	42.08	PASS	48.2	42.78	42.89	96-HOUR	42.89	PASS	54.53
NB2970	48.29	42.07	PASS	48.2	42.78	42.88	96-HOUR	42.88	PASS	54.53
NB2980	47.35	42.01	PASS	47.5	42.71	42.81	96-HOUR	42.81	PASS	54.53
NB2990	46.93	41.94	PASS	47.1	42.63	42.73	96-HOUR	42.73	PASS	47.36
NB3000	46.53	41.84	PASS	47.5	42.51	42.60	96-HOUR	42.60	PASS	47.99
NB3010	46.27	41.75	PASS	46.2	42.41	42.50	96-HOUR	42.50	PASS	46.44
NB3015	46.87	45.65	PASS	47.0	46.44	46.48	96-HOUR	46.48	PASS	47.24
NB3020	46.17	41.57	PASS	47.0	42.19	42.27	96-HOUR	42.27	PASS	47.34
NB3025	46.17	41.43	PASS	47.3	41.62	41.66	96-HOUR	41.66	PASS	47.34
NB3030	46.35	40.85	PASS	47.3	41.39	41.47	96-HOUR	41.47	PASS	47.34
NB3040	--	38.90	--	--	39.40	39.47	96-HOUR	39.47	--	N/A
NB3050	--	38.56	--	--	39.02	39.06	96-HOUR	39.06	--	N/A
NC0040	--	44.33	--	--	46.09	46.74	96-HOUR	46.74	--	N/A
NC0050	43.15	43.36	**FAIL**	46.6	43.77	43.83	96-HOUR	43.83	PASS	N/A
NC0060	43.15	42.00	PASS	49.0	42.02	42.03	96-HOUR	42.03	PASS	49.30
NC0070	45.30	45.54	**FAIL**	48.3	45.63	45.63	96-HOUR	45.63	PASS	48.32
NC0080	44.15	44.30	**FAIL**	--	44.51	44.55	96-HOUR	44.55	PASS	N/A
NC0090	41.56	42.75	**FAIL**	--	42.97	43.14	96-HOUR	43.14	PASS	N/A
NC0100	39.41	42.01	**FAIL**	--	42.01	42.02	96-HOUR	42.02	PASS	N/A

TABLE 7-2
MODEL NODE MAX RESULTS SUMMARY AND LEVEL OF SERVICE (LOS) ASSESSMENT

	ROADWAY OVERTOPPING			STRUCTURE IMPACTS						
MODEL NODE NAME*	ROAD FLOODING ELEVATION**	10 YR / 24 HOUR MAX STAGE (FEET)	APPARENT ROAD FLOODING LOS (PASS/ FAIL)	STRUCTURE FLOODING ELEVATION (INTERPRETED FROM TERRAIN, FEET)	100 YR / 24 HOUR MAX STAGE (FEET)	100 YR / 96 HOUR MAX STAGE (FEET)	HIGHEST 100 YR MAX STAGE COMPARISON (24-HOUR OR 96-HOUR)	100 YR MAX STAGE (FEET) USED FOR LOS	APPARENT STRUCTURE FLOODING LOS FROM TERRAIN (PASS/FAIL)	STRUCTURE SURVEYED FINISHED FLOOR REFERENCE ELEVATION (FT)***
NC0110	45.84	44.66	PASS	--	45.09	45.25	96-HOUR	45.25	PASS	N/A
NC0120	43.80	44.11	**FAIL**	--	44.39	44.49	96-HOUR	44.49	PASS	N/A
NC0130	--	44.45	--	--	45.52	45.60	96-HOUR	45.60	--	N/A
NC0140	48.14	44.54	PASS	--	45.23	45.72	96-HOUR	45.72	PASS	N/A
NC0150	44.85	44.76	PASS	--	45.10	45.26	96-HOUR	45.26	PASS	N/A
NC0160	45.03	44.82	PASS	--	45.22	45.34	96-HOUR	45.34	PASS	N/A
NC0170	--	46.29	--	53.4	49.51	50.23	96-HOUR	50.23	--	55.04
NC0180	44.80	44.66	PASS	--	45.09	45.25	96-HOUR	45.25	PASS	N/A
NC0190	45.03	45.20	**FAIL**	--	45.28	45.35	96-HOUR	45.35	PASS	N/A
NC0200	--	45.34	--	--	46.33	46.43	96-HOUR	46.43	--	N/A
NC0210	42.02	44.27	**FAIL**	--	44.53	44.60	96-HOUR	44.60	PASS	N/A
ND0080	59.56	51.47	PASS	--	51.47	51.47	96-HOUR	51.47	**FAIL**	61.82
ND0090	--	51.21	--	58.3	51.21	51.21	96-HOUR	51.21	--	59.89
ND0100	54.33	52.21	PASS	61.5	52.21	52.21	96-HOUR	52.21	PASS	61.82
ND0110	60.28	58.02	PASS	--	58.02	58.02	96-HOUR	58.02	PASS	N/A
ND0120	49.18	47.55	PASS	50.3	48.10	48.56	96-HOUR	48.56	PASS	50.80
ND0140	54.41	52.16	PASS	70.8	55.17	55.23	96-HOUR	55.23	PASS	71.55
ND0150	49.24	48.08	PASS	55.3	49.32	49.40	96-HOUR	49.40	PASS	55.99
ND0160	49.02	47.19	PASS	--	47.36	47.43	96-HOUR	47.43	PASS	N/A
ND0170	53.09	44.97	PASS	54.8	45.61	45.98	96-HOUR	45.98	PASS	54.81
ND0180	55.94	53.77	PASS	57.6	53.77	53.77	96-HOUR	53.77	PASS	58.05
ND0190	49.18	47.55	PASS	54.6	48.10	48.56	96-HOUR	48.56	PASS	54.89
ND0200	46.84	44.03	PASS	47.5	44.83	45.39	96-HOUR	45.39	PASS	47.54
ND0210	60.03	58.17	PASS	63.1	58.17	58.17	96-HOUR	58.17	PASS	63.52
ND0230	47.76	45.73	PASS	54.8	45.73	45.73	96-HOUR	45.73	PASS	54.81
ND0240	54.82	52.99	PASS	61.3	52.99	52.99	96-HOUR	52.99	PASS	61.35
ND0260	47.93	45.72	PASS	63.2	46.37	46.89	96-HOUR	46.89	PASS	63.50
ND0270	49.27	47.32	PASS	--	47.32	47.32	96-HOUR	47.32	PASS	N/A
ND0280	60.87	58.93	PASS	66.5	58.93	58.93	96-HOUR	58.93	PASS	67.91
ND0290	48.36	48.28	PASS	62.3	48.28	48.28	96-HOUR	48.28	PASS	62.87
ND0360	55.06	41.77	PASS	--	43.93	44.52	96-HOUR	44.52	PASS	N/A
ND0440	48.16	42.00	PASS	51.5	42.85	43.36	96-HOUR	43.36	PASS	51.60
ND0450	62.09	46.00	PASS	--	46.00	46.00	96-HOUR	46.00	PASS	N/A
ND0460	48.16	45.69	PASS	54.3	45.80	45.90	96-HOUR	45.90	PASS	54.51
ND0470	59.20	49.50	PASS	53.1	53.07	53.98	96-HOUR	53.98	**FAIL**	N/A
ND0480	56.96	54.52	PASS	62.4	54.52	54.61	96-HOUR	54.61	PASS	62.68
ND0490	56.96	54.75	PASS	64.8	54.81	54.88	96-HOUR	54.88	PASS	65.00
ND0500	--	42.92	--	58.7	44.15	44.56	96-HOUR	44.56	--	59.23
ND0520	56.74	54.78	PASS	--	54.87	54.97	96-HOUR	54.97	PASS	N/A
ND0530	65.81	62.69	PASS	--	62.82	63.03	96-HOUR	63.03	PASS	N/A
ND0540	47.76	43.79	PASS	45.4	44.27	44.65	96-HOUR	44.65	PASS	49.67

NOTES:
* Only nodes inside Royal Trails subdivision shown. For full model results refer to the DVD included with this report
** Road Flooding Elevation corresponds to the elevation of the lowest road overtopping weir connected to the node
*** Surveyed Finished Floor Elevation is provided for informational purposes only and is not necessarily considered the elevation at which a structure would be impacted by the 100-year flood. In some cases finished floor may be raised above land surface but other property impacts may still occur
"--" indicates that the node is not connected to a road overtopping weir or does not have a structure in it's contributing area.
All elevations reference the NAVD88 vertical datum.

The surveyed structure finished floor elevations (FFE) referenced on Table 7-2 and the apparent structure elevations interpreted from the terrain are significantly different at several locations. The reasons for this appear to include varied interpretation by the surveyor at some locations and houses with finished floors elevated on cinder blocks. Apparent structure flooding was interpreted from the terrain for purposes of this report.

The model results were compared to the drainage and flooding related maintenance requests and resident comments discussed in Section 2. Only 2 of the 5 maintenance request locations show flooding during the modeled storm events. The 3 problems that do not show flooding were maintenance related problems that would not necessarily be reflected in the model.

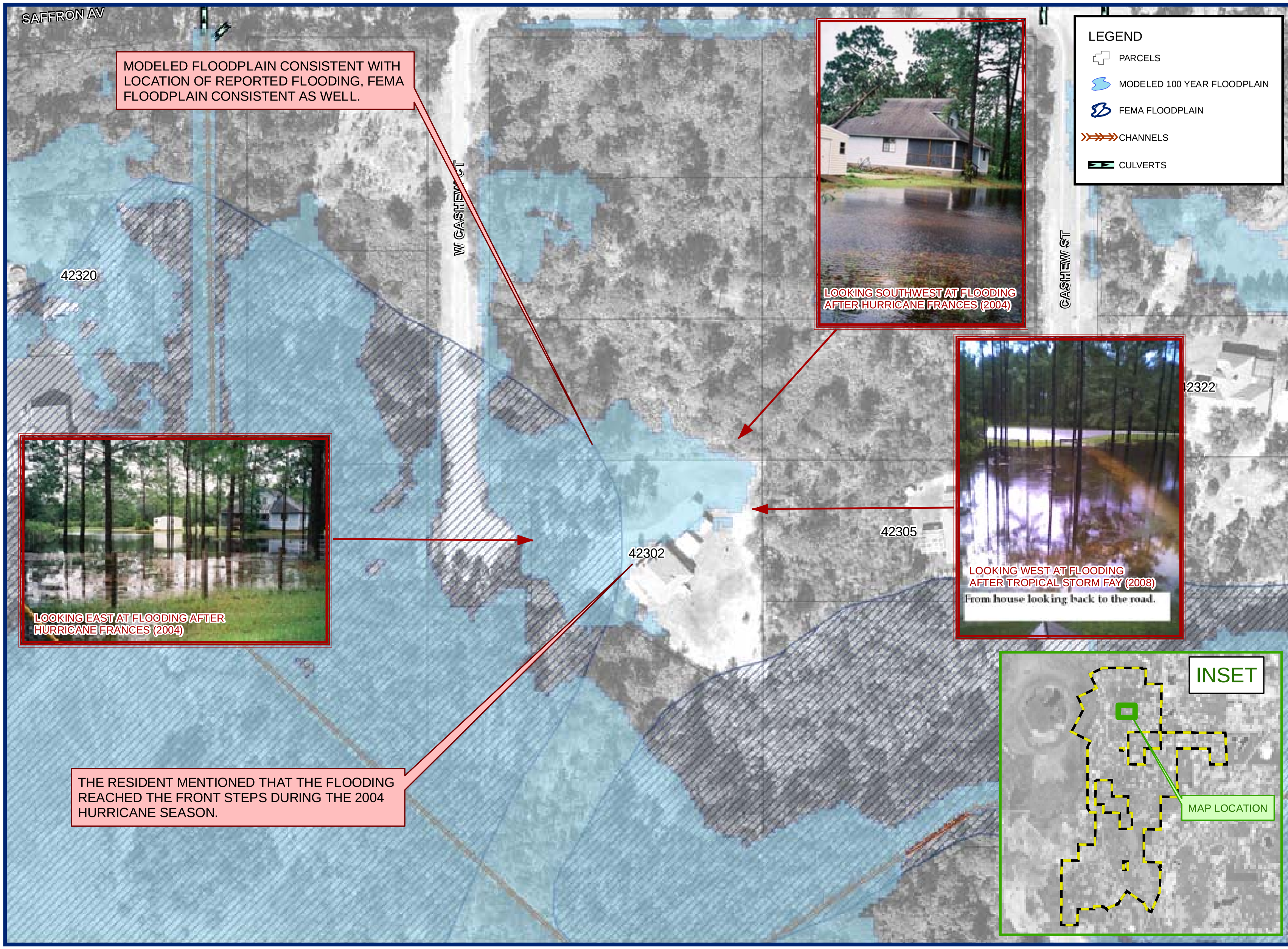
The model shows flooding problems similar to the problems reported by 2 of the 3 residents who reported flooding at their property based on interviews. A more detailed comparison of the model results to the information provided by residents' is provided in Section 8 - Verification & Validation Data.

8.0 VERIFICATION & VALIDATION DATA

Limited data exists within the Royal Trails subdivision that can be used as an independent verification of model assumptions and/or validation of its results. Other data sources for model verification / validation such as hydrologic gauge data or other long term stage records were not available. The only data available for verification / validation of the flood model were comments and other information received from the residents of the subdivision. At best this limited verification data can confirm that flooding may be expected to occur in areas where 100 year floodplains are delineated, but would not necessarily substantiate specific elevations or extent. The modeled storm events are of a regular distribution and of differing rainfall depths than what has likely resulted at these problem areas. Comments and information regarding flooding from interviewed subdivision residents that were followed up with as part of this study, with a comparison to the flood model results is summarized below:

- *42302 West Cashew Ct* – Resident reported flooding on the property that lasted several weeks during the 2004 hurricane season and some slightly less severe flooding after Tropical Storm Fay. The water level rose up to the front steps but did not flood the house. The modeled-100 year floodplain is close to the house but does not appear to impact the house. This is similar to what was described. See Figure 8-1 for a depiction of the floodplain at the property.
- *41513 Aspen St* – Resident reported flooding on his property that impacted his house during 2004 and 2005. The flooding apparently lasted for several months. The modeled 100-year floodplain appears to impact the property in a similar manner as described. See Figure 8-2 for a depiction of the floodplain at the property.
- *30116 Viola Avenue* – Resident reported several instances of flooding to the house. The most severe flooding occurred during the 2004 hurricane season when the water level was roughly 2' deep in the storage area under the house. The modeled-100 year floodplain is close to the house but does not appear to impact the house. Some type of obstruction to the ditch or downstream culvert that conveys stormwater from the wetland behind the house to the west toward Lake Tracy may have caused the water levels at the property to rise above the modeled floodplain elevation. See Figure 8-3 for a depiction of the floodplain at the property.
- *39915 Greenbrier Street* – Resident did not report any flooding problems at the property. The modeled 100-year floodplain does not show any flooding impacts to the property, which is consistent with the resident's report.
- *31610 Nutmeg Avenue* - Resident did not report any flooding problems at the property. The modeled 100-year floodplain does not show any flooding impacts to the property, which is consistent with the resident's report.
- *41203 Royal Trails Road* - Resident did not report any flooding problems at the property. The modeled 100-year floodplain does not show any flooding impacts to the property, which is consistent with the resident's report.

In general, floodplains presence appears consistent with resident reports with the exception of the residence at 30116 Viola Avenue. Other extenuating circumstances may have caused flooding at that location which warrants further investigation in the Deficiency Correction task of this project.



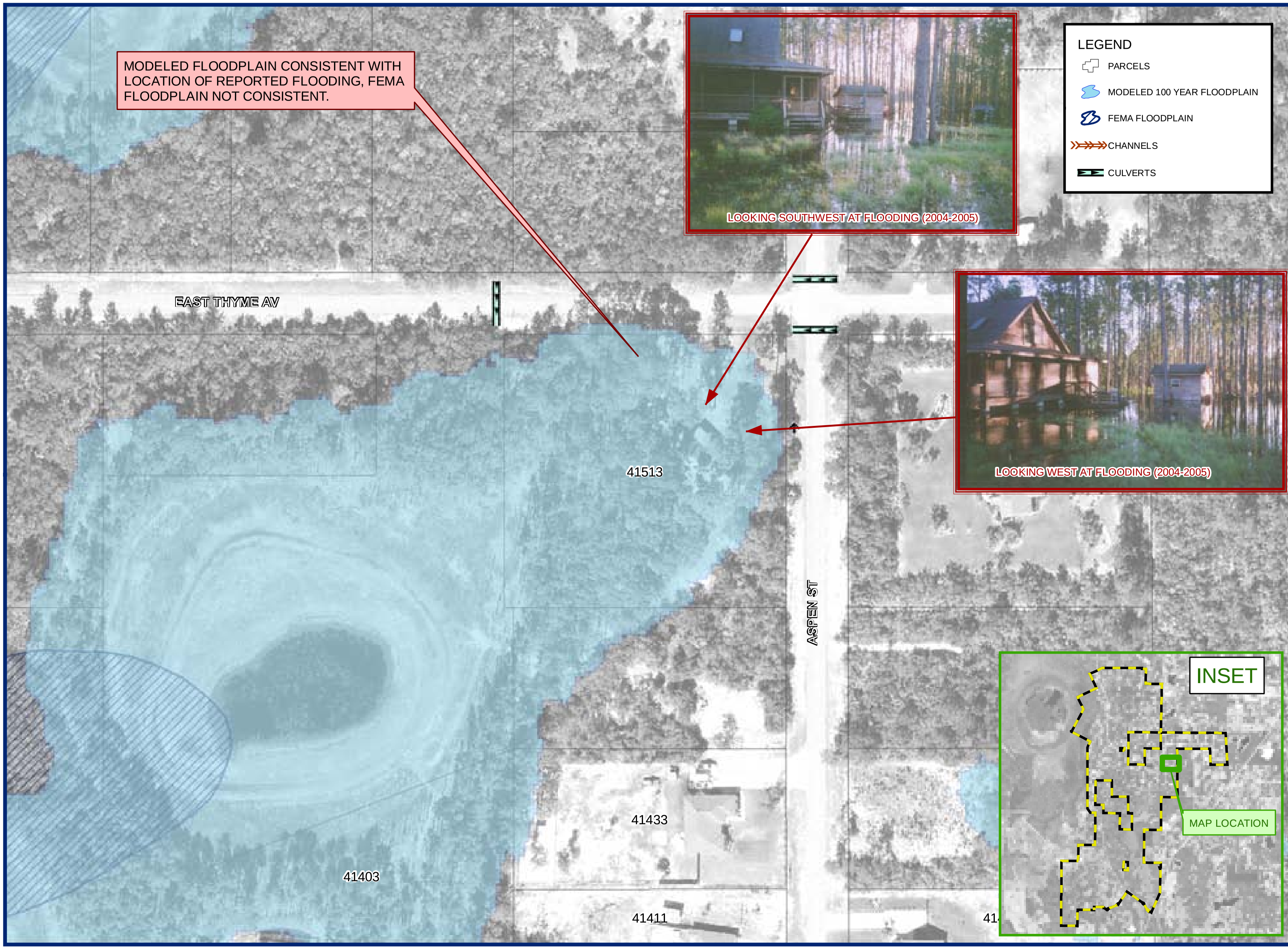
DATA SOURCES:
ROADS: LAKE COUNTY, 2006
PARCELS: LAKE COUNTY, 2008
PHOTOS: GERALD AND MARJORIE DEL NEGRO

FIGURE 8-1

42302 WEST CASHEW COURT FLOOD SUMMARY MAP

Royal Trails Flood Study

Inwood consulting engineers



LAKE COUNTY FLORIDA

0 50 100 Feet

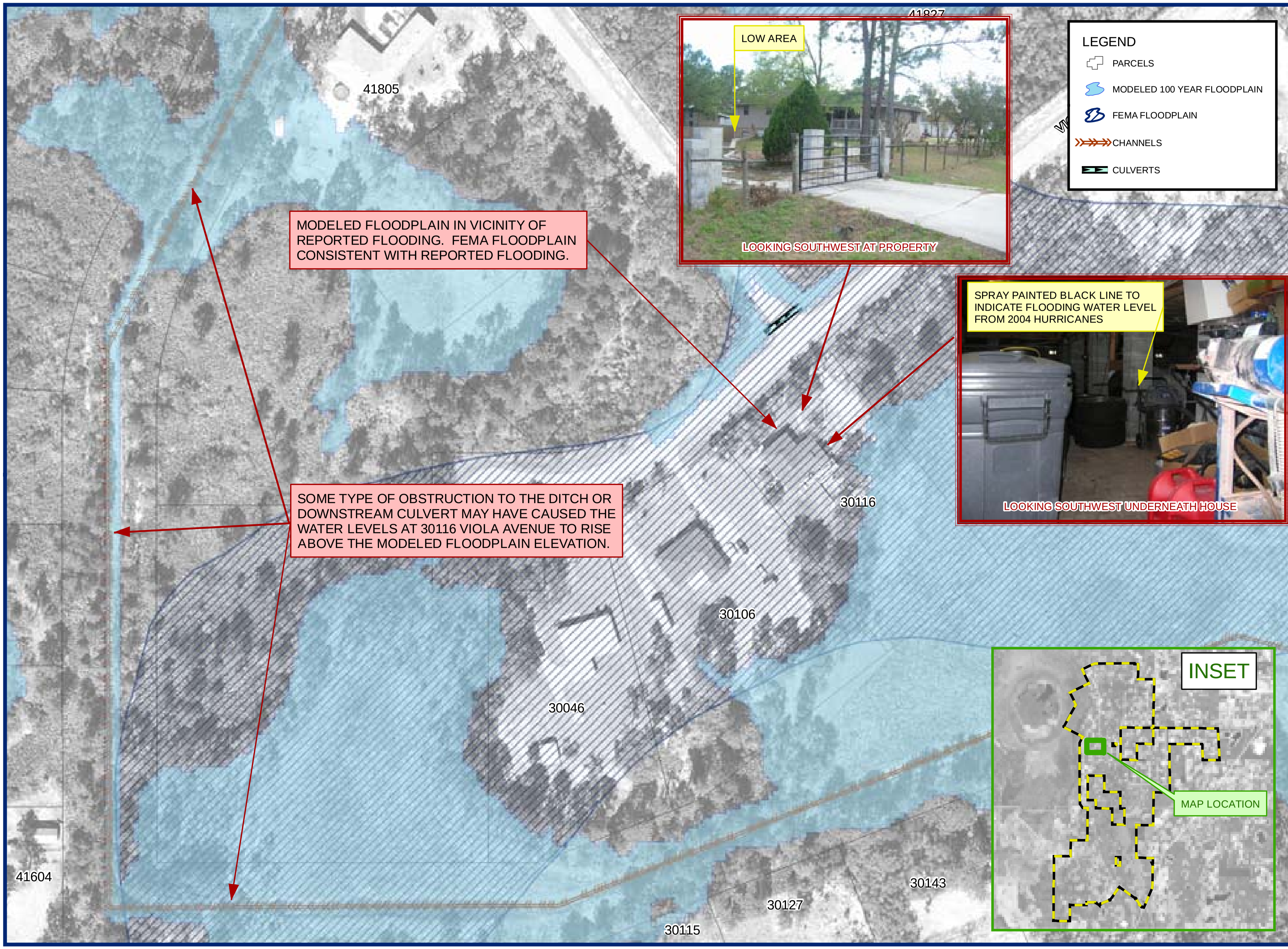
DATA SOURCES:
ROADS: LAKE COUNTY, 2006
PARCELS: LAKE COUNTY, 2008
PHOTOS: CARL MANNY

FIGURE 8-2

41513 ASPEN STREET FLOOD SUMMARY MAP

Royal Trails Flood Study

Inwood consulting engineers



LAKE COUNTY FLORIDA

0 50 100 Feet

DATA SOURCES:
ROADS: LAKE COUNTY, 2006
PARCELS: LAKE COUNTY, 2008

FIGURE 8-3
30116 VIOLA AVENUE FLOOD SUMMARY MAP

Royal Trails Flood Study

Inwood consulting engineers

9.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the flood study of the Royal Trails subdivision, the floodplains predicted by the modeling detailed in this report are considered reasonably accurate on which to base floodplain management decisions. In addition, several potential flooding areas exist in the subdivision that warrant further evaluation during the subsequent Deficiency Correction Task portion of this project. The potential problem areas are shown on Figure 9-1.

It is also recommended that the design function of the several control structures with flashboards in place or missing be evaluated. The goal would be to restore hydration to potentially artificially drained areas while still providing flood protection. The location of the control structures is also shown on Figure 9-1.

APPARENT FLOOD IMPACT SUMMARY

HOUSES IMPACTED BY 100-YEAR STORM EVENT

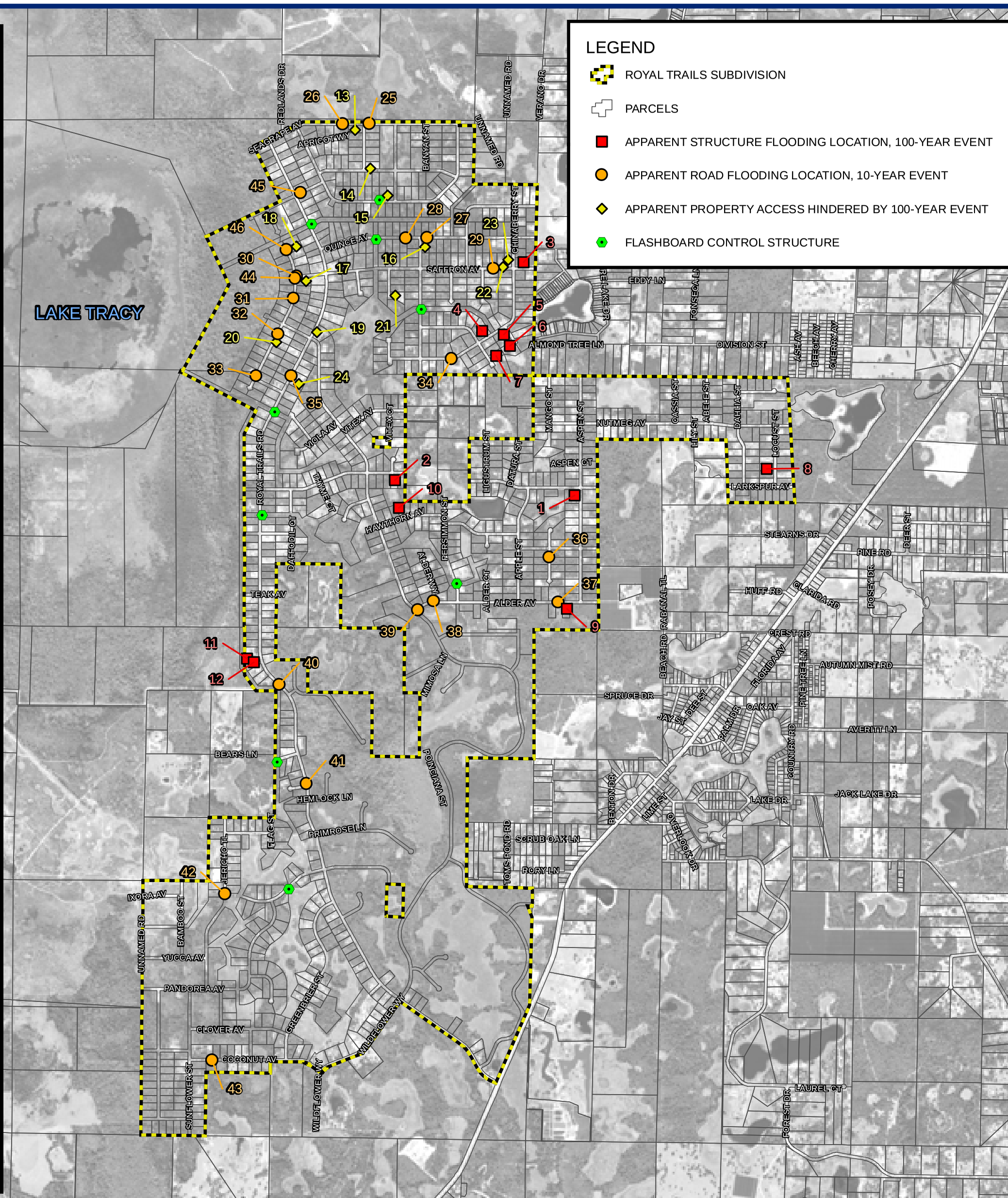
ID #	ADDRESS
1	41513 ASPEN ST
2	30428 WEST THYME ST
3	30911 SAFFRON AVE
4	42141 CHINABERRY ST
5	42133 CHINABERRY CT
6	42111 CHINABERRY CT
7	30839 KUMQUAT AVE
8	41631 LOCUST ST
9	31110 ALDER AVE
10	30451 HAWTHORN ST
11	40901 ROYAL TRAILS RD
12	40835 ROYAL TRAILS RD

YARDS IMPACTED BY 100-YEAR STORM EVENT

ID #	ADDRESS
13	42943 HONEYSUCKLE ST
14	42810 HONEYSUCKLE ST
15	30411 APRICOT AVE
16	30554 QUINCE AVE
17	42330 TAMARAC ST
18	42454 TAMARACK WAY
19	42122 POINCIANA ST
20	42106 SOUTH TAMARAC ST
21	42302 WEST CASHEW CT
22	30849 SAFFRON AVE
23	30901 SAFFRON AVE
24	41942 ROYAL TRAILS RD

ROAD OVERTOPPING DURING 10-YEAR STORM EVENT

ID #	ROAD NAME
25	SEAGRAPE AV
26	SEAGRAPE AV
27	QUINCE AV
28	QUINCE AV
29	SAFFRON AV
30	SAFFRON AV
31	TAMARAC ST
32	TAMARAC ST
33	TAMARAC ST
34	CHINABERRY ST
35	ROYAL TRAILS RD
36	BALSAM ST
37	ALDER AV
38	ALDER AV
39	ALDER AV
40	ROYAL TRAILS RD
41	ROYAL TRAILS RD
42	JERICHO TL
43	COCONUT AV
44	TAMARAC ST
45	CINNAMON AV
46	TAMARAC ST



LAKE COUNTY FLORIDA

DATA SOURCES:
SUBDIVISION: LAKE COUNTY, 2006
ROADS: LAKE COUNTY, 2006
PARCELS: LAKE COUNTY, 2008

FIGURE 9-1

RECOMMENDED PROBLEM AREA EVALUATION MAP

Royal Trails Flood Study

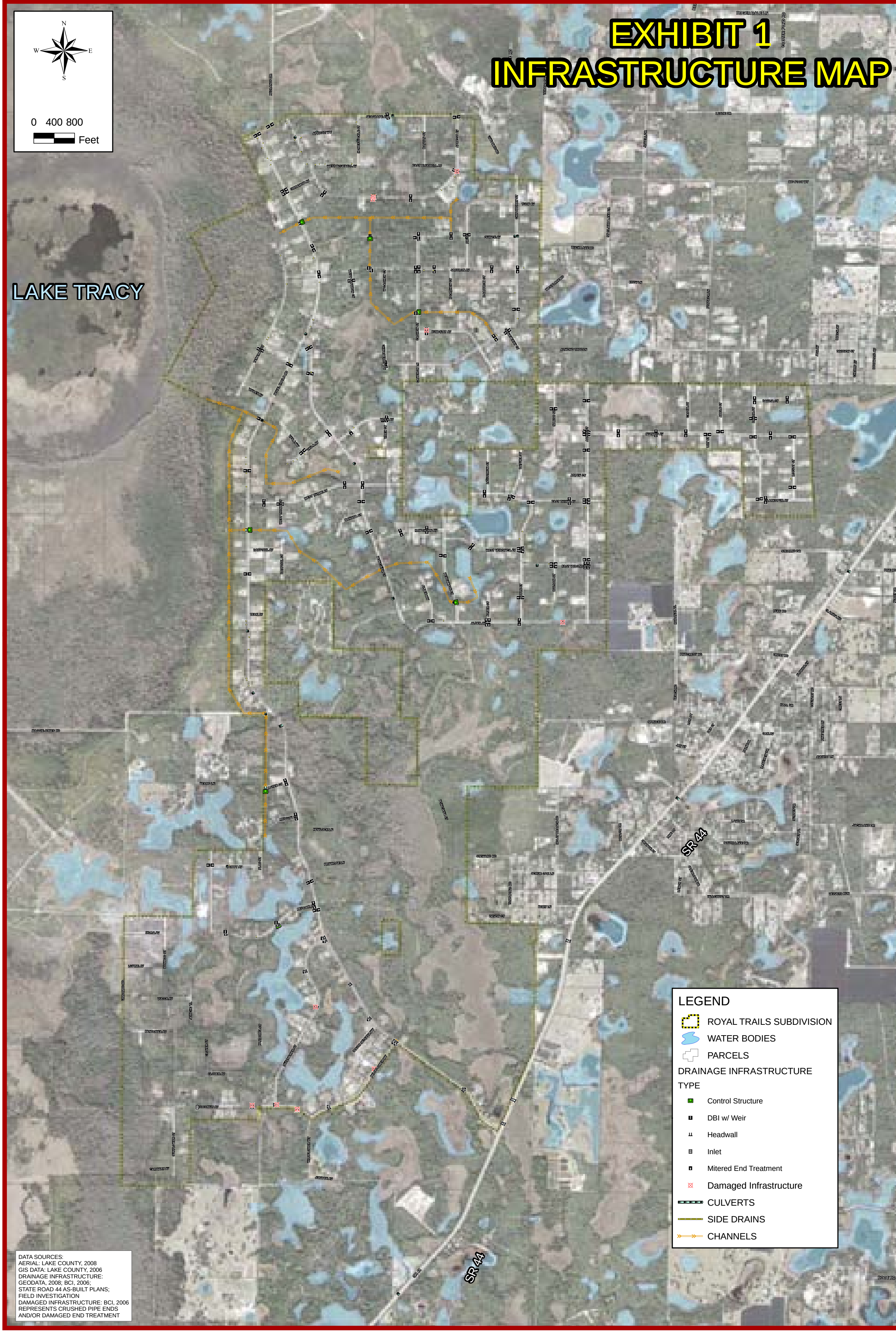
Inwood consulting engineers

REFERENCES

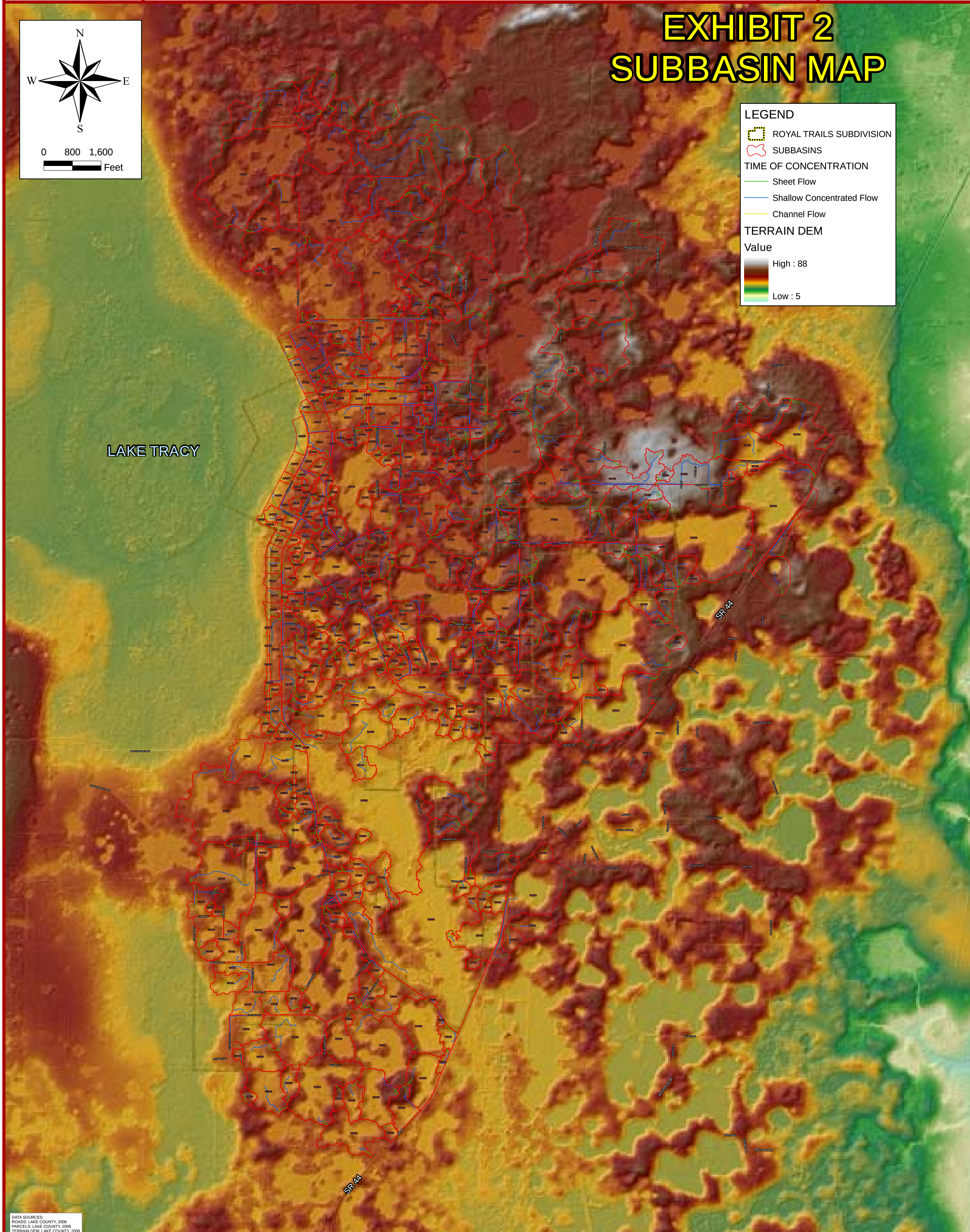
1. BCI, Drainage Inventory Survey, 2006.
2. CDM, Lake County Stormwater Management Needs Assessment, May 1991.
3. Devo Engineering, Geotechnical Engineering Report for Royal Trails Subdivision Drainage Study, 2008.
4. FDOT, SR 44 As-Built Plans, 1954.
5. FEMA, Flood Insurance Study, July 2002.
6. Florida Department of Transportation. *Florida Land Use, Cover and Forms Classification System Handbook*, January 1999.
7. Geodata Consultants, Inc., Royal Trails Subdivision Flood Study Survey, 2008.
8. Lake County Development Regulations, www.municode.com.
9. Lotspeich and Associates, Ecological Technical Memorandum Royal Trails Stormwater Study, 2008.
10. SWFWMD, Determination of Green-Ampt Parameters for Hydrology Computations in ICPR, August 2008.
11. USGS, 1:24,000 Topographic Quadrangle Maps, 1962 (Photo Revised 1988).
12. USGS, 1:250,000 Topographic Quadrangle Maps, 1955 (Photo Revised 1972).
13. Wicks Consulting Services, Inc., Royal Trails Municipal Service Taxing Unit Project, April 1989.

EXHIBITS

ROYAL TRAILS
FLOOD STUDY



ROYAL TRAILS
FLOOD STUDY



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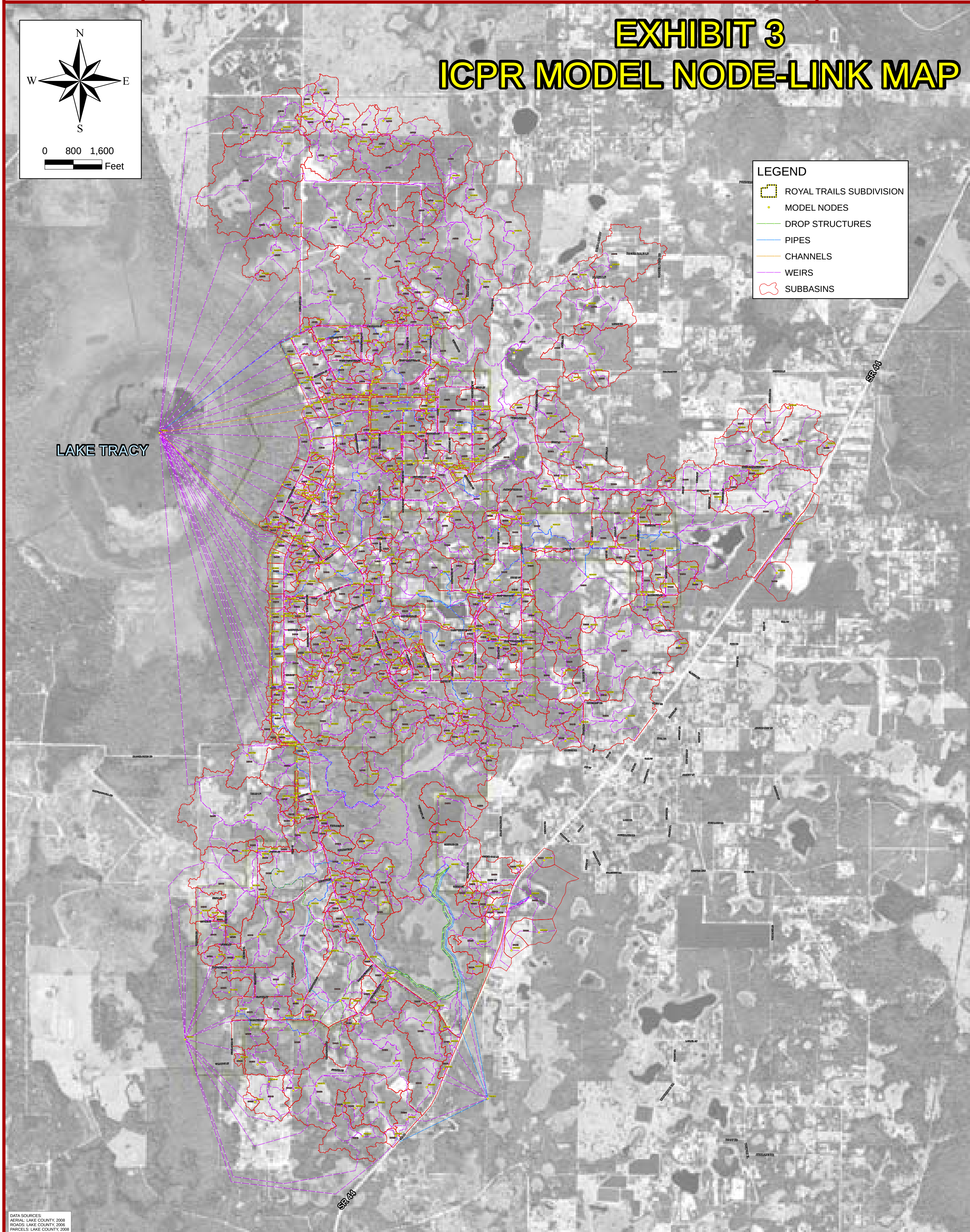

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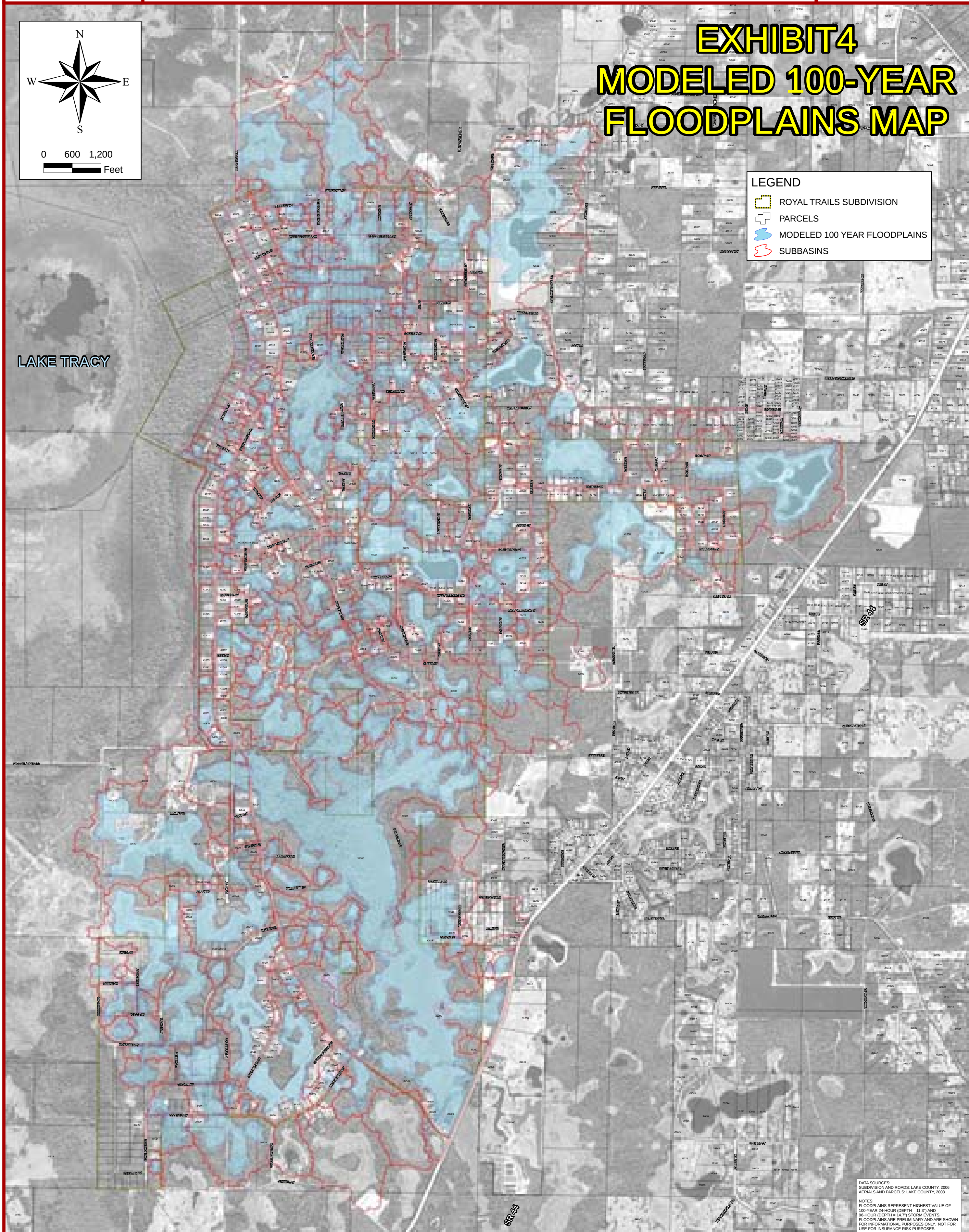

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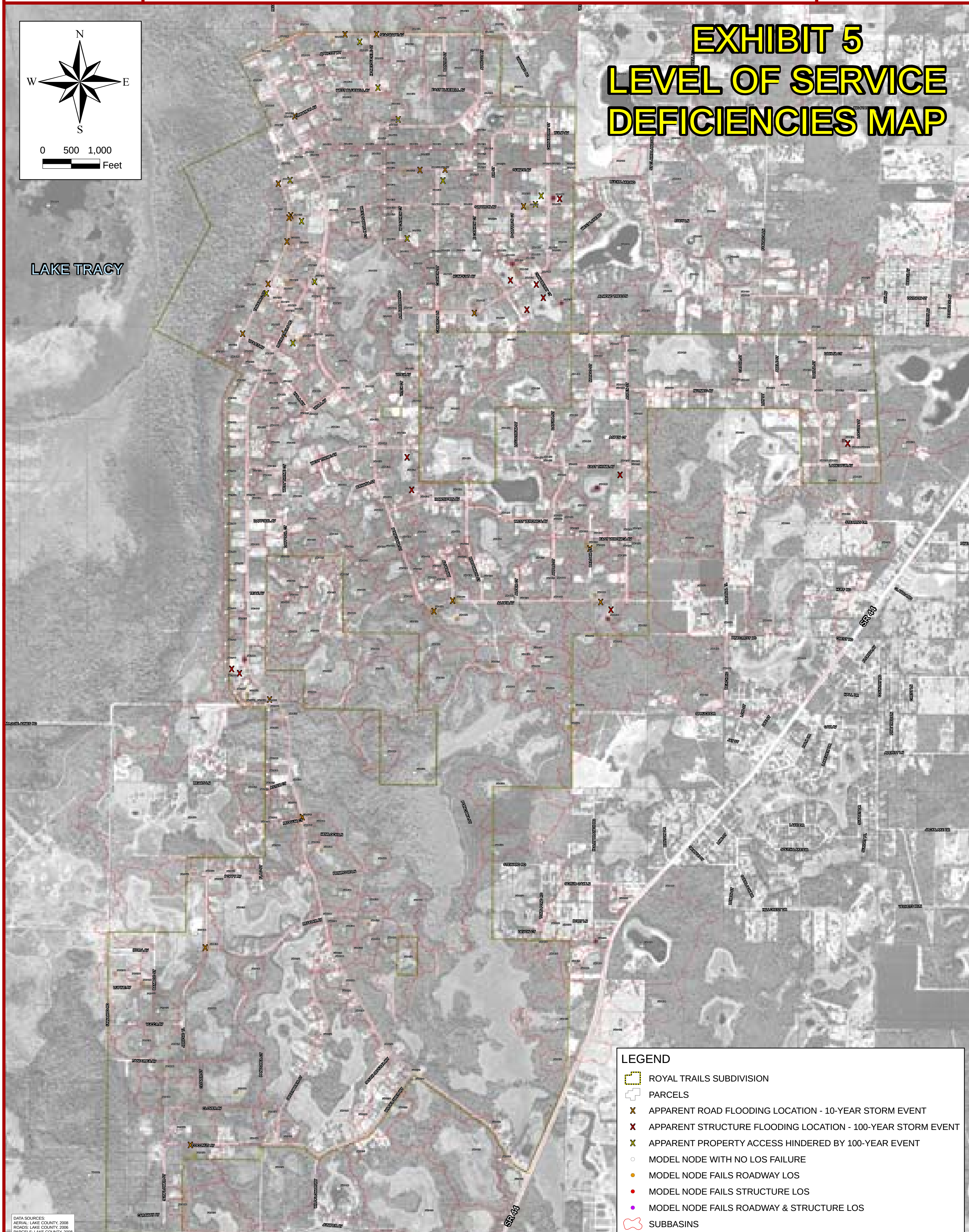

DVD

Directory Structure on Disk

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- [Geodatabase]
- [Models]
  - [INPUT]
  - [RESULTS]
- [Report]
  - [PREVIOUS_REPORTS]
- [TSDN_Report]
  - [1_General_Documentation]
    - [Certification]
    - [Contact_Reports]
    - [General_Correspondence]
    - [Meeting_Minutes_Reports]
    - [Special_Problem_Reports]
  - [2_Engineering_analyses]
    - [Hydrologic_Analyses]
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    - [Key_to_Transect_Labeling]
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  - [4_Mapping]
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  - [5_Misc_Ref_Materials]
    - [_GIS_REFERENCE_DATA]
    - [FEMA_DATA]
      - [FLOODPLAIN_LOMAS]
    - [ROYAL_TRAILS_MAINTENANCE_REQUESTS_&_LOGS]
    - [SCANNED_DOCUMENTS]
  - [Introduction]

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