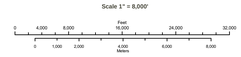
Appendix C

Maps

MAP 1
LOCATION MAP

Scale 1" = 8,000'



MANATEE

HARDEE

SARASOTA

DESOTO

CHARLOTTE

LEE

Little Salt Spring

Warm Mineral Springs

Sarasota

Bradenton

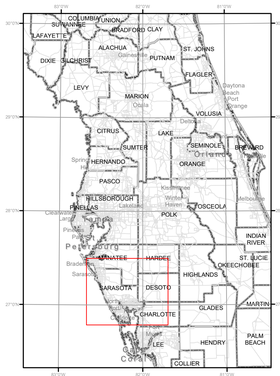
Venice

Punta Gorda

Port Charlotte

Arcadia

- Springs
- Interstate
- Highway
- Major Road
- City of North Port in Big Slough Watershed
- Watershed
- County Limits



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Prepared by: TJC	Modified by:	Modified:
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BIG SLOUGH/CITY OF NORTH PORT WATERSHED MANAGEMENT PROGRAM

LOCATION MAP

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants
Phone: 407-855-3860 Fax: 407-859-8121
8008 South Orange Avenue
Orlando, Florida 32809

MAP 2
2007 MINUS 2004 TERRAIN

N
W E
S

Scale 1" = 2,000'

Feet
0 1,000 2,000 4,000 6,000 8,000

Meters
0 250 500 1,000 1,500 2,000

City of North Port in Big Slough Watershed
County Limits

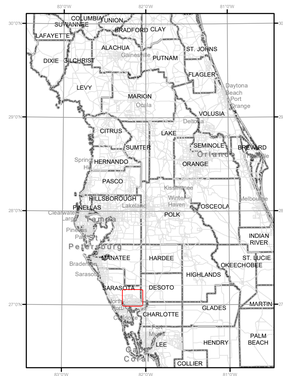
Elevation Change (feet)

- -25 - -10
- -10 - -5
- -5 - -1
- -1 - 1
- 1 - 5
- 5 - 10
- 10 - 60

SARASOTA

DESOTO

CHARLOTTE



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BIG SLOUGH/CITY OF NORTH PORT WATERSHED MANAGEMENT PROGRAM

TERRAIN MODEL COMPARISON

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Geotechnical, Environmental and Materials Consultants
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8008 South Orange Avenue
Orlando, Florida 32809

MAP 3
100 YEAR FLOODPLAIN

N
W E
S

Scale 1" = 2,000'

Feet
0 1,000 2,000 4,000 6,000 8,000

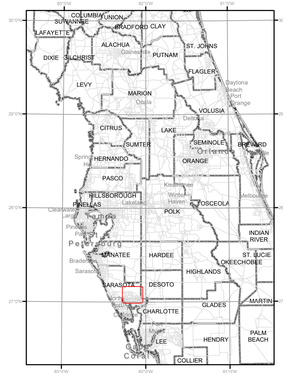
Meters
0 250 500 1,000 1,500 2,000

City of North Port in Big Slough Watershed
Floodplain
County Limits

SARASOTA

DESOTO

CHARLOTTE



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Prepared by: TJC	Modified by:	Modified:
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BIG SLOUGH/CITY OF NORTH PORT WATERSHED MANAGEMENT PROGRAM

100 YEAR FLOODPLAIN

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Geotechnical, Environmental and Materials Consultants
Phone: 407-855-3860 Fax: 407-859-8121
8008 South Orange Avenue
Orlando, Florida 32809

MAP 4
ACREAGE CHANGE

N
W E
S

Scale 1" = 2,000'

Feet
0 1,000 2,000 4,000 6,000 8,000

Meters
0 250 500 1,000 1,500 2,000

County Limits
City of North Port in Big Slough Watershed

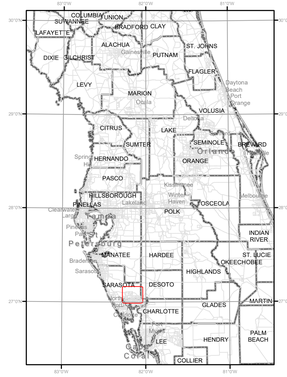
FEMA vs. Ardaman Flooded Area
No Change
Decrease
Increase

Acreage Change (Absolute Value)
0 - 10
10 - 25
25 - 50
50 - 75
75 - 115

SARASOTA

DESOTO

CHARLOTTE



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BIG SLOUGH/CITY OF NORTH PORT WATERSHED MANAGEMENT PROGRAM

FEMA VS. ARDAMAN FLOODPLAIN COMPARISON

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants
Phone: 407-855-3860 Fax: 407-859-8121
8008 South Orange Avenue
Orlando, Florida 32809

MAP 6
PERCENT CHANGE BY BASIN AREA

N
W E
S

Scale 1" = 2,500'

Feet
0 1,000 2,000 4,000 6,000 8,000

Meters
0 250 500 1,000 1,500 2,000

SARASOTA

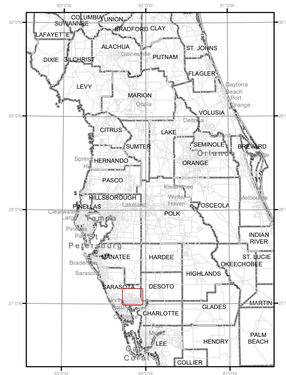
DESOTO

CHARLOTTE

City of North Port in Big Slough Watershed
County Limits

FEMA vs. Ardaman Flooded Area
- No Change
- Decrease
- Increase

Percent Change (Absolute Value)
- 0 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100



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Prepared by: TJC	Modified by:	Modified:
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BIG SLOUGH/CITY OF NORTH PORT WATERSHED MANAGEMENT PROGRAM

FEMA VS. ARDAMAN FLOODPLAIN COMPARISON

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Geotechnical, Environmental and Materials Consultants
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8008 South Orange Avenue
Orlando, Florida 32809

MAP 7
FLOOD RISK COMPARISON

N
W E
S

Scale 1" = 2,000'

Feet
0 1,000 2,000 4,000 6,000 8,000

Meters
0 250 500 1,000 1,500 2,000

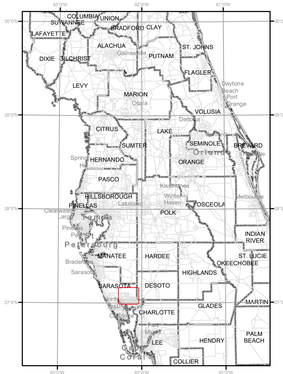
SARASOTA

DESOTO

CHARLOTTE

City of North Port in Big Slough Watershed
FEMA Floodplain
Ardaman 2010 Floodplain

	Acres	Parcels
FEMA	1,825	2,370
Ardaman 2010	13,544	2,630



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Prepared by: TJC	Modified by: / Modified:
File: \\Model_Maintenance\ArcGIS_ArcLayouts\Dec 2010 Justification Report\Flood Risk Comparison 36x48.mxd	

BIG SLOUGH/CITY OF NORTH PORT WATERSHED MANAGEMENT PROGRAM

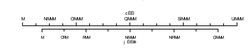
FLOOD RISK COMPARISON

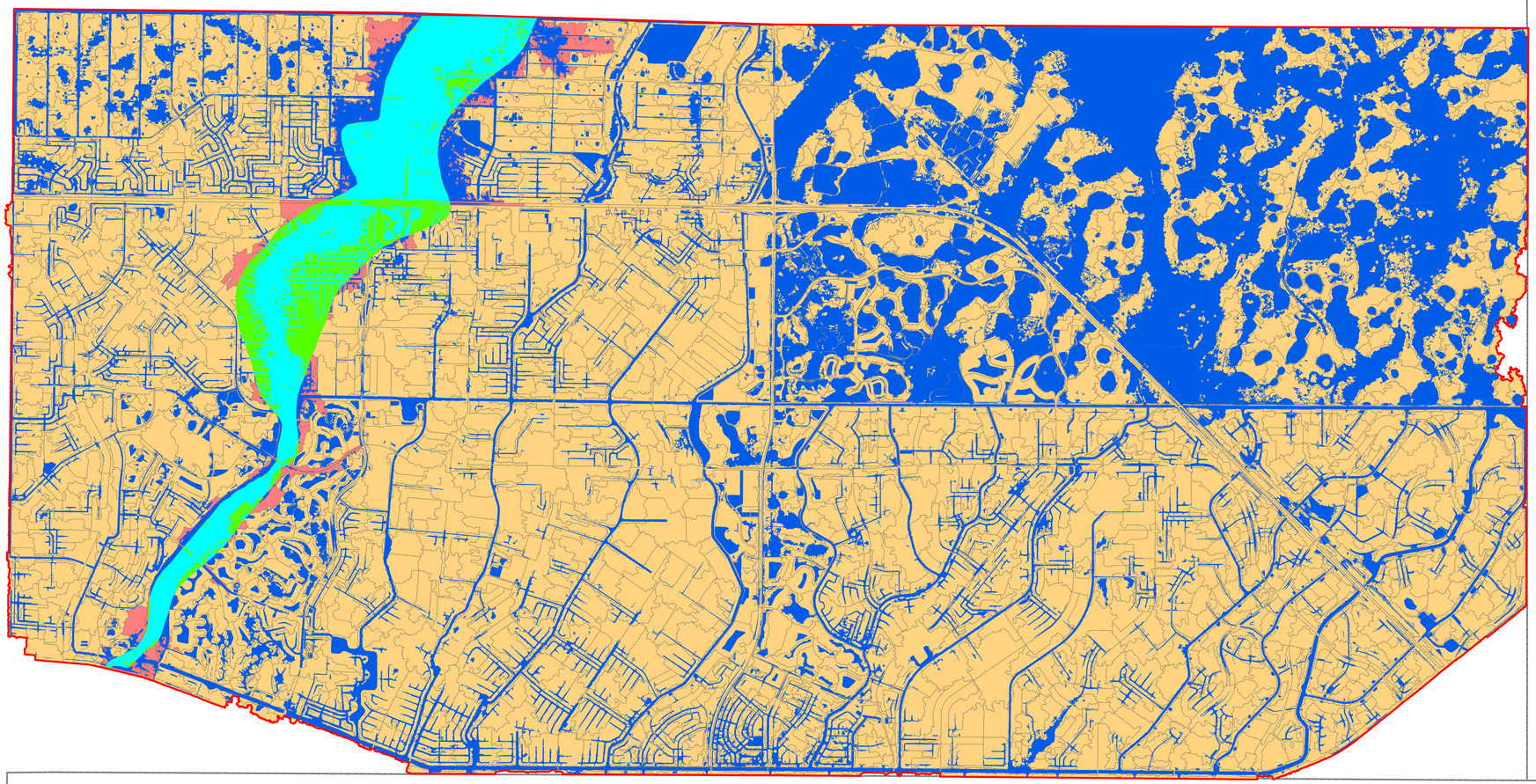
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants
Phone: 407-855-3860 Fax: 407-859-8121
8008 South Orange Avenue
Orlando, Florida 32809

j^m= U
gr pq fcf` ^q fl k ǂ^ m

N
W E
S

Scale 1" = 2,000'





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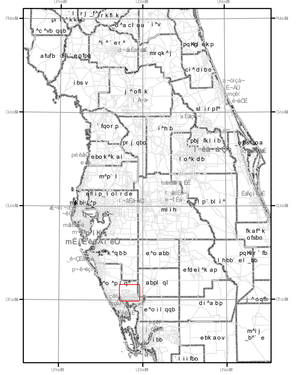

FEMA vs. Ardaman Flooded Area

Reason for Floodplain Change

BIG SLOUGH/CITY OF NORTH PORT WATERSHED MANAGEMENT PROGRAM

cbj^= spK=^o a^j ^k =ci l l ami^fk= l jm^o fpl k

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

Appendix C

Watershed Management Program Consulting Services in the Big Slough Watershed (K883), Best Management Practices (BMP) Analysis Final Report

Ardaman & Associates, Inc., September 2014

Watershed Management Program Consulting Services in the Big Slough Watershed (K883)

Best Management Practices (BMP) Analysis
Final Report

Prepared for

Southwest Florida Water Management District
&
City of North Port

Prepared by

Ardaman & Associates, Inc.

September 2014

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LIST OF APPENDICES

1.0 INTRODUCTION

As described in the Southwest Florida Water Management District's Watershed Management Program Guidelines and Specifications, Best Management Practice (BMP) Alternatives Analysis involves modification of the existing model condition to evaluate best management practices, to address the enhancement and protection of natural systems, recharge, and water quality while achieving flood protection.

BMP alternatives analysis involves the use and modification of the existing model condition to evaluate BMPs, to address habitual flooding conditions while ensuring no adverse impact.

Best management practices (BMP) is a phrase which means the best available techniques to reduce harmful environmental impacts. Usually, BMPs for urban watershed management are storage devices that temporarily store and/or treat urban runoff to reduce flooding and/or remove pollutants. For this task, the following alternative methods were evaluated with the unique purpose of reducing flooding: flow diversion, conveyance improvements, detention, exclusion of all existing drop structures and water control structures (WCS), and modification of gated structure and raising road elevations.

1.1 Authorization

Ardaman and Associates was contracted by the Southwest Florida Water Management District to conduct specific tasks of a Watershed Management Program for the North Port/Big Slough Watershed. The project was initiated in July 2003 and a series of work orders were issued. Work order number 4, issued in August 2005, included BMP alternative analysis for the North Port/Big Slough watershed.

1.2 Project Location and General Description

The Big Slough Watershed is located in southeastern Sarasota County, and the slough is tributary to the Myakka River. Portions of the incorporated City of North Port (those areas east of the Myakka) are located within the southern portion of the watershed. The 195.5 square mile watershed encompasses numerous depressional features, including wetlands and water bodies, the most prominent of which is the Big Slough Canal (also called Myakkahatchee Creek in its lower reaches). The Big Slough Canal passes from north to south through the City of North Port, and receives inflows from an internal system of waterways which provide surface drainage throughout the City, before discharging beneath U.S. Highway 41 toward its confluence with the Myakka River. The Big Slough Watershed and portions of the City of North Port are traversed from east to west by Interstate Highway 75.

1.3 Purpose and Objectives

The objective of this study is to evaluate BMP alternatives that would solve flooding conditions within the City of North Port. Existing condition model results and Floodplain

Level of Service (LOS) were used to identify present watershed flooding condition. Various BMP concepts and alternatives were evaluated for their effectiveness in solving flooding problems, permitablity, and economic viability.

1.4 Previous Reports

Over the course of the project, numerous interim reports have been submitted along with supporting data to SWFWMD and City of North Port. Those prior reports contain additional details and supporting documentation regarding these tasks completion, and include the following:

WO#1 – Watershed Evaluation

Task 1.1.2.1 – Existing Watershed Feature Data Evaluation and Assembly
Task 1.1.2.2 – Sub-basin delineations and landuse inventory

WO#2 – Watershed Evaluation

Task 1.1.2 – Watershed Evaluation
- 1.1.2.2 Hydrologic Feature Inventory
- 1.1.2.3 Hydraulic Feature Inventory
- 1.1.2.4 Field Reconnaissance
- 1.1.2.5 ID of Surveys to be Completed by a PLS
- 1.1.2.6 Preliminary Junction/Reach Coverage Development
- 1.1.2.7 SW Assessment Inventory and Approach Development
- 1.1.2.9 Watershed Evaluation Deliverables

WO#3 – Watershed Evaluation

Task 2.3.1 – Surveys by a Professional Land Surveyor

WO#4 – Watershed Management Plan

Task 1.1.3.2 – Watershed Parameterization
Task 1.1.3.3 – Watershed Model Development & Verification
Task 1.1.3.4 – Floodplain Analysis and Delineation Report
Task 1.1.3.5a – Level of Service Determination – original analysis
Task 1.1.3.5b – Level of Service Determination – with model maintenance
Task 1.1.3.7a – BMP Alternative Formulation Report – original analysis
Task 1.1.3.7a – BMP Evaluation of Four Crossings
Task 1.1.3.7b – BMP Evaluation Price Boulevard
Task 1.1.3.7b – BMP Evaluation WCS-162
Task 1.1.3.7b – Final BMP Report

WO#7 – Maintenance of Watershed Parameters and Models

Task 2.2.1 – 2004-2007 LiDAR Comparison
Task 2.3.1.1 – Collect and Evaluate Environmental Resource Permit (ERP) Information
Task 2.3.4 – Limited Field Reconnaissance

Task 2.3.6 and 2.3.7 – Generic Hydrologic Features and Generic Hydraulic Features
Task 2.3.6, 2.3.7, and 2.4.1 – Generic Hydrologic Features, Generic Hydraulic Features, and Refined Generic and Semi-generic Geodatabase and Parameterization
Task 2.4.1, 2.4.2, 2.4.3 – Refined Generic and Semi-generic Geodatabase and Parameterization, Watershed Computer Simulation Model Development and Verification, and Floodplain Analysis and Delineation
Task 2.4.3 – Floodplain Analysis and Delineation
Task N/A – Justification Report and Peer Review Presentation

WO#8 – Maintenance of Watershed Parameters and Models

Task 2.2.2 – 2007 LiDAR Review

WO#12 – Maintenance of Watershed Parameters and Models

Task 2.4.11 - Floodway Analysis Report

2.0 CHARACTERIZATION OF FLOOD PRONE AREAS

The Big Slough watershed is located in the Gulf coastal lowlands of southwestern Florida, characterized by flat topography and sandy, shelly and silty sand soils with little organic matter. Its headwaters are rural, consisting primarily of agricultural and undeveloped lands. A vast majority of urban and built up lands occur in the southern portion of the watershed, within in the City of North Port. Commercial development is generally limited to main thoroughfares within the city, especially along the US 41 corridor. Myakkahatchee Creek/Big Slough Canal begins in the southeastern part of Manatee County (near Edgeville) and flows approximately 21 miles through the City of North Port and ultimately empties to the estuarine portion of the Myakka River.

2.1 Hydrologic Inventory

2.1.1 *Subbasin Delineation Process*

Subbasin delineations were performed to support watershed parameterization and modeling. The subbasins were delineated using Arc Hydro Tools with LiDAR-based terrain data, where available. The surface model was prepared for “automated” subbasin delineation by combining the large terrain models with highly detailed secondary flow path information. The secondary flow paths were digitized based on scanned and orthorectified as-built information, terrain model features, and field observations of drainage patterns.

A set of protocols was developed for assigning subbasin break points, to allow for batch processing of the watershed using the delineation tools. As a result of pre-processing the surface model in the manner described here, the Arc Hydro tools were better able to recognize surface drainage characteristics and provide accurate subbasin delineations for use in model parameterization. In those areas where LiDAR was not available, other

topographic and drainage delineation information was employed to support automated and manual delineations.

2.1.2 *Tributary Subbasins and Characterization.*

Tributary areas were defined primarily by grouping surface storage features according to their connectivity (via culverts) or primary overflow paths (across topographic saddles). Open channel conveyance systems were also used to identify unique tributary areas. Each tributary area could then be summarized using GIS to describe unique characteristics, as discussed below.

Subbasin sizes range throughout the study area from 0.33 to 1,673.79 acres. Table 2-1 summarizes subbasin size by tributary area.

Table 2-1: Subbasin Size Summary per Tributary

Tributary ID	Count	Minimum	Maximum	Average
A	60	0.33	36.00	9.17
B	1282	0.06	1244.70	30.97
C	339	0.12	61.14	9.91
D	67	1.23	75.40	26.24
E	210	0.19	151.42	10.30
F	54	0.32	83.20	20.68
G	130	0.32	66.63	11.58
H	42	0.77	35.93	11.87
I	58	0.86	71.29	21.11
J	153	0.60	69.53	14.49
K	188	0.63	79.83	10.53
L	33	0.70	70.08	24.53
M	84	1.38	1040.82	133.85
N	119	0.16	28.22	8.22
O	76	0.88	82.72	15.89
P	38	0.11	120.69	13.19
Q	288	1.04	167.71	25.23
R	263	0.42	234.44	21.53
S	361	0.28	1139.68	21.10
T	65	0.28	45.34	13.73
U	799	0.03	410.92	24.79
V	116	0.42	89.73	14.68
W	29	15.55	1673.79	320.55
X	42	0.36	32.10	9.11
Y	84	0.24	47.38	12.87
Z	36	0.41	54.12	17.78

2.1.3 *Tributary Land Use Characterization*

While the headwaters of the Big Slough Watershed remain predominantly undeveloped or agricultural, changes in land uses throughout the City of North Port reflect significant population growth, with continued commercial and industrial growth along the US 41 corridor and the Price Boulevard intersections with Sumter Boulevard and Toledo Blade Boulevard.

Land use types were acquired as a GIS coverage from the SWFWMD and updated using 2004 aerial photography. Table 2-2 summarizes generalized land use encountered and respective percent areas of coverage, by tributary.

Table 2-2: Generalized Land Use Summary per Tributary

Tributary ID	Residential	Com/Industrial	Upland/Open	Water/Wetland
A	10.55	0.00	86.54	2.91
B	9.06	1.41	66.33	23.19
C	51.87	6.30	34.51	7.32
D	97.99	0.06	0.18	1.77
E	64.02	2.86	24.11	9.02
F	89.64	2.37	5.43	2.56
G	85.46	0.19	10.80	3.56
H	24.47	0.51	33.01	42.01
I	73.04	3.46	16.82	6.68
J	76.21	3.39	16.98	3.42
K	34.18	3.62	58.39	3.81
L	65.17	0.48	25.84	8.51
M	2.02	0.22	75.29	22.47
N	0.32	4.18	88.79	6.71
O	85.80	0.15	11.00	3.04
P	67.31	2.43	11.53	18.73
Q	0.00	0.75	71.86	27.39
R	32.98	0.78	40.77	25.48
S	16.20	2.33	56.24	25.22
T	57.69	5.05	27.44	9.82
U	1.18	1.95	62.64	34.23
V	35.95	7.19	36.04	20.82
W	1.49	0.27	79.92	18.32
X	76.68	2.32	8.57	12.42
Y	85.27	4.58	9.13	1.03
Z	98.90	0.00	0.00	1.10

2.1.4 *Tributary Soil Characterization.*

Low permeability, hydric soils associated with depressional areas and flood plains are predominant within the study area.

Soil types were identified using soil survey data for Sarasota, Charlotte, Manatee and DeSoto Counties acquired as a GIS coverage from SWFWMD. Individual soil types were categorized according to their runoff potential. In order to perform that categorization, the hydrologic soil group of each soil was defined according to the relevant soil survey reports. A brief discussion of each hydrologic soil group's characteristics is provided below.

HYDROLOGIC SOIL GROUP A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively well drained sands or gravelly sands. These soils have a high rate of water transmission.

HYDROLOGIC SOIL GROUP B. Soils having a moderate infiltration when thoroughly wet. These consist mainly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

HYDROLOGIC SOIL GROUP C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

HYDROLOGIC SOIL GROUP D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have high shrink-swell potential, soils that have a permanent high water table, soils that have a clay pan or clay layer at or near the surface, and soils that are shallow over nearly impervious material.

Some soil types are classified as belonging to dual hydrologic soil groups, such as A/D, B/D, or C/D. These ratings mean that, under natural conditions, the soil is classified as belonging to hydrologic soil group D, but by artificial methods the water table could be lowered sufficiently so that the soil would fit into a lower runoff potential category.

Table 2-3 presents a summary of hydrologic soil groups encountered (with dual classified groups assigned to the un-drained condition “D”) and respective percent areas of coverage.

Table 2-3: Hydrologic Soil Group Summary per Tributary

Tributary	Hydrologic Soil Coverage Area %								
	A	A/D	B	B/D	C	C/D	D	UND	W
A	0.00	0.00	0.00	70.01	0.36	0.88	28.75	0.00	0.00
B	0.00	0.00	0.09	70.30	1.07	0.04	28.16	0.23	0.10
C	0.00	0.06	0.00	61.51	7.64	0.87	25.03	0.00	4.89
D	0.00	0.00	0.00	71.73	0.09	0.21	27.98	0.00	0.00
E	0.00	0.00	0.00	77.85	0.71	0.91	18.81	0.00	1.73
F	0.00	0.00	0.00	63.79	0.00	1.48	34.73	0.00	0.00
G	0.00	0.00	0.00	50.55	0.04	0.00	49.41	0.00	0.00
H	0.00	0.00	0.00	90.15	5.12	0.00	4.73	0.00	0.00
I	0.00	0.00	0.00	66.44	0.06	0.77	32.73	0.00	0.00
J	0.00	0.00	0.00	65.84	0.00	0.85	33.09	0.00	0.22
K	0.00	0.00	0.00	70.16	0.08	1.21	28.08	0.00	0.47
L	0.00	0.00	0.00	50.53	0.00	1.90	47.57	0.00	0.00
M	0.38	0.00	0.36	77.05	4.82	0.00	17.38	0.01	0.00
N	0.00	0.00	0.00	68.48	0.00	0.45	29.89	0.00	1.18
O	0.00	0.00	0.00	67.36	0.00	0.00	32.50	0.14	0.00
P	0.00	0.00	0.00	75.24	0.00	0.12	24.64	0.01	0.00
Q	0.00	0.00	0.00	64.78	0.00	0.13	35.09	0.00	0.00
R	0.00	0.00	0.00	65.45	0.00	0.90	33.62	0.02	0.00
S	0.00	0.00	0.00	63.35	0.00	0.07	36.57	0.00	0.00
T	0.00	0.00	0.00	70.31	0.00	0.52	29.17	0.00	0.00
U	0.00	0.00	0.00	64.62	0.00	0.01	34.98	0.00	0.39
V	0.00	0.00	0.00	48.77	0.00	0.00	51.23	0.00	0.00
W	0.61	0.00	0.25	75.03	11.94	0.00	12.17	0.00	0.00
X	0.00	0.00	0.00	56.73	0.00	0.00	42.64	0.00	0.64
Y	0.00	0.00	0.00	70.24	0.00	0.15	29.61	0.00	0.00
Z	0.00	0.00	0.00	73.02	0.00	3.30	23.69	0.00	0.00

2.1.5 *Tributary Hydrologic Parameterization*

Subbasin parameterization was performed in order to assign values for hydrologic model development, including: Time of Concentration (Tc), Runoff Curve Number (CN), Percentages of imperviousness, and Peak Rate Factor (K').

Time of Concentration (Tc) is generally defined as the amount of time it takes for a drop of water to travel from the most hydrologically distant point in a basin to the point where that basin discharges to a receiving water body (represented in the model as a node). It is used as a parameter in the computation of a runoff hydrograph, when using the SCS Unit Hydrograph method for hydrograph generation.

The Tc computation was made according to techniques recommended in TR-55 by the National Resource Conservation Service. According to that methodology, runoff generally moves along the surface of a basin as sheet flow, shallow concentrated flow, open channel flow, or some combination of these until it is intercepted by a storage or conveyance system. Travel times for each flow segment are computed and summed, yielding a time of concentration for the basin. Further adjustments can be made to account for movement through ponds, storm sewers and the like in order to account for additional travel time, when not accounted for in the modeled conveyance system.

Travel segment data for this study was developed using aerial photography, one foot SWFWMD 1"=200' scale aerial imagery, 2-foot SWFWMD digital photogrammetric contours and the digital terrain model to define travel paths, lengths, slopes and land cover for sheet and shallow concentrated flow segments. For open channel segments, cross sectional geometry and roughness values were estimated, and lengths and slopes taken from the terrain model. For conveyance systems (such as pipes, channels, embedded ponds and wetlands) a velocity method was employed to adjust times of concentration.

Runoff Curve Numbers were developed for each subbasin, based on land use and hydrologic soil group designations. Using GIS, basin, land use and soils polygon coverages were intersected with one another, resulting in the creation of a single composite polygon coverage. Each polygon in the composite coverage contains a land use code, a hydrologic soil group, and a basin assignment. Combinations of land use and soils were then used, along with a lookup table of curve number values, to define area-weighted runoff curve numbers within each basin. Percentages of imperviousness were developed in a like manner, based on land use within each subbasin area. Runoff curve numbers that were employed in this analysis were representative of average antecedent moisture conditions (AMC-II) and were adapted from tables provided in the NRCS publication, TR-55.

The peak rate factor (K') is a numeric value used to describe the shape of a unit hydrograph for a basin. The peak rate factor varies from one basin to another. Throughout the state, typical values applied by hydrologists range from 256 to 484, with even lower values applied in flat, swampy areas. A peak rate factor of 256 was used for all subbasins within the Big Slough watershed. That value is most appropriate in basins that exhibit little topographic relief, which includes the vast majority of all subbasins delineated in the study area.

2.2 Hydraulic Feature Inventory

2.2.1 *Hydraulic Feature Inventory*

An inventory of hydraulic features within the watershed area was initially performed using digital aerial photography, as-built and ERP data, in order to identify conveyance structures, open channels, SMSAs, lakes and wetlands greater than one acre in area throughout the watershed. Each feature was assigned a unique HYD-ID, as an identifier for subsequent field reconnaissance and survey. The hydraulic feature inventory served as an initial database of features to be incorporated into a model database for simulation.

2.2.2 *Summary of Water Body Features by Tributary and Type*

Wetlands and water bodies of varying size are located throughout the watershed area. Named water bodies include: Big Slough Canal or Myakkahatchee Creek, Cocoplum Water Way, Snover Water Way and a series of named internal water ways providing surface drainage for the City of North Port. Area lakes range in size from 1.0 to 125 acres. In addition, numerous retention and detention ponds are present, providing stormwater attenuation and water quality treatment throughout the area. Table 2-4 presents a summary of water bodies and their sizes in each tributary.

Table 2-4: Water Body Size Summary per Tributary

Tributary	Count	Minimum Area (acres)	Maximum Area (acres)	Average Area (acres)
A	0	0.00	0.00	0.00
B	386	0.20	110.46	4.90
C	9	0.60	2.77	1.72
D	0	0.00	0.00	0.00
E	37	0.19	25.93	3.06
F	1	3.99	3.99	3.99
G	9	1.26	17.93	3.93
H	10	0.77	12.99	3.98
I	11	0.07	12.23	2.79
J	5	0.40	2.39	1.20
K	3	2.21	11.54	5.96
L	3	2.86	5.06	3.88
M	18	1.01	6.89	3.13
N	6	1.22	13.75	4.75
O	3	1.05	3.04	1.73
P	1	75.40	75.40	75.40
Q	121	1.03	36.57	4.72
R	77	1.22	60.85	9.02
S	112	0.35	35.30	5.72
T	20	1.08	19.34	5.93
U	363	0.13	125.04	5.61
V	12	1.12	30.60	12.98
W	0	0.00	0.00	0.00
X	5	1.18	15.20	7.16
Y	0	0.00	0.00	0.00
Z	0	0.00	0.00	0.00

2.2.3 *Summary of Conveyance Features by Tributary and Type*

Surface drainage throughout the watershed consists largely of natural sloughs, creeks and numerous manmade ditches and canals. Manmade storage features (SMSA) and natural depressional features (lakes and wetlands) are interconnected by drainage culverts or joined across natural topographic saddles. Table 2-5 summarizes number of conveyance features and Table 2-6 presents lengths of open channels in each tributary.

Table 2-5: Conveyance Features per Tributary

Tributary	Bridge	Channel	Culvert	Riser Pipes	Weir
A	1	23	10	50	175
B	16	382	210	39	3631
C	16	156	108	129	1028
D	0	43	9	3	194
E	0	67	67	50	616
F	0	27	13	1	175
G	1	63	42	28	384
H	2	17	9	13	138
I	0	27	10	17	195
J	0	87	51	1	427
K	4	75	51	77	531
L	0	19	6	0	103
M	0	9	18	0	202
N	2	49	27	69	316
O	0	39	19	13	218
P	0	24	15	0	95
Q	1	65	18	0	867
R	0	114	72	0	752
S	6	104	44	49	1050
T	0	27	19	10	197
U	3	47	116	62	2316
V	1	51	50	5	345
W	1	15	18	0	48
X	0	28	11	0	94
Y	0	49	23	0	239
Z	0	19	11	0	97

Table 2-6: Open Channel Lengths per Tributary

Tributary ID	Count	Minimum (feet)	Maximum (feet)	Average (feet)
A	23	267	1600	780
B	382	124	4819	1173
C	155	193	3674	1011
D	44	252	1896	1067
E	67	221	2110	855
F	27	185	1977	1053
G	64	243	1985	801
H	16	361	2261	908
I	28	293	2347	1179
J	87	255	2844	956
K	75	265	1935	897
L	19	491	2443	1167
M	10	723	5785	2052
N	49	231	2501	882
O	39	260	2186	973
P	24	88	2890	1070
Q	65	367	2677	1300
R	110	384	2878	1449
S	103	257	2309	932
T	26	260	2021	996
U	47	500	4442	1623
V	51	255	2202	786
W	15	1137	4578	2372
X	32	257	2421	1254
Y	49	224	2426	896
Z	19	443	2191	1044

2.2.4 *Tributary Hydraulic Connectivity*

Connectivity within tributary areas was determined through review of aerial photographs, as-built and construction drawings, topographic data and field investigation. That connectivity is defined and stored in the project database as a node-reach topological relationship.

2.3 Magnitude of Present Flooding

The magnitude of present flooding in the watershed was identified by using the results of floodplain and flood protection level of service (LOS) analyses.

2.3.1 *Identification of Flooded Areas*

The City of North Port experiences three distinct types of flooding problems. The most severe and the least common problem is a small number of habitable structures near Big Slough that experience flooding in the 100 year event. Also significant and very isolated is major road flooding in 25-year and 100-year events. Finally extensive local road flooding is common even during a smaller storm event. While inconvenient, this local road flooding poses little risk of damage to the citizens' property.

As shown in Figure 2-1, 2-2, and 2-3 (10, 25, and 100-year LOS figures), the majority of flooding within the City is related to street flooding. An arterial street/emergency route (West Price Boulevard), which provides access to the City's emergency facilities, will flood in 10-year or higher storm events.

Most of the habitable structures that flood in a 100-year storm event are located in the neighborhood located adjacent to Big Slough/Myakkahatchee Creek between Cocoplum Waterway and Tropicaire Boulevard. Locations of the houses that would flood (model predicted) in a 100-year storm event are shown in Figure 2-3 (100-year LOS figure).

2.3.2 *Estimated Number of Structures Flooded (10-, 25-, and 100-year)*

Based on the model results, it is estimated that ~5 structures will flood in a 10-year storm event; ~ 7 structures will flood in a 25-year storm event; and ~75 structures will flood in a 100-year storm event within the City of North Port.

Habitable structures were identified by visually inspecting 2008 aerial imagery in the City of North Port, and placing a point in GIS on the topographical high of the 2004/2007 hybrid LiDAR DTM. The elevation of the 2004/2007 hybrid LiDAR DTM at the point was compared with 10-year, 25-year and 100-year modeled maximum stages. Where maximum stages were higher than the habitable structure, it was reported as a flooded structure. Since the surveyed house pad elevations (finished floor elevations) data was not available, the method applied in estimating the number of flooded structures is very approximate.

2.3.3 *Emergency and Evacuation Route Inundation (10-, 25-, and 100-year)*

Estimated lengths of emergency and evacuation route inundation are presented in Table 2-7. As stated earlier, the majority of flooding within the City is associated with street/road flooding.

Evacuation routes were received from the City of North Port, and emergency routes were identified by Ardaman as the shortest route from an emergency facility to an evacuation route. Street centerlines were acquired from Sarasota County. The positions of all lines were verified in GIS as on the centerline of the road, and moved to the centerline if necessary. Any portion of the centerline of the road that overlapped with the 10-year, 25-year or 100-year floodplain was reported as inundated.

Table 2-7: Estimated Lengths of Road Inundation

Storm Event	Length of Emergency Route Inundation (feet)	Length of Evacuation Route Inundation (feet)
10-year	6,403	1,464
25-year	7,758	3,077
100-year	19,625	7,218

3.0 ALTERNATIVE BMP FORMULATION

According to Southwest Florida Water Management District's Watershed Management Program Guidelines and Specifications (SWFWMD G&S), the generation of best management practices (BMP) alternatives must take into account many watershed management issues in order to formulate an alternative that is permittable, economically viable, and is supported by the public. This study is mainly focused in addressing storm event flooding conditions within the City of North Port.

3.1 BMP Development Process

As described in the SWFWMD G&S, alternatives analysis involves the use and modification of the existing model condition to evaluate BMPs, to address habitual flooding conditions while ensuring no adverse impact.

Best management practice is a phrase which means the best available techniques to reduce harmful environmental impacts. Usually, BMPs for urban watershed management are storage devices that temporarily store and/or treat urban runoff to reduce flooding and/or remove pollutants. For this task, the following alternative methods were evaluated with the unique purpose of reducing flooding: Flow diversion, conveyance improvements, detention and exclusion of all existing drop structures and water control structures (WCS), modification of gated structure and raising road elevations.

3.2 Alternative BMP Concepts

Various BMP alternative concepts evaluated in this study include conveyance improvements, stormwater management storage areas, flood proofing, and flow diversions.

3.3 Alternative BMP Evaluation

BMP alternative evaluations were performed using the existing watershed model and updating it to reflect various BMP scenarios. The following sections provide a brief description of each evaluated BMP alternative and a summary of the evaluation outcome.

3.3.1 *Regional BMPs:*

BMP alternatives that could potentially improve flooding condition in a large area are considered as regional BMPs. These alternatives could significantly alter the hydrodynamics of the drainage system. Although the alternatives presented in this report might not be permittable or economically viable, they provide a better understanding of the hydraulic response when applying the BMPs to further understand improvement limitations.

Six different regional BMPs were evaluated. Results from each BMP evaluation were compared to a benchmark scenario to evaluate the impact of the BMP. The benchmark scenario used was the 24-hour-100 year existing condition model previously submitted. The storm event used for the evaluations was the 24-hour, 100 year event with a Type II, Florida modified rainfall distribution.

For these analyses, the following GIS procedures were used when comparing the existing condition (Benchmark) and the proposed scenario (BMP):

Three potential analyses were considered when comparing each BMP scenario to the Benchmark Scenario.

- For the first analysis, the geoprocessing tool “Symmetric Difference” was applied with the BMP floodplain and benchmark floodplain as inputs, resulting in flooded area reduction and flooded area increase polygons for each scenario. Flooded area reduction represents area that flooded in the benchmark scenario, but not in the BMP scenario, and flooded area increase represents area that did not flood in the benchmark scenario, but did flood in the BMP scenario. Results were then summarized by sub-watershed in acres.

- The second analysis compared the length of street flooding in the BMP scenarios to length of street flooding in the benchmark scenario. The BMP scenario floodplain shapefile was intersected with the streets shapefile, and the total length of flooding was summarized by sub-watershed. Benchmark flooded street data was obtained from previous analysis per LOS (Level of Service) requirements.

- The final analysis compared the number of flooded parcels in the benchmark scenario to the number of flooded parcels in the BMP scenarios. To determine which parcels were flooded we used the parcels polygon shapefile downloaded from Sarasota County. Elevations were extracted from the LiDAR-based terrain data utilizing the centroid of the parcel as a calculation point, and one foot was added to the calculated elevation to represent buildings on fill material. Parcels in waterways or ponds were eliminated and not considered in these analyses. These elevations were then compared to the maximum stages from the CHAN model output for the BMP and benchmark simulation. Any parcels with elevations less than the maximum stage were considered flooded. The comparisons of the BMP scenario to the benchmark scenario were then broken down by sub-watershed for better understanding of local response to the BMP.

3.3.1.1 *BMP #1: Remove Structures throughout City of North Port Waterways*

Objective:

The objective of this BMP is to understand current primary drainage system capacity assuming no losses due to water control structures or drop structures within several waterways. Also, additional connectivity was provided among a few R canals southwest of the I-75 corridor to evaluate the response when transferring some of the existing load throughout less compromised areas.

Description:

Water control structures (WCS) and drop structures (DS) depicted in Figure 3-1 were removed and replaced with an equivalent channel section that mimics the immediate upstream canal's section. Also, and as stated before, additional connections were provided between a few existing secondary manmade R canals. Specifically, canal R-36 was hydraulically connected to the R-43 canal via a weir with equivalent channel geometry. Similarly, the R-43 canal was also connected with the R-24 and R-32 (See Figure 3-1).

Results:

Overall results indicate general improvements immediately north of Price Blvd and along Bass Point waterway while increasing flooding between S Toledo Blvd and S Sumter Blvd. Also, improvements are observed southwest of I-75 where supplemental canal connectivity was provided. An initial evaluation suggests that this BMP may not be feasible due to potential loss of potable water supply, fish and wildlife habitat, and wetlands. Please refer to Figure 3-1 and Table 3-1 for a summary of BMP#1 analysis results.

Table 3-1: BMP#1 Results Summary

Sub-Watershed	Bench Mark Total Flooded Area (Acres)	BMP1 Total Flooded Area (Acres)	BMP1 Total Flooded Area Change (%)	Bench Mark Flooded Street Length (Feet)	BMP1 Flooded Street Length (Feet)	BMP1 Flooded Street Length Change (%)	Bench Mark Flooded Parcels (Units)	BMP1 Flooded Parcels (Units)	BMP1 Flooded Parcels Change (%)
A	58	59	0.8	7,959	8,124	2.1	2	2	0.0
B	15,839	15,881	0.3	304,750	306,791	0.7	665	655	-1.5
C	724	745	2.8	118,951	124,883	5.0	38	40	5.3
D	150	172	14.5	38,510	47,969	24.6	15	17	13.3
E	407	446	9.5	47,961	65,534	36.6	2	2	0.0
F	98	124	25.7	22,234	34,741	56.3	1	1	0.0
G	250	208	-16.7	53,687	36,920	-31.2	17	9	-47.1
H	199	186	-6.4	1,082	548	-49.3	2	2	0.0
I	165	165	0.2	21,519	25,051	16.4	2	1	-50.0
J	335	298	-11.2	84,088	57,952	-31.1	15	15	0.0
K	240	237	-1.3	45,022	44,366	-1.5	5	5	0.0
L	69	67	-1.5	11,354	11,267	-0.8	0	0	0.0
M	2,426	2,475	2.0	0	0	0.0	0	0	0.0
N	150	146	-2.7	14,407	14,101	-2.1	1	1	0.0
O	189	177	-6.2	56,008	49,468	-11.7	9	8	-11.1
P	191	192	0.5	11,134	11,173	0.4	6	6	0.0
Q	3,733	3,735	0.1	0	0	0.0	0	0	0.0
R	2,294	2,320	1.1	86,929	99,236	14.2	43	60	39.5
S	2,489	2,454	-1.4	23,286	20,576	-11.6	74	74	0.0
T	206	190	-8.1	14,915	9,256	-37.9	5	2	-60.0
U	9,907	9,888	-0.2	8,973	8,934	-0.4	19	19	0.0
V	553	545	-1.5	20,054	18,184	-9.3	6	6	0.0
W	1,207	1,207	0.0	0	0	0.0	0	0	0.0
X	92	92	0.4	7,471	7,445	-0.3	2	2	0.0
Y	189	179	-5.1	70,162	63,890	-8.9	11	11	0.0
Z	51	48	-5.9	14,978	14,783	-1.3	0	0	0.0
Total	42,211	42,236	0.1	1,085,434	1,081,192	-0.4	940	938	-0.2

3.3.1.2 *BMP #2: Constrain Flow Entering City Of North Port at Big Slough Canal*

Objective:

The objective of this BMP is to constrain the volume of water coming from offsite areas through the Big Slough canal prior to entering the City in the Estates area.

The BMP would involve real estate acquisition, maintenance activities, dam construction and removal of existing hydraulic structures (culverts).

Description:

On the northwest City boundary, at the intersection of Big Slough canal with R-36 and R-580 waterways, all existing earthen weirs were raised to limit runoff from offsite areas, leaving the Big Slough canal as the only conveyance system into the western portion of the City (see Figure 3-2). All earthen weirs farther north, at the intersection of Big Slough canal and Power Line Road were raised as well.

Results:

This BMP results in approximately 0.5 feet flood stage reduction within the vicinity of the Big Slough canal from the City's northern border to just south of I-75. Likewise, results indicate that flood stages increase approximately 1.0 foot in the offsite areas north of R-36 and R-580 waterways. Table 3-2 summarizes BMP#2 analysis results.

Table 3-2: BMP#2 Results Summary

Sub-Watershed	Bench Mark Total Flooded Area (Acres)	BMP2 Total Flooded Area (Acres)	BMP2 Total Flooded Area Change (%)	Bench Mark Flooded Street Length (Feet)	BMP2 Flooded Street Length (Feet)	BMP2 Flooded Street Length Change (%)	Bench Mark Flooded Parcels (Units)	BMP2 Flooded Parcels (Units)	BMP2 Flooded Parcels Change (%)
A	58	58	0.0	7,959	7,958	0.0	2	2	0.0
B	15,839	16,092	1.6	304,750	260,559	-14.5	665	458	-31.1
C	724	725	0.0	118,951	118,959	0.0	38	38	0.0
D	150	150	0.0	38,510	38,460	-0.1	15	15	0.0
E	407	407	0.0	47,961	47,969	0.0	2	2	0.0
F	98	98	0.0	22,234	22,241	0.0	1	1	0.0
G	250	250	0.0	53,687	53,666	0.0	17	17	0.0
H	199	199	-0.1	1,082	1,078	-0.4	2	2	0.0
I	165	165	0.0	21,519	21,514	0.0	2	2	0.0
J	335	314	-6.4	84,088	72,205	-14.1	15	12	-20.0
K	240	240	0.0	45,022	45,020	0.0	5	5	0.0
L	69	69	0.0	11,354	11,354	0.0	0	0	0.0
M	2,426	2,421	-0.2	0	0	0.0	0	0	0.0
N	150	150	0.0	14,407	14,407	0.0	1	1	0.0
O	189	189	0.0	56,008	55,994	0.0	9	9	0.0
P	191	179	-6.1	11,134	10,124	-9.1	6	4	-33.3
Q	3,733	3,742	0.2	0	0	0.0	0	0	0.0
R	2,294	2,302	0.3	86,929	86,186	-0.9	43	45	4.7
S	2,489	2,486	-0.2	23,286	20,530	-11.8	74	73	-1.4
T	206	206	0.0	14,915	14,904	-0.1	5	5	0.0
U	9,907	9,907	0.0	8,973	8,973	0.0	19	19	0.0
V	553	552	-0.2	20,054	20,043	-0.1	6	6	0.0
W	1,207	1,207	0.0	0	0	0.0	0	0	0.0
X	92	87	-5.1	7,471	5,780	-22.6	2	2	0.0
Y	189	188	-0.5	70,162	69,877	-0.4	11	11	0.0
Z	51	51	-0.1	14,978	14,952	-0.2	0	0	0.0
Total	42,211	42,434	0.5	1,085,434	1,022,753	-5.8	940	729	-22.4

3.3.1.3 *BMP #3: Diversion Alternative*

Objective:

The purpose of this BMP is to divert flows from offsite areas via the existing R-36 canal, by increasing its capacity and improving its hydraulic connectivity with Deer Prairie Slough canal.

This BMP would involve construction of new structures, maintenance activities, real estate acquisition, and detailed hydrologic and hydraulic evaluation of the western boundary (Deer Prairie Slough watershed).

Description:

On the northwest boundary, along R-36 canal, two earthen overflow weirs were provided to enhance the R-36 waterway connectivity with Deer Prairie Slough canal (See Figure 3). Weir location and parameters were selected based on terrain and hydraulic constraints. The weirs were located on the northwest corner to address flooding in the Estates area and along Big Slough canal. Weir lengths and elevation used are as follows: Weir 1, L: 300 feet at EL:22.0 feet, NAVD88 and Weir 2, L:450 feet at EL:21.0 feet, NAVD88. The R-36 canal capacity was also doubled by replacing the existing cross-section with a 60 feet bottom width trapezoidal channel with 4:1 side slopes. The current model assumes no tailwater influence from Deer Prairie Slough.

Results:

As anticipated, simulation results indicate flood reduction throughout the Estates area, along the Big Slough Canal between the R-36 canal and I-75 corridor as well as in the localized area along Big Slough south of I-75 (See Figure 3-3). Overall results indicate a flood stage reduction between 0.1 foot and 1.0 foot throughout the aforementioned areas.

As mentioned before, these results were obtained assuming no increase in stages in the Deer Prairie Slough Canal since a fixed tailwater condition was used for modeling purposes. Further consideration of impacts of additional flow into the Deer Prairie Slough watershed should be taken into account during final evaluation of BMP's. Table 3-3 summarizes BMP#3 analysis results.

Table 3-3: BMP#3 Results Summary

Sub-Watershed	Bench Mark Total Flooded Area (Acres)	BMP3 Total Flooded Area (Acres)	BMP3 Total Flooded Area Change (%)	Bench Mark Flooded Street Length (Feet)	BMP3 Flooded Street Length (Feet)	BMP3 Flooded Street Length Change (%)	Bench Mark Flooded Parcels (Units)	BMP3 Flooded Parcels (Units)	BMP3 Flooded Parcels Change (%)
A	58	58	0.0	7,959	7,958	0.0	2	2	0.0
B	15,839	15,720	-0.8	304,750	282,118	-7.4	665	568	-14.6
C	724	724	-0.1	118,951	118,890	-0.1	38	38	0.0
D	150	150	-0.2	38,510	38,348	-0.4	15	15	0.0
E	407	407	-0.1	47,961	47,880	-0.2	2	2	0.0
F	98	98	-0.3	22,234	22,141	-0.4	1	1	0.0
G	250	250	0.0	53,687	53,663	0.0	17	17	0.0
H	199	198	-0.3	1,082	1,065	-1.5	2	2	0.0
I	165	165	0.0	21,519	21,463	-0.3	2	2	0.0
J	335	316	-5.7	84,088	73,854	-12.2	15	13	-13.3
K	240	240	0.0	45,022	45,022	0.0	5	5	0.0
L	69	69	0.0	11,354	11,354	0.0	0	0	0.0
M	2,426	2,426	0.0	0	0	0.0	0	0	0.0
N	150	150	0.0	14,407	14,407	0.0	1	1	0.0
O	189	189	0.0	56,008	55,998	0.0	9	9	0.0
P	191	184	-3.4	11,134	10,572	-5.0	6	4	-33.3
Q	3,733	3,731	-0.1	0	0	0.0	0	0	0.0
R	2,294	2,199	-4.1	86,929	64,689	-25.6	43	27	-37.2
S	2,489	2,486	-0.1	23,286	20,653	-11.3	74	73	-1.4
T	206	206	0.0	14,915	14,892	-0.2	5	5	0.0
U	9,907	9,907	0.0	8,973	8,973	0.0	19	19	0.0
V	553	552	-0.2	20,054	19,978	-0.4	6	6	0.0
W	1,207	1,207	0.0	0	0	0.0	0	0	0.0
X	92	86	-5.6	7,471	6,029	-19.3	2	2	0.0
Y	189	184	-2.4	70,162	68,020	-3.1	11	9	-18.2
Z	51	51	-0.2	14,978	14,924	-0.4	0	0	0.0
Total	42,211	41,953	-0.6	1,085,434	1,022,891	-5.8	940	820	-12.8

3.3.1.4 *BMP #4: R-580 Improvements*

Objective:

The objective of this alternative is to induce additional flows through Creighton waterway by improving current conveyance capacity in the R-580 waterway.

Description:

Waterway R-580's bottom profile was reset assuming a flat ditch at its lower elevation of 15.0 feet, NAVD along the entire stretch. The current bottom configuration of the R-580 waterway transitions between 17.71 feet, NAVD88 bottom elevation on the most western end to 23.0 feet, NAVD88 bottom elevation at the most eastern end and sags between these ends at elevation 15.0 feet, NAVD88 (see Figure 3-4).

Results:

This alternative results in small improvements within the vicinity of Big Slough. However, and as intended, additional flows were induced towards Creighton waterway. Inducing additional flow through Creighton waterway will result in additional flooding near I-75 for this particular rainfall event as shown on Figure 3-4. A summary of BMP#4 analysis results is presented in Table 3-4.

Table 3-4: BMP#4 Results Summary

Sub-Watershed	Bench Mark Total Flooded Area (Acres)	BMP4 Total Flooded Area (Acres)	BMP4 Total Flooded Area Change (%)	Bench Mark Flooded Street Length (Feet)	BMP4 Flooded Street Length (Feet)	BMP4 Flooded Street Length Change (%)	Bench Mark Flooded Parcels (Units)	BMP4 Flooded Parcels (Units)	BMP4 Flooded Parcels Change (%)
A	58	58	-0.1	7,959	7,953	-0.1	2	2	0.0
B	15,839	15,806	-0.2	304,750	298,627	-2.0	665	638	-4.1
C	724	725	0.1	118,951	119,411	0.4	38	38	0.0
D	150	151	0.2	38,510	38,526	0.0	15	15	0.0
E	407	408	0.1	47,961	48,223	0.6	2	2	0.0
F	98	99	0.4	22,234	22,517	1.3	1	1	0.0
G	250	250	0.1	53,687	53,782	0.2	17	17	0.0
H	199	199	-0.1	1,082	1,077	-0.4	2	2	0.0
I	165	165	0.1	21,519	21,636	0.6	2	2	0.0
J	335	329	-1.9	84,088	80,578	-4.2	15	15	0.0
K	240	240	0.0	45,022	45,026	0.0	5	5	0.0
L	69	69	0.0	11,354	11,354	0.0	0	0	0.0
M	2,426	2,426	0.0	0	0	0.0	0	0	0.0
N	150	150	0.0	14,407	14,412	0.0	1	1	0.0
O	189	189	0.1	56,008	56,041	0.1	9	9	0.0
P	191	189	-0.7	11,134	11,005	-1.2	6	5	-16.7
Q	3,733	3,720	-0.4	0	0	0.0	0	0	0.0
R	2,294	2,288	-0.3	86,929	85,260	-1.9	43	43	0.0
S	2,489	2,489	0.0	23,286	22,823	-2.0	74	74	0.0
T	206	206	0.0	14,915	14,957	0.3	5	5	0.0
U	9,907	9,910	0.0	8,973	8,973	0.0	19	19	0.0
V	553	577	4.3	20,054	23,139	15.4	6	10	66.7
W	1,207	1,207	0.0	0	0	0.0	0	0	0.0
X	92	90	-1.3	7,471	7,215	-3.4	2	2	0.0
Y	189	188	-0.4	70,162	69,897	-0.4	11	11	0.0
Z	51	51	-0.1	14,978	14,939	-0.3	0	0	0.0
Total	42,211	42,179	-0.1	1,085,434	1,077,371	-0.7	940	916	-2.6

3.3.1.5 *BMP #5: Increase Capacity on Southern Boundary*

Objective:

The objective of this alternative is to evaluate the system response when doubling the southern boundary discharge capacity into Charlotte Harbor area.

The BMP would involve conveyance improvements, construction of new structures and/ or reconditioning of existing structures, maintenance activities, real estate acquisition, and detailed evaluation of the southern boundary through hydrology and hydraulic modeling.

Description:

All structures discharging from Cocoplum waterway into the Charlotte Harbor area under Hillsborough Blvd and their upstream weirs were doubled in capacity. A total of 13 structures under Hillsborough Blvd were double in the model and a total of 6 lateral weirs along Cocoplum waterway were doubled in size (see Figure 3-5).

Results:

This alternative was evaluated for information purposes only, as it is understood that inducing additional flows into Charlotte Harbor would not be desirable. Results indicate that improvements relative to house flooding were not significant; however roads experienced a considerable flood reduction between S Sumter Blvd and Atwater Dr. (see Figure 3-5). A summary of BMP#5 analysis results is presented in Table 3-5.

Table 3-5: BMP#5 Results Summary

Sub-Watershed	Bench Mark Total Flooded Area (Acres)	BMP5 Total Flooded Area (Acres)	BMP5 Total Flooded Area Change (%)	Bench Mark Flooded Street Length (Feet)	BMP5 Flooded Street Length (Feet)	BMP5 Flooded Street Length Change (%)	Bench Mark Flooded Parcels (Units)	BMP5 Flooded Parcels (Units)	BMP5 Flooded Parcels Change (%)
A	58	58	0.1	7,959	8,001	0.5	2	1	-50.0
B	15,839	15,836	0.0	304,750	304,487	-0.1	665	665	0.0
C	724	612	-15.6	118,951	75,331	-36.7	38	25	-34.2
D	150	121	-19.8	38,510	20,694	-46.3	15	7	0.0
E	407	395	-3.1	47,961	42,761	-10.8	2	2	0.0
F	98	76	-22.7	22,234	8,236	-63.0	1	1	-11.8
G	250	245	-2.1	53,687	51,993	-3.2	17	15	0.0
H	199	196	-1.4	1,082	1,000	-7.6	2	2	-50.0
I	165	143	-13.1	21,519	8,237	-61.7	2	1	0.0
J	335	335	0.0	84,088	84,042	-0.1	15	15	0.0
K	240	238	-0.8	45,022	44,688	-0.7	5	5	0.0
L	69	67	-2.1	11,354	11,317	-0.3	0	0	0.0
M	2,426	2,426	0.0	0	0	0.0	0	0	0.0
N	150	149	-0.6	14,407	14,407	0.0	1	1	0.0
O	189	180	-4.6	56,008	51,322	-8.4	9	9	0.0
P	191	191	0.0	11,134	11,133	0.0	6	6	0.0
Q	3,733	3,733	0.0	0	0	0.0	0	0	0.0
R	2,294	2,293	-0.1	86,929	86,339	-0.7	43	43	0.0
S	2,489	2,489	0.0	23,286	23,282	0.0	74	74	0.0
T	206	206	-0.3	14,915	14,756	-1.1	5	5	0.0
U	9,907	9,907	0.0	8,973	8,973	0.0	19	19	0.0
V	553	553	0.0	20,054	20,047	0.0	6	6	0.0
W	1,207	1,207	0.0	0	0	0.0	0	0	0.0
X	92	92	0.0	7,471	7,471	0.0	2	2	0.0
Y	189	189	0.0	70,162	70,161	0.0	11	11	0.0
Z	51	51	0.0	14,978	14,976	0.0	0	0	0.0
Total	42,211	41,988	-0.5	1,085,434	983,655	-9.4	940	915	-2.7

3.3.1.6 *BMP #6: Upstream Detention Alternative*

Objective:

The objective of this analysis is to examine the effects when attenuating peak flow rates in agricultural areas along the Big Slough canal with a series of new detention facilities.

This BMP would involve construction of stormwater management storage areas, maintenance activities and real estate acquisition.

Description:

In offsite areas, seven detention facilities were added to the model. Each detention area has a 100 acre footprint and is more than 10 feet deep. These areas were located on upland sites along Big Slough canal where feasible (see Figure 3-6). The bottom elevations of these detention areas were set at the adjacent canal initial elevation. Each of these ponds was linked to the Big Slough canal by a 500 feet weir. The crest elevations were set at the bottom of the pond. The total anticipated detained volume is 600 acre-ft per detention site, a total of 4,200 acre-ft.

Results:

Results indicate that the supplemental detention area alternative produces little reduction in peak water surface elevations. Elevations along Big Slough were reduced by only 0.1 to 0.6 feet, making this option less attractive. The extent of flooding for this BMP is essentially the same as the existing scenario with few flood reduction areas along the Big Slough canal (see Figure 3-6). Initial evaluation suggests that the costs associated with purchasing the proposed detention areas from private landowners will likely be high. In addition the complexity of building reservoirs will make it a less attractive solution; e.g. runup wave analysis will increase the height of the perimeter berm. Total costs include an initial cost of location, proper land acquisition and construction, in addition to recurring maintenance and operation costs. A summary of BMP#6 analysis results is presented in Table 3-6.

Table 3-6: BMP#6 Results Summary

Sub-Watershed	Bench Mark Total Flooded Area (Acres)	BMP6 Total Flooded Area (Acres)	BMP6 Total Flooded Area Change (%)	Bench Mark Flooded Street Length (Feet)	BMP6 Flooded Street Length (Feet)	BMP6 Flooded Street Length Change (%)	Bench Mark Flooded Parcels (Units)	BMP6 Flooded Parcels (Units)	BMP6 Flooded Parcels Change (%)
A	58	58	0.0	7,959	7,959	0.0	2	2	0.0
B	15,839	15,645	-1.2	304,750	280,497	-8.0	665	563	-15.3
C	724	724	-0.1	118,951	118,818	-0.1	38	38	0.0
D	150	150	-0.5	38,510	38,067	-1.2	15	15	0.0
E	407	407	-0.1	47,961	47,827	-0.3	2	2	0.0
F	98	98	-0.6	22,234	22,019	-1.0	1	1	0.0
G	250	250	0.0	53,687	53,659	-0.1	17	17	0.0
H	199	197	-0.8	1,082	1,021	-5.6	2	2	0.0
I	165	165	-0.1	21,519	21,418	-0.5	2	2	0.0
J	335	311	-7.2	84,088	72,123	-14.2	15	13	-13.3
K	240	240	0.0	45,022	45,022	0.0	5	5	0.0
L	69	69	0.0	11,354	11,354	0.0	0	0	0.0
M	2,426	2,426	0.0	0	0	0.0	0	0	0.0
N	150	150	0.0	14,407	14,407	0.0	1	1	0.0
O	189	189	-0.1	56,008	55,961	-0.1	9	9	0.0
P	191	183	-3.8	11,134	10,588	-4.9	6	4	-33.3
Q	3,733	3,723	-0.3	0	0	0.0	0	0	0.0
R	2,294	2,268	-1.2	86,929	80,023	-7.9	43	42	-2.3
S	2,489	2,485	-0.2	23,286	20,307	-12.8	74	73	-1.4
T	206	206	0.0	14,915	14,866	-0.3	5	5	0.0
U	9,907	9,907	0.0	8,973	8,973	0.0	19	19	0.0
V	553	550	-0.5	20,054	19,833	-1.1	6	6	0.0
W	1,207	1,207	0.0	0	0	0.0	0	0	0.0
X	92	88	-4.4	7,471	6,413	-14.2	2	2	0.0
Y	189	187	-0.7	70,162	69,679	-0.7	11	11	0.0
Z	51	51	-0.4	14,978	14,887	-0.6	0	0	0.0
Total	42,211	41,934	-0.7	1,085,434	1,035,721	-4.6	940	832	-11.5

3.3.2 *BMP Evaluation of Four Crossings*

Under this evaluation, as requested by the City of North Port, hydraulic performance and the effects of potential conveyance improvements at four sites, including: R-36 Canal at I-75, Myakkahatchee Creek at I-75, R-36 Canal at Tropicaire Boulevard, and Myakkahatchee Creek at Tropicaire Boulevard were analyzed.

A systematic evaluation was conducted to first understand the existing hydraulic behavior of each of the four crossings under various synthetic storm events. Head differences across each structure, flow conditions at peak discharge, and hydraulic connectivity (including flow patterns in adjacent areas) were assessed to understand unique conditions at each crossing.

In order to evaluate effectiveness of potential BMP improvements at these locations (including any resulting flood reduction and/or downstream flood increase), conveyance capacity at each site was increased by doubling the number of existing structures. This was achieved by adding a duplicate set of model reach elements at each location. A description of existing crossings and the applied BMP for evaluation are provided in Table 3-7.

Table 3-7: Location and Description of Existing and BMP Conditions

Crossing Location	Existing Crossing	BMP Condition
R-36 Canal at I-75	Two (2) 7.5' x 6' box culverts	Two (2) identical 7.5' x 6' box culverts were added in parallel to existing structure
Myakkahatchee Creek at I-75	Two (2) parallel bridges with 8 piers and a total span of 540 feet	Two (2) identical parallel bridges were added in parallel to existing structure
R-36 Canal at Tropicaire Blvd	Two (2) 5' diameter RCP culverts	Two (2) identical 5' diameter RCP culverts were added in parallel to existing structure
Myakkahatchee Creek at Tropicaire Blvd	One (1) bridge with 4 piers and a total span of 150 feet	One (1) identical bridge was added in parallel to existing structure

3.3.2.1 *R-36 Canal at I-75 Evaluation*

Existing condition model results indicate that more than two feet of head difference occurs across this structure during the 100-year storm event (see Table 3-8 and Figures 3-7 & 3-8). Under the proposed BMP condition, model results indicate that a peak stage reduction of up to 0.6 feet occurs upstream of the crossing, while a stage increase of approximately 0.6 feet occurs in the downstream areas. It is notable that reduced discharges are observed from the R-36 Canal westward into the adjacent Deer Prairie Slough watershed for the proposed BMP condition. This overflow connection with the adjacent watershed to the west is located north of I-75. The reduced overflow results in an increased total volume remaining within the North Port area, by virtue of the improved conveyance capacity of the proposed BMP. In summary, increasing the crossing capacity of the R-36 Canal at I-75 may reduce water levels upstream of the crossing, but

also raises flood elevations in the downstream areas. Mitigation of flooding in downstream areas was beyond the scope of this evaluation.

Table 3-8: R-36 Canal at I-75 Crossing Evaluation Results Summary

Table 3-8 (a): Existing Condition Upstream and Downstream Node Maximum Stages and Flows

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)*	NR3210	17.47	19.57	20.38	20.99	21.69	22.30
D/S Node Max Stage (ft)*	NR3220	16.82	18.33	18.86	19.20	19.56	19.92
Difference in Stage (ft)	n/a	0.65	1.24	1.52	1.78	2.14	2.38
Flow (cfs)	n/a	424	586	654	710	779	846

Table 3-8 (b): With BMP Upstream and Downstream Node Maximum Stages and Flows

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)*	NR3210	17.05	18.97	19.74	20.34	21.08	22.08
D/S Node Max Stage (ft)*	NR3220	16.88	18.61	19.25	19.69	20.19	20.74
Difference in Stage (ft)	n/a	0.17	0.36	0.49	0.65	0.90	1.34
Flow (cfs)	n/a	433	631	735	845	997	1223

Table 3-8 (c): Difference in Flows and Stages between BMP and Existing Condition

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)	NR3210	-0.42	-0.60	-0.64	-0.65	-0.61	-0.22
D/S Node Max Stage (ft)	NR3220	0.06	0.28	0.39	0.49	0.63	0.82
Flow (cfs)	n/a	9	45	82	135	218	377

*Vertical datum of stage reported in the table is with reference to NAVD88 Datum.

3.3.2.2 *Myakkahatchee Creek at I-75 Evaluation*

Existing condition model results indicate that approximately one foot of head difference occurs across this structure during extreme storm events (see Table 3-9 and Figures 3-9 & 3-10). This head difference is relatively small considering the magnitude of flow that arrives from the upstream contributing watershed (up to 8000 cubic feet per second). The applied BMP at this location assumes that the conveyance capacity of the bridge

crossing was doubled. In other words, an identical, parallel 540-foot bridge span was added to investigate the benefit of increasing bridge capacity. Under this hypothetical scenario, model results indicate that a localized stage reduction of 0.7 feet is observed immediately at the upstream end of the crossing. However, peak stage reductions decrease further upstream of the crossing along the creek. No significant change in peak elevations is observed 1,200 feet upstream of the crossing. Also, no significant change to flooding conditions is observed in areas downstream of the crossing. In summary, increasing the crossing capacity of the bridge over Myakkahatchee Creek at I-75 may reduce water levels immediately upstream of the crossing, but does not generally improve flooding conditions north of I-75. The area impacted by this improvement is very localized and would not justify the cost of the improvement.

3.3.2.3 *R-36 Canal at Tropicaire Boulevard Evaluation*

Existing condition model results indicate that up to three feet of head difference occurs across this structure during various storm events (see Table 3-10 and Figures 3-11 & 3-12). Under the proposed BMP conditions, model results indicate a peak stage reduction of approximately 0.8 feet upstream of the crossing, while a stage increase of up to 1.1 feet occurs downstream of Tropicaire. During all events, discharges from the R-36 canal into Deer Prairie Slough watershed are observed north of Tropicaire Boulevard. The proposed BMP results in a reduction of those discharges to Deer Prairie Slough and a resulting increased total volume remaining within the North Port area. In summary, while increasing the crossing capacity of the R-36 Canal at Tropicaire Boulevard may reduce water levels upstream of the crossing, it also raises flood elevations in downstream areas. Mitigation of flooding in downstream areas was beyond the scope of this evaluation.

3.3.2.4 *Myakkahatchee Creek at Tropicaire Boulevard Evaluation*

Existing condition model results indicate that the maximum calculated head difference for the various storm events is 0.2 feet; therefore the bridge is not causing a flow restriction (see Table 3-11 and Figures 3-13 & 3-14). Regardless, a BMP was applied for evaluation and assumes that the conveyance capacity was increased (doubled) by adding an identical bridge element in parallel to the existing structure. Under this scenario, model results indicate that a maximum localized stage reduction of approximately 0.1 feet was calculated, yet no significant change is observed further upstream nor downstream of the crossing. In summary, increasing the crossing capacity of the bridge over Myakkahatchee Creek at Tropicaire Boulevard does not substantially improve flooding conditions north of I-75.

Model results (maximum stages and maximum flows) for various storm events (Mean Annual, 5-year, 10-year, 25-year, 50-year, and 100-year) are provided in tabular form within the accompanying geodatabase.

Table 3-9: Myakkahatchee Creek at I-75 Crossing Evaluation Results Summary

Table 3-9 (a): Existing Condition Upstream and Downstream Node Maximum Stages and Flows

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)*	NB0750	20.40	21.89	22.19	22.46	22.82	23.93
D/S Node Max Stage (ft)*	NB0780	19.81	20.86	21.13	21.37	21.79	22.83
Difference in Stage (ft)	n/a	0.59	1.03	1.07	1.09	1.02	1.10
Flow (cfs)	n/a	1306	3045	3640	4236	5290	7816

Table 3-9 (b): With BMP Upstream and Downstream Node Maximum Stages and Flows

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)*	NB0750	19.97	21.16	21.45	21.71	22.14	23.35
D/S Node Max Stage (ft)*	NB0780	19.82	20.87	21.14	21.39	21.83	23.02
Difference in Stage (ft)	n/a	0.16	0.29	0.31	0.32	0.30	0.33
Flow (cfs)	n/a	1311	3601	3673	4291	5175	8509

Table 3-9 (c): Difference in Flows and Stages between BMP and Existing Condition

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)	NB0750	-0.43	-0.72	-0.75	-0.75	-0.68	-0.58
D/S Node Max Stage (ft)	NB0780	0.00	0.01	0.01	0.02	0.04	0.20
Flow (cfs)	n/a	5	556	33	55	-115	692

*Vertical datum of stage reported in the table is with reference to NAVD88 Datum.

Table 3-10: R-36 Canal at Tropicaire Boulevard Crossing Evaluation Results Summary

Table 3-10 (a): Existing Condition Upstream and Downstream Node Maximum Stages and Flows

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)*	NR0170	21.57	21.99	22.08	22.15	22.22	22.33
D/S Node Max Stage (ft)*	NR3190	18.15	19.74	20.48	21.07	21.73	22.31
Difference in Stage (ft)	n/a	3.42	2.25	1.61	1.08	0.49	0.01
Flow (cfs)	n/a	414	420	420	420	421	420

Table 3-10 (b): With BMP Upstream and Downstream Node Maximum Stages and Flows

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)*	NR0170	20.77	21.77	21.94	22.06	22.18	22.32
D/S Node Max Stage (ft)*	NR3190	19.29	20.68	21.11	21.49	21.90	22.32
Difference in Stage (ft)	n/a	1.48	1.10	0.83	0.57	0.28	0.00
Flow (cfs)	n/a	550	575	576	578	578	577

Table 3-10 (c): Difference in Flows and Stages between BMP and Existing Condition

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)	NR0170	-0.80	-0.21	-0.14	-0.09	-0.04	0.00
D/S Node Max Stage (ft)	NR3190	1.14	0.94	0.63	0.42	0.17	0.01
Flow (cfs)	n/a	136	156	156	157	158	157

*Vertical datum of stage reported in the table is with reference to NAVD88 Datum.

Table 3-11: Myakkahatchee Creek at Tropicaire Boulevard Crossing Evaluation Results Summary

Table 3-11(a): Existing Condition Upstream and Downstream Node Maximum Stages and Flows

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)*	NB0700	22.79	24.28	24.51	24.71	24.99	26.13
D/S Node Max Stage (ft)*	NB0710	22.70	24.08	24.31	24.52	24.83	26.07
Difference in Stage (ft)	n/a	0.09	0.19	0.20	0.20	0.16	0.06
Flow (cfs)	n/a	1332	2582	2785	2890	2973	2756

Table 3-11(b): With BMP Upstream and Downstream Node Maximum Stages and Flows

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)*	NB0700	22.73	24.17	24.41	24.63	24.94	26.11
D/S Node Max Stage (ft)*	NB0710	22.71	24.12	24.35	24.57	24.88	26.09
Difference in Stage (ft)	n/a	0.02	0.05	0.06	0.06	0.05	0.02
Flow (cfs)	n/a	1353	2712	3001	3167	3278	3031

Table 3-11(c): Difference in Flows and Stages between BMP and Existing Condition

Location	Node Name	Mean Annual	1 Day 10YR	1 Day 25YR	1 Day 50YR	1 Day 100YR	5 Day 100YR
U/S Node Max Stage (ft)	NB0700	-0.06	-0.10	-0.10	-0.09	-0.06	-0.02
D/S Node Max Stage (ft)	NB0710	0.01	0.04	0.04	0.05	0.05	0.02
Flow (cfs)	n/a	21	131	217	277	305	275

*Vertical datum of stage reported in the table is with reference to NAVD88 Datum.

3.3.3 *WCS-162 Evaluation*

WCS-162 is located on the R-36 Canal, north of Interstate 75, and immediately upstream of Tropicaire Boulevard (refer to Figure 3-15). This is the only gated weir structure on the R-36 Canal, with one 2.25 feet high by 2 feet wide pull up slide gate. The City generally operates this structure by fully opening the gate in anticipation of a storm event to lower the water level in the R-36 canal to minimize potential upstream flooding; otherwise, the gate remains closed. The City staff would like to determine if adding gates would help draw down the canal more quickly and increase conveyance capacity.

3.3.3.1 *R-36 Canal Drawdown Evaluation*

To reduce impacts downstream of WCS-162 while improving peak conditions upstream of the structure, an evaluation was performed to determine the benefits of adding additional gates. The evaluation included calculating the drawdown time for the R-36 canal and the additional conveyance capacity provided by the additional gates.

To evaluate BMPs at WCS-162, Ardaman requested to survey the structure to better understand the geometry of the structure and canal with the purpose of assessing availability of adequate space for additional gates. The survey data provided by Van Buskirk/Fish & Associates, Inc. is included in Appendix A, and the structure pictures are provided in Appendix B. The existing condition model was revised using the latest (2014) survey information for this BMP Evaluation. The update model simulated results rendered no change in model results compared to the May 2012 Governing Board approved model.

The benefits of reducing time required to lower R-36 canal elevation by adding gates at WCS-162 upstream of the structure were assessed by performing a drawdown analysis. For the drawdown evaluation, the R-36 canal upstream of WCS-162 was assumed to be at the control elevation of the weir (elevation 18.3 feet NAVD88). The water level at the canal was simulated by fully opening the existing gate with no additional flows coming into the canal. The existing condition drawdown simulation results indicates that it would take approximately 18 hours to lower the canal to elevation 15 feet (refer to Figure 3-16).

The canal drawdown simulation was repeated for one and two additional gates scenarios. The canal stage hydrographs upstream of the structure with additional gates are also plotted in Figure 3-16. As shown in Figure 3-16, the time required to drawdown R-36 canal will decrease to 11 hours by adding an identical gate. When 2 additional matching gates are provided, the time require to drawdown R-36 canal would decrease to 9 hours. Therefore, the total time required to drawdown R-36 canal (to elevation 15 feet) upstream of WCS-162 will be reduced by 7 and 9 hours by adding one and two additional gates respectively.

3.3.3.2 *Storm Events Simulation Results*

The mean annual, 5-year, and 10-year storm events were simulated using the updated existing condition model with 2014 survey information. The City's water control structure operation criteria were employed in these simulations. The gates are closed at the

beginning of the simulation, and they will be fully open when Big Slough Canal stage at Tropicaire rises to Elevation 15.88 feet NAVD88.

Benefits of flood control at the upstream of WCS-162 during a storm event were evaluated by simulating the mean annual storm event starting at the drawdown stage levels (Elevation 15 feet NAVD88). For this evaluation, initial stages in R-36 Canal upstream of WCS-162 were set to the drawdown levels, i.e. simulated canal stages after 18 hours of drawdown simulation. The lower initials at the canal will account for the additional canal storage capacity available upstream of WCS-162. During the lower initial condition simulation, the WCS-162 gate was assumed to be opened throughout the simulation. Model results with lowered initials were compared to the results with the normal initial stage, which is at the invert elevation (at elevation 18.29 feet NAVD88) of WCS-162 weir. Table 3-12 presents model results and comparison of max stages of R-36 canal upstream of WCS-162 weir with normal and lowered initial stage at the canal for the mean annual storm event. As indicated in the table, simulated results suggest that there will be no difference in peak stages in R-36 canal due to the lower initial canal stage. It should be noted that model results suggest the 50-foot wide weir at WCS-162 overtops by 2.6 feet conveying 328 cfs of peak flow across the structure during the mean annual storm event. The R-36 Canal upstream of WCS-162 holds approximately 30 acre-feet of storage capacity behind the gate, whereas more than 3,000 acre-feet of runoff volume is conveyed by the canal during the mean annual storm event. The additional available storage seems to be insignificant compared to the runoff conveyed by the canal during the storm event.

In addition, benefits of having one additional gate with the lowered R-36 canal stages upstream of WCS-162 were also evaluated. For this scenario, both gates (one existing and one additional BMP gate) were assumed to be fully opened throughout the simulation. The model results for mean annual storm event for this scenario are also presented in Table 3-12. The simulated results suggest that there will be no difference in R-36 canal max stages upstream of WCS-162 with an additional gate at the structure. As no difference in peak stages were predicted for the mean annual storm event, no other higher return period storm events (5-year and 10-year) were analyzed with additional gates.

In conclusion, providing one or two additional gates at WCS-162 will help to reduce the time required to drawdown canal levels at the upstream of the structure; however the model results suggest that lower initial levels in R-36 canal upstream of the structure will provide no benefits in terms of reducing flooding at the upstream areas even for small storm events such as mean annual storm event. Also, the modeling results suggest that there would be no adverse impacts in the downstream of WCS-162 due to the additional gate.

Table 3-12: Mean Annual Event Simulated Maximum Stages in R-36 Canal Upstream of WCS-162

Model Node+	Existing Condition Max Stage (ft, NAVD88)	Scenario 1: Existing with Lowered Initials		Scenario 2: One Additional Gate BMP with Lowered Initials	
		Max Stage (ft, NAVD88)	Difference in Max Stage (ft)	Max Stage (ft, NAVD88)	Difference in Max Stage(ft)
NR0170*	21.55	21.55	0.00	21.56	0.01
Water Control Structure WCS-162					
NR3160**	21.86	21.86	0.00	21.85	0.00
NR3150	21.87	21.86	0.00	21.86	0.00
NR3140	22.09	22.09	0.00	22.09	0.00
NR3130	22.23	22.23	0.00	22.23	0.00
NR3125	22.42	22.41	-0.01	22.41	-0.01
NR3120	22.58	22.57	-0.01	22.57	-0.01
NR3110	22.76	22.76	-0.01	22.76	-0.01
NR3100	22.85	22.84	-0.01	22.84	-0.01
NR3090	22.94	22.94	0.00	22.94	0.00
NR3080	23.01	23.01	0.00	23.01	0.00
NR3070	23.09	23.09	0.00	23.08	0.00
NR3060	23.20	23.20	0.00	23.20	0.00
NR3050	23.40	23.40	0.00	23.40	0.00
NR3040	23.44	23.44	0.00	23.44	0.00
NR3030	23.51	23.51	0.00	23.51	0.00
NR3025	23.58	23.58	0.00	23.58	0.00
NR3020	23.59	23.59	0.00	23.59	0.00
NR3010	23.62	23.62	0.00	23.62	0.00
NB5695	23.65	23.65	0.00	23.65	0.00

+ Model nodes are presented from downstream to upstream location at R-36 canal

* Model Node Downstream of WCS-162

** Model Node Upstream of WCS-162

3.3.4 *Price Boulevard LOS Improvements*

Existing condition model results (May 2012 Governing Board approved model) predict that West Price Boulevard would intermittently flood between Locher Road and the Big Slough Canal during the 10, 25, and 100-year, 24-hour storm events. The currently designated City of North Port Level of Service (LOS) is shown in Figure 3-17. As shown on this figure, the West Price Boulevard stretch is identified as an arterial street that floods during the 100-year, 24-hour design storm event. This arterial street is critical to stormwater emergency response since it provides access to emergency facilities such as North Port Utilities Building, North Port High School and Heron Creek Middle School. Therefore, the City of North Port requested further evaluation of the stretch of West Price Boulevard between North Biscayne Boulevard and the Big Slough Canal to provide BMP recommendations to meet the City of North Port LOS criteria. City Unified Land Development Code Chapter 18 Level of Service criteria for arterial roads states that flooding must be less than 6 inches, as measured at the outside edge of pavement in a 100-year, 24-hour design storm event.

Ardaman staff reviewed the May 2012 Governing Board approved model setup within the area of interest (AOI) to verify whether the current model adequately represents the 2014 condition. With desktop and field reconnaissance of the area, it was observed that a section of the surface and sub-surface drainage systems near the North Port High School had been recently updated. Ardaman recommended surveying the AOI to better represent the existing condition. The survey data provided by Van Buskirk/Fish & Associates, Inc. is included in Appendix C.

Existing (2014) Condition Description:

Based on recent survey, stormwater runoff collected from the north and south swales of West Price Boulevard generally flows west from the North Port Utilities Building, whereas stormwater runoff from the remaining areas flows east from this location. Accumulated stormwater runoff going west from the North Port Utilities Building ultimately flows north via the Indian burial ground toward the R-32 canal.

Stormwater runoff going east toward Big Slough is routed through a series of surface water features (ditches, swales and inlets) which connects to a sub-surface system along the north side of West Price Boulevard.

Existing Condition Model Update and Results:

The May 2012 Governing Board approved model was updated using the 2014 survey provided by Van Buskirk/Fish & Associates, Inc. The revised 100-year storm event model results indicate that West Price Boulevard would not flood near the North Port High School as previously predicted. However, the stretch of West Price Boulevard north of Little Salt Spring would still flood by 0.4 feet at the crown during the 10-year storm event. Survey data indicates that road overtopping would occur at the lowest point (near the culvert crossing) at 17.3 feet NAVD88. The model predicted the 25-year and 100-year storm maximum stages at West Price Boulevard are 17.9 and 18.2 feet NAVD88 respectively. The revised existing condition floodplain delineations for the 100-year storm event and the revised LOS are presented in Figure 3-18.

BMP Alternative Analysis

The objective of this series of BMPs is to mitigate flooding along the stretch of West Price Boulevard near the Indian burial ground to meet the existing City of North Port LOS criteria.

Five different BMP alternatives were considered. Only the three alternatives that were determined to be effective in improving the LOS are described below:

3.3.4.1 *West Price Boulevard BMP 1*

Description

The first BMP alternative involves dredging the R-24 and R-32 canals. As shown in Figure 3-19, this alternative would require: dredging 2,300 feet of R-24 canal and 1,800 feet of R-32 canal to add approximately 2 to 3 feet of depth; and installing one extra parallel 36-inch pipe at the existing culvert crossing, between Indian burial ground and the R-32 canal. Figures showing comparison of existing and BMP cross-sections and bottom profiles of these canals are provided in Appendix D.

The City is not allowed to disturb the 50-foot wide drainage right-of-way through the Indian burial ground.

Results

Model results, comparison of floodplains, and the maximum stages at notable locations are presented in Figure 3-19. Model results with BMP_1 alternative suggest that West Price Boulevard would not overtop during the 25-year storm event. In addition, this alternative would reduce flooding on some local streets (Dundee Ave, Surf Ave, and San Salvador Road) located north of R-32 canal.

The model predicted that the 100-year maximum stage at West Price Boulevard with BMP_1 alternative will be reduced from 18.2 to 17.5 feet NAVD88. West Price Boulevard would still overtop by 0.2 feet over the crown of the road at the lowest section during the 100-year storm event. However, the road would be passable according to City of North Port LOS criteria. Figure 3-20 shows the comparison of the 100-year floodplain and maximum stages at notable locations with BMP 1 alternative. Model results also indicate that there will be no adverse impacts at downstream areas due to this improvement.

3.3.4.2 *West Price Boulevard BMP 2*

Description

The second BMP alternative consists of raising the road (West Price Boulevard) such that it would not flood during the 100-year design storm event. This alternative would involve raising approximately 1,900 feet of West Price Boulevard to an elevation of 18.5 feet NAVD88. Survey data suggests that the lowest segment of the road, which is located at the culvert crossing, needs to be raised by 1.2 feet to reach an elevation of 18.5 feet NAVD88. Figure 3-21 shows the comparison of the 100-year floodplain as well

as the extent of West Price Boulevard that needs to be raised to reduce flooding potential during the event.

Results

Model results suggest that the 100-year peak stages upstream and downstream of the culvert across West Price Boulevard would be 18.2 feet NAVD88 with this alternative. The model predicted the 100-year maximum stage at West Price Boulevard is below the recommended raised road crown elevation of 18.5 feet NAVD88. The peak stage model results suggest that there will be no adverse impacts or increase in stages upstream or downstream of the improvement for any modeled storm event.

Additional right-of-way requirement to raise the road and its availability should be thoroughly assessed prior to selecting this BMP alternative.

3.3.4.3 *West Price Boulevard BMP 3*

Description

The third BMP alternative evaluated incorporates both BMP_1 and BMP_2 improvements, i.e. dredging the R-32 and R-24 canals, adding a new pipe crossing, and raising the road such that it would not flood during the 100-year storm event.

Results

Model results suggest that the 100-year peak stage upstream of the culvert across West Price Boulevard would be 17.6 feet NAVD88 with this alternative. Figure 3-22 shows the comparison of the 100-year floodplain as well as the elements of BMP_3 improvements. This alternative would require raising approximately 950 feet of West Price Boulevard to elevation 18.0 feet NAVD88. Compared to BMP_2 improvements, this alternative would reduce the required road improvement length by half at a lower elevation (6 inches lower than BMP_2). Similar to BMP_1 and BMP_2, the peak stage model results suggest that there will be no adverse impacts or increase in stages upstream or downstream of the road improvement for any model storm event.

3.3.4.4 *Other Evaluated BMPs*

In addition to the three previously described BMP alternatives, a few other BMPs were evaluated. However, modeling results suggest that theses BMPs would not mitigate the flooding conditions along the evaluated stretch of West Price Boulevard.

One of the other BMPs evaluated was to install a 24-inch pipe at the south side of West Price Boulevard near the culvert that would run approximately 1,400 feet to the east and connect to the existing sub-surface system inlet. This BMP did not show any improvements since the BMP pipe is too long and there was not sufficient hydraulic gradient available to convey the necessary flow rate through the pipe.

Another BMP evaluated was to provide a 20-foot wide cut/swale that would connect the flooded area south of West Price Boulevard to the south towards the Little Salt Spring basin. 25-year storm event model results suggest that this BMP alternative would lower

peak stages at West Price Boulevard only by 0.2 feet. However, the road would still flood during this event. Also, this BMP may raise environmental concerns considering that it would require diverting stormwater runoff from the road towards Little Salt Spring basin.

3.3.4.5 *Summary and Recommendations*

Various BMP alternatives were evaluated to mitigate flooding at West Price Boulevard with the purpose of meeting City of North Port LOS criteria. BMP_1 alternative (dredging R-24 and R-32 canals) would eradicate the road flooding in a 25-year design storm event, and it would minimize flooding in a 100-year storm event to make it passable during the event. BMP_2 alternative would eliminate road flooding in a 100-year design storm event by raising West Price Blvd. BMP_3 alternative would also eliminate West Price Boulevard road flooding in a 100-year storm event while minimizing road improvements. A summary of 100-year peak stages for each BMP alternatives and recommended road crown and edge of pavement elevations are provided in Table 3-13. It is estimated that it would cost $0.8 million, $0.9 million, and $1.3 million for BMP_1, BMP_2, and BMP_3, respectively (see Appendix E for the detailed cost estimates). These cost estimates are approximate, and they are used for the comparison purpose only. Considering the project cost, BMP_2 alternative (raising the road) appears to be the most effective approach to eliminate road flooding conditions for the 100-year design storm event. In 2010, the city cleaned these canals with the purpose of removing mucks accumulated at the bottom. It is recommended current cross-sections and bottom profiles of these canals be surveyed to verify dredging requirements prior to selecting dredging alternatives. Also, canal dredging cost could be less, if City of North Port performs the dredging using in-house resources.

Table 3-13: Summary of West Price Boulevard BMPs

BMP Description	100-year Flood Elevation (ft, NAVD88)		EOP Elevation (ft, NAVD88)		Road Crown Elevation (ft, NAVD88)		Preliminary Cost Estimate for Construction in 2017
	Without BMP	With BMP	Existing	Proposed	Existing	Proposed	
No. 1- Dredge R-24 and 32, add 36" pipe	18.2	17.5	17	17	17.3	17.3	$832,000
No. 2- Raise 1900 LF of Price Blvd 1.2' higher	18.2	18.2	17	18.2	17.3	18.5	$859,000
No. 3- Dredge R-24 and 32, add 36" pipe, Raise 850 LF of Price Blvd 0.7' higher	18.2	17.6	17	17.7	17.3	18.0	$1,308,000

The 25-year and 100-year storm events revised existing condition and BMP 1, 2, and 3 alternatives model results (maximum stages and maximum flows) are provided in tabular form within the accompanying geodatabase along with updated model network (basins, nodes, and reaches). CHAN model data and simulation run files for these alternatives are also included in an external hard drive.

4.0 CONCEPTUAL PERMIT APPLICATION

Conceptual permit application was not included in this project.

5.0 CONCLUSIONS

It is recommended that the City of North Port purchas the small number of habitable structures in which flooding is predicted in the 100 year event. Purchasing the affected properties may be more cost effective than implementing any BMPs. Figure 5-1 shows the 74 parcels (one parcel contains two habitable structures) identified in the LOS analysis, in addition to 25 parcels reported as flooded in 1992 and 27 properties reported as damaged in 2003 (also see Table 5-1 below). Several parcels were identified as flooded in more than one event, which is noted in the table.

It is recommended that finished floor elevations of the 101 parcels are acquired by survey, and finished floor elevations are compared with modeled 100 year event maximum stages, to determine which properties flood in the 100 year event. Highlighted rows indicate parcels that were identified as flooded in the LOS analysis, and have documented flooding in the 1992 and/or 2003 event.

Table 5-1: Summary of Parcels to Survey

PID	Address	City, State, Zip	In 100 Year Level of Service Analysis	Reported as Flooded in 1992	Reported as Flooded in 2003
1122-16-0325	1297 NACKMAN RD	NORTH PORT, FL 34288	Yes		
1008-25-5316	1400 LONGBOW AVE	NORTH PORT, FL 34288	Yes		
0976-26-4128	2386 VESTRIDGE ST	NORTH PORT, FL 34287	Yes		
0964-08-1404	2912 OKLAHOMA ST	NORTH PORT, FL 34286	Yes		
0995-18-2835	2989 SARLETTO ST	NORTH PORT, FL 34287		Yes	
0995-18-2836	2999 SARLETTO ST	NORTH PORT, FL 34287		Yes	
0967-06-0117	3166 SNOWBIRD ST	NORTH PORT, FL 34291	Yes	Yes	Yes
0993-26-4012	3236 MONTCLAIR CIR	NORTH PORT, FL 34287	Yes		
0993-26-3801	3262 MONTCLAIR CIR	NORTH PORT, FL 34287	Yes		
0993-26-3730	3589 MONTCLAIR CIR	NORTH PORT, FL 34287	Yes		
0993-26-3815	3626 MONTCLAIR CIR	NORTH PORT, FL 34287	Yes		
0993-26-3816	3652 MONTCLAIR CIR	NORTH PORT, FL 34287	Yes		

PID	Address	City, State, Zip	In 100 Year Level of Service Analysis	Reported as Flooded in 1992	Reported as Flooded in 2003
0954-14-2522	4268 BACKENSTO ST	NORTH PORT, FL 34291	Yes		Yes
1144-07-4316	4268 LEESBURG AVE	NORTH PORT, FL 34288	Yes		
1002-18-4613	4353 MCKIBBEN DR	NORTH PORT, FL 34287	Yes		
1002-27-6618	4399 MONGITE RD	NORTH PORT, FL 34287	Yes		
1002-18-4810	4440 MONGITE RD	NORTH PORT, FL 34287	Yes		
0955-15-4601	4441 COBBLER LN	NORTH PORT, FL 34286	Yes		
1002-27-6621	4441 MONGITE RD	NORTH PORT, FL 34287	Yes		
0996-19-1923	4531 NELE ST	NORTH PORT, FL 34287		Yes	
1002-18-4806	4534 MONGITE RD	NORTH PORT, FL 34287	Yes		
1002-27-6627	4567 MONGITE RD	NORTH PORT, FL 34287	Yes		
0996-19-1922	4573 NELE ST	NORTH PORT, FL 34287		Yes	
1002-27-6628	4583 MONGITE RD	NORTH PORT, FL 34287	Yes		
1002-27-6629	4599 MONGITE RD	NORTH PORT, FL 34287	Yes		
1002-27-6630	4609 MONGITE RD	NORTH PORT, FL 34287	Yes		
1002-27-6631	4625 MONGITE RD	NORTH PORT, FL 34287	Yes		
1002-18-5011	4628 MONGITE RD	NORTH PORT, FL 34287	Yes		
1002-18-5010	4640 MONGITE RD	NORTH PORT, FL 34287	Yes		
1002-27-6632	4641 MONGITE RD	NORTH PORT, FL 34287	Yes		
1002-18-5008	4668 MONGITE RD	NORTH PORT, FL 34287	Yes		
0996-19-4324	4943 GROBE ST	NORTH PORT, FL 34287	Yes		
0996-19-2317	4964 GROBE ST	NORTH PORT, FL 34287		Yes	
1001-27-6105	4974 ESCALANTE DR	NORTH PORT, FL 34287	Yes		
1001-27-6106	4982 ESCALANTE DR	NORTH PORT, FL 34287	Yes		
1001-27-6316	4983 ESCALANTE DR	NORTH PORT, FL 34287	Yes		
0996-19-4325	4987 GROBE ST	NORTH PORT, FL 34287	Yes		
1001-27-6107	4990 ESCALANTE DR	NORTH PORT, FL 34287	Yes		
0996-19-2318	4991 BULLARD ST	NORTH PORT, FL 34287		Yes	

PID	Address	City, State, Zip	In 100 Year Level of Service Analysis	Reported as Flooded in 1992	Reported as Flooded in 2003
0953-15-2713	5005 LACEY ST	NORTH PORT, FL 34286	Yes		Yes
0996-09-4126	5009 BULLARD ST	NORTH PORT, FL 34287	Yes		
0955-15-3218	5060 IBSON LN	NORTH PORT, FL 34286	Yes		
0942-15-3308	5089 HABLOW LN	NORTH PORT, FL 34286	Yes		
0942-15-3307	5101 HABLOW LN	NORTH PORT, FL 34286	Yes		
1001-27-6115	5102 ESCALANTE DR	NORTH PORT, FL 34287	Yes		
0942-15-3205	5133 INKS LN	NORTH PORT, FL 34286	Yes		
1001-27-6117	5142 ESCALANTE DR	NORTH PORT, FL 34287	Yes		
0942-15-3204	5149 INKS LN	NORTH PORT, FL 34286	Yes		
0942-15-3301	5173 HABLOW LN	NORTH PORT, FL 34286	Yes		
0953-15-2415	5208 GRIGGS AVE	NORTH PORT, FL 34291	Yes		
0953-15-2214	5224 HACKLEY RD	NORTH PORT, FL 34291	Yes		
0953-15-2615	5272 GADBOYS AVE	NORTH PORT, FL 34291	Yes		
0953-15-2614	5278 GADBOYS AVE	NORTH PORT, FL 34291	Yes		
0953-15-2324	5290 HAAS AVE	NORTH PORT, FL 34291	Yes		
1001-27-6122	5292 TREKELL ST	NORTH PORT, FL 34287	Yes		
1001-27-6123	5302 TREKELL ST	NORTH PORT, FL 34287	Yes		
0996-19-4339	5323 GROBE ST	NORTH PORT, FL 34287		Yes	
0944-15-2728	5363 LACEY ST	NORTH PORT, FL 34286	Yes		Yes
0955-15-4505	5382 NOHAVA RD	NORTH PORT, FL 34286	Yes		
0954-14-2930	5437 MANDRAKE TER	NORTH PORT, FL 34291	Yes		
0954-14-2515	5497 LADY SLIPPER AVE	NORTH PORT, FL 34291			Yes
0953-14-1109	5516 REISTERSTOWN RD	NORTH PORT, FL 34291			Yes
0944-07-1204	5519 GARRISON AVE	NORTH PORT, FL 34291			Yes
0953-14-1108	5547 TANEYTOWN ST	NORTH PORT, FL 34291			Yes
0953-14-1208	5551 REISTERSTOWN RD	NORTH PORT, FL 34291	Yes	Yes	Yes

PID	Address	City, State, Zip	In 100 Year Level of Service Analysis	Reported as Flooded in 1992	Reported as Flooded in 2003
0953-14-1113	5555 HENNESSY ST	NORTH PORT, FL 34291	Yes	Yes	Yes
0953-14-1207	5585 REISTERSTOWN RD	NORTH PORT, FL 34291			Yes
0953-14-1111	5588 REISTERSTOWN RD	NORTH PORT, FL 34291	Yes		Yes
0944-07-1202	5621 GARRISON AVE	NORTH PORT, FL 34291	Yes		
0953-14-1206	5621 REISTERSTOWN RD	NORTH PORT, FL 34291	Yes	Yes	Yes
0953-14-1112	5624 REISTERSTOWN RD	NORTH PORT, FL 34291	Yes	Yes	Yes
0942-08-0004	5625 N SUMTER BLVD	NORTH PORT, FL 34286	Yes		
1002-18-4802	5650 POSTMA ST	NORTH PORT, FL 34287	Yes		
0954-14-2520	5654 LADY SLIPPER AVE	NORTH PORT, FL 34291			Yes
0944-07-1309	5664 GARRISON AVE	NORTH PORT, FL 34291	Yes		Yes
0944-07-1304	5779 REISTERSTOWN RD	NORTH PORT, FL 34291	Yes	Yes	Yes
0967-05-8905	5788 SYLVANIA AVE	NORTH PORT, FL 34291			Yes
0967-05-8904	5814 SYLVANIA AVE	NORTH PORT, FL 34291			Yes
0942-04-1904	5815 SUMTER BLVD	NORTH PORT, FL 34286	Yes		Yes
0968-05-7474	5834 BURWIN AVE	NORTH PORT, FL 34291	Yes		
0968-05-7448	5839 BATTERSEA AVE	NORTH PORT, FL 34291	Yes		Yes
0968-05-7450	5861 BATTERSEA AVE	NORTH PORT, FL 34291	Yes		Yes
0968-05-8024	5933 BURWIN AVE	NORTH PORT, FL 34291	Yes		
0968-05-7454	5971 BATTERSEA AVE	NORTH PORT, FL 34291	Yes		Yes
0941-04-1613	6527 REISTERSTOWN RD	NORTH PORT, FL 34291			Yes
0943-01-1009	6531 TANEYTOWN ST	NORTH PORT, FL 34291		Yes	
0941-04-1611	6669 REISTERSTOWN RD	NORTH PORT, FL 34291	Yes	Yes	Yes
0941-04-1609	6869 REISTERSTOWN RD	NORTH PORT, FL 34291		Yes	Yes

PID	Address	City, State, Zip	In 100 Year Level of Service Analysis	Reported as Flooded in 1992	Reported as Flooded in 2003
0941-04-1615	6969 REISTERSTOWN RD	NORTH PORT, FL 34291			Yes
0952-12-1121	7254 MUNCEY RD	NORTH PORT, FL 34291	Yes		
0996-09-3204	8515 FAY AVE	NORTH PORT, FL 34287		Yes	
0996-19-4520	8634 HERBISON AVE	NORTH PORT, FL 34287		Yes	
0996-19-4508	8645 CRISTOBAL AVE	NORTH PORT, FL 34287		Yes	
0996-19-4519	8664 HERBISON AVE	NORTH PORT, FL 34287		Yes	
0996-19-4517	8720 HERBISON AVE	NORTH PORT, FL 34287	Yes		
0996-19-4515	8772 HERBISON AVE	NORTH PORT, FL 34287		Yes	
0996-19-4513	8795 CRISTOBAL AVE	NORTH PORT, FL 34287		Yes	
0995-19-2413	8796 PORTO BELLO AVE	NORTH PORT, FL 34287	Yes		
0996-19-4514	8798 HERBISON AVE	NORTH PORT, FL 34287	Yes	Yes	
0995-18-2838	8855 CHESEBRO AVE	NORTH PORT, FL 34287		Yes	
0995-18-2837	8875 CHESEBRO AVE	NORTH PORT, FL 34287		Yes	

We trust that this report satisfies your expectations and appreciate the opportunity to work with you on this important project. If you have any questions, or if we can be of further service to you, please do not hesitate to call.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

10/10/2014

Nestor Aceituno, P.E.
Senior Project Engineer

Shankar Gautam
N.A.

Shankar Gautam, P.E.
Project Engineer

cc: Elizabeth Wong, City of North Port

FIGURES

FIGURE 2-1

564000 576000 588000 600000 612000 624000 636000

1028000 1016000 1004000 992000 980000

N W E S

0 3,000 6,000
Feet

Scale: 1" = 6000'

- Evacuation Route Floods
- Collector Street Floods
- Local Street Floods
- Northport Boundary

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/17/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\LOS 10.mxd		

10 YEAR LEVEL OF SERVICE

CITY OF NORTH PORT, SARASOTA COUNTY, FL

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants
Phone: 407-855-3860 Fax: 407-859-8121
8008 South Orange Avenue
Orlando, Florida 32809

FIGURE 2-2

564000 576000 588000 600000 612000 624000 636000

1028000 1016000 1004000 992000 980000

N W E S

0 3,000 6,000
Feet

Scale: 1" = 6000'

- Evacuation Route Floods in 25 Year Event
- Arterial Street Floods in 25 Year Event
- Collector Street Floods in 25 Year Event
- Local Street Floods in 25 Year Event
- Northport Boundary

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/17/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\LOS 10.mxd		

25 YEAR LEVEL OF SERVICE

CITY OF NORTH PORT, SARASOTA COUNTY, FL

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Geotechnical, Environmental and Materials Consultants
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8008 South Orange Avenue
Orlando, Florida 32809

FIGURE 2-3

N
W E
S

0 3,000 6,000
Feet

Scale: 1" = 6000'

564000 576000 588000 600000 612000 624000 636000

1028000
1016000
1004000
992000
980000

- Habitable Structure Floods
- Evacuation Route Floods
- Arterial Street Floods
- Collector Street Floods
- Local Street Floods
- Northport Boundary

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/17/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\LOS 100.mxd		

100 YEAR LEVEL OF SERVICE

CITY OF NORTH PORT, SARASOTA COUNTY, FL

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8008 South Orange Avenue
Orlando, Florida 32809

564000 576000 588000 600000 612000 624000 636000

1028000 1016000 1004000 992000 980000

Big Slough

WCS-162 Removed

CUN-001 Removed

Big Slough

N I75

S I75

WCS-115 Removed

WCS-120 Removed

WCS-123 Removed

WCS-113 Removed

WCS-114 Removed

DS-119 Removed

DS-122 Removed

DS-126 Removed

DS-129 Removed

DS-133 Removed

DS-135 Removed

DS-136 Removed

DS-139 Removed

WCS-121 Removed

WCS-125 Removed

WCS-128 Removed

DS-132 Removed

WCS-101

WCS-106

WCS-124 Removed

WCS-131 Removed

WCS-111 Removed

WCS-127 Removed

WCS-117 Removed

WCS-107 Removed

WCS-108 Removed

WCS-130 Removed

WCS-109 Removed

WCS-110 Removed

564000 576000 588000 600000 612000 624000 636000

FIGURE 3-1

N

W E

S

0 3,000 6,000

Feet

Scale: 1" = 6000'

Legend

- WCS
- Removed Structures
- New Connections
- Subwatershed
- Existing Condition Floodplain
- Flood Area Reduction
- Flood Area Increase

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: Florida East West	
Prepared: 10-11-07	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\BMP1.mxd		

NORTH PORT / BIG SLOUGH WMP

BMP ALTERNATIVE 1 - 1 DAY 100 YEAR EVALUATION

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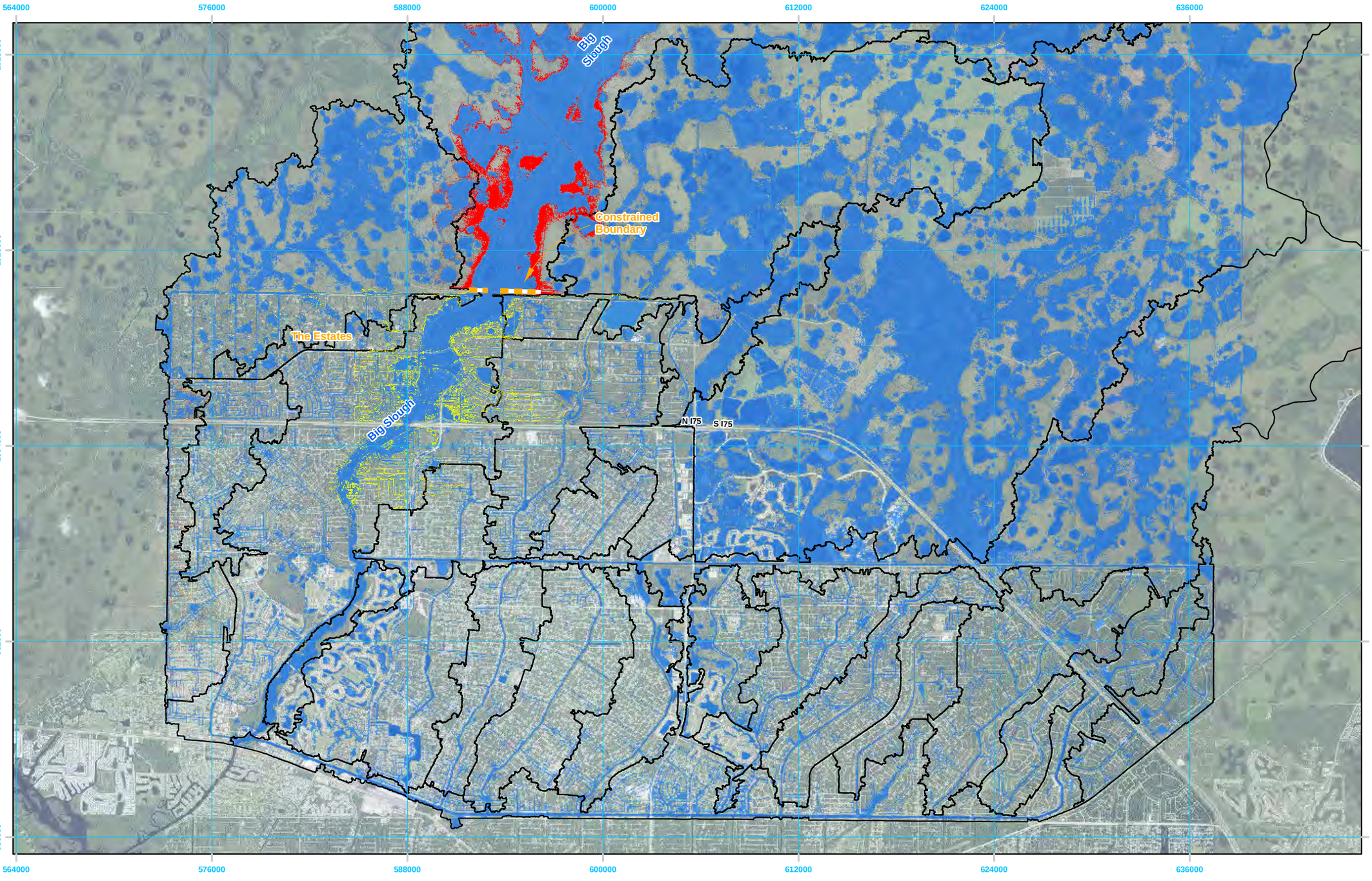
8008 South Orange Avenue
Orlando, Florida 32809

FIGURE 3-2



N

W E

S

0 3,000 6,000

Feet

Scale: 1" = 6000'

- Constrained Boundary
- Subwatershed
- Existing Condition Floodplain
- Flood Area Reduction
- Flood Area Increase

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/9/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\BMP2.mxd		

NORTH PORT / BIG SLOUGH WMP

BMP ALTERNATIVE 2 - 1 DAY 100 YEAR EVALUATION

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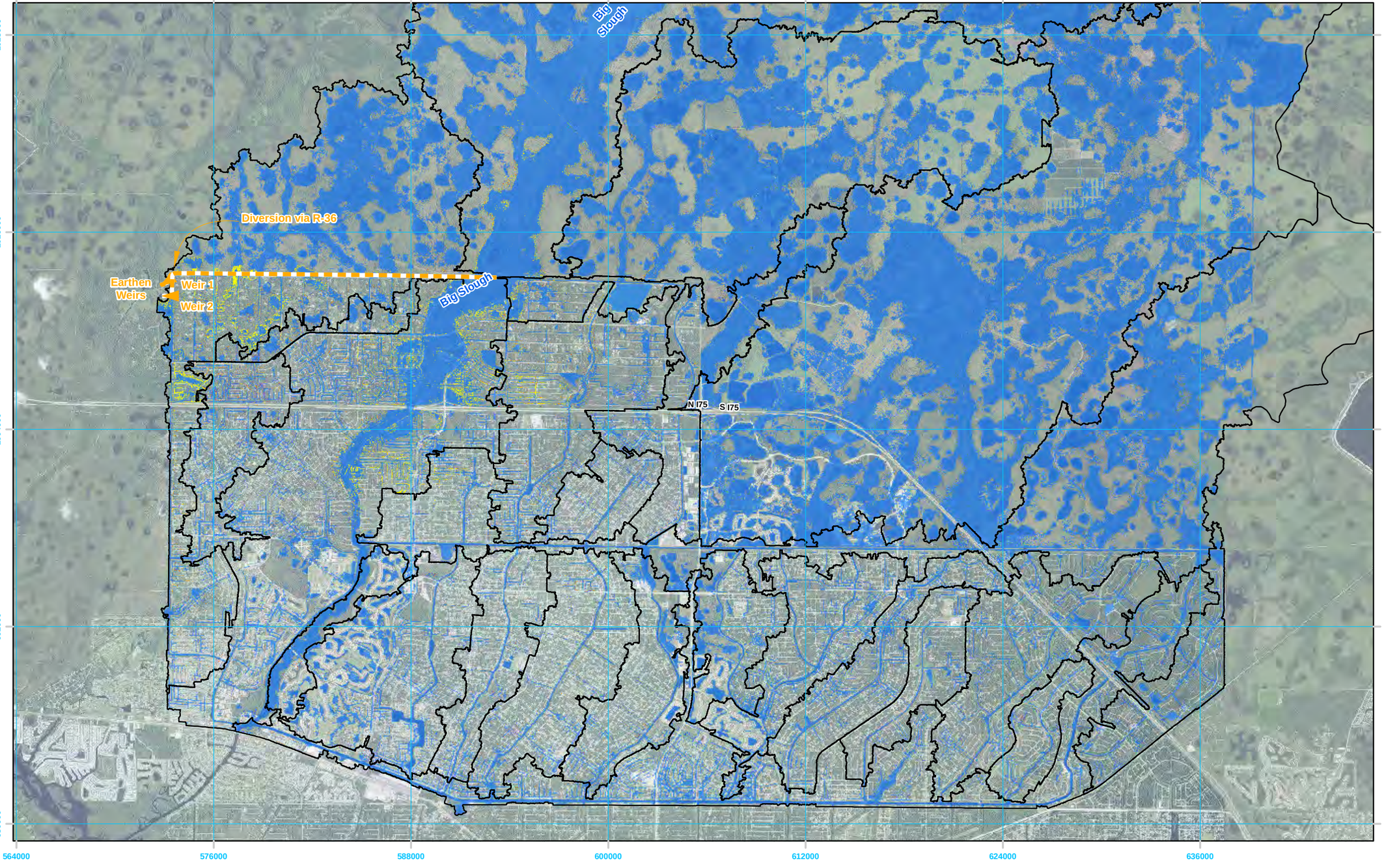
Orlando, Florida 32809

FIGURE 3-3



N

W E

S

0 3,000 6,000

Feet

Scale: 1" = 6000'

- Diversion
- Subwatershed
- Flood Area Reduction
- Flood Area Increase
- Existing Condition Floodplain

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/9/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\BMP3.mxd		

NORTH PORT / BIG SLOUGH WMP

BMP ALTERNATIVE 3 - 1 DAY 100 YEAR EVALUATION

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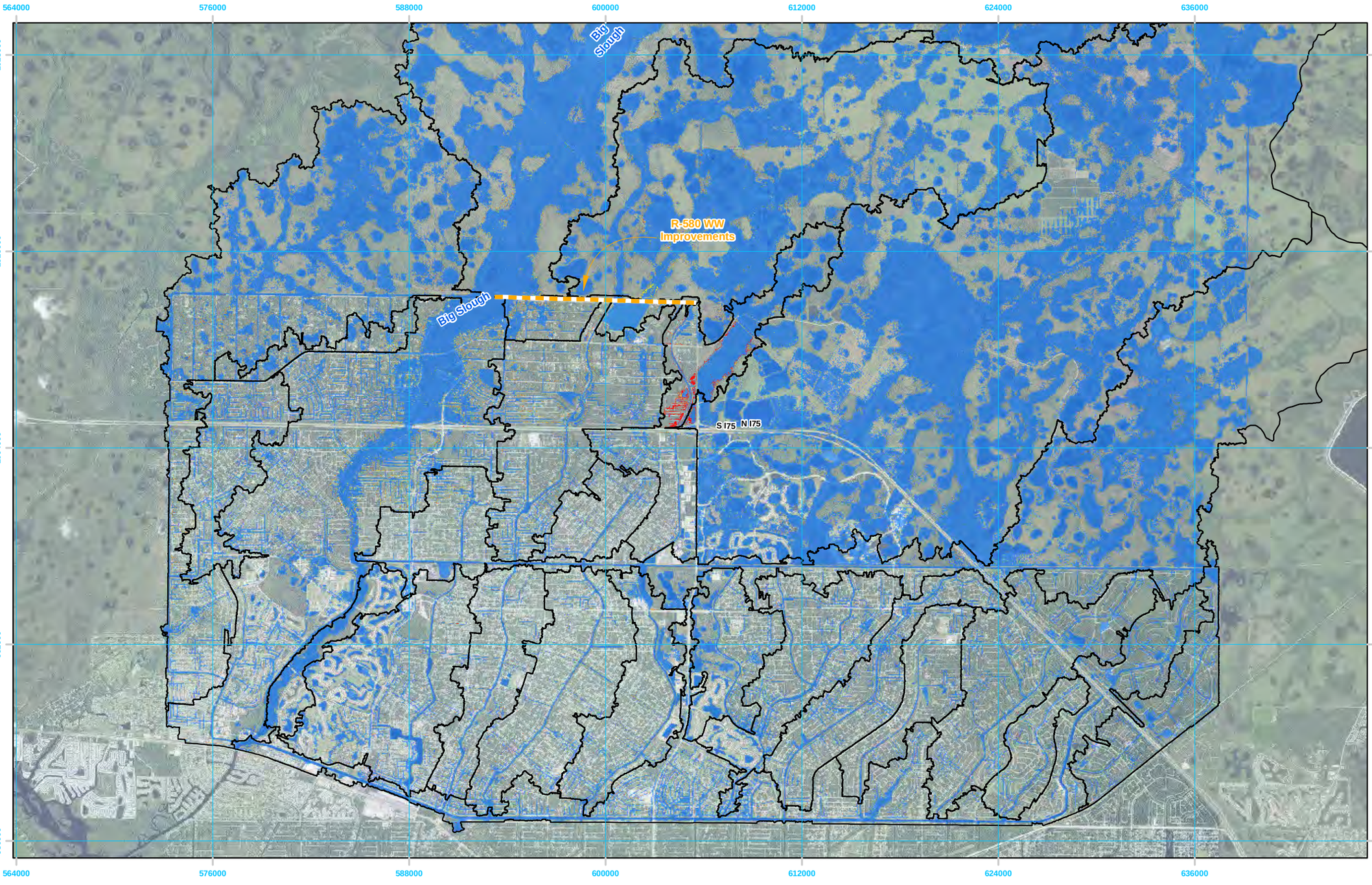
Orlando, Florida 32809

FIGURE 3-4



N
W E
S

0 3,000 6,000
Feet

Scale: 1" = 6000'

- R-580 WW Improvements
- Subwatershed
- Existing Condition Floodplain
- Flood Area Reduction
- Flood Area Increase

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/9/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\BMP4.mxd		

NORTH PORT / BIG SLOUGH WMP

BMP ALTERNATIVE 4 - 1 DAY 100 YEAR EVALUATION

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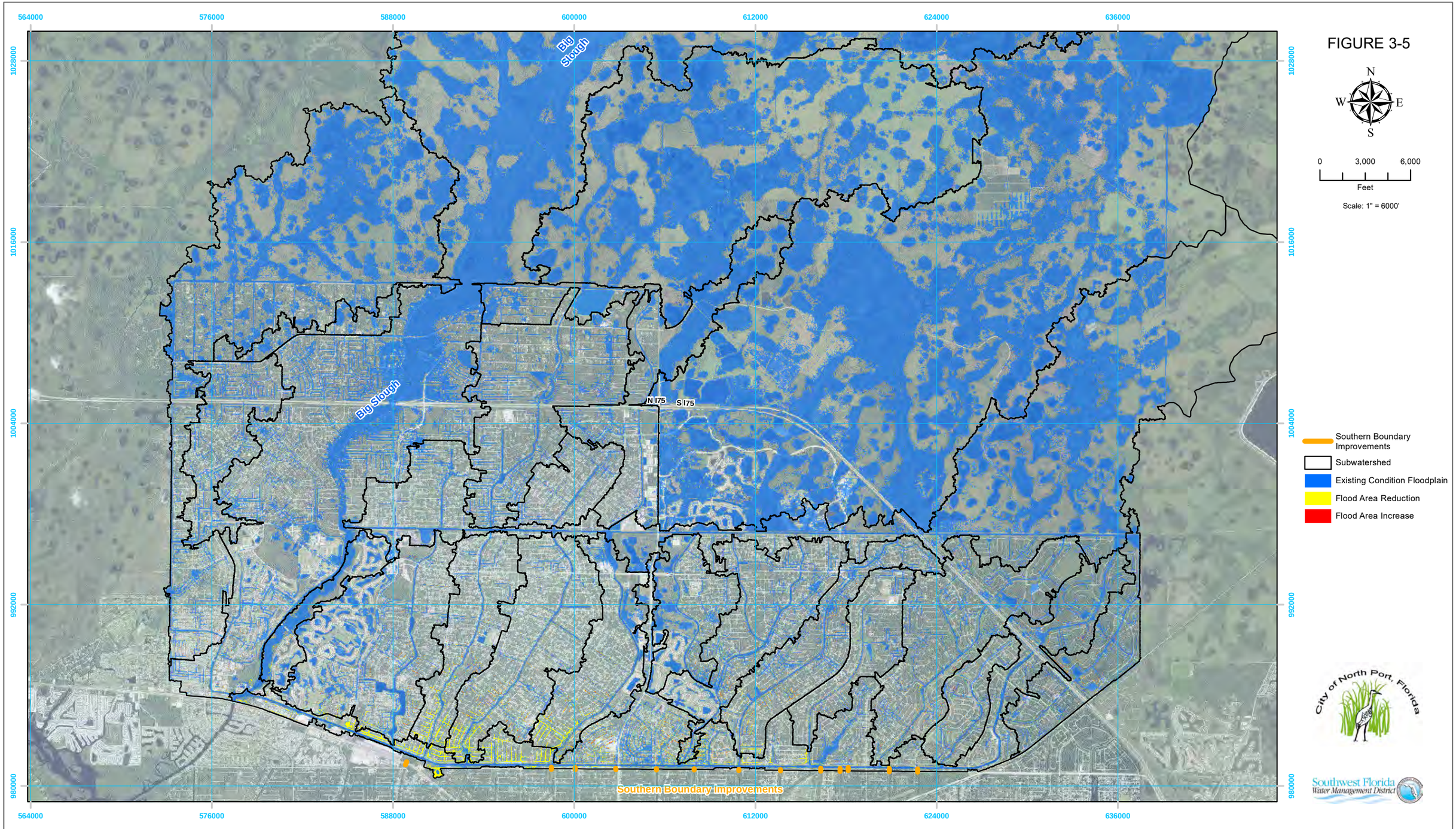
FIGURE 3-5



N

W E

S

0 3,000 6,000

Feet

Scale: 1" = 6000'

- Southern Boundary Improvements
- Subwatershed
- Existing Condition Floodplain
- Flood Area Reduction
- Flood Area Increase

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/9/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\BMP5.mxd		

NORTH PORT / BIG SLOUGH WMP

BMP ALTERNATIVE 5 - 1 DAY 100 YEAR EVALUATION

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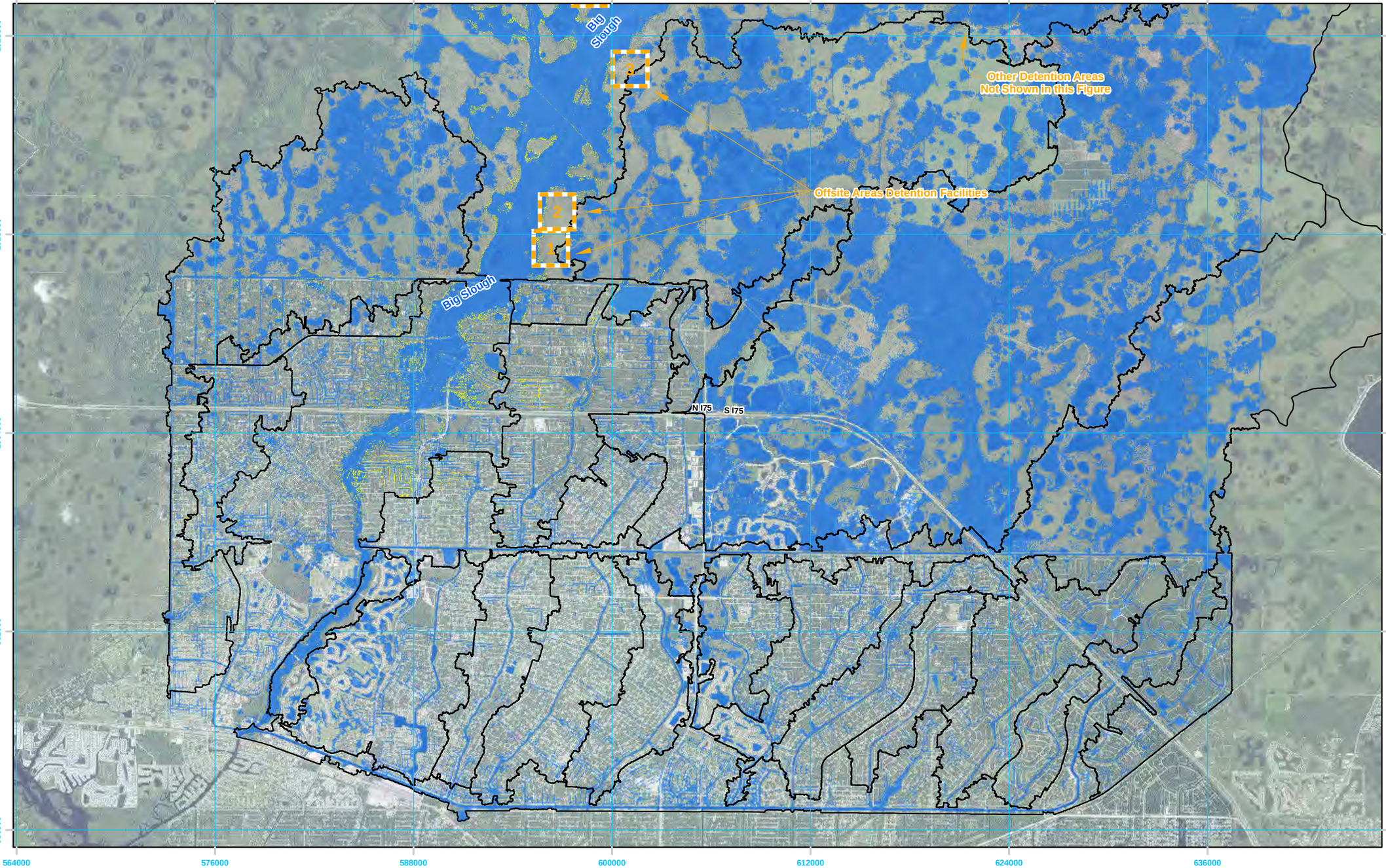
Orlando, Florida 32809

FIGURE 3-6



N

W E

S

0 3,000 6,000

Feet

Scale: 1" = 6000'

- Offsite Areas Detention Facilities
- Subwatershed
- Existing Condition Floodplain
- Flood Area Reduction
- Flood Area Increase

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/9/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\BMP6.mxd		

NORTH PORT / BIG SLOUGH WMP

BMP ALTERNATIVE 6 - 1 DAY 100 YEAR EVALUATION

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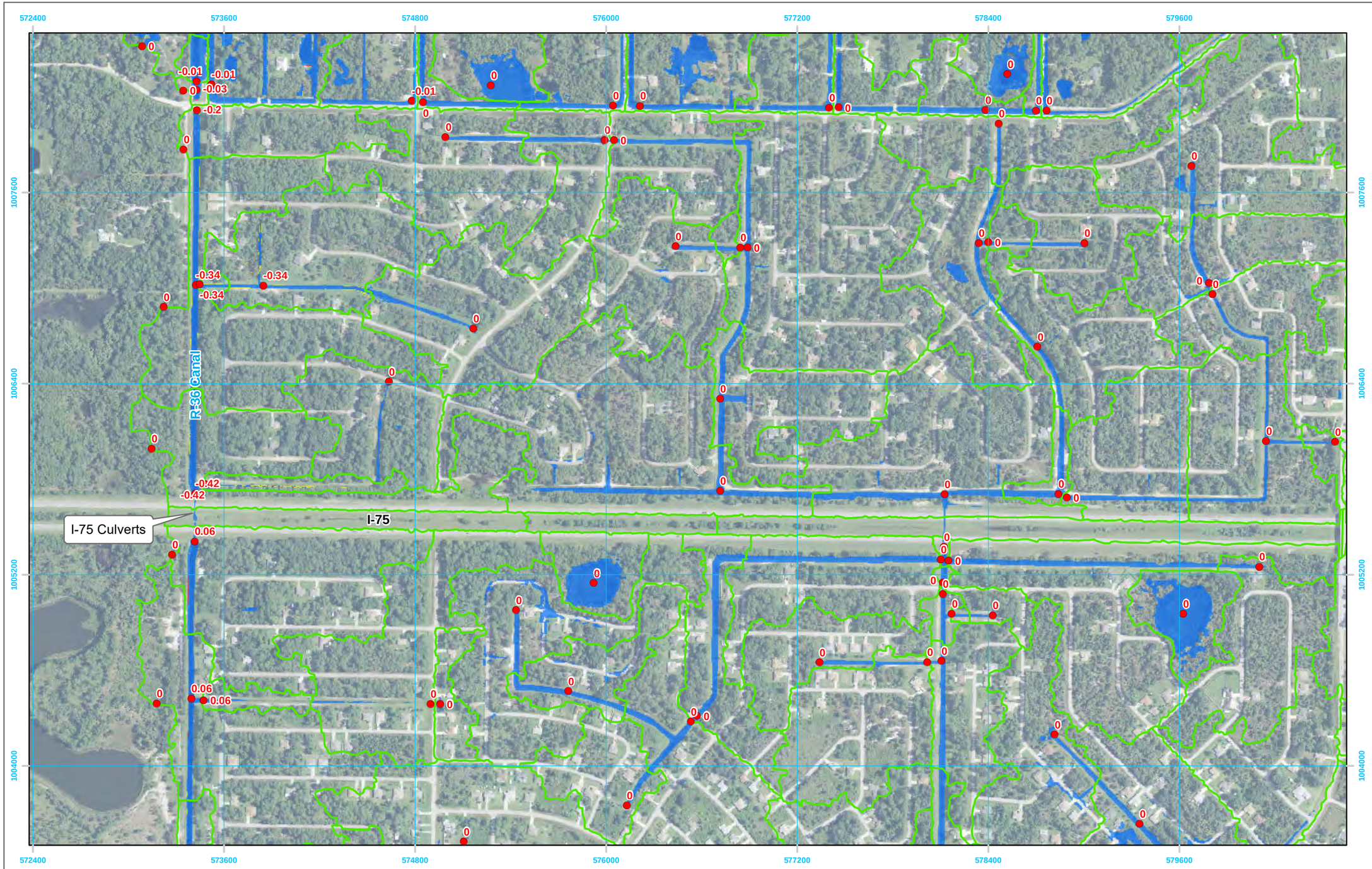
FIGURE 3-7



N
W E
S

0 300 600
Feet

Scale: 1" = 600'

- Network Nodes
- Basins

Floodplain Change

- Decrease
- Increase
- No Change

City of North Port, Florida

Southwest Florida Water Management District

MODEL RESULTS WITH MEAN ANNUAL FLOODPLAIN COMPARISON AND DIFFERENCE IN MAX STAGES

R-36 CANAL AT I-75 BMP EVALUATION

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/10/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\20140909 - Final BMP Figures\BMP1 Crossing Mean Ann.mxd		

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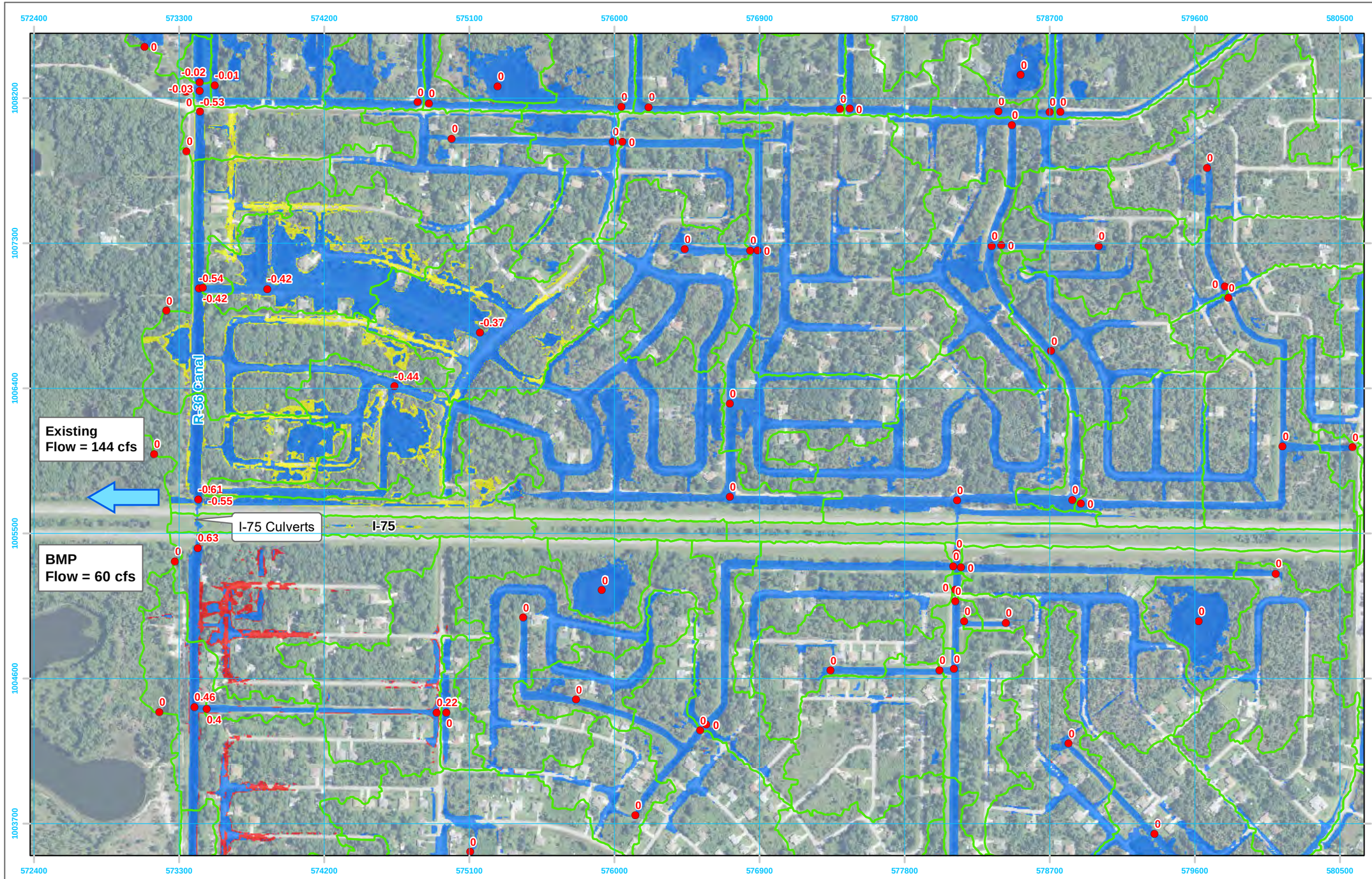
Orlando, Florida 32809

FIGURE 3-8



N
W E
S

0 300 600
Feet

Scale: 1" = 600'

- Network Nodes
- Basins

Floodplain Change

- Decrease
- Increase
- No Change

City of North Port, Florida

Southwest Florida Water Management District

MODEL RESULTS WITH 1-DAY 100-YEAR FLOODPLAIN COMPARISON AND DIFFERENCE IN MAX STAGES

R-36 CANAL AT I-75 BMP EVALUATION

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/10/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\20140909 - Final BMP Figures\BMP1 Crossing 1D100Yr.mxd		

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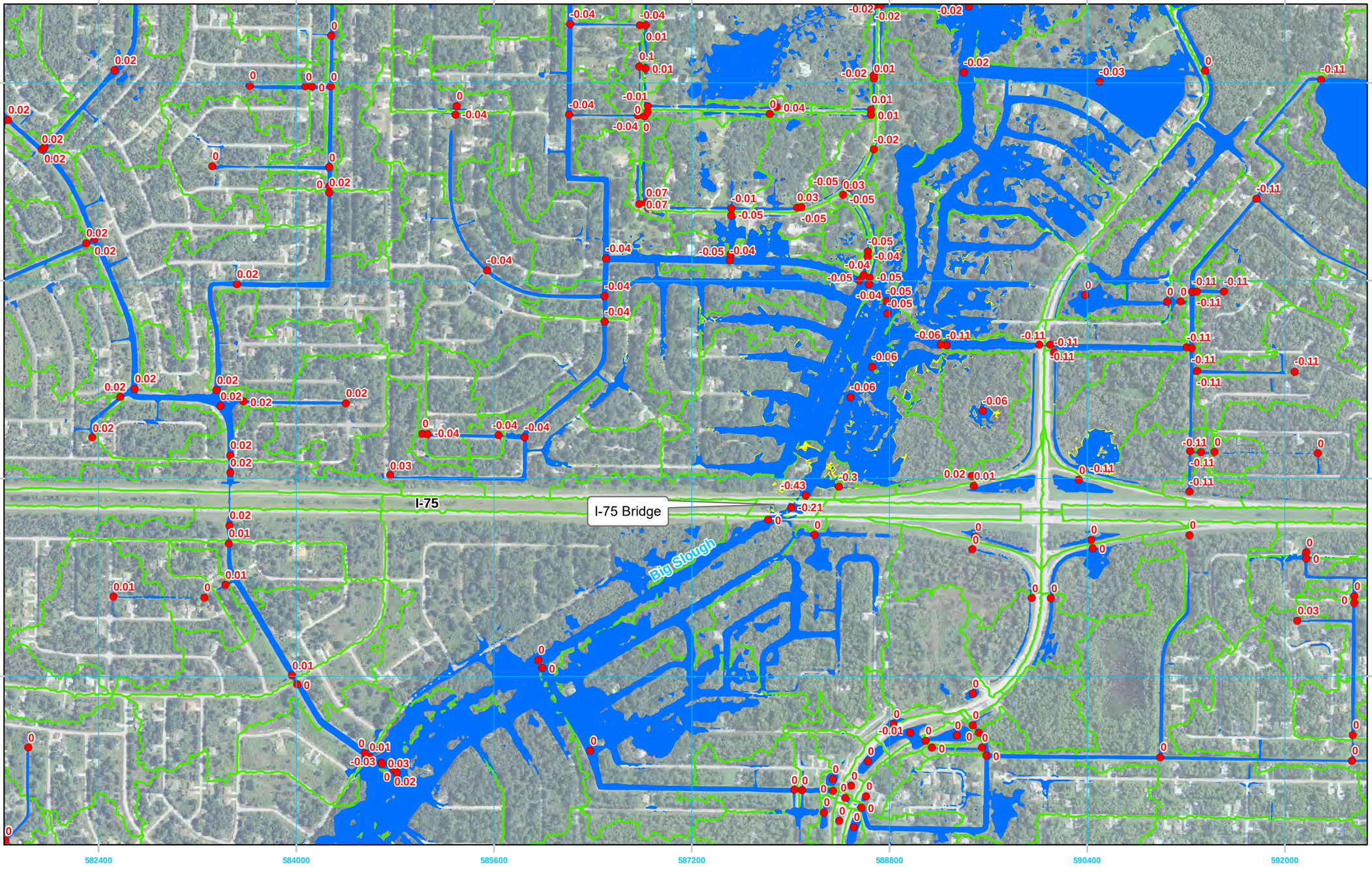
Orlando, Florida 32809

FIGURE 3-9



N
W E
S

0 400 800
Feet

Scale: 1" = 450'

Network Nodes
Basins

Floodplain Change

Decrease
Increase
No Change

City of North Port, Florida

Southwest Florida Water Management District

MODEL RESULTS WITH MEAN ANNUAL FLOODPLAIN COMPARISON AND DIFFERENCE IN MAX STAGES

MYAKKAHATCHEE CREEK AT 1-75 BMP EVALUATION

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/10/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\20140909 - Final BMP Figures\BMP2 Crossing Mean Ann.mxd		

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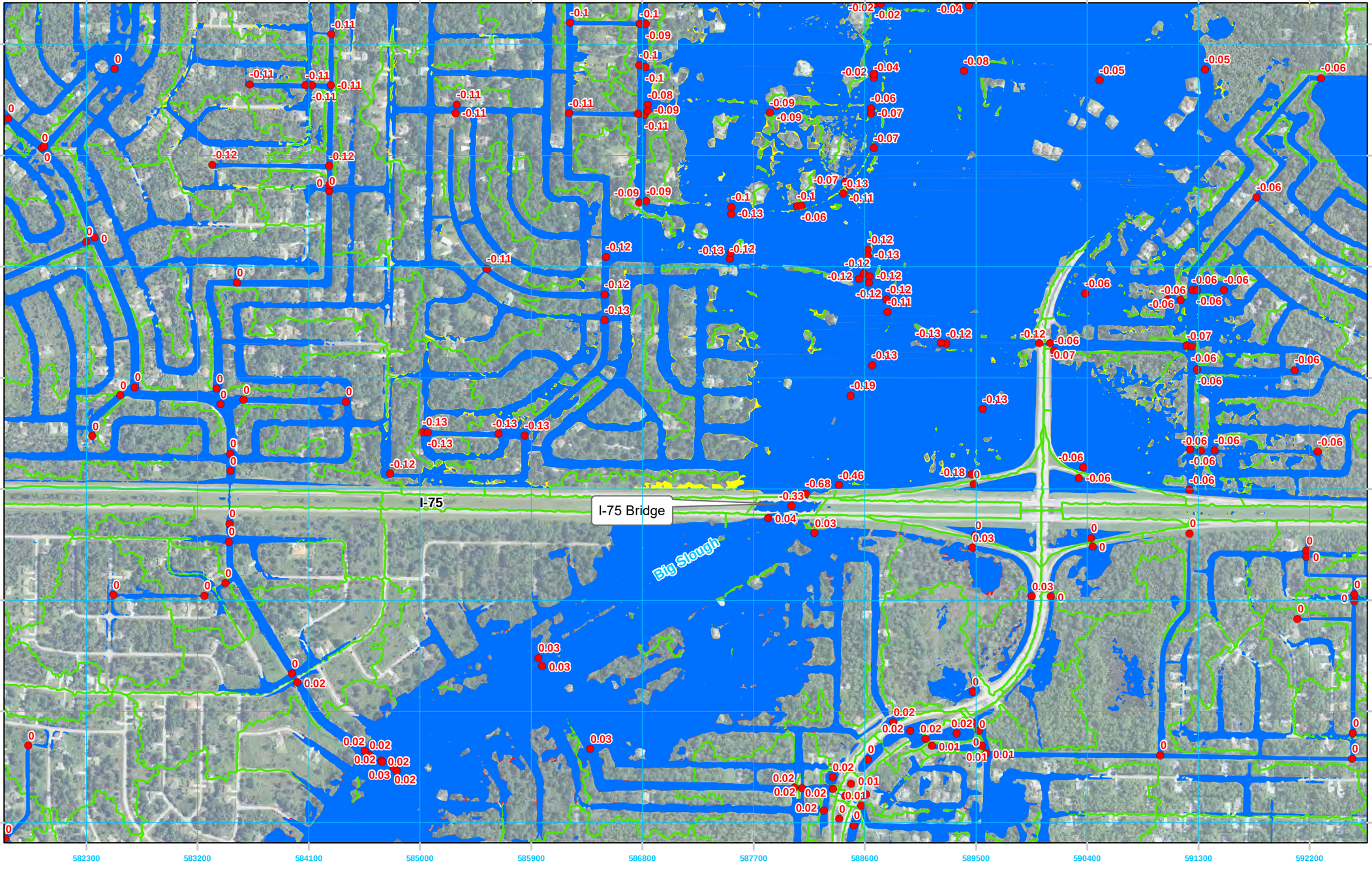
FIGURE 3-10



N
W E
S

0 400 800
Feet

Scale: 1" = 800'

Network Nodes
Basins

Floodplain Change

Decrease
Increase
No Change

City of North Port, Florida

Southwest Florida Water Management District

MODEL RESULTS WITH 1-DAY 100-YEAR FLOODPLAIN COMPARISON AND DIFFERENCE IN MAX STAGES

MYAKKAHATCHEE CREEK AT I-75 BMP EVALUATION

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/10/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: _ArcLayouts\20140909 - Final BMP Figures\BMP2 Crossing 1D100Yr.mxd		

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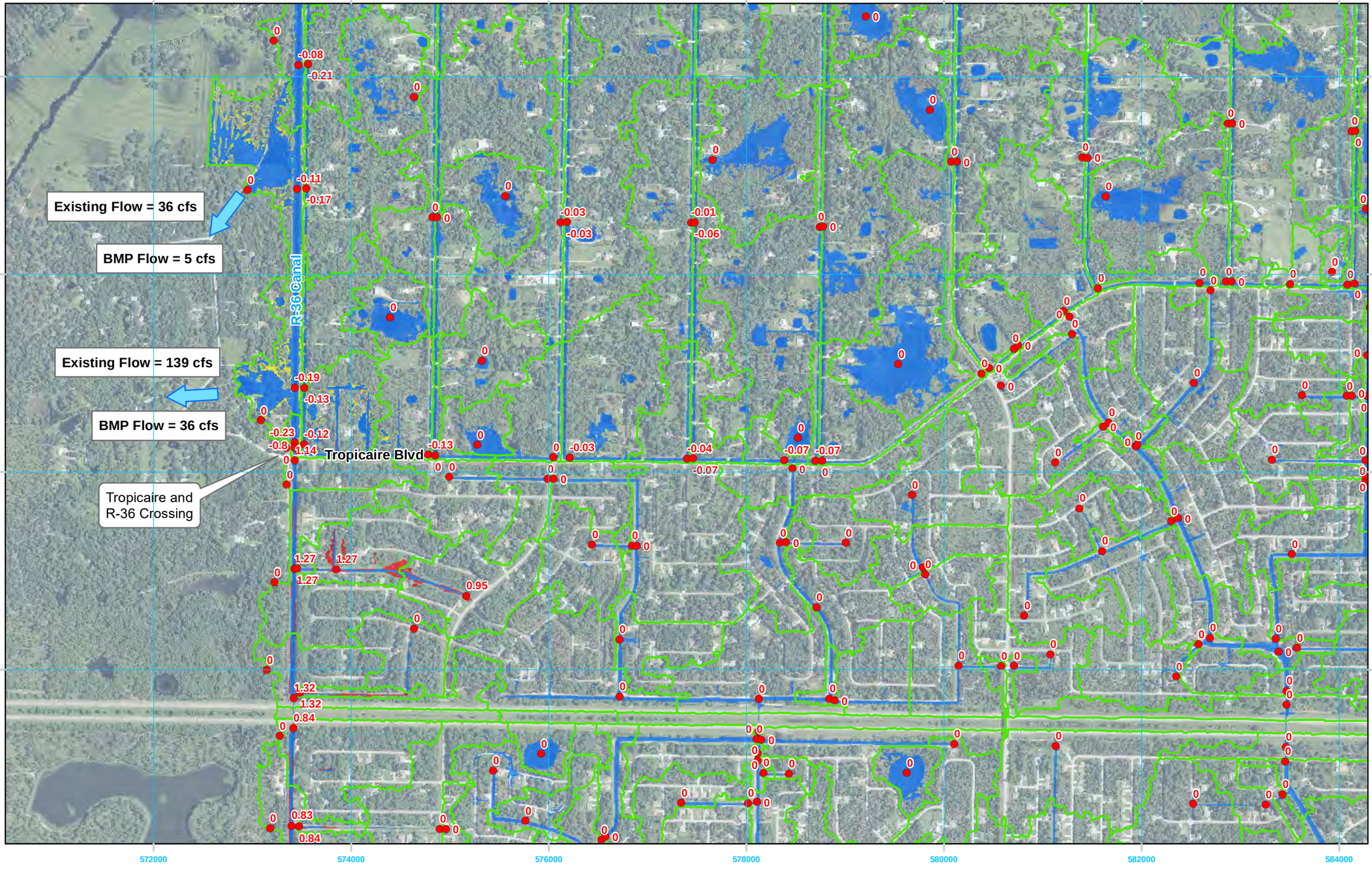
FIGURE 3-11



N
W E
S

0 500 1,000
Feet

Scale: 1" = 1000'

- Network Nodes
- Basins

Floodplain Change

- Decrease
- Increase
- No Change

City of North Port, Florida

Southwest Florida Water Management District

MODEL RESULTS WITH MEAN ANNUAL FLOODPLAIN COMPARISON AND DIFFERENCE IN MAX STAGES

R-36 CANAL AT TROPICAIRE BOULEVARD BMP EVALUATION

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/10/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\20140909 - Final BMP Figures\BMP3 Crossing Mean Ann.mxd		

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FIGURE 3-12

Existing Flow = 619 cfs

BMP Flow = 603 cfs

Existing Flow = 822 cfs

BMP Flow = 759 cfs

Tropicaire and R-36 Crossing

R-36 Canal

Tropicaire Blvd

572000 574000 576000 578000 580000 582000 584000

1012000 1010000 1008000 1006000

N W E S

0 500 1,000 Feet

Scale: 1" = 1000'

Network Nodes

Basins

Floodplain Change

Decrease

Increase

No Change

City of North Port, Florida

Southwest Florida Water Management District

MODEL RESULTS WITH 1-DAY 100-YEAR FLOODPLAIN COMPARISON AND DIFFERENCE IN MAX STAGES

R-36 CANAL AT TROPICAIRE BOULEVARD BMP EVALUATION

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/10/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\20140909 - Final BMP Figures\BMP3 Crossing 1D100Yr.mxd		

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582400 584000 585600 587200 588800 590400 592000

1012000 1010400 1008800 1007200

Tropicaire Blvd

Tropicaire Bridge

Big Slough

FIGURE 3-13

N W E S

0 400 800
Feet

Scale: 1" = 800'

Network Nodes
Basins

Floodplain Change

Decrease
Increase
No Change

City of North Port, Florida

Southwest Florida Water Management District

MODEL RESULTS WITH MEAN ANNUAL FLOODPLAIN COMPARISON AND DIFFERENCE IN MAX STAGES

MYAKKAHATCHEE CREEK AT TROPICAIRE BOULEVARD BMP EVALUATION

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/10/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\20140909 - Final BMP Figures\BMP4 Crossing Mean Ann.mxd		

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FIGURE 3-14

582400 584000 585600 587200 588800 590400 592000

1012000 1010400 1008800 1007200

Tropicaire Blvd

Tropicaire Bridge

Big Slough

N

W E

S

0 400 800

Feet

Scale: 1" = 800'

Network Nodes

Basins

Floodplain Change

Decrease

Increase

No Change

City of North Port, Florida

Southwest Florida Water Management District

MODEL RESULTS WITH 1-DAY 100-YEAR FLOODPLAIN COMPARISON AND DIFFERENCE IN MAX STAGES

MYAKKAHATCHEE CREEK AT TROPICAIRE BOULEVARD BMP EVALUATION

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/10/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\20140909 - Final BMP Figures\BMP4 Crossing 1D100Yr.mxd		

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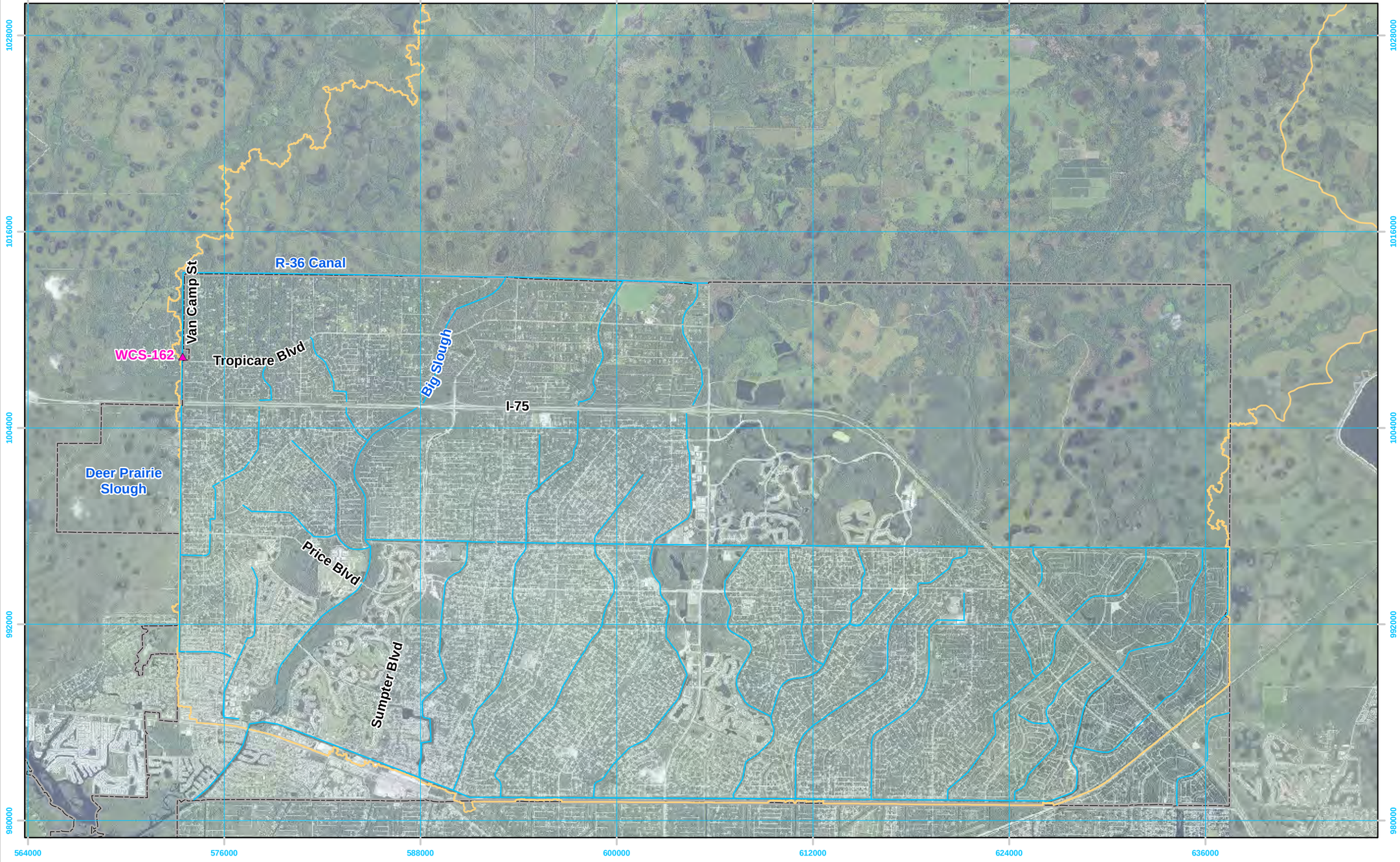
FIGURE 3-15



N
W E
S

0 3,000 6,000
Feet

Scale: 1" = 6000'

- Water Control Structures
- Waterway Flow
- Watershed Boundary
- Northport Boundary

City of North Port, Florida

Southwest Florida Water Management District

Project: 03-065	Projection: State Plane Florida West	
Prepared: 9/9/2014	Horizontal Datum: NAD83	Vertical Datum: N/A
Prepared by: CGG	Modified by:	Modified:
File: \\03-065\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\WCS-162.mxd		

LOCATION OF WCS-162

CITY OF NORTH PORT, SARASOTA COUNTY, FL

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Figure 3-16. Stage at R-36 Canal Upstream of WCS-162

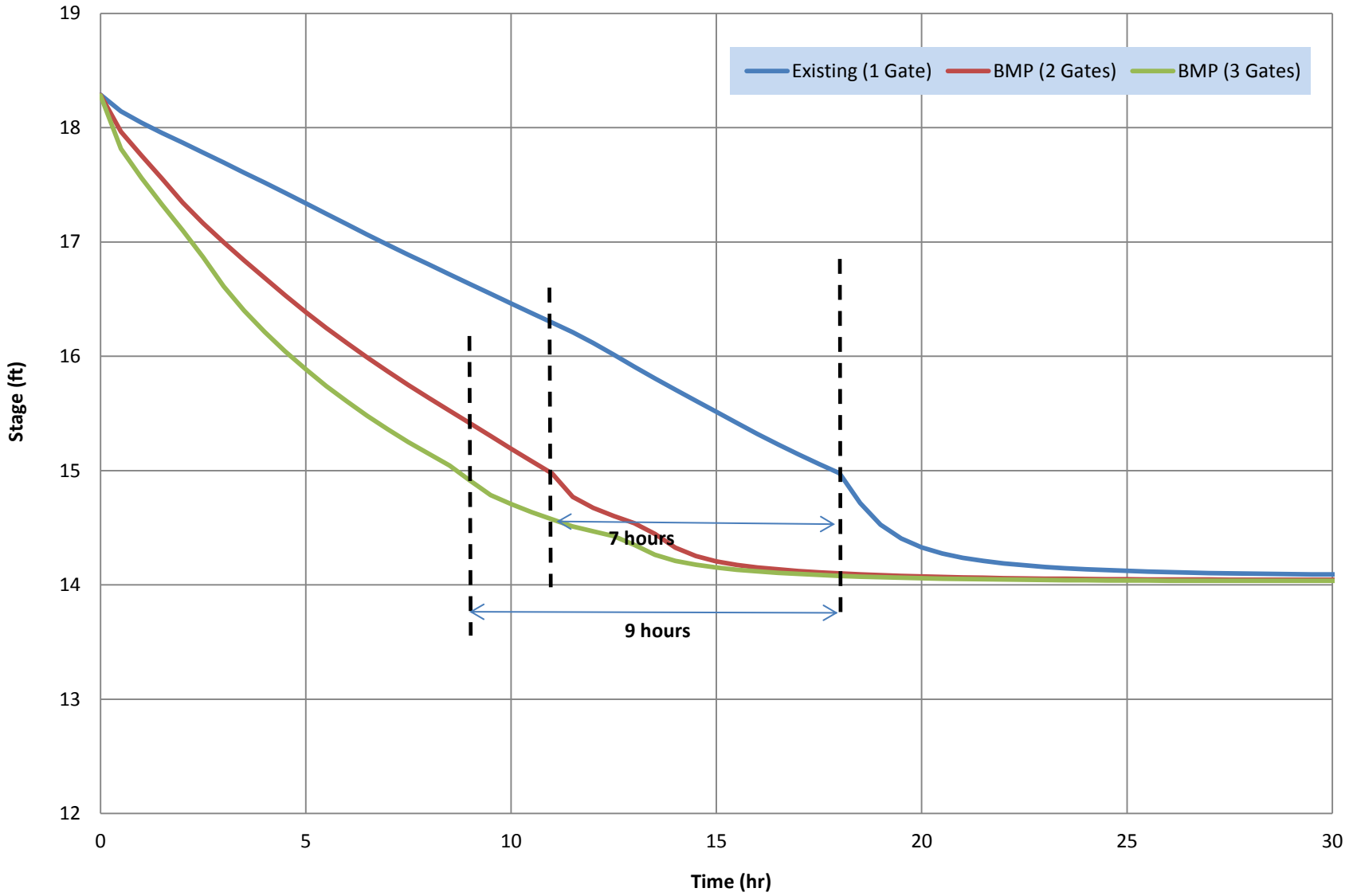
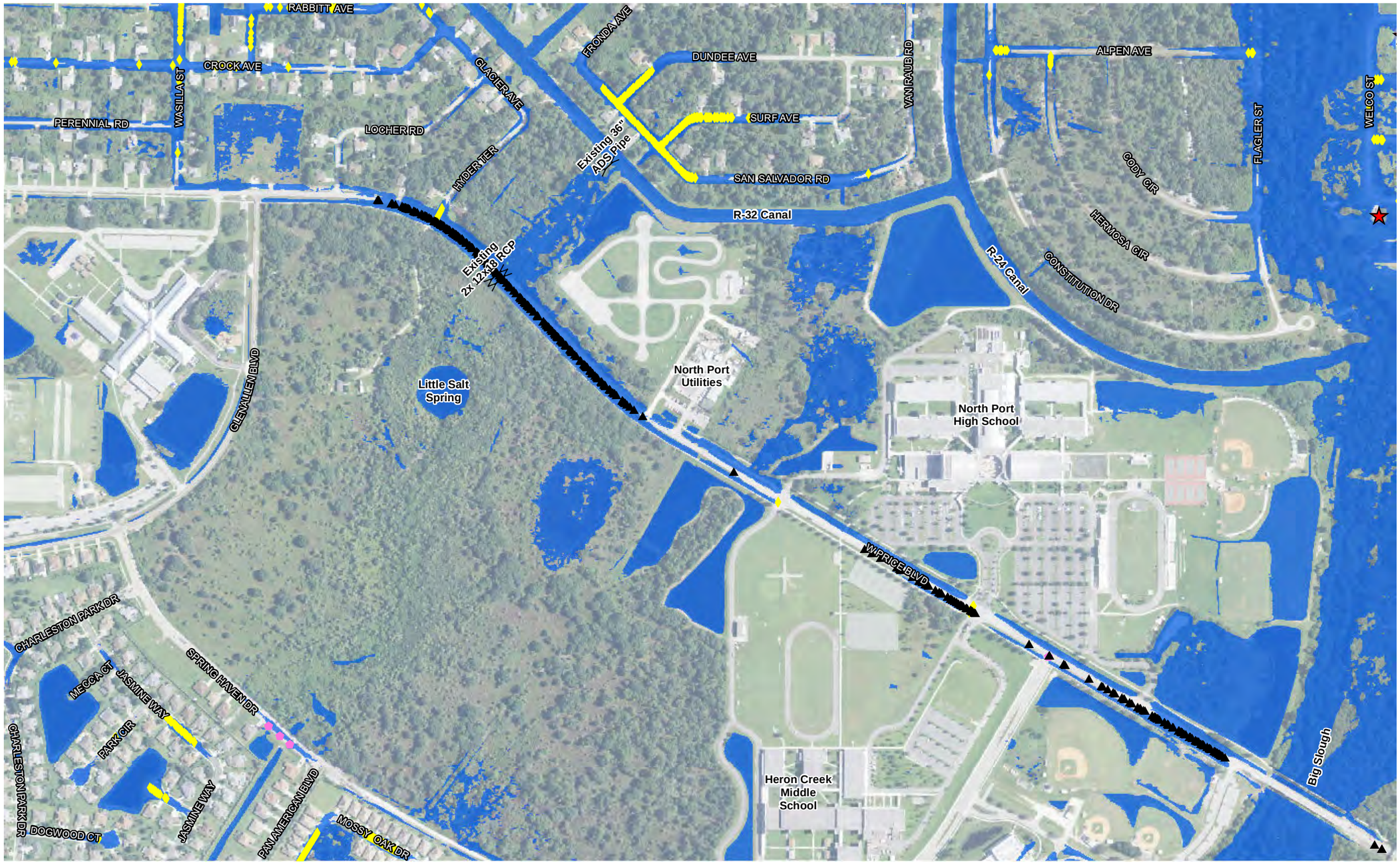


FIGURE 3-17



N
W E
S

0 250 500
Feet

Scale: 1" = 500'

- Habitable Structure Floods in 100 Year Event
- Arterial Street Floods in 100 Year Event
- Evacuation Route Floods in 100 Year Event
- Collector Street Floods in 25 Year Event
- Local Street Flods in 25 Year Event

City of North Port, Florida

Southwest Florida Water Management District

EXISTING CONDITION LOS AND 100-YEAR FLOODPLAIN
NORTH PORT/BIG SLOUGH WMP

Project: 03-065	Projection: State Plane Florida West	
Prepared: 08-05-14	Horizontal Datum: HARN	Vertical Datum: N/A
Prepared by: TJC	Modified by:	Modified:
File: _ArcLayouts\20140909 - Final BMP Figures\LOS2012 City Criteria.mxd		

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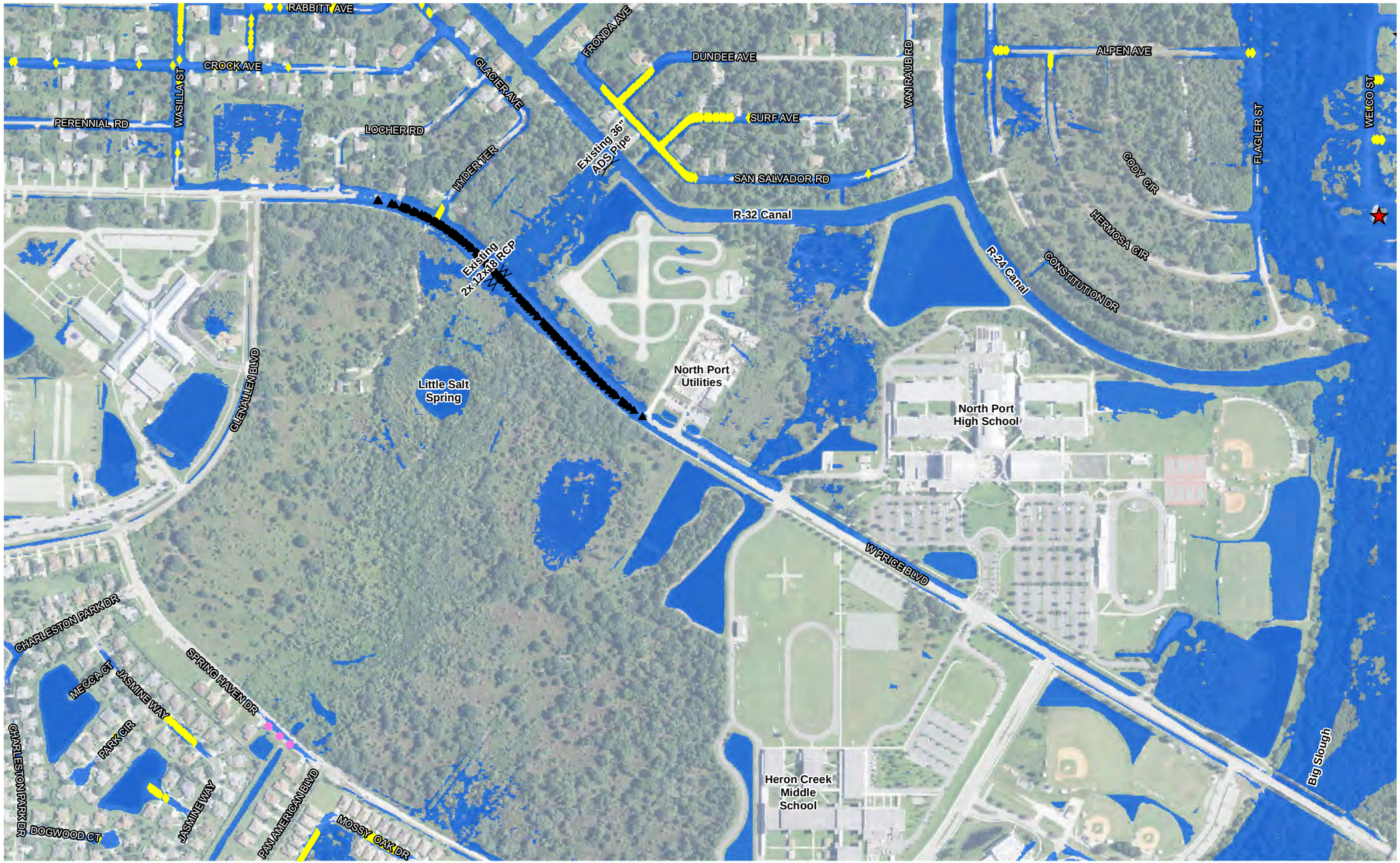
Orlando, Florida 32809

FIGURE 3-18



N
W E
S

0 250 500
Feet

Scale: 1" = 500'

- Habitable Structure Floods in 100 Year Event
- Arterial Street Floods in 100 Year Event
- Evacuation Route Floods in 100 Year Event
- Collector Street Floods in 25 Year Event
- Local Street Flods in 25 Year Event

City of North Port, Florida

Southwest Florida Water Management District

UPDATED EXISTING CONDITION 100-YEAR FLOODPLAIN
NORTH PORT/BIG SLOUGH WMP

Project: 03-065	Projection: State Plane Florida West	
Prepared: 08-05-14	Horizontal Datum: HARN	Vertical Datum: N/A
Prepared by: TJC	Modified by:	Modified:
File: _ArcLayouts\20140909 - Final BMP Figures\Price Blvd Existing_1D100Y.mxd		

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FIGURE 3-19

N
W E
S

0 250 500
Feet

- Node (Maxstage Change)
- BMP_1
- Decrease
- Increase
- No Change

City of North Port, Florida

Southwest Florida Water Management District

BMP_1 25-YEAR FLOODPLAIN COMPARISON
NORTH PORT/BIG SLOUGH WMP

Project: 03-065	Projection: State Plane Florida West	
Prepared: 08-05-14	Horizontal Datum: HARN	Vertical Datum: N/A
Prepared by: TJC	Modified by:	Modified:
File: _ArcLayouts\20140909 - Final BMP Figures\Price Blvd BMP1_1D25Y.mxd		

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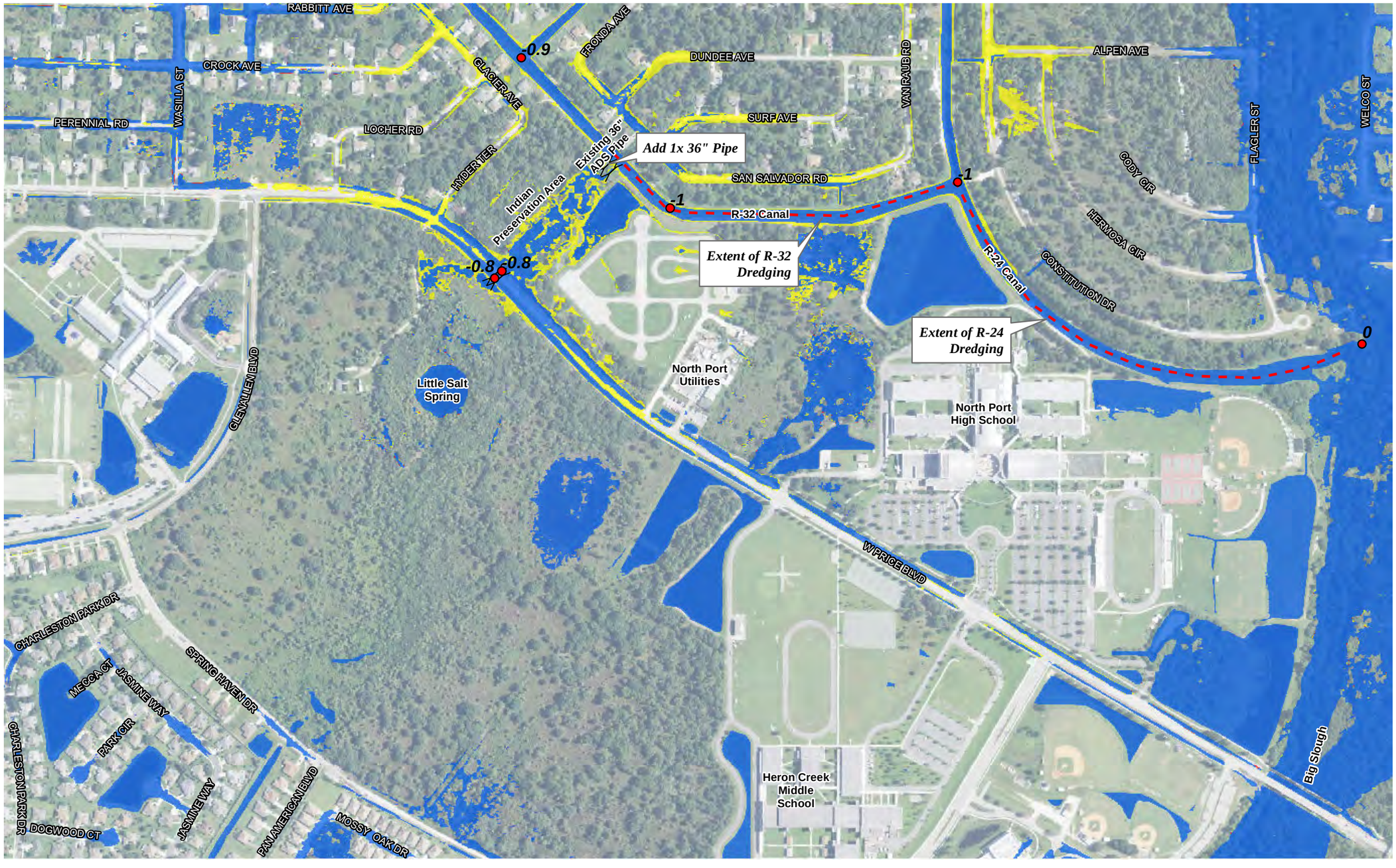
Orlando, Florida 32809

FIGURE 3-20



N
W E
S

0 250 500
Feet

Scale: 1" = 500'

- Node (Maxstage Change)
- BMP_1
- Decrease
- Increase
- No Change

City of North Port, Florida

Southwest Florida Water Management District

BMP_1 100-YEAR FLOODPLAIN COMPARISON
NORTH PORT/BIG SLOUGH WMP

Project: 03-065	Projection: State Plane Florida West	
Prepared: 08-05-14	Horizontal Datum: HARN	Vertical Datum: N/A
Prepared by: TJC	Modified by:	Modified:
File: _ArcLayouts\20140909 - Final BMP Figures\Price Blvd BMP1_1D100Y.mxd		

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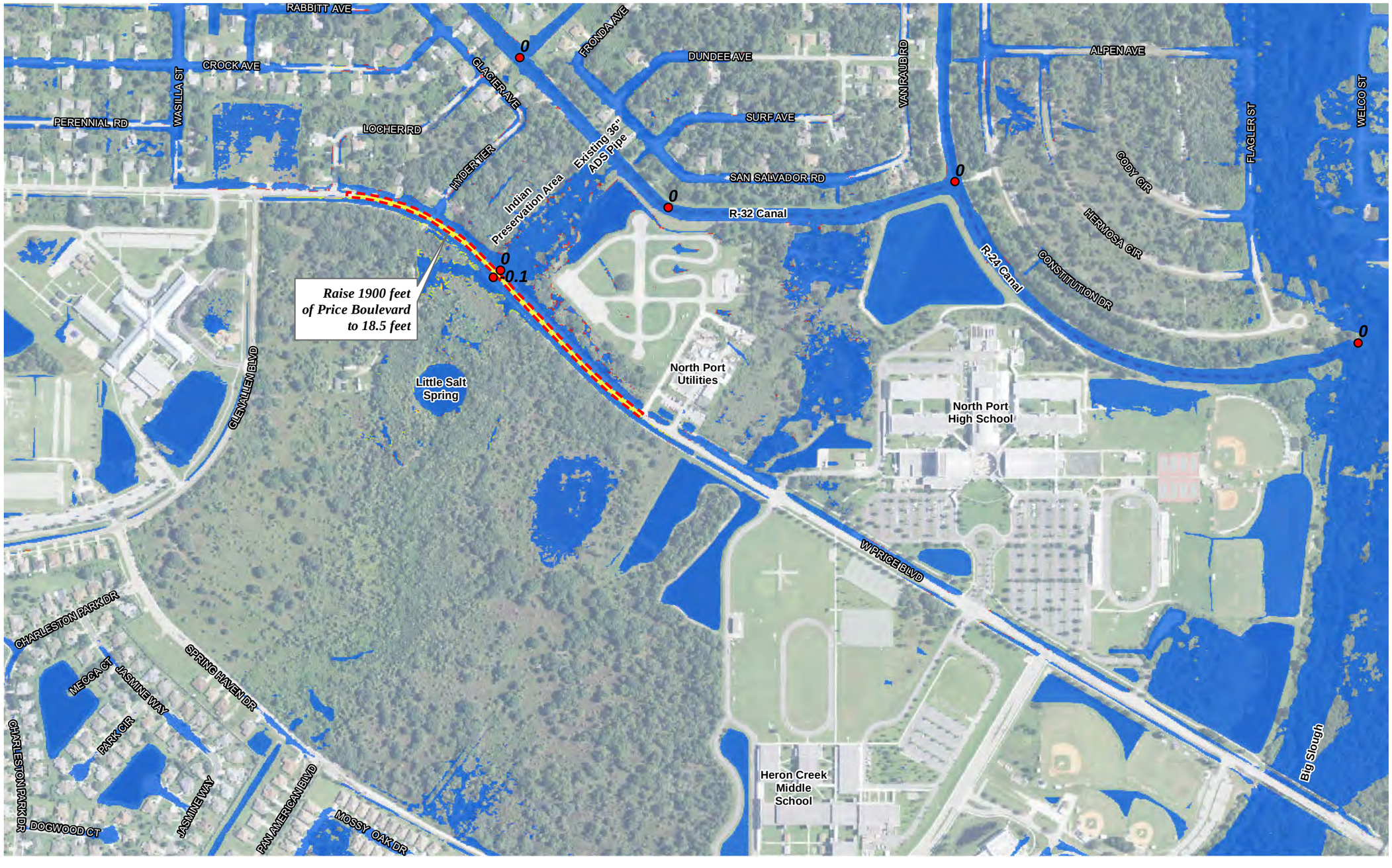
Orlando, Florida 32809

FIGURE 3-21



N
W E
S

0 250 500
Feet

- Node (Maxstage Change)
- BMP_2
- Decrease
- Increase
- No Change

City of North Port, Florida

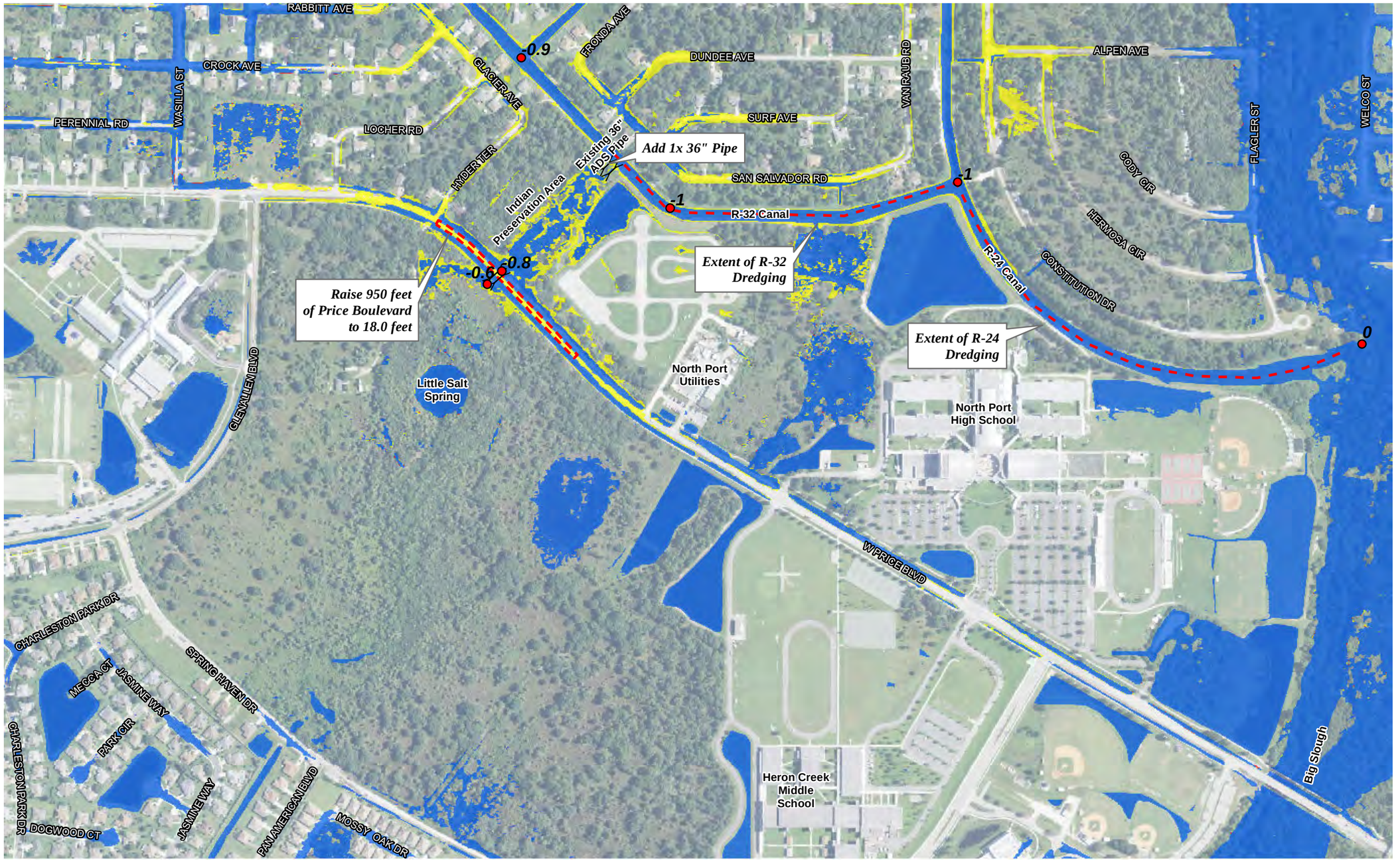
Southwest Florida Water Management District

BMP_2 100-YEAR FLOODPLAIN COMPARISON
NORTH PORT/BIG SLOUGH WMP

Project: 03-065	Projection: State Plane Florida West	
Prepared: 08-05-14	Horizontal Datum: HARN	Vertical Datum: N/A
Prepared by: TJC	Modified by:	Modified:
File: \\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\Price Blvd BMP 2.mxd		

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants
Phone: 407-855-3860 Fax: 407-859-8121
8008 South Orange Avenue
Orlando, Florida 32809

FIGURE 3-22



N
W E
S

0 250 500
Feet

- Node (Maxstage Change)
- BMP_3
- Decrease
- Increase
- No Change

City of North Port, Florida

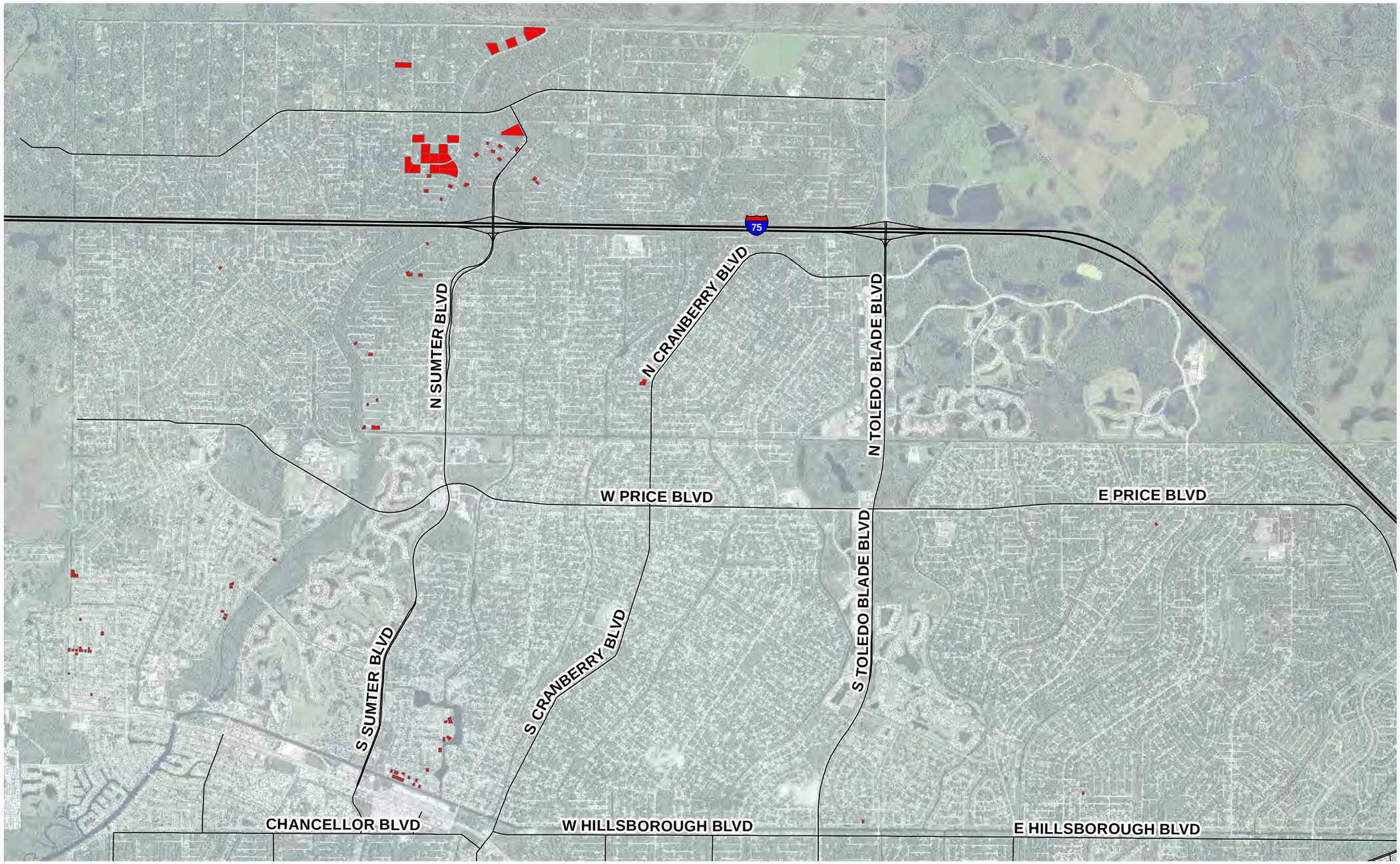
Southwest Florida Water Management District

BMP_3 100-YEAR FLOODPLAIN COMPARISON
NORTH PORT/BIG SLOUGH WMP

Project: 03-065	Projection: State Plane Florida West	
Prepared: 08-05-14	Horizontal Datum: HARN	Vertical Datum: N/A
Prepared by: TJC	Modified by:	Modified:
File: \\ArcGIS_ArcLayouts\20140909 - Final BMP Figures\Price Blvd BMP 3.mxd		

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants
Phone: 407-855-3860 Fax: 407-859-8121
8008 South Orange Avenue
Orlando, Florida 32809

FIGURE 5-1



N
W E
S

0 2,000 4,000
Feet

City of North Port, Florida

Southwest Florida Water Management District

FLOODED PARCELS TO SURVEY
NORTH PORT/BIG SLOUGH WMP

Project: 03-065	Projection: State Plane Florida West	
Prepared: 09-30-14	Horizontal Datum: HARN	Vertical Datum: N/A
Prepared by: TJC	Modified by:	Modified:
File: \\Model_Maintenance\ArcGIS_ArcLayouts\Flooded_Parcels_To_Survey.mxd		

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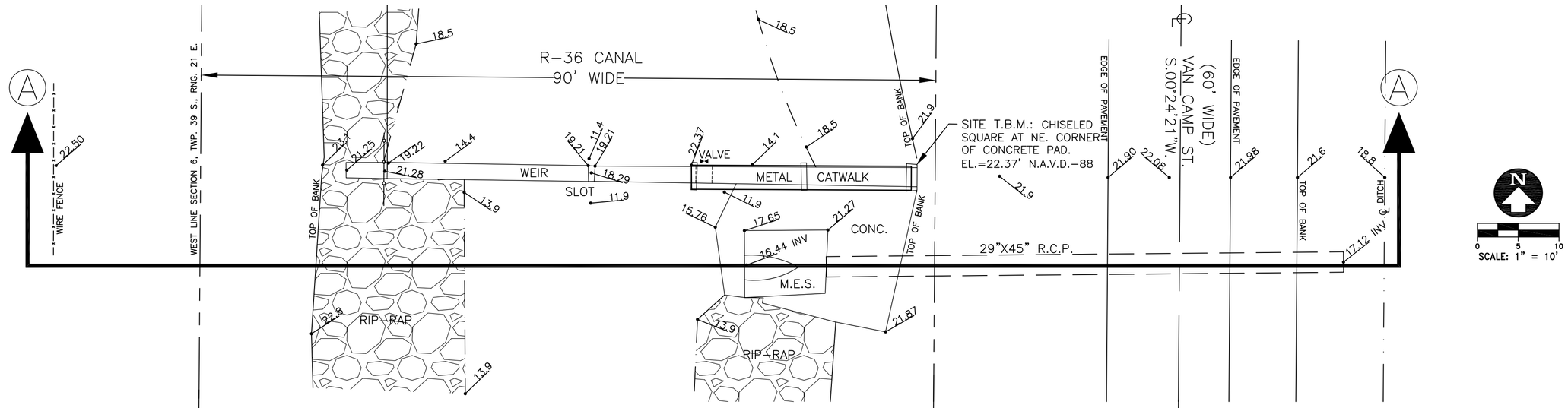
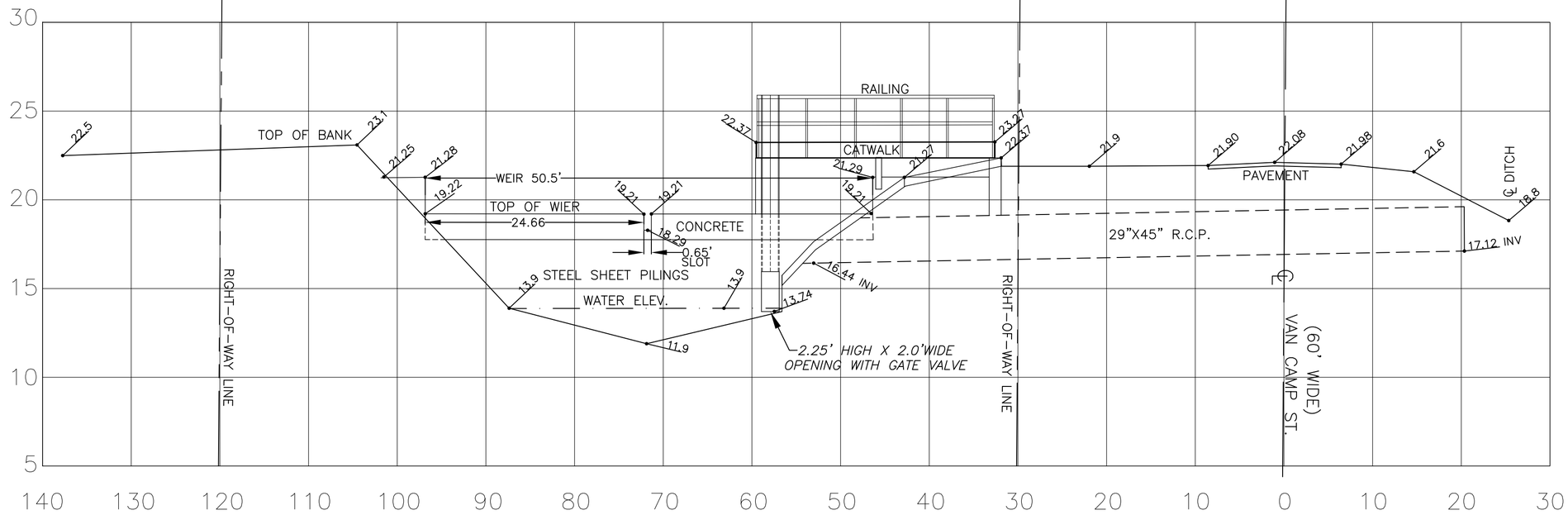
Geotechnical, Environmental and Materials Consultants
Phone: 407-855-3860 Fax: 407-859-8121
8008 South Orange Avenue
Orlando, Florida 32809

APPENDIX A

2014 Survey Data of WCS-162





SECTION "A"-"A"
WATER CONTROL STRUCTURE #162

LEGEND

T.B.M.	TEMPORARY BENCH MARK
E.O.P.	EDGE OF PAVEMENT
℄	CENTERLINE
7.7	TYPICAL SPOT ELEVATION
R.C.P.	REINFORCED CONCRETE PIPE
M.E.S.	MITERED END SECTION

SURVEYOR'S NOTES/REPORT:

1) BEARINGS ARE BASED ON AN ASSUMED MERIDIAN. A BEARING OF S.00°24'21"W. WAS ASSIGNED TO THE CENTERLINE OF VAN CAMP STREET PER RECORD PLAT OF NORTH PORT CHARLOTTE ESTATES.
2) ELEVATIONS SHOWN ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988. F.D.E.P. BENCH MARK N-698-2007.
3) THE ACCURACY OF THIS MAP OF SURVEY IS BASED ON CONTROL MEASUREMENTS THAT MEET OR EXCEED THE MINIMUM ACCURACY REQUIREMENTS FOR THIS TYPE OF SURVEY AS SPECIFIED IN CHAPTER 5J-17, FAC. THIS MAP'S DIGITAL DATA IS INTENDED TO BE DISPLAYED AT A SCALE OF 1"=20' OR SMALLER.
4) SURVEY PERFORMED FOR THE "SPECIFIC PURPOSE" OF PROVIDING ELEVATION AND DIMENSION DETAILS OF THE WATER CONTROL STRUCTURE FOR USE BY THE CITY OF NORTH PORT DEPARTMENT OOF ENGINEERING.

FOR: CITY OF NORTH PORT
DEPARTMENT OF ENGINEERING

CERTIFICATE

I, hereby certify that this Map/Report of Survey as shown and/or described herein represents the results of Field Surveys performed under my supervision, that it is true and correct to the best of my knowledge, information and belief and meets the requirements of Chapter 5J-17, F.A.C. pursuant to Section 472.027, F.S. Subject to all notations as shown herein.

Van Buskirk / Fish & Associates, Inc., LB#3739

By: _____
Alan K. Fish, P.S.M.
Registered Professional Surveyor & Mapper
Florida Certificate No. 3941

Date of Survey: JUNE 19TH, 2014

"Not valid without the signature and the original raised seal of a Florida licensed surveyor and mapper."

FIELD BOOK: 587 PAGE(S): 3

REVISIONS:	BY:

MAP OF "SPECIFIC PURPOSE SURVEY, OF WATER CONTROL STRUCTURE # 162 IN NORTH PORT CHARLOTTE ESTATES CITY OF NORTH PORT, SARASOTA COUNTY, FLORIDA

Van Buskirk / Fish & Associates, Inc.
SURVEYORS - MAPPERS - DEVELOPMENT CONSULTANTS
VBF
12450 Unit C Tamiami Trail · North Port, FL 34287 · (941) 426-0681

DATE: 6-19-2014
SCALE: AS NOTED
DRAWN: GC
PROJECT NO. 14-1087
SHEET 1 OF 1 SHEETS

APPENDIX B

WCS-162 Pictures

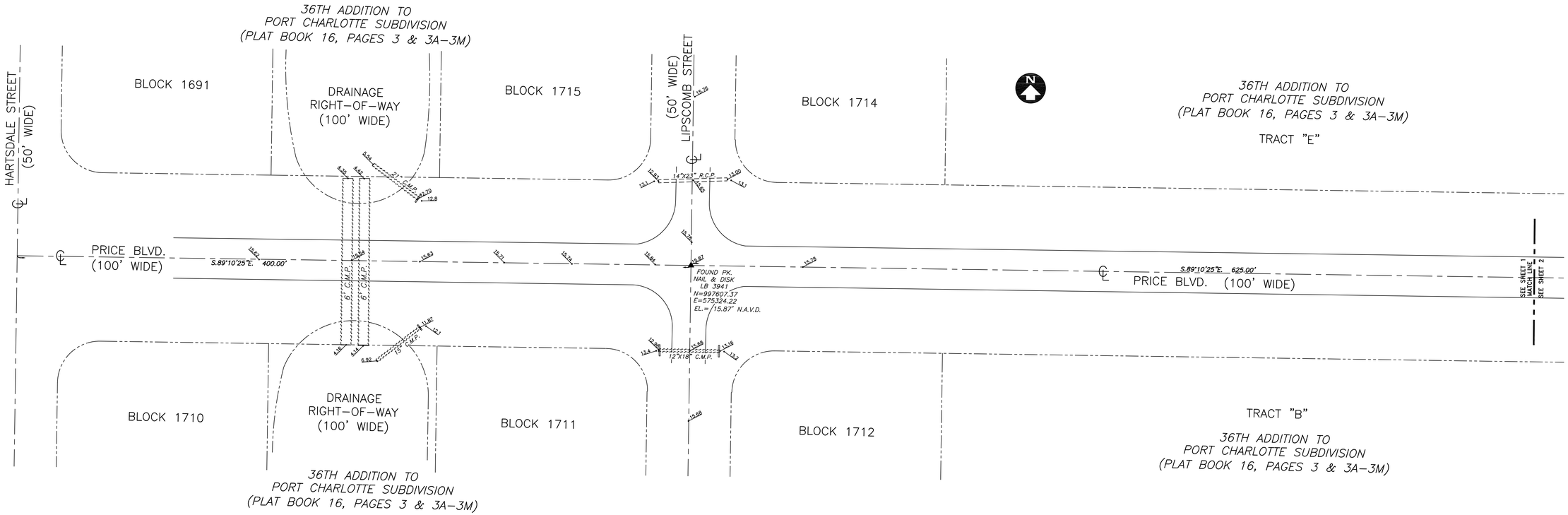
Looking North-West from the downstream of WCS-162

Looking South-West from the upstream of WCS-162

Looking South-West from the upstream of WCS-162

APPENDIX C

2014 Survey Data of West Price Boulevard



LEGEND

- FOUND 4" X 4" CONCRETE MONUMENT (DISK NUMBER NOTED, IF ANY)
- SET 4"X 4" CONCRETE MONUMENT WITH L.S. 3941 DISK.
- FOUND #4 OR #5 IRON ROD (CAP NUMBER NOTED, IF ANY)
- SET #4 IRON ROD WITH L.B. 3739 CAP.
- FOUND 1/2" TO 1" IRON PIPE (NUMBER NOTED, IF ANY)
- FOUND NAIL OR NAIL & DISC (NUMBER NOTED, IF ANY)
- SET NAIL & DISC, LS #3941
- ( ) PARENTHESES INDICATE RECORD BEARING OR DISTANCE IF DIFFERENT THAN MEASURED
- UTILITY POLE & GUY ANCHOR
- LIGHT POLE
- MAIL BOX
- STREET SIGN
- WATER VALVE
- BACK FLOW PREVENTION DEVICE
- SANITARY CLEAN OUT
- ELECTRICAL BOX
- GTE CANISTER
- PHONE RISER
- WATER METER
- HYDRANT
- SANITARY SEWER MANHOLE
- PHONE BOX
- TYPICAL SPOT ELEVATION
- 7.7 SPOT ELEVATION (POST CONSTRUCTION)
- RE–ENFORCED CONCRETE PIPE (R.C.P.)
- CORRUGATED METAL PIPE (C.M.P.)
- CORRUGATED PLASTIC PIPE (C.P.P.)

- OHL — OHL — OVERHEAD UTILITY LINES
- UGT — UGT — UNDER GROUND TELEPHONE LINES
- W — W — WATER MAIN
- WS — WS — WATER SERVICE
- GAS — GAS — UNDER GROUND GAS LINE
- CHAIN LINK FENCE
- WIRE FENCE
- WOOD FENCE

P.C.	POINT OF CURVATURE
P.T.	POINT OF TANGENCY
P.O.B.	POINT OF BEGINNING
P.O.C.	POINT OF COMMENCEMENT
P.R.M.	PERMANENT REFERENCE MONUMENT
P.C.P.	PERMANENT CONTROL POINT
T.B.M.	TEMPORARY BENCH MARK
E.O.P.	EDGE OF PAVEMENT
℄	CENTERLINE
B	BASELINE
FND.	FOUND
I.P.	IRON PIPE
I.R.	IRON ROD
C.M.P.	CORRUGATED METAL PIPE
R.C.P.	REINFORCED CONCRETE PIPE
C.M.	CONCRETE MONUMENT
EL.	ELEVATION
F.F.	FINISH FLOOR
H.W.	HEAD WALL
B.O.C.	BACK OF CURB
P.R.C.	POINT OF REVERSE CURVATURE
B.F.P.	BACK FLOW PREVENTION DEVICE
M.A.F.L.	MEAN ANNUAL FLOOD LINE
F.S.P.C.S.	FLORIDA STATE PLANE COORDINATE SYSTEM

- PINE TREE (TYP)
- OAK TREE (TYP)
- PALM TREE 10" DIAMETER (TYP)

SURVEYOR'S NOTES/REPORT:

1) BEARINGS ARE BASED ON "GRID NORTH" FLORIDA STATE PLANE COORDINATE SYSTEM, "WEST ZONE". COORDINATES ARE NAD 1983/2007.
2) ELEVATIONS SHOWN ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988.
3) THIS SURVEY WAS PERFORMED FOR THE "SPECIFIC PURPOSE" OF PROVIDING TOPOGRAPHIC SPOT ELEVATIONS, CULVERT AND STORM DRAIN PIPE SIZES AND ELEVATIONS, CULVERT MATERIAL TYPES AND OTHER SELECTED ELEVATION DATA FOR USE IN A DRAINAGE STUDY OF THE PORTIONS OF PRICE BLVD. SHOWN ON THIS MAP OF SURVEY.
4) EASEMENTS SHOWN IF ANY, ARE INTERPRETED FROM RECORD PLAT DEDICATIONS OR TITLE INFORMATION SUPPLIED TO OR ACQUIRED BY, THE SURVEYOR AT TIME OF SURVEY. THE SURVEYED PROPERTY MAY BE SUBJECT TO OTHER RESERVATIONS, RESTRICTIONS, COVENANTS, EASEMENTS OR AGREEMENTS AFFECTING THE PROPERTIES NOT DEPICTED ON THIS SURVEY. UNDERGROUND UTILITIES HAVE NOT BEEN LOCATED. IF UTILITY LINES ARE SHOWN, THEY WERE LOCATED AS MARKED BY OTHERS AND THE SURVEYOR ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OR THE COMPLETENESS OF SAID UTILITY LOCATIONS.
5) THE ACCURACY OF THIS MAP OF SURVEY IS BASED ON CONTROL MEASUREMENTS THAT MEET OR EXCEED THE MINIMUM ACCURACY REQUIREMENTS FOR THIS TYPE OF SURVEY AS SPECIFIED IN CHAPTER 5J–17, FAC. THIS MAP'S DIGITAL DATA IS INTENDED TO BE DISPLAYED AT A SCALE OF 1"=20' OR SMALLER.

FOR: THE CITY OF NORTH PORT, FLORIDA

CERTIFICATE

I, hereby certify that this Map/Report of Survey Sheets 1 through 8, as shown herein represents the results of Field Surveys performed under my supervision, that it is true and accurate to the best of my knowledge, information and belief and meets the requirements of Chapter 5J–17, F.A.C. pursuant to Section 472.027, F.S. Subject to all notations as shown herein.

Van Buskirk / Fish & Associates, Inc., LB#3739

By: _____
Alan K. Fish, P.S.M.
Registered Professional Surveyor & Mapper
Florida Certificate No. 3941

ALAN K. FISH LICENSE NUMBER No. 3941 STATE OF FLORIDA Professional Surveyor & Mapper

Date of Survey: JUNE 17, 2014

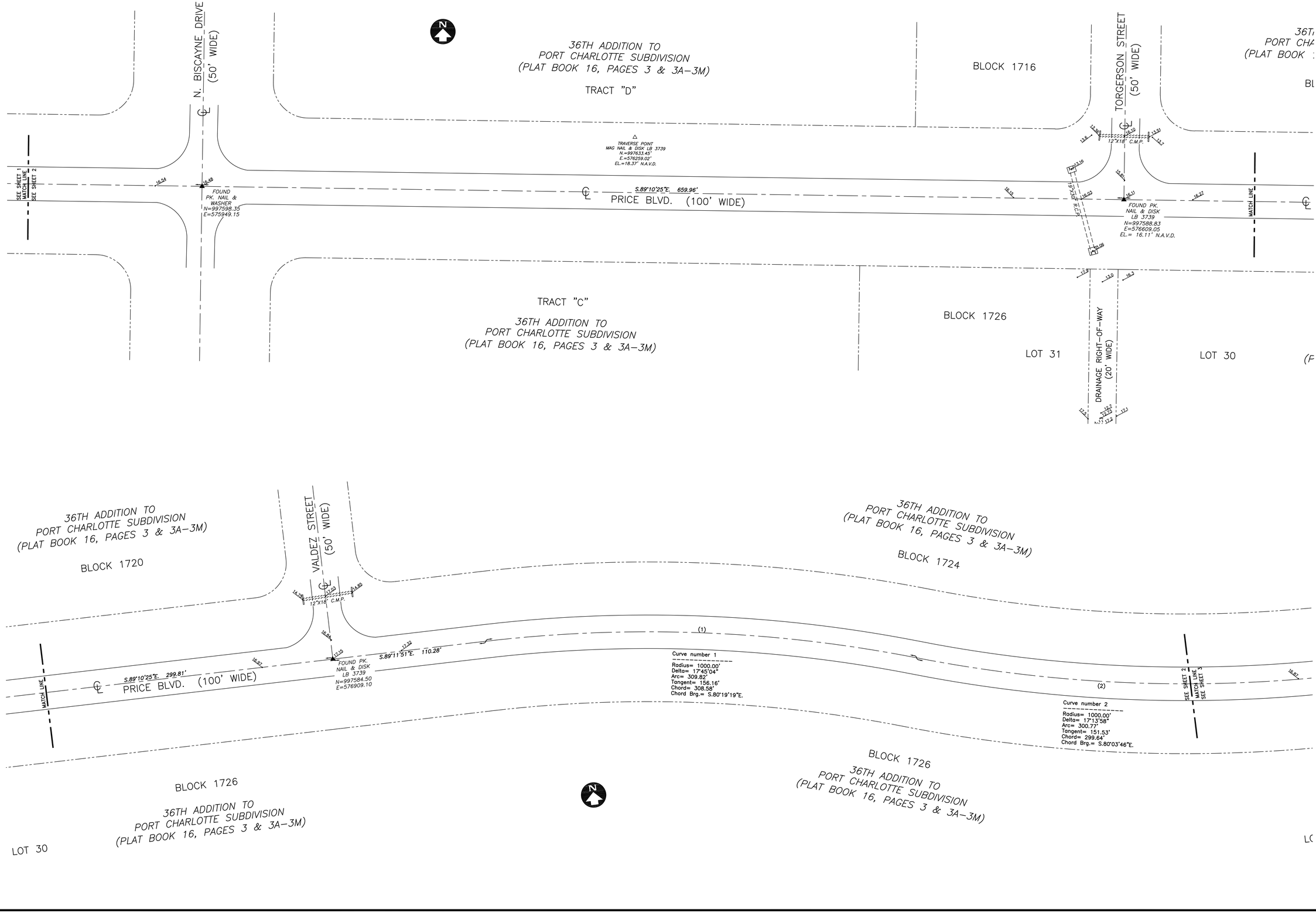
"Not valid without the signature and the original raised seal of a Florida licensed surveyor and mapper."

REVISIONS:	BY:

MAP OF "SPECIFIC PURPOSE SURVEY" SHOWING FIELD SURVEY DATA COLLECTED FOR A DRAINAGE STUDY ALONG A PORTION OF PRICE BLVD. IN THE CITY OF NORTH PORT, FLORIDA

Van Buskirk / Fish & Associates, Inc.
SURVEYORS - MAPPERS - DEVELOPMENT CONSULTANTS
12450 Unit C Tamiami Trail · North Port, FL 34287 · (941) 426-0681

DATE:	6-17-2014
SCALE:	1" = 30'
DRAWN:	GC
PROJECT NO.	14-1088
SHEET	1
OF	7 SHEETS



REVISIONS:	BY:

MAP OF "SPECIFIC PURPOSE SURVEY" SHOWING FIELD SURVEY DATA COLLECTED FOR A DRAINAGE STUDY ALONG A PORTION OF PRICE BLVD. IN THE CITY OF NORTH PORT, FLORIDA

Van Buskirk / Fish & Associates, Inc.
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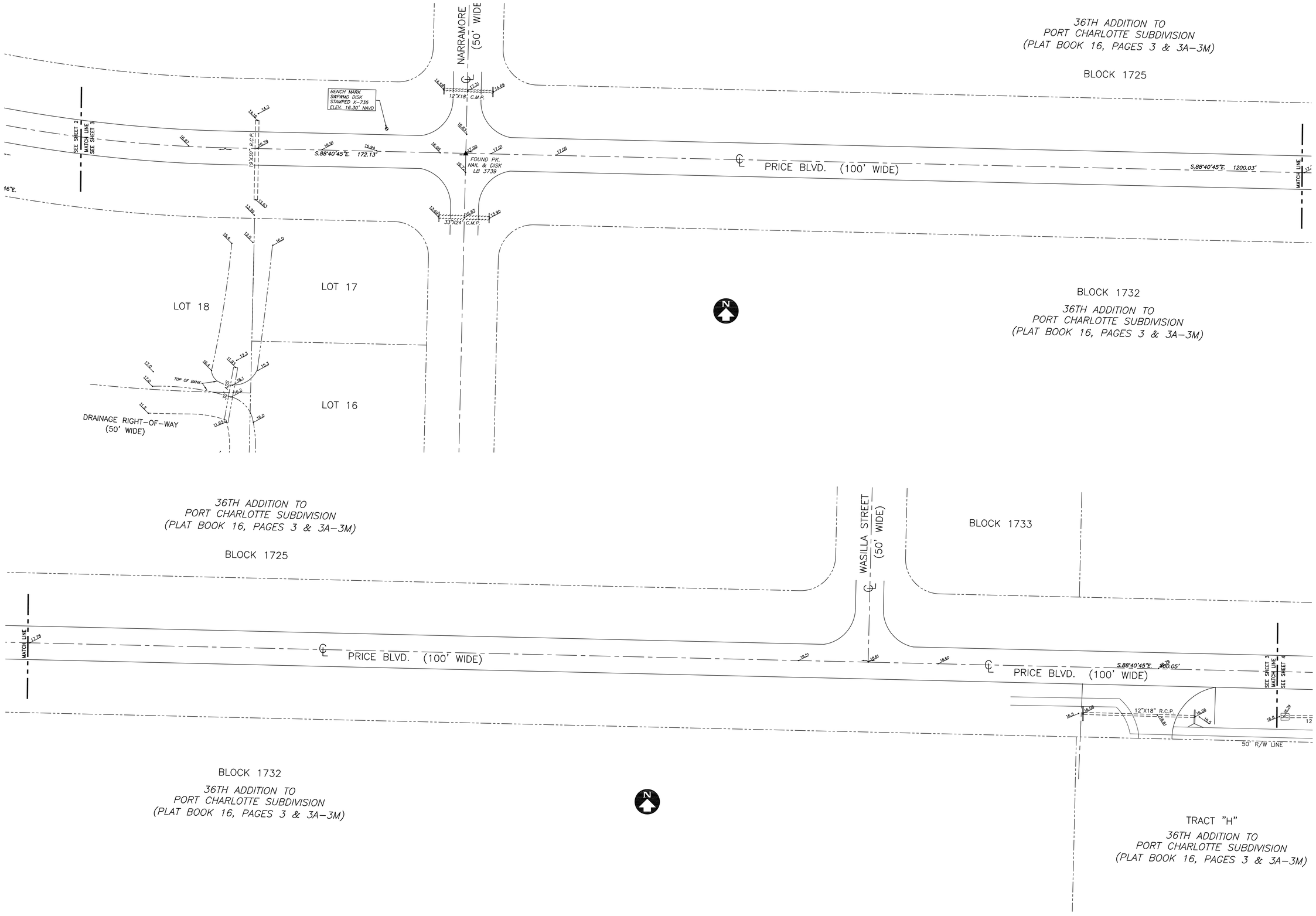
12450 Unit C Tamiami Trail · North Port, FL 34287 · (941) 426-0681

DATE:	6-17-2014
SCALE:	1" = 30'
DRAWN:	GC
PROJECT NO.	14-1088
SHEET	2
OF	7 SHEETS



REVISIONS:	BY:

MAP OF "SPECIFIC PURPOSE SURVEY" SHOWING FIELD SURVEY DATA COLLECTED FOR A DRAINAGE STUDY ALONG A PORTION OF PRICE BLVD. IN THE CITY OF NORTH PORT, FLORIDA

Van Buskirk / Fish & Associates, Inc.
SURVEYORS - MAPPERS -
DEVELOPMENT CONSULTANTS
12450 Unit C Tamiami Trail · North Port, FL 34287 · (941) 426-0681

DATE:	6-17-2014
SCALE:	1" = 30'
DRAWN:	AKF
PROJECT NO.	14-1088
SHEET	3
OF	7 SHEETS

36TH ADDITION TO
PORT CHARLOTTE SUBDIVISION
(PLAT BOOK 16, PAGES 3 & 3A–3M)

TRACT "J"

BLOCK 1733

LOCHER TERRACE
(50' WIDE)

36TH ADDITION TO
PORT CHARLOTTE SUBDIVISION
(PLAT BOOK 16, PAGES 3 & 3A–3M)

BLOCK 1737

50' R/W LINE

12"X18" R.C.P.

SEE SHEET 3
MATCH LINE
SEE SHEET 4

PRICE BLVD. (100' WIDE)

S.88°40'45"E. 394.94'

24.94'

FOUND MAG. NAIL & LB 3739 DISK
N=997438.37
E=579390.52

FOUND MAG. NAIL & LB 3739 DISK
N=997429.47
E=579785.35

FOUND MAG. NAIL & LB 3739 DISK
PC. CURVE
N=997428.96
E=579810.28

SOUTHERLY HALF OF
PRICE BLVD.
(O.R. 1749, PG.1592)

CONCRETE WALK

W LINE

8" P.V.C.

T.B.M.: SET PK & DISK L.B. 3739 DISK IN WALK
EL.=18.04' NAVD
N.=997393.78'
E.=579418.83'

TRAVERSE POINT 5" IRON ROD & CAP LB 3739
N.=997398.61'
E.=578981.53'
EL.=17.93' NAVD

Curve number 3
Radius= 999.98'
Delta= 27°56'39"
Arc= 487.71'
Tangent= 248.81'
Chord= 482.89'
Chord Brg.= S.74°43'41"E.

(3)

MATCH LINE

40' R/W LINE

GLENALLEN BLVD.
(80' WIDE)

EASTERLY HALF OF
GLENALLEN BLVD.
O.R. 1749, PG.1592)

ELEVATIONS ARE NAVD–88
COORDINATES ARE NAD 1983/2007

36TH ADDITION TO
PORT CHARLOTTE SUBDIVISION
(PLAT BOOK 16, PAGES 3 & 3A–3M)

BLOCK 1738

BLOCK 1736

HYDER TERRACE
(50' WIDE)

ACADIAN TERRACE
(50' WIDE)
"NOT OPEN"

DRAINAGE RIGHT–OF–WAY
(50' WIDE)
"NOT CONSTRUCTED"
"LIMIT OF PLAT"

LANDS OF THE SCHOOL BOARD
OF SARASOTA COUNTY
(O.R. 2533, PAGE 751)

LANDS OF THE CITY
OF NORTH PORT
(O.R. 1771, PAGE 469)

13"X22" CMP

STORM INLET
TOP=16.80'

15" ADS

FOUND MAG. NAIL & LB 3739 DISK
0.15'SW

Curve number 4
Radius= 999.98'
Delta= 17°10'35"
Arc= 299.78'
Tangent= 151.02'
Chord= 298.66'
Chord Brg.= S.52°10'05"E.

(4)

PT. CURVE

PRICE BLVD.
150.00'
(100' WIDE)

SOUTHERLY HALF OF
PRICE BLVD.
(O.R. 1749, PG.1592)

TRAVERSE POINT 5" IRON ROD & CAP LB 3739
N.=997193.04'
E.=580399.19'
EL.=17.09' NAVD

12"X18" R.C.P.

SEE SHEET 5
MATCH LINE
SEE SHEET 4

PRICE BLVD.
(O.R. 1749, PG.1592)
(100' WIDE)

S.43°34'47"E. 748.45'

598.45'

TRAVERSE POINT 5" IRON ROD & CAP LB 3739
N.=996786.62'
E.=580797.55'
EL.=17.03' NAVD

SEE SHEET 5
MATCH LINE
SEE SHEET 4

16"X22" CMP

BENCH MARK
SW"MD DISK
STAMPED W-735
ELEV. 17.94' NAVD

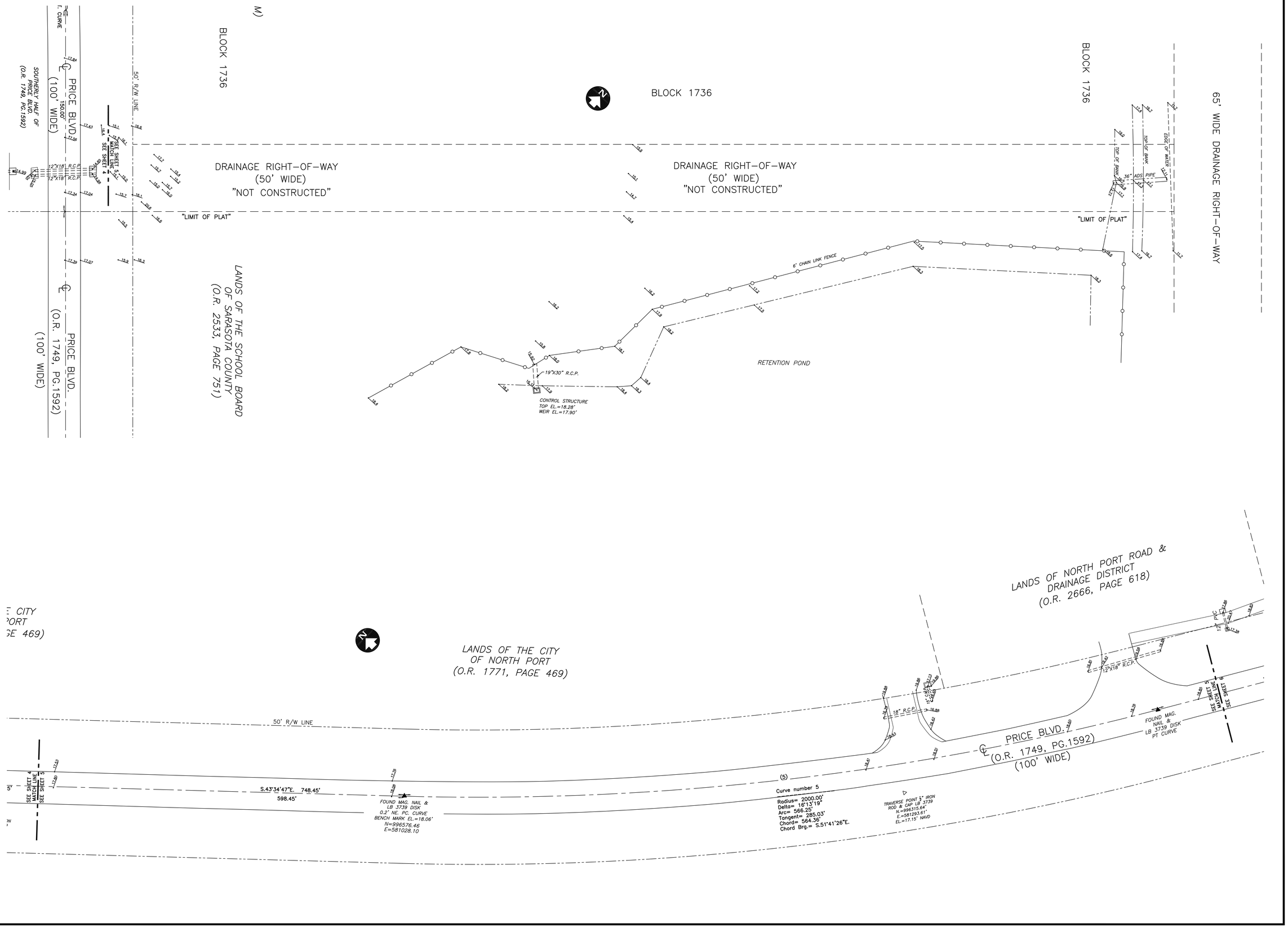
MATCH LINE

REVISIONS:	BY:

MAP OF "SPECIFIC PURPOSE SURVEY" SHOWING FIELD SURVEY DATA COLLECTED FOR A DRAINAGE STUDY ALONG A PORTION OF PRICE BLVD. IN THE CITY OF NORTH PORT, FLORIDA

Van Buskirk / Fish & Associates, Inc.
SURVEYORS · MAPPERS · DEVELOPMENT CONSULTANTS
12450 Unit C Tamiami Trail · North Port, FL 34287 · (941) 426-0681

DATE:	6-17-2014
SCALE:	1" = 30'
DRAWN:	AKF
PROJECT NO.	14-1088
SHEET	4
OF	7 SHEETS

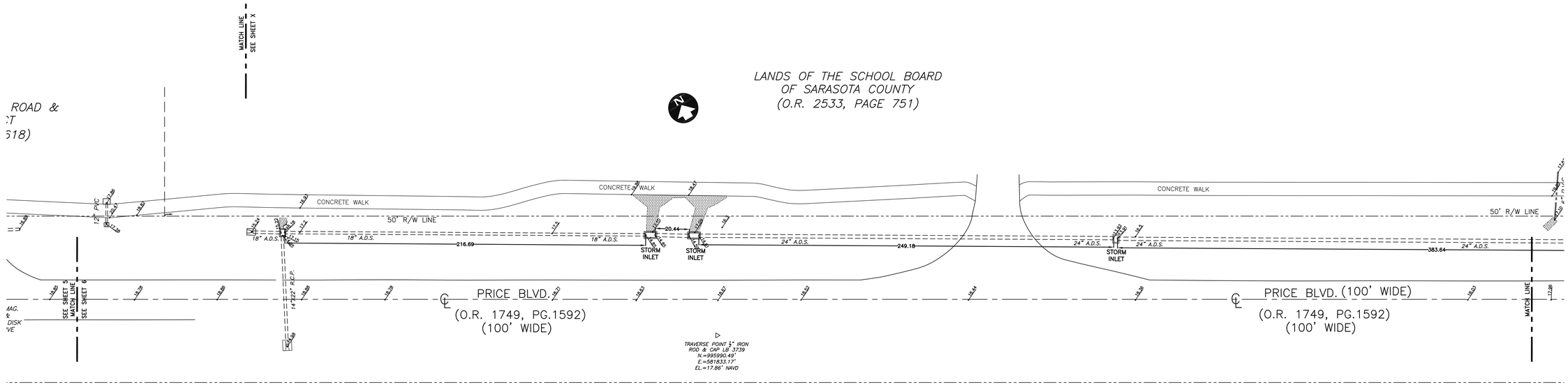


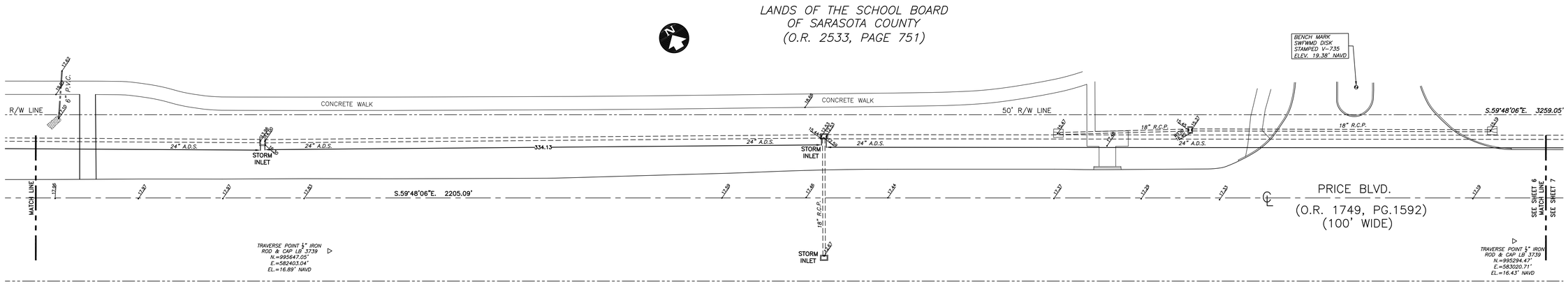
REVISIONS:	BY:

MAP OF "SPECIFIC PURPOSE SURVEY" SHOWING FIELD SURVEY DATA COLLECTED FOR A DRAINAGE STUDY ALONG A PORTION OF PRICE BLVD. IN THE CITY OF NORTH PORT, FLORIDA

Van Buskirk / Fish & Associates, Inc.
SURVEYORS - MAPPERS - DEVELOPMENT CONSULTANTS
12450 Unit C Tamiami Trail - North Port, FL 34287 - (941) 426-0681

DATE:	6-17-2014
SCALE:	1" = 30'
DRAWN:	AKF
PROJECT NO.	14-1088
SHEET	5
OF	7 SHEETS





REVISIONS:	BY:

MAP OF "SPECIFIC PURPOSE SURVEY" SHOWING FIELD SURVEY DATA COLLECTED FOR A DRAINAGE STUDY ALONG A PORTION OF PRICE BLVD. IN THE CITY OF NORTH PORT, FLORIDA

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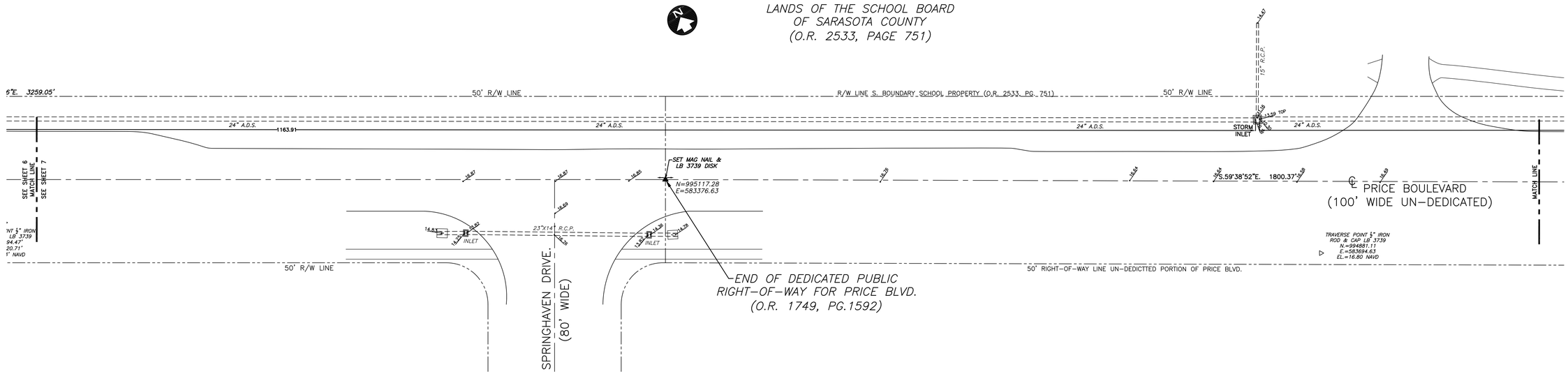
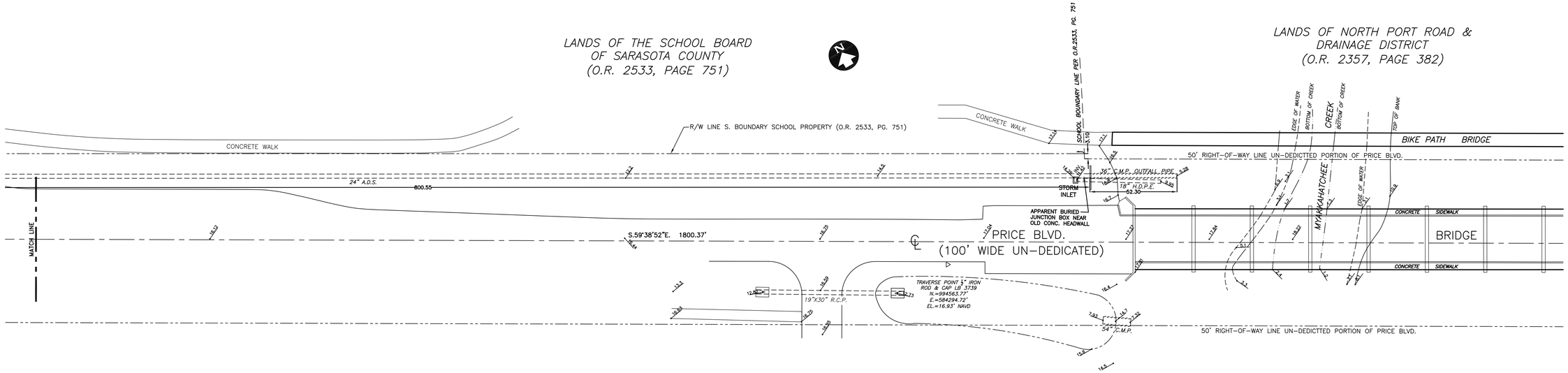
12450 Unit C Tamiami Trail · North Port, FL 34287 · (941) 426-0681

DATE:	6-17-2014
SCALE:	1" = 30'
DRAWN:	AKF
PROJECT NO.	14-1088
SHEET	6
OF	7 SHEETS





REVISIONS:	BY:

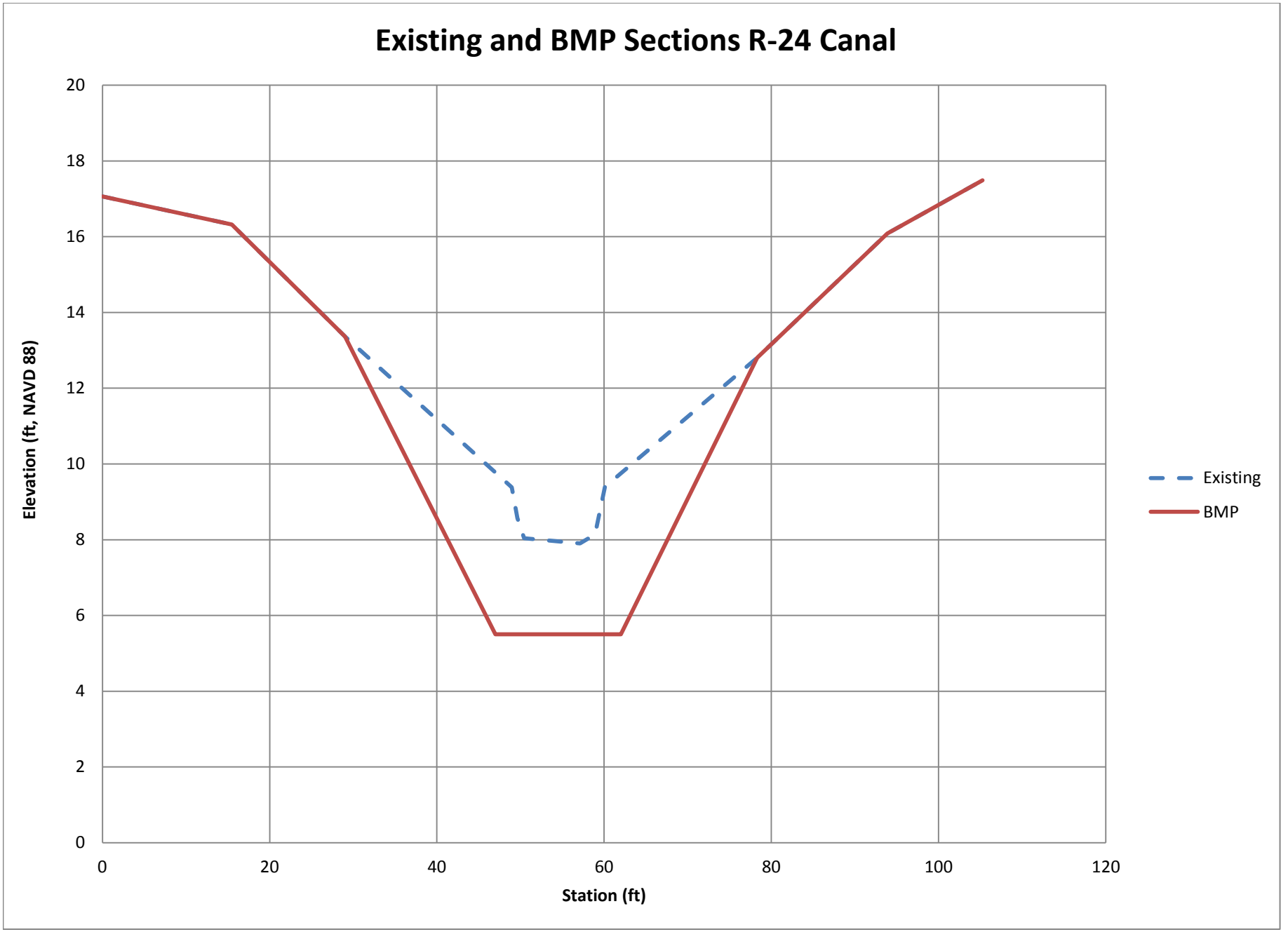
MAP OF "SPECIFIC PURPOSE SURVEY" SHOWING FIELD SURVEY DATA COLLECTED FOR A DRAINAGE STUDY ALONG A PORTION OF PRICE BLVD. IN THE CITY OF NORTH PORT, FLORIDA

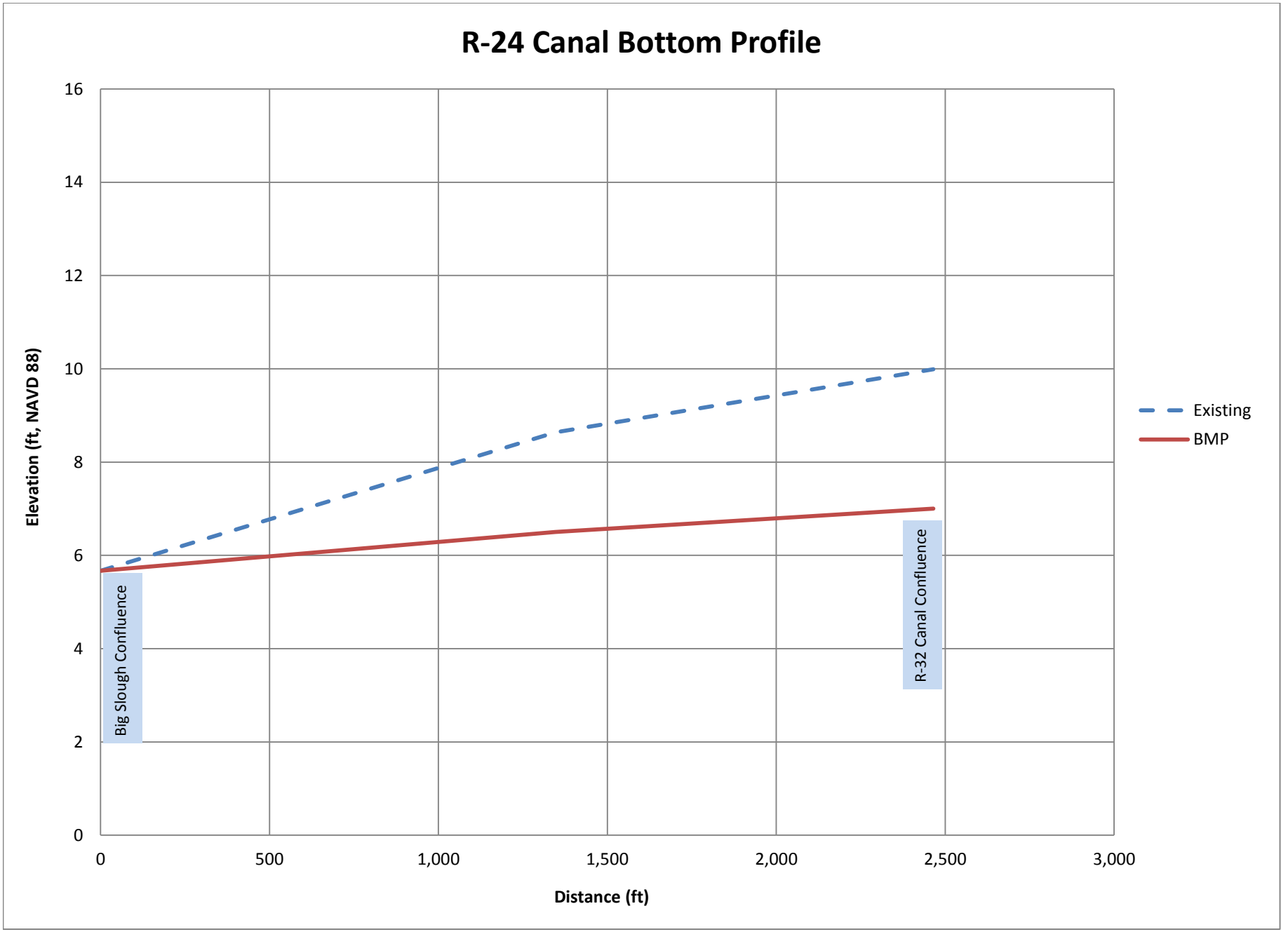
Van Buskirk / Fish & Associates, Inc.
SURVEYORS - MAPPERS -
DEVELOPMENT CONSULTANTS
12450 Unit C Tamiami Trail · North Port, FL 34287 · (941) 426-0681

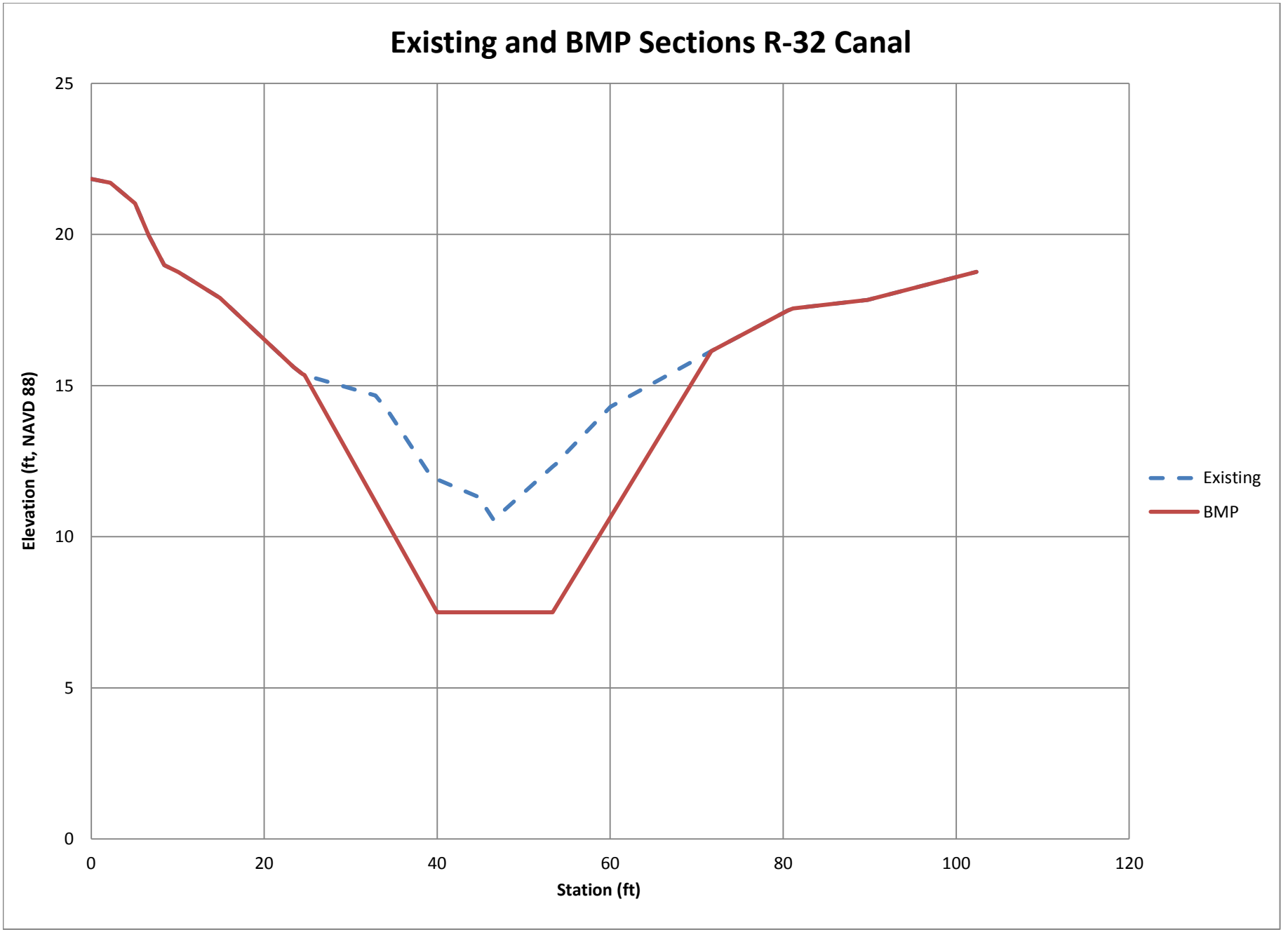
DATE:	6-17-2014
SCALE:	1" = 30'
DRAWN:	AKF
PROJECT NO.	14-1088
SHEET	7
OF	7 SHEETS

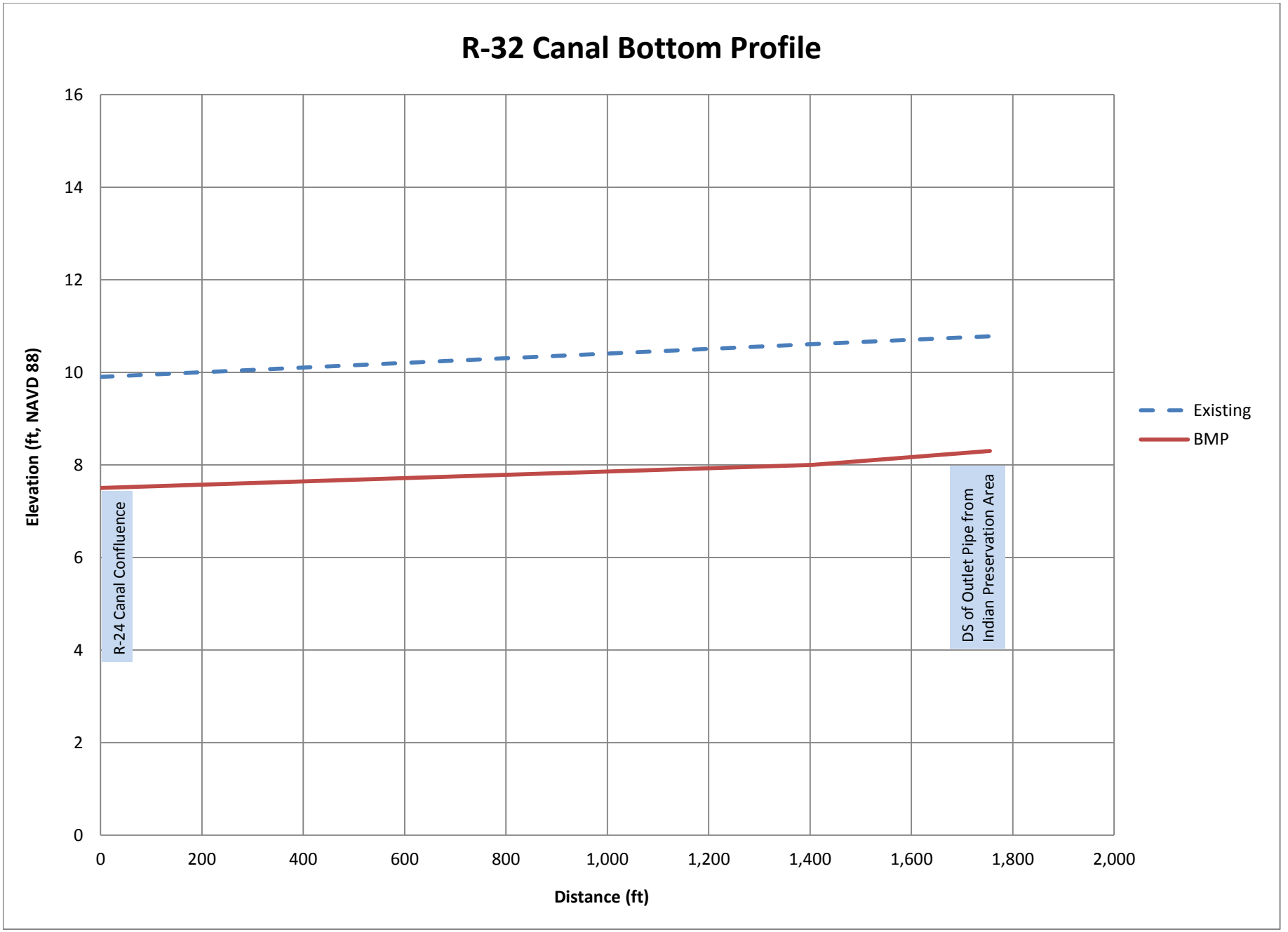
APPENDIX D

Canal Cross-sections and Profiles


Existing and BMP Sections R-24 Canal
Elevation (ft, NAVD 88)
20
18
16
14
12
10
8
6
4
2
0
0
20
40
60
80
100
120
Station (ft)
Existing
BMP


R-24 Canal Bottom Profile
16
14
12
10
8
6
4
2
0
Elevation (ft, NAVD 88)
0
500
1,000
1,500
2,000
2,500
3,000
Distance (ft)
Big Slough Confluence
R-32 Canal Confluence
Existing
BMP


Existing and BMP Sections R-32 Canal
Elevation (ft, NAVD 88)
25
20
15
10
5
0
0
20
40
60
80
100
120
Station (ft)
Existing
BMP


R-32 Canal Bottom Profile
Elevation (ft, NAVD 88)
16
14
12
10
8
6
4
2
0
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
Distance (ft)
R-24 Canal Confluence
DS of Outlet Pipe from Indian Preservation Area
Existing
BMP

APPENDIX E

Preliminary Cost Estimates

BMP No. 1 (Dredging R-24 and R-32 Canals) Preliminary Cost Estimates

Item	Length (ft)	Width (ft)	Cross Section area	Quantity	Unit	Unit Cost *	Estimated Cost	Comments
Dredging and removal of dredgings - 1,800 ft of R-32 Canal	1800		144.5	9633	CY	$ 25	$ 240,833	
Dredging and removal of dredgings - 2,300 ft of R-24 Canal	2300		118.3	10077	CY	$ 25	$ 251,935	
Bank Stabilization R-32 Canal Assume 1, 800ft long 20 feet wide on each side	1800	38		7600	SY	$ 2	$ 15,200	
Bank Stabilization R-24 Canal Assume 2,300 ft long 20 feet wide on each side	2300	38		9711	SY	$ 2	$ 19,422	
36-inch Pipe Crossing				40	LF	$ 50	$ 2,000	
Erosion and Sediment Control							$ -	
MOT				1	LS	$ 5,000	$ 5,000	
Mobilization and Demobilization				1	LS	$ 5,000	$ 5,000	
Other Project Costs				1	LS	$ 5,000	$ 5,000	
Subtotal							**$ 544,391**	
Design and Permitting Consultant Services (15%)							$ 81,659	
Construction and Inspection Consultant Services (5%)							$ 27,220	
Contingency (10%)							$ 65,327	
Total FY 2014 cost							$ 718,596	
Total FY 2017 Inflated Cost (5% per year)							**$ 831,864**	

* Estimated Costs from Thomas Marine Construction

BMP No. 2 (Raising 1,900 ft of Price Boulevard) Preliminary Cost Estimates

Item	Length (ft) *	Width (ft)	Depth (in)	Quantity	Unit	Unit Cost	Estimated Cost **	Comments
Detail Topographic Survey				1	ea	$ 5,000	$ 5,000	
Mill Existing Asphalt	2100	24		5600	SY	$ 15	$ 84,000	
Add road base to elevate road 1.2'	2100	26	15	6067	SY	$ 30	$ 182,000	$15 per SY per 8" thickness. Double cost for 15" thickness.
Type SP Structural Course 1.5"	2100	26	1.5	455	TON	$ 100	$ 45,500	100lb per SY per inch thickness / 2000lb per ton
Friction Course 1.5"	2100	26	1.5	455	TON	$ 120	$ 54,600	
Swale Regrading and sodding (assume 20 ft wide each side of Price Blvd)	2100	20		9333	SY	$ 5	$ 46,667	
Surveying (Construction staking, surveying, as-builts)				1	LS	$ 7,500	$ 7,500	
Erosion and Sediment Control				1	LS	$ 5,000	$ 5,000	
MOT				1	LS	$100,000	$ 100,000	Need bypass lanes
Mobilization and Demobilization (6%)				1	LS	$ 31,816	$ 31,816	
Subtotal							**$ 562,083**	
Design and Permitting Consultant Services (15%)							$ 84,312	
Construction and Inspection Consultant Services (5%)							$ 28,104	
Contingency (10%)							$ 67,450	
Total FY 2014 cost							$ 741,949	
Total FY 2017 Inflated Cost (5% per year)							**$ 858,899**	

* Add 100 feet on each for transition to existing road pavement elevation

** Cost inflated about 15% from 2014 Sumter/Price Intersection improvements cost from Ben Newman

BMP No. 3 (Raising 950 ft of Price Boulevard and Dredging R-24 and R-32 Canals) Preliminary Cost Estimates

Item	Length (ft) *	Width (ft)	Depth (in)	Quantity	Unit	Unit Cost	Estimated Cost **	Comments
Detail Topographic Survey				1	ea	$ 5,000	$ 5,000	
Mill Existing Asphalt	1150	24		3067	SY	$ 15	$ 46,000	
Add road base to elevate road 8"	1150	26	8	3322	SY	$ 15	$ 49,833	$15 per SY per 8" thickness.
Type SP Structural Course 1.5"	1150	26	1.5	249	TON	$ 100	$ 24,917	100lb per SY per inch thickness / 2000lb per ton
Friction Course 1.5"	1150	26	1.5	249	TON	$ 120	$ 29,900	
Swale Regrading and sodding (assume 20 ft wide each side of Price Blvd)	1150	20		5111	SY	$ 5	$ 25,556	
Surveying (Construction staking, surveying, as-builts)				1	LS	$ 7,500	$ 7,500	
Erosion and Sediment Control				1	LS	$ 5,000	$ 5,000	
MOT				1	LS	$100,000	$ 100,000	Need bypass lanes
Mobilization and Demobilization (6%)				1	LS	$ 17,622	$ 17,622.33	
Dredging R-24 and R-34 Canals (see BMP 1 cost estimate for detailed cost breakdown)							$ 544,391	
Subtotal							**$ 855,719**	
Design and Permitting Consultant Services (15%)							$ 128,358	
Construction and Inspection Consultant Services (5%)							$ 42,786	
Contingency (10%)							$ 102,686	
Total FY 2014 cost							$ 1,129,549	
Total FY 2017 Inflated Cost (5% per year)							**$ 1,307,594**	

* Add 100 feet on each for transition to existing road pavement elevation

** Cost inflated about 15% from 2014 Sumter/Price Intersection improvements cost from Ben Newman

Appendix D

Task 1.1.3 Big Slough Flood Reduction Study, Summary of Prior BMP Evaluations

DeLoach Engineering Science, PLLC., November 2016

MEMORANDUM

To: Elizabeth Wong, PE (City of North Port)
From: Dave DeLoach, PE; Trillian Baldassari, PE
Copy: Rod Ghioto, PE
File: 14-00400-00

Subject: Task 1.1.3 Big Slough Flood Reduction Study, Summary of Prior BMP Evaluations

November 21, 2016

Summary of Prior BMP Evaluations

The Big Slough watershed and City of North Port stormwater management system have been the subjects of prior investigations. The Big Slough Flood Reduction Study will build upon that prior work to advance previously developed concepts and develop original ideas to achieve some degree of flood mitigation in areas where residential structures are shown as flooding in recently updated Flood Insurance Rate Maps (FIRMs). Flood reduction performance of proposed improvements will be considered relative to storm events from mean annual to the 100-year recurrence to more broadly evaluate cost and benefit relationships. This memorandum briefly summarizes prior BMP evaluations that were performed and their findings, using much of the same language found in those prior reports.

Stormwater Management Master Plan (1993)

As part of the City of North Port's stormwater improvement program, Camp Dresser & McKee, Inc. (CDM) developed a Stormwater Management Master Plan (SWMMP) for the Big Slough watershed. The plan sought to evaluate flooding problems and determine engineering solutions, and was conducted in three phases. The third phase included analyses of alternatives for flood reduction. Detailed modeling was conducted to assess potential flood reduction afforded by alternatives. A cost/benefit analysis was conducted to evaluate the alternatives and recommend a plan for detailed design.

Development of Conceptual Solutions

A Phase III, Task l interim report (CDM, 1992) outlined conceptual solutions to identified flooding problems. Preliminary stormwater model runs were conducted to provide an initial assessment of each solution's effectiveness in reducing flooding. Results and preliminary cost estimates were developed for each solution. The costs and benefits of each conceptual solution were compared in a matrix.

Solutions considered in the preliminary evaluation included the following:

- Acquisition: Purchase of flooded lands would preclude flooding damage by preventing the development of the property, but would not prevent roadway flooding.
- Storage: Construction of stormwater detention basins would detain flow from the agricultural areas north of the city would reduce and attenuate peak flow rates.
- Diversion: Stormwater flows would be diverted into an adjacent watershed to the west (Deer Prairie Slough), thus reducing flow through the city.
- Conveyance: Increased conveyance capacity of the city's hydraulic system would include excavating existing channels, resizing culverts at stream crossings, cleaning existing channels, and constructing relief channels parallel to existing channels.

Based upon preliminary analyses, purchase of flooded lands was removed from consideration and the three remaining alternatives, and combinations of those alternatives, were examined in more detail.

Evaluation of Alternatives

City of North Port Big Slough Watershed Study Phase III Task 2 Final Report, Stormwater Management Master Plan (CDM, 1993) presents conceptual solutions for flooding as well as assessments of potential water supplies and of nonpoint source pollution and describes a stormwater management plan to reduce flooding during extreme storm events.

The specific set of alternatives evaluated in greater detail included:

- Alternative 1: Relief channel+ culvert improvements
- Alternative 2: Stormwater diversion by pumping + culvert improvements
- Alternative 3: Stormwater diversion by channel + culvert improvements
- Alternative 4: Upstream detention
- Alternative 5: Combination of Alternatives 1 and 2
- Alternative 6: Combination of Alternatives 1 and 3

Culvert improvements were recommended for the first phase of each alternative and included replacement of culverts on the R-36 canal at Bullard and Biscayne and on Cosmic and Creighton waterways at Tropicaire Blvd. Cleaning of portions of the Creighton and Cosmic waterways was also recommended to return those canals to original design dimensions. Flood reduction effects from the culvert improvements would be predominantly local, but some flooding would also be relieved by transferring flow from the upper reaches of the Big Slough and R-36 to the R-580 and Snover waterways.

The relief channel (Alternative 1) under consideration would reach from the northern boundary of the city to the Snover waterway. It could act as a parallel conveyance for peak storm flows and be integrated into a linear park system along the Big Slough. The channel would be 5 feet deep, have gentle grassed side slopes, and would be dry except during extreme storm events. When the relief channel is combined with the culvert improvements, the expected flooded area would be reduced by 540 residences.

The diversion alternative had two options: a pumping option and a channel option. The diversion pumping option (Alternative 2) would require a pumping station with a weir near Price Boulevard on the R-36 canal to convey stormwater to a bermed storage area on the Futrell tract. Release from the tract to Deer Prairie Slough would be at the existing rate and would take about a week to drain down under 25-year/24-hour storm conditions. Normally, pumping would only be initiated under high storm flow (2 feet above weir crest) conditions. To minimize noise, primary power would be by direct connection to Florida Power & Light with a diesel generator back-up.

The diversion channel option (Alternative 3) would utilize two weirs for diversion to a channel south of the Futrell tract, directly connected to the Deer Prairie Slough. The weir discharge rate would closely match the pumping capacity and would also discharge only under storm conditions. Both the pumping and channel options would have similar results by reducing downstream flooding along the R-36 canal. They provide flood relief only in the southwest area of the city, but more than 1,000 residences would benefit from this alternative by diverting water from the existing flooding area.

Upstream detention (Alternative 4) would consist of a berm designed to detain flood waters north of the city and slowly release those waters after the peak flows had passed. Six foot berms were proposed with a total storage capacity of 4,011 acre feet and 1 foot of freeboard. Little flood reduction was evident when compared to the other alternatives. The amount of land necessary and the limited benefit restricted the viability of this alternative.

Alternatives 5 and 6 combined the relief channel with each of the diversion alternatives. Simulation results indicated a significant reduction in flooding along Sumter Boulevard, as well as those areas mentioned previously. A reduction in flooded land of 4,200 acres, 1,152 residences, and 10.1 miles of roadway was predicted from the modeling.

Flooding problems along the Cocoplum Waterway were not alleviated by any of the suggested alternatives. Preliminary modeling results indicated that structural solutions to the flooding problems along the Cocoplum Waterway are cost-prohibitive. Consequently, non-structural measures should be considered.

Comparison of Alternatives/Recommendation

Alternatives were evaluated per the following weighted criteria:

- Flood protection benefit (10 point maximum)
- Annual cost (30 point maximum)
- Implementability (20 point maximum)
- Water quality benefits (10 point maximum)
- Water supply benefits {10 point maximum)

Evaluation results indicated that Alternative 2 (diversion pumping option to Futrell tract coupled with culvert improvements) scored highest (62 total points). Alternative 5, which is Alternative 2 with the addition of the relief channel, was tied for second place (60 points) with Alternative 3 (diversion channel

option plus culvert improvements). While total scores were close, Alternative 5 provided considerably more flood protection than Alternatives 2 and 3. Alternative 5 was recommended because it included the top ranked alternative, provided the greatest flood protection benefit, and could be phased.

The culvert improvements and the stormwater diversion phases were recommended first because they addressed existing flooding problems in an area of the city that is already populated. The relief channel would provide much of its benefit in areas that are currently sparsely populated but expected to grow.

For the Cocoplum Waterway, non-structural methods of flood reduction were recommended, since any feasible structural measures would be cost-prohibitive. Measures to be considered included specifying minimum first floor elevations in the city's zoning requirements, based on the 25-year or 100-year flood maps. For existing development, primarily around Blueridge Lake, local measures were recommended, such as raising structures, constructing small walls or levees around structures, and adding watertight flood shields for windows and exterior doors. While these measures will not reduce roadway flooding, they will reduce the potential structural damage from an extreme storm event.

Status of Recommendations

The 1993 Stormwater Management Master Plan was partially implemented, providing increased local conveyance through replacement of culvert structures at four locations. Those improvements are accounted for in the current Existing Conditions model. Other plan components were not completed including those for storage and flow diversion, apparently due to regulatory and financial constraints.

Watershed Management Program Consulting Services in the Big Slough Watershed (2014)

Ardaman & Associates, Inc. evaluated various BMP alternatives to address flooding conditions based on effectiveness, permittability, and economic viability. Under the WMP project, an Existing Conditions model was developed and six regional BMP alternatives were evaluated that could potentially reduce flooding through combinations of conveyance improvements, stormwater management storage areas, flood proofing, and flow diversion. Although the regional alternatives developed under the WMP project were not incorporated into a specific plan for implementation, the work provides insight to the system's hydraulic response and BMP limitations. Performance of several additional, site-specific BMPs were also evaluated and are also briefly discussed, here.

Regional BMPs

Simulations were performed of six regional BMP scenarios to evaluate the impact of various large-scale flood mitigation concepts. The benchmark scenario for comparison and performance evaluation was the SWFWMD Governing Board-approved 100-year 24-hour existing condition model.

- Remove structures throughout City of North Port waterways.
    - The objective of evaluating this BMP was to understand primary drainage system capacity assuming no losses due to water control structures or drop structures. Additional connectivity was provided among a few R canals southwest of the I-75 corridor to transferring some of the existing load to less compromised areas.

  - Water control structures (WCS) and drop structures (DS) were removed and replaced with an equivalent channel section that mimics the immediate upstream canal's section. The R-36 canal was connected to the R-43 canal via a weir with equivalent channel geometry and the R-43 canal was similarly connected to the R-24 and R-32 canals.
  - Results indicate flood stage reduction immediately north of Price Blvd and along Bass Point waterway while increasing flooding between S Toledo Blvd and S Sumter Blvd. Also, improvements are observed southwest of I-75 where new canal connectivity was provided. It was noted that structure removal may not be feasible due to potential loss of potable water supply, fish and wildlife habitat, and wetlands.
- Constrain Flow Entering City of North Port at Big Slough Canal
  - The objective of this BMP was to constrain the volume of water coming from offsite areas through the Big Slough canal prior to entering the City in the Estates area. The BMP would involve real estate acquisition, maintenance activities, dam construction and removal of existing hydraulic structures.
  - On the northwest City boundary, at the intersection of Big Slough canal with R-36 and R-580 waterways, all existing earthen weirs were raised to limit runoff from offsite areas, leaving the Big Slough canal as the only conveyance system into the western portion of the City. All earthen weirs farther north, at the intersection of Big Slough canal and Power Line Road were raised as well.
  - Results indicate approximately 0.5 feet flood stage reduction near the Big Slough canal from the City's northern boundary to just south of I-75 while flood stages increase approximately 1.0 foot in offsite areas north of the R-36 and R-580 waterways.
- Diversion Alternative
  - The purpose of this BMP is to divert flows from offsite areas via the existing R-36 canal, by increasing its capacity and improving its hydraulic connectivity with Deer Prairie Slough canal. This BMP would involve construction of new structures, maintenance activities, real estate acquisition, and detailed hydrologic and hydraulic evaluation of the western boundary (Deer Prairie Slough watershed).
  - On the northwest boundary, along R-36 canal, two earthen overflow weirs were provided to enhance the R-36 waterway connectivity with Deer Prairie Slough canal. Weir location and parameters were selected based on terrain and hydraulic constraints. The weirs were located on the northwest corner to address flooding in the Estates area and along Big Slough canal. R-36 canal capacity was also doubled by replacing the existing cross-section with a 60 feet bottom width trapezoidal channel with 4:1 side slopes. The current model assumes no tailwater influence from Deer Prairie Slough.
  - Results indicate flood reduction throughout the Estates area, along the Big Slough Canal between the R-36 canal and I-75 corridor as well as in the localized area along Big Slough south of I-75, with flood stage reductions between 0.1 foot and 1.0 foot throughout those areas. Impacts of additional flow into the Deer Prairie Slough watershed were not considered.

- R-580 Improvements
    - The purpose of this BMP is to induce additional flows through Creighton waterway by improving conveyance capacity in the R-580 waterway.
    - The R-580 waterway's bottom profile was reconfigured, assuming a flat ditch along its entire length at elevation 15.0 feet, NAVD. The current bottom sags to elevation 15.0 feet and reaches 17.7 feet and 23.0 feet at its western and eastern ends, respectively.
    - Results indicate small improvements near Big Slough. However, inducing additional flow through Creighton Waterway causes additional flooding near I-75.
- Increase Capacity on Southern Boundary
    - The objective of this alternative was to evaluate system response when doubling the southern boundary discharge capacity along the County line into Port Charlotte. The BMP would involve conveyance improvements, construction of new structures and/ or reconditioning of existing structures, maintenance activities, real estate acquisition, and evaluation of the receiving waters through hydrologic and hydraulic modeling.
    - All structures within Cocoplum Waterway and discharging beneath Hillsborough Boulevard were doubled in size. This included 6 lateral weirs along Cocoplum waterway and 13 structures beneath Hillsborough Boulevard.
    - Results indicate that improvements relative to house flooding were not significant. However, roads experienced a considerable flood reduction between S Sumter Blvd and Atwater Drive. This alternative was evaluated for information purposes only, as it is understood that allowing additional flows into Port Charlotte may not be desirable.
- Upstream Detention Alternative
    - The objective of this analysis is to examine the effects when attenuating peak flow rates in agricultural areas along the Big Slough canal with a series of new detention facilities. This BMP would involve construction of stormwater management storage areas, maintenance activities and real estate acquisition.
    - Seven detention facilities were added to the model in upstream offsite areas. Each detention area has a 100-acre footprint and is more than 10 feet deep. These areas were located on upland sites along Big Slough canal where feasible. Bottom elevations of the detention areas were set at the adjacent canal initial water level. Each was linked to the Big Slough canal by a 500-foot weir. Weir crest elevations were set at the bottom of the pond. The total anticipated detained volume is 600 acre-feet per detention site for a total of 4,200 acre-ft.
    - Results indicate relatively small reduction in peak water surface elevations on the order of 0.1 to 0.6 feet along Big Slough. The extent of flooding for this BMP is essentially the same as the existing scenario with few flood reduction areas along the Big Slough canal.

BMP Evaluation of Four Road Crossings

Simulations were performed to assess hydraulic performance and the effects of potential conveyance improvements at four sites, including: R-36 Canal at I-75, Myakkahatchee Creek at I-75, R-36 Canal at Tropicaire Boulevard, and Myakkahatchee Creek at Tropicaire Boulevard. A systematic evaluation was

conducted to understand existing hydraulic behavior at each of the four crossings under various synthetic storm events. Head differences across each structure, flow conditions at peak discharge, and hydraulic connectivity (including flow patterns in adjacent areas) were reviewed at each crossing.

To evaluate effectiveness of potential BMP improvements at these four locations (including resulting flood reduction and/or downstream flood increase), conveyance capacity at each site was increased by doubling the number of existing structures. This was achieved by adding a duplicate set of model reach elements at each location.

- R-36 Canal at I-75 Evaluation
    - Existing condition model results indicate that more than two feet of head difference occurs across this structure during the 100-year storm event. Under proposed BMP conditions, model results indicate that a peak stage reduction of up to 0.6 feet occurs upstream of the crossing, while a stage increase of approximately 0.6 feet occurs in downstream areas. It is notable that reduced discharges are observed from the R-36 Canal westward into the adjacent Deer Prairie Slough watershed for the proposed BMP condition. This overflow connection with the adjacent watershed to the west is located north of I-75. The reduced overflow results in an increased total volume remaining within the North Port area, by virtue of the improved conveyance capacity of the proposed BMP.
    - Increasing the crossing capacity of the R-36 Canal at I-75 may reduce water levels upstream of the crossing, but also raises flood elevations in the downstream areas. Mitigation of flooding in downstream areas was beyond the scope of this evaluation.
- Myakkahatchee Creek at I-75 Evaluation
    - Existing condition model results indicate that approximately one foot of head difference occurs across this structure during extreme storm events. This head difference is relatively small considering the magnitude of flow that arrives from the upstream contributing watershed (up to 8000 cubic feet per second). The applied BMP at this location assumes that the conveyance capacity of the bridge crossing was doubled. In other words, an identical, parallel 540-foot bridge span was added to investigate the benefit of increasing bridge capacity. Under this hypothetical scenario, model results indicate that a localized stage reduction of 0.7 feet is observed immediately at the upstream end of the crossing. However, peak stage reductions decrease further upstream of the crossing along the creek. No significant change in peak elevations is observed 1,200 feet upstream of the crossing. Also, no significant change to flooding conditions is observed in areas downstream of the crossing.
    - Increasing conveyance capacity of the bridge over Myakkahatchee Creek at I-75 may reduce water levels immediately upstream of the crossing, but does not generally improve flooding conditions north of I-75. The area impacted by this improvement is very localized and would not justify the cost of the improvement.

- R-36 Canal at Tropicaire Boulevard Evaluation
    - Existing condition model results indicate that up to three feet of head difference occurs across this structure during various storm events. Under proposed BMP conditions, model results indicate a peak stage reduction of approximately 0.8 feet upstream of the crossing, while a stage increase of up to 1.1 feet occurs downstream of Tropicaire. During all events, discharges from the R-36 canal into Deer Prairie Slough watershed are observed north of Tropicaire Boulevard. The proposed BMP results in a reduction of those discharges to Deer Prairie Slough and a resulting increased total volume remaining within the North Port area.
    - While increasing the crossing capacity of the R-36 Canal at Tropicaire Boulevard may reduce water levels upstream of the crossing, it also raises flood elevations in downstream areas. Mitigation of flooding in downstream areas was beyond the scope of this evaluation.
- Myakkahatchee Creek at Tropicaire Boulevard Evaluation
    - Existing condition model results indicate that the maximum calculated head difference for the various storm events is 0.2 feet; therefore, the bridge is not causing a flow restriction. Regardless, a BMP was applied, for evaluation, and assumes that the conveyance capacity was increased (doubled) by adding an identical bridge element in parallel to the existing structure. Under this scenario, model results indicate that a maximum localized stage reduction of approximately 0.1 feet was calculated, yet no significant change is observed further upstream nor downstream of the crossing.
    - Increasing the crossing capacity of the bridge over Myakkahatchee Creek at Tropicaire Boulevard does not substantially improve flooding conditions north of I-75.

WCS-162 Evaluation

WCS-162 is located on the R-36 Canal, north of Interstate 75, and immediately upstream of Tropicaire Boulevard. This is the only gated weir structure on the R-36 Canal, with one 2.25 feet high by 2 feet wide pull up slide gate. The City generally operates this structure by fully opening the gate in anticipation of a storm event to lower the water level in the R-36 canal to minimize potential upstream flooding; otherwise, the gate remains closed. The City staff would like to determine if adding gates would help draw down the canal more quickly and increase conveyance capacity.

- R-36 Canal Drawdown Evaluation
    - To reduce impacts downstream of WCS-162 while improving peak conditions upstream of the structure, an evaluation was performed to determine the benefits of adding additional gates. The evaluation included calculating the drawdown time for the R-36 canal and the additional conveyance capacity provided by the additional gates.
    - The benefits of reducing time required to lower R-36 canal elevation by adding gates at WCS-162 upstream of the structure were assessed by performing a drawdown analysis. For the drawdown evaluation, the R-36 canal upstream of WCS-162 was assumed to be at the control elevation of the weir (elevation 18.3 feet NAVD88). The water level at the

canal was simulated by fully opening the existing gate with no additional flows coming into the canal. The existing condition drawdown simulation results indicates that it would take approximately 18 hours to lower the canal to elevation 15 feet.

- The canal drawdown simulation was repeated for one and two additional gates scenarios. The time required to drawdown R-36 canal will decrease to 11 hours by adding an identical gate. When 2 additional matching gates are provided, the time require to drawdown R-36 canal would decrease to 9 hours. Therefore, the total time required to drawdown R-36 canal (to elevation 15 feet) upstream of WCS-162 will be reduced by 7 and 9 hours by adding one and two additional gates respectively.

The mean annual, 5-year, and 10-year storm events were simulated using the updated existing condition model with 2014 survey information. The City's water control structure operation criteria were employed in these simulations. The gates are closed at the beginning of the simulation, and they will be fully open when Big Slough Canal stage at Tropicaire rises to Elevation 15.88 feet NAVD88.

Benefits of flood control upstream of WCS-162 during a storm event were evaluated by simulating the mean annual storm event starting at the drawdown stage levels (Elevation 15 feet NAVD88). For this evaluation, initial stages in R-36 Canal upstream of WCS-162 were set to the drawdown levels, i.e. simulated canal stages after 18 hours of drawdown simulation. The lower elevations will account for the additional available canal storage capacity upstream of WCS-162. During the lower initial condition simulation, the WCS-162 gate was assumed to be opened throughout the simulation. Model results with lowered initials were compared to the results with the normal initial stage, which is at the invert elevation (at elevation 18.29 feet NAVD88) of WCS-162 weir. Simulated results suggest that there will be no difference in peak stages in R-36 canal due to the lower initial canal stage. It should be noted that model results suggest the 50-foot wide weir at WCS-162 overtops by 2.6 feet conveying 328 cfs of peak flow across the structure during the mean annual storm event. The R-36 Canal upstream of WCS-162 holds approximately 30 acre-feet of storage capacity behind the gate, whereas more than 3,000 acre-feet of runoff volume is conveyed by the canal during the mean annual storm event. The additional available storage seems to be insignificant compared to the runoff conveyed by the canal during the storm event.

In addition, benefits of having one additional gate with the lowered R-36 canal stages upstream of WCS-162 were also evaluated. For this scenario, both gates (one existing and one additional BMP gate) were assumed to be fully opened throughout the simulation. Simulated results suggest that there will be no difference in R-36 canal max stages upstream of WCS-162 with an additional gate at the structure. As no difference in peak stages were predicted for the mean annual storm event, no other higher return period storm events (5-year and 10-year) were analyzed with additional gates.

In conclusion, providing one or two additional gates at WCS-162 will help to reduce the time required to draw down canal levels upstream of the structure. However, model results suggest that lower initial levels in R-36 canal upstream of the structure will provide no benefits in terms of reducing flooding at the upstream areas even for small storm events such as mean annual storm event. Modeling results suggest that there would be no adverse impacts downstream of WCS-162 due to the additional gate.

Price Boulevard LOS Improvements

Existing condition model results (May 2012 Governing Board approved model) predict that West Price Boulevard would intermittently flood between Locher Road and the Big Slough Canal during the 10, 25, and 100-year, 24-hour storm events. The West Price Boulevard stretch is identified as an arterial street that floods during the 100-year, 24-hour design storm event.

This arterial street is critical to stormwater emergency response since it provides access to emergency facilities such as North Port Utilities Building, North Port High School and Heron Creek Middle School. Therefore, the City of North Port requested further evaluation of the stretch of West Price Boulevard between North Biscayne Boulevard and the Big Slough Canal to provide BMP recommendations to meet the City of North Port LOS criteria. City Unified Land Development Code Chapter 18 Level of Service criteria for arterial roads states that flooding must be less than 6 inches, as measured at the outside edge of pavement in a 100-year, 24-hour design storm event.

Ardaman staff reviewed the May 2012 Governing Board approved model setup within the area of interest (AOI) to verify whether the current model adequately represents the 2014 condition. With desktop and field reconnaissance of the area, it was observed that a section of the surface and sub-surface drainage systems near the North Port High School had been recently updated. Ardaman recommended surveying the area of interest to better represent the existing condition. The survey data was provided by Van Buskirk/Fish & Associates, Inc.

Based on recent survey, stormwater runoff collected from the north and south swales of West Price Boulevard generally flows west from the North Port Utilities Building, whereas stormwater runoff from the remaining areas flows east from this location. Accumulated stormwater runoff going west from the North Port Utilities Building ultimately flows north via the Indian burial ground toward the R-32 canal. Stormwater runoff going east toward Big Slough is routed through a series of surface water features (ditches, swales and inlets) which connects to a sub-surface system along the north side of West Price Boulevard.

The May 2012 Governing Board approved model was updated using the 2014 survey provided by Van Buskirk/Fish & Associates, Inc. The revised 100-year storm event model results indicate that West Price Boulevard would not flood near the North Port High School as previously predicted. However, the stretch of West Price Boulevard north of Little Salt Spring would still flood by 0.4 feet at the crown during the 10-year storm event. Survey data indicates that road overtopping would occur at the lowest point (near the culvert crossing) at 17.3 feet NAVD88. The model predicted the 25-year and 100- year storm maximum stages at West Price Boulevard are 17.9 and 18.2 feet NAVD88 respectively.

The objective of this series of BMPs is to mitigate flooding along the stretch of West Price Boulevard near the Indian burial ground to meet the existing City of North Port LOS criteria. Five different BMP alternatives were considered.

Only the three alternatives that were determined to be effective in improving the LOS are described below:

- West Price Boulevard BMP 1- Dredging the R-24 and R-32 canals
    - This alternative would require: dredging 2,300 feet of R-24 canal and 1,800 feet of R-32 canal to add approximately 2 to 3 feet of depth; and installing one extra parallel 36-inch pipe at the existing culvert crossing, between Indian burial ground and the R-32 canal. The City is not allowed to disturb the 50-foot wide drainage right-of-way through the Indian burial ground.
    - Model results suggest that West Price Boulevard would not overtop during the 25-year storm event. In addition, this alternative would reduce flooding on some local streets (Dundee Ave, Surf Ave, and San Salvador Road) located north of R-32 canal.
    - The model predicted that the 100-year maximum stage at West Price Boulevard will be reduced from 18.2 to 17.5 feet NAVD88. West Price Boulevard would still overtop by 0.2 feet over the crown of the road at the lowest section during the 100-year storm event. However, the road would be passable per City of North Port LOS criteria. Model results also indicate that there will be no adverse impacts at downstream areas.
- West Price Boulevard BMP 2 - Raising the Road
    - This alternative would involve raising approximately 1,900 feet of West Price Boulevard to an elevation of 18.5 feet NAVD88. Survey data suggests that the lowest segment of the road, which is located at the culvert crossing, needs to be raised by 1.2 feet to reach an elevation of 18.5 feet NAVD88.
    - Model results suggest that the 100-year peak stages upstream and downstream of the culvert across West Price Boulevard would be 18.2 feet NAVD88 with this alternative. The model predicted the 100-year maximum stage at West Price Boulevard is below the recommended raised road crown elevation of 18.5 feet NAVD88. The peak stage model results suggest that there will be no adverse impacts or increase in stages upstream or downstream of the improvement for any modeled storm event.
    - Additional right-of-way requirement to raise the road and its availability should be thoroughly assessed prior to selecting this BMP alternative.
- West Price Boulevard BMP 3 - Dredging the R-32 and R-24 canals and Raising the Road
    - This alternative incorporates all of the aforementioned West Price Blvd improvements.
    - Model results suggest that the 100-year peak stage upstream of the culvert across West Price Boulevard would be 17.6 feet NAVD88 with this alternative. This alternative would require raising approximately 950 feet of West Price Boulevard to elevation 18.0 feet NAVD88. Compared to BMP 2 improvements, this alternative would reduce the required road improvement length by half at a lower elevation (6 inches lower than BMP 2). Like BMP 1 and BMP 2, the peak stage model results suggest that there will be no adverse impacts or increase in stages upstream or downstream of the road improvement.

In addition to the three previously described BMP alternatives, a few other BMPs were evaluated. However, modeling results suggest that theses BMPs would not mitigate the flooding conditions along the evaluated stretch of West Price Boulevard.

- One of the other BMPs evaluated was to install a 24-inch pipe at the south side of West Price Boulevard near the culvert that would run approximately 1,400 feet to the east and connect to the existing sub-surface system inlet. This BMP did not show any improvements since the BMP pipe is too long and there was not sufficient hydraulic gradient available to convey the necessary flow rate.
- Another BMP evaluated was to provide a 20-foot wide cut/swale that would connect the flooded area south of West Price Boulevard to the south towards the Little Salt Spring basin. 25-year storm event model results suggest that this BMP alternative would lower peak stages at West Price Boulevard only by 0.2 feet. However, the road would still flood during this event. Also, this BMP may raise environmental concerns considering that it would require diverting stormwater runoff from the road towards Little Salt Spring basin.

Conclusions

It was recommended that the City of North Port purchase the small number of habitable structures in which flooding is predicted for the 100-year event. Purchasing the affected properties may be more cost effective than implementing BMPs evaluated under the WMP project.

Status of Recommendations

The 2012 WMP project did not result in a plan for improvements.

<u>The Big Slough Flood Reduction Study (current)</u>

The Big Slough Flood Reduction Study will build upon the above prior work to advance previously developed concepts and develop original ideas to mitigate flooding. The City of North Port has also provided a list of BMP concepts for consideration. These and other concepts will be the subject of discussion between the Consultant team and City staff prior to evaluation.

Appendix E

Task 1.2 Big Slough Flood Reduction Study, Definition of Existing Flooding Problems

DeLoach Engineering Science, PLLC., January 2017

MEMORANDUM

To: Elizabeth Wong, PE (City of North Port)
From: Dave DeLoach, PE; Trillian Baldassari, PE
Copy: Rod Ghioto, PE
File: 14-00400-00

Subject: Task 1.2 Big Slough Flood Reduction Study, Definition of Existing Flooding Problems

January 30, 2017

Definition of Existing Flooding Problems

This memorandum briefly describes existing flooding problems that are routinely experienced in portions of the Big Slough watershed, specifically along Myakkahatchee Creek near I-75 and within the Jockey Club. Information presented in this memorandum addresses the following elements of the Project Plan (Task 1.2).

- Define Existing Flooding Problems
  - Confirm Ability to Reproduce WMP Project Model Results
    - Simulations of Mean Annual to 100-Year Events
    - Flood Mapping and Comparison to Ardaman Results
    - Update Model to include a Small Number of Prior Conveyance Improvements
    - Flood Mapping and Comparison of Updated Model to Ardaman Results
  - Characterize Local Flooding Conditions
    - Myakkahatchee Creek at I-75
    - Jockey Club

<u>Ability to Reproduce WMP Project Model Results</u>

As discussed in the Big Slough Flood Reduction Study Project Plan, this project builds upon prior work performed and utilizes modeling tools previously developed by others under the Southwest Florida Water Management District (SWFWMD) Watershed Management Program (WMP). Before using those modeling tools for evaluation and development of flood reduction alternatives, it is important to confirm the ability to reproduce simulation results and inundation mapping of previous studies.

Simulations of Mean Annual to 100-year Events

Simulations were performed for the mean annual, 10-year, and 100-year 24-hour design storm events using both the 2012[1] and 2014[2] Versions of the 2004 Condition model (by Ardaman). Model network and runtime control files were retrieved directly from WMP project deliverable folders and used to perform the simulations. No changes were made to the retrieved model parameters or runtime controls.

Computed peak stages for each simulation were tabulated and compared to results taken directly from files provided as deliverables by Ardaman under the WMP project. Table 1 presents comparisons of Ardaman results to DES results for each design storm event and model version. Only those nodes with differences greater than 0.01-foot are shown.

Table 1 - Comparison of Computed Peak Stage for 24-Hour Design Storm Events, 2012 to 2014 Versions (A=Ardaman, D=DES)

Node	Version 2012									Version 2014								
	2.33-Yr			10-Yr			100-Yr			2.33-Yr			10-Yr			100-Yr		
	A	D	Δ	A	D	Δ	A	D	Δ	A	D	Δ	A	D	Δ	A	D	Δ
NU9091	26.42	26.42	-	26.65	26.65	-	26.92	26.91	***-0.01***	26.42	26.42	-	26.65	26.65	-	26.91	26.91	-
NB4856	18.71	18.73	***0.02***	20.40	20.40	-	21.39	21.39	-	18.71	18.71	-	20.40	20.40	-	21.39	21.39	-

Computational differences between Ardaman and DES results are very few in number and very small in magnitude, and may result from different runtime environments (computers, operating systems, etc.). It is possible that some model parameters or controls were slightly different at the time that the Ardaman simulations were performed and results compiled as compared to those that made their way into final project deliverables. Regardless, **simulation results indicate that DES can replicate Ardaman results reasonably well with the files retrieved from WMP project deliverables**. Mapping of 100-year inundation areas was performed and confirmed the ability to replicate prior Ardaman floodplain mapping.

Differences between the 2012 and 2014 versions of the model, as depicted in Figure 1 and Table 2, are substantially larger in magnitude than the foregoing computational differences and are owing to several specific model updates that were performed by Ardaman over the period from 2012 to 2014. These differences in computed peak stage reflect modifications that were made to the conveyance system (e.g., accounting for drainage improvements in the vicinity Price Boulevard) and/or changes in the accuracy of the model input data in describing certain features (e.g., using field survey data collected by a PLS in the vicinity of WCS-162). The 2014 results are considered more representative of conditions in the watershed in those local areas that were updated, but it should be noted that both the 2012 and 2014 models generally reflect a 2004 land use condition.

[1] SWFWMD Governing Board approved (May 22, 2012)
[2] Big Slough Watershed Study, K883 (October 10, 2014)

Table 2 - Difference Between Computed Peak Stages for 2012 and 2014 Model Versions

Node	2.33-Yr			10-Yr			100-Yr		
	2012	2014	**Δ**	2012	2014	**Δ**	2012	2014	**Δ**
NB0905	16.12	15.54	***-0.58***	16.62	16.23	***-0.38***	16.89	16.68	***-0.20***
NB0907	16.12	15.93	***-0.19***	16.62	16.23	***-0.38***	16.94	16.69	***-0.26***
NB0934	15.57	13.98	***-1.58***	15.87	14.99	***-0.88***	16.26	15.54	***-0.72***
NB0935	15.56	14.93	***-0.64***	15.85	15.25	***-0.60***	16.16	15.57	***-0.59***
NB0936	15.89	15.60	***-0.29***	16.16	15.65	***-0.51***	16.36	15.70	***-0.67***
NB0938	16.42	15.78	***-0.64***	16.47	16.06	***-0.42***	16.53	16.79	***0.26***
NB0943	14.27	14.27	-	14.95	14.95	-	16.09	15.42	***-0.68***
NB0945	14.93	14.93	-	15.14	15.14	-	16.15	15.51	***-0.64***
NB9035	18.07	19.37	***1.30***	18.10	19.40	***1.30***	18.14	19.43	***1.29***
NB9045	17.54	16.36	***-1.18***	17.94	17.27	***-0.67***	18.07	17.88	***-0.20***
NB9073	16.89	14.58	***-2.31***	17.03	16.02	***-1.01***	17.17	16.86	***-0.31***
NB9080	16.89	14.37	***-2.52***	17.03	16.01	***-1.02***	17.17	17.02	***-0.15***
NB9090	16.16	14.43	***-1.73***	16.27	14.50	***-1.77***	16.48	16.13	***-0.34***
NB9095	16.48	16.48	-	16.59	16.58	-	16.81	16.66	***-0.15***
NB9100	16.14	12.30	***-3.84***	16.19	14.48	***-1.71***	16.37	16.13	***-0.23***
NB9110	15.22	14.11	***-1.11***	15.87	14.16	***-1.71***	16.26	15.52	***-0.74***
NB9120	14.30	12.11	***-2.19***	15.87	13.44	***-2.43***	16.26	15.52	***-0.74***

Update of Selected Model Parameters Using Existing Available Data

The base model for this project was planned to be the SWFWMD Governing Board-approved 2012 Version of 2004 Condition model. City of North Port staff requested, and DES agreed, that a specific set of model features be updated in that 2012 Version of the model, as follows:

- add a single 24-inch PVC pipe from Public Works site to Creighton WW (check)
- utilize available as-built survey data and add two (2) gates at WCS 101
- incorporate available survey and storm pipe data in Price Blvd area
- change 30-inch ADS pipe, flowing from Price Blvd to R-32, to 36-inch ADS
- add three (3) 48-inch CMP beneath Appomattox Blvd (Stantec plans available)

It is evident from review of prior WMP project reports that many of these same revisions were already implemented by Ardaman over the period from 2012 through 2014, with the SWFWMD Governing Board-approved 2012 Version of 2004 Condition model as a base. In some cases, during Ardaman's development of the 2014 Version of 2004 Condition model, design-level (not "as-built") information was employed and will need to be revised. However, in other cases, site-specific field survey data was collected by a Professional Land Surveyor (PLS) and employed in Ardaman model updates. Specifically, Ardaman incorporated field survey data that was collected by a PLS at Water Control Structure WCS-162 and throughout the vicinity of Price Boulevard.

In the Ardaman WMP Project report, entitled "North Port/Big Slough Watershed Management Program (K883), Work Order #4, Completion Report for Task 1.1.3.7b – Formulation and Evaluations of BMPs for WCS-162" (Sep 2, 2014), reference is made to model revisions near WCS-162:

> "To evaluate BMPs at WCS-162, Ardaman requested to survey the structure to better understand the geometry of the structure and canal with the purpose of assessing availability of adequate space for additional gates. The survey data provided by Van Buskirk/Fish & Associates, Inc. is included in Attachment A, and the structure pictures are provided in Attachment B. The existing condition model was revised using the latest (2014) survey information for this BMP Evaluation. The update model simulated results rendered no change in model results compared to the May 2012 Governing Board approved model."

In the Ardaman report, entitled "North Port/Big Slough Watershed Management Program (K883), Work Order #4, Completion Report for Task 1.1.3.7b – Formulation and Evaluation of BMPs for Price Boulevard to Improve LOS" (Sep 22, 2014), reference is made to model revisions along Price Boulevard:

> "Ardaman staff reviewed the May 2012 Governing Board approved model setup within the area of interest (AOI) to verify whether the current model adequately represents the 2014 condition. With desktop and field reconnaissance of the area, it was observed that a section of the surface and sub-surface drainage systems near the North Port High School had been recently updated. Ardaman recommended surveying the AOI to better represent the existing condition…"

> "Based on recent survey, stormwater runoff collected from the north and south swales of West Price Boulevard generally flows west from the North Port Utilities Building, whereas stormwater runoff from the remaining areas flows east from this location. Accumulated stormwater runoff going west from the North Port Utilities Building ultimately flows north via the Indian burial ground toward the R-32 canal. Stormwater runoff going east toward Big Slough is routed through a series of surface water features (ditches, swales and inlets) which connects to a sub-surface system along the north side of West Price Boulevard…"

> "The May 2012 Governing Board approved model was updated using the 2014 survey provided by Van Buskirk/Fish & Associates, Inc. The revised 100-year storm event model results indicate that West Price Boulevard would not flood near the North Port High School as previously predicted. However, the stretch of West Price Boulevard north of Little Salt Spring would still flood by 0.4 feet at the crown during the 10-year storm event."

It is evident from those prior reports that the model network input data changes, particularly in the Price Boulevard area, were quite extensive. It is also understood that most of the other requested model updates (see bulleted items, above) were already incorporated and tested prior to development of the September 22, 2014 version of the Existing Condition model by Ardaman.

To expedite the 2016 model update, the September 22, 2014 version of the 2004 Condition model was used as a starting point. An added benefit to using this model as a starting point is that model element naming conventions are preserved and will match all references in reports, notes, and correspondence generated by Ardaman during the period from 2012 through 2014.

Rather than replicating modifications already made, DES staff reviewed and supplemented the 2014 model revisions as discussed in the following.

- **Add a single 24-inch PVC pipe from Public Works site to Creighton WW (check).**
  The Ardaman Sep 22, 2014 model was found to contain the 24-inch PVC pipe. Specifically, model Reach RI0016 from Node NI0016 to Node NI0020 contains a 77-foot 24-inch pipe with upstream invert 20.21 feet, NAVD, and downstream invert 17.65 feet, NAVD. A Network_Arc feature was added to the project geodatabase as the pipe was not included in the Ardaman geodatabase.

- **Utilize available as-built survey data and add two (2) gates at WCS 101**
  The Ardaman Sep 22, 2014 model does not contain up to date control structure data for the additional gates. As-built drawings provided to DES by the City of North Port were used to update model reach data for the gates as well as to correct adjacent weir lengths. Specifically, no changes were made to RB1060A representing the four original gates, RB1060B was added to represent the two new gates, and weir reaches RB1060E, F, and G were replaced with RB1060C. Network_Arcs were edited in the project Geodatabase to reflect these changes.

- **Incorporate available survey and storm pipe data in Price Blvd area**
  The Ardaman Sep 22, 2014 model was found to incorporate site-specific field survey data collected in the Price Boulevard area. Model input was compared to survey drawings (Van Buskirk / Fish & Associates, June 17, 2014) for consistency, and no revisions were deemed necessary.

- **Change 30-inch ADS pipe, flowing from Price Blvd to R-32, to 36-inch ADS**
  The Ardaman Sep 22, 2014 model was found to correctly reflect a 36-inch diameter pipe with inverts as indicated on field survey Sheet 5 of 7 Van Buskirk / Fish & Associates dated June 17, 2014.

- **Add three (3) 48-inch CMP beneath Appomattox Blvd (Stantec plans available)**
  The Ardaman Sep 22, 2014 model does not include these conveyance features. Three (3) 48-inch corrugated metal pipes (CMPs) were added to the model input data set per information contained in plans provided to DES by the City of North Port. Specifically, model Reach RH0110A was added from Node NH0110 to Node NH0130, containing three 48” CMPs with upstream inverts 3.09, 2.92, and 2.87 feet, NAVD, and downstream inverts 2.51, 2.79, and 2.76 feet, NAVD. Information was taken from Stantec design drawings provided by the City of North Port for Phase 3 Reclaimed Water Main Extension Appomattox Drive (2014), assuming NAVD and estimating 100-ft pipe lengths. One Network_Arc was added to the project Geodatabase to reflect pipe connectivity.

Flood Mapping and Comparison of Updated Model to Ardaman Results

Simulations were performed for the mean annual, 10-year, and 100-year 24-hour design storm events to allow comparison of the 2016 Version (DES) to the 2014 Version (Ardaman) of the 2004 Condition. The sole differences between the 2016 and 2014 versions of the model include WCS-101 control structure improvements and three 48-inch CMP culverts at Appomattox Boulevard using as-built information.

Differences in computed peak stage between the 2014 and 2016 versions of the model are depicted in Figure 2 and Table 3. Mapping of inundation areas was performed to confirm the very small spatial extent of changes resulting from the revisions. Stage differences, found only in results of simulations of the 100-year storm event, are related to model stability and result from a change in the computational time step from 0.1 seconds (for the 2014 model) to 1 second (for the 2016 model).

Table 3 - Comparison of Computed Peak Stage for 24-Hour Design Storm Events, 2014 to 2016 Versions (2014 Version by DES)

Node	2.33-Yr			10-Yr			100-Yr		
	2014	2016	***Δ***	2014	2016	***Δ***	2014	2016	***Δ***
NE7053	13.07	13.07	-	13.68	13.68	-	14.19	14.32	***0.12***
NS5578	17.65	17.65	-	17.99	17.99	-	18.30	18.51	***0.21***
NS2810	20.91	20.91	-	21.07	21.07	-	21.24	21.13	***-0.11***
NU9087	26.95	26.95	-	27.14	27.14	-	27.13	27.31	***0.18***

Characterize Local Flooding Conditions

The City has routinely experienced flooding in the Big Slough Watershed. Two such flood zones are the areas near Myakkahatchee Creek at I-75 and the areas in and around the Jockey Club.

Myakkahatchee Creek at I-75

The Myakkahatchee Creek at I-75 Study Area covers approximately 335 acres adjacent to the Myakkahatchee Creek. The area is bounded on the east by Sumter Boulevard and traversed from east to west by Interstate Highway 75. Figure 2a depicts existing mean annual and 10-year floodplains within the I-75 study area adjacent to Myakkahatchee Creek, both north and south of the interstate, as developed during the North Port/Big Slough WMP project. Figure 2b shows sub-basin delineations and the model network features used to simulate response to rainfall during the WMP project. Figure 2c depicts hydrologic soils groups.

Routine flooding of the area is due to Myakkahatchee Creek exceeding its banks in low areas of poorly drained soils. Comparison of hydrologic soil groups to areas of inundation suggest that the slough has historically flooded these low areas on a frequent basis. Alternative development will focus on reducing flows in this section of Myakkahatchee Creek, through diversion, storage, bypass, or other means.

Myakkahatchee Creek at Jockey Club

The northern section of the Jockey Club Study Area covers approximately 62 acres and is bounded on the north by Appomattox Drive, on the west by Pan American Boulevard, and on the east by Myakkahatchee Creek. The southern section of the Jockey Club Study Area near Ketona Road is also included and is approximately 82 acres in size. Figure 3a depicts existing mean annual and 10-year floodplains within the Jockey Club study area adjacent to Myakkahatchee Creek, both north and south of the interstate, as developed during the North Port/Big Slough WMP project. Figure 3b shows sub-basin delineations and the model network features used to simulate response to rainfall during the WMP project. Figure 3c depicts hydrologic soils groups.

Flooding may result from either backwater effects or local collection system capacity, depending upon the event. Recent improvements to the collection system (ditch lining) may improve capacity during short-duration local rainfall events. Alternative development will focus on improving flooding conditions related to backwater conditions.

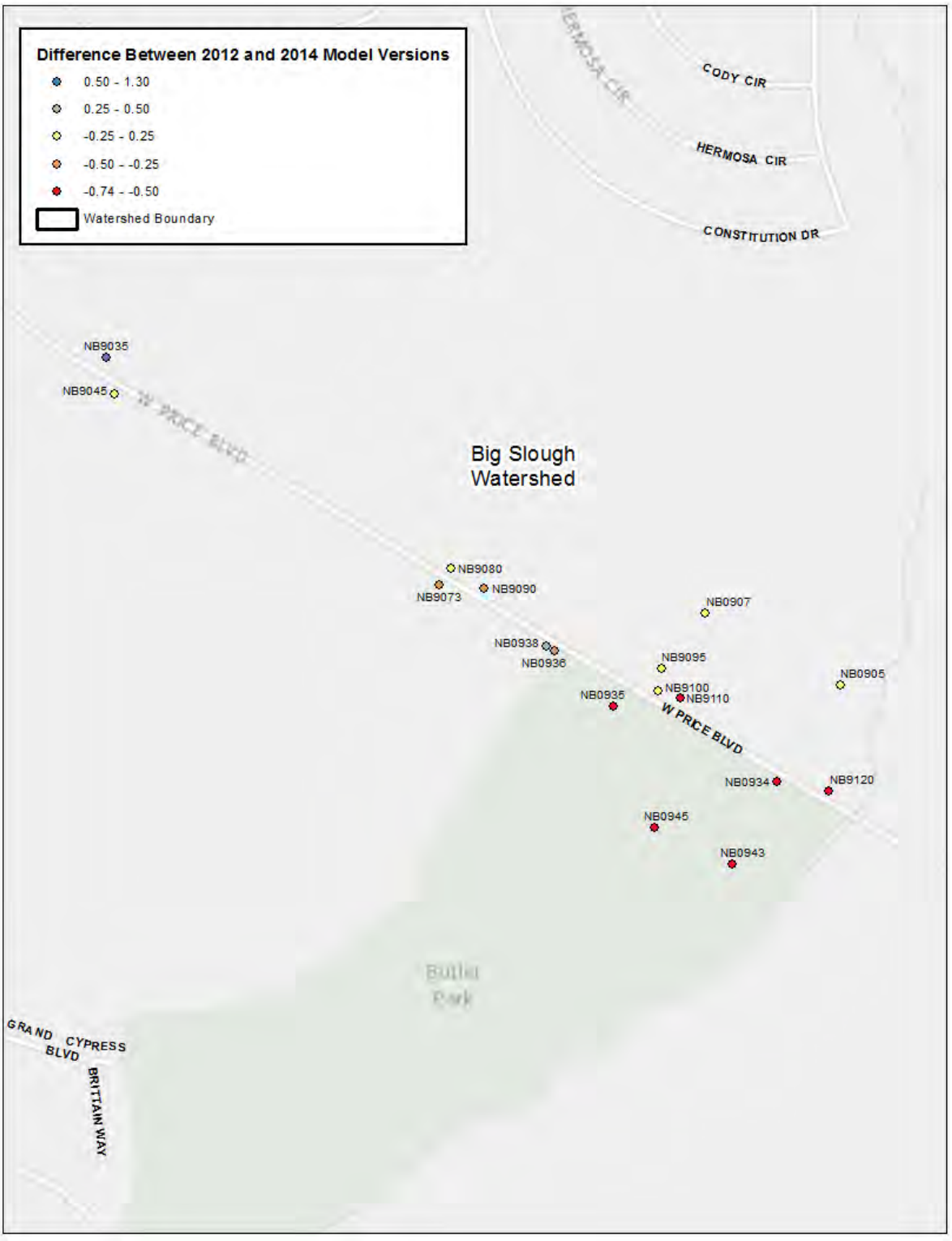


Figure 1 – Locations of Differences in Computed Peak Stages between 2012 and 2014 Model Versions

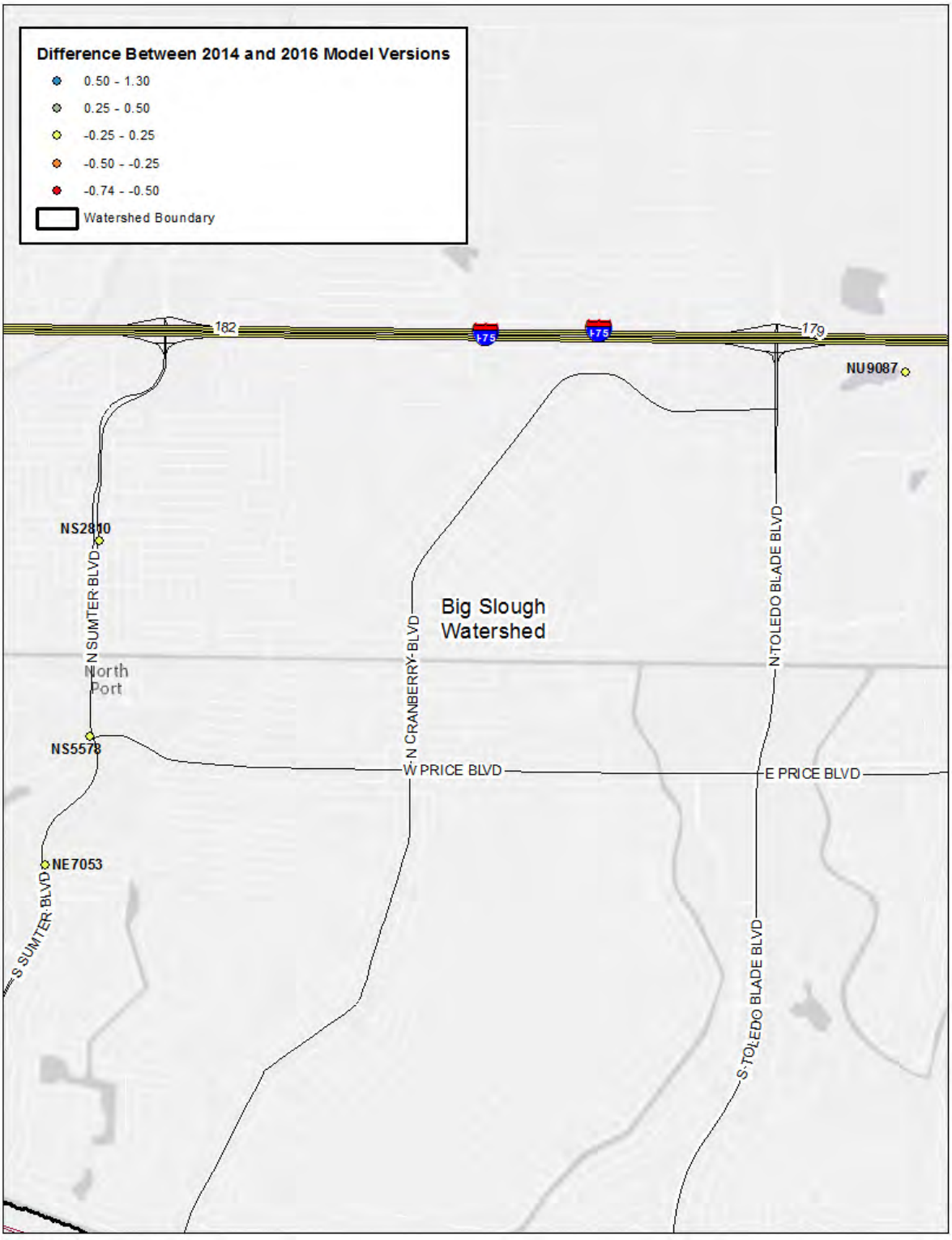


Figure 2 - Locations of Differences in Computed Peak Stages between 2014 and 2016 Model Versions

Figure 3a: I-75 Study Area, Mean Annual and 10-Year Floodplains

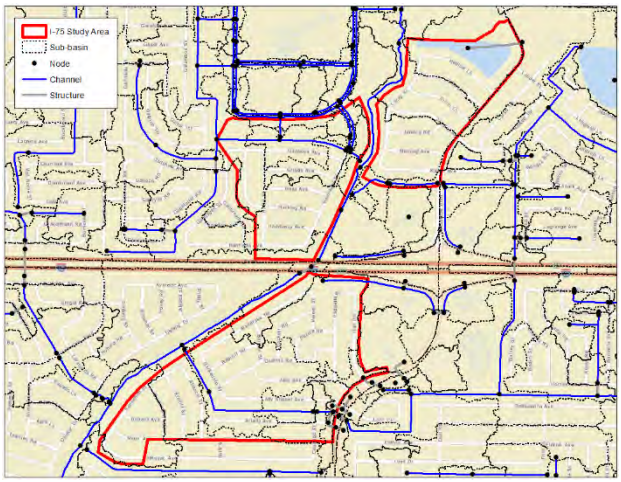


Figure 3b: I-75 Study Area, Model Network

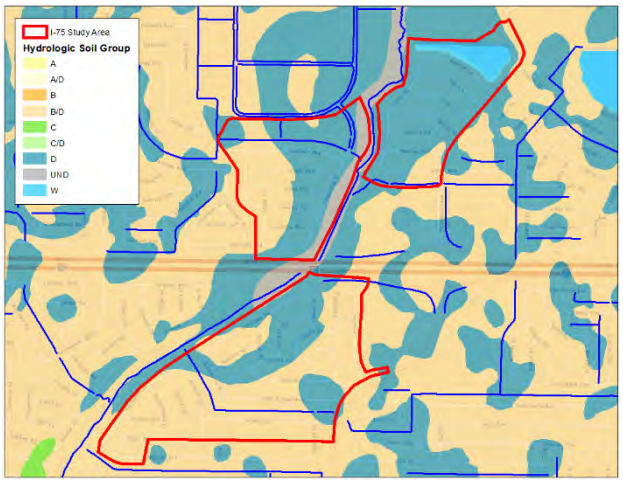


Figure 3c: I-75 Study Area, Hydrologic Soil Groups

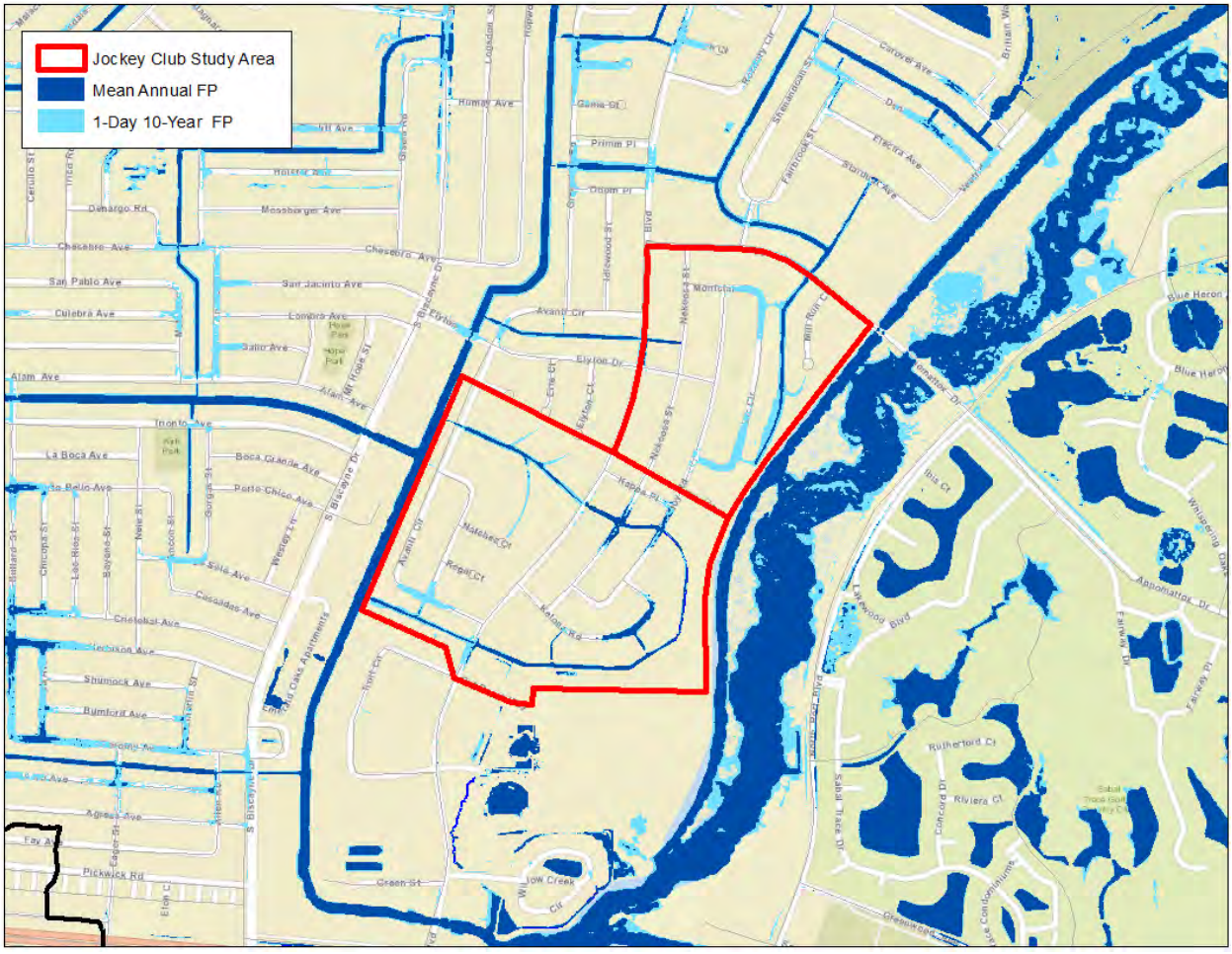


Figure 4a: Jockey Club Study Area, Mean Annual and 10-Year Floodplains

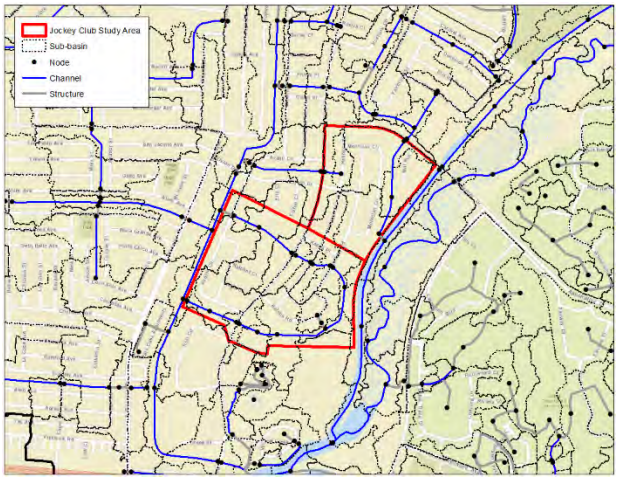


Figure 4b: Jockey Club Study Area, Model Network

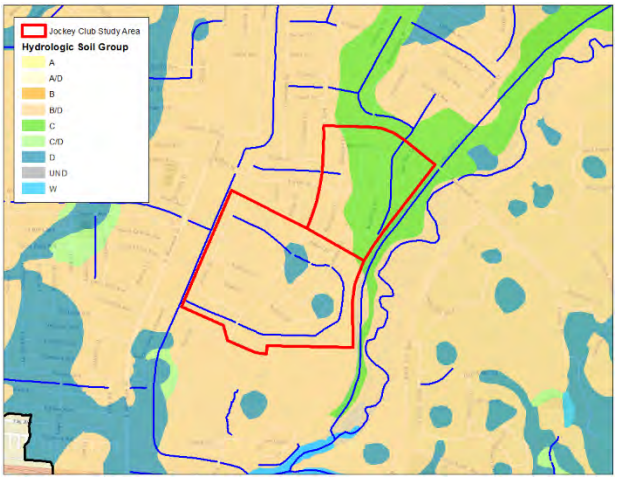


Figure 4c: Jockey Club Study Area, Hydrologic Soil Groups

Appendix F

Task 1.4 Big Slough Flood Reduction Study, Potential Solutions for Hydraulic Evaluation

DeLoach Engineering Science, PLLC., January 2017

MEMORANDUM

To: Elizabeth Wong, PE (City of North Port)
From: Dave DeLoach, PE; Trillian Baldassari, PE
Copy: Rod Ghioto, PE
File: 14-00400-00

Subject: Task 1.4 Big Slough Flood Reduction Study, Potential Solutions for Hydraulic Evaluation

January 30, 2017

Potential Solutions for Hydraulic Evaluation

As discussed in the Big Slough Flood Reduction Study Project Plan, this project builds upon prior work performed while advancing and supplementing flood reduction concepts previously developed by others. This memorandum briefly summarizes potential solutions which have been considered, including data needs and constraints on implementation, and identifies a specific set of alternatives selected from among the potential solutions for hydraulic evaluation. Information presented in this memorandum addresses the following elements of the Project Plan (Task 1.3).

- Formulate List of Potential Solutions for Hydraulic Evaluation
  - Describe Each Potential Solution and Any Known or Expected Obstacles to Success
  - Identify Additional Data Needs to Support Hydraulic Evaluation
  - Meeting to Review and Discuss List of Potential Solutions
  - Select a Set of Alternatives from Among Potential Solutions for Hydraulic Evaluation

<u>Potential Solutions and Obstacles to Success</u>

One-page descriptions of potential solutions (Attachment 1) were distributed for review and discussion by team members. These solutions may be applicable to either Task 1 Myakkahatchee Creek at I-75 and Jockey Club areas or Task 2 regional flood reduction objectives, or both.

Flood reduction solutions that were formulated generally included:

- Internal Flow Diversion and Increased Conveyance Capacity
- External Flow Diversion
- Offsite Storage
- Gate Operations
- Floodproofing
- Property Acquisition
- Elevation of Roadways

Meeting to Review and Discuss List of Potential Solutions

A project team meeting was held on December 20, 2016 to discuss potential solutions to achieve flood reduction and to develop a selected set of alternatives for hydraulic evaluation. For each concept, prior work and findings were discussed and expected obstacles to success were considered. Comments from the meeting are included in Attachment 2. From this collaboration, a set of alternatives were selected by the team for Task 1 and Task 2 hydraulic evaluations. Hydraulic evaluations will serve to better inform the team as to effectiveness of the individual solutions and will point the way toward a preferred plan for improvements.

Selected Alternatives for Hydraulic Evaluation

The following set of alternatives were selected by the team for hydraulic evaluations.

Internal Flow Diversion and Increased Conveyance Capacity

- Parallel Relief Channel Construction

  A new, parallel canal could be constructed from the northern City boundary to Price Boulevard along Tier 1 and Tier 2 lots that have been acquired on the west side of the Myakkahatchee Creek. The additional conveyance may reduce flow rate and thus peak stages along the main channel from start to end of the parallel relief channel.

- Channel Improvements along R-580

  The R-580 waterway's bottom profile could be reconfigured, creating a more uniform and hydraulically efficient conveyance way. Improvement of the R-580 Waterway would induce more flow eastward from Big Slough along the City's northern boundary toward Creighton Waterway, resulting in reduced flows and flood stages in Myakkahatchee Creek.

- R-36 Improvements to South of WCS-101

  A whole series of improvements could be made to canal segments and structures to enhance the overall conveyance capacity of the R-36 waterway system. The additional stormwater conveyance capacity may induce higher westward flow out of Big Slough at the north boundary of the City. Diverting those higher flows southward to WCS-101 would reduce flow and stages along the more flood prone segments of Myakkahatchee Creek.

- Snover Waterway to Cocoplum Waterway

  Improvements could be made to existing structures along Snover Waterway and beneath Price Boulevard to increase flow through canals that connect with Cocoplum Waterway. The additional conveyance capacity may induce higher eastward flow out of Big Slough into Snover Waterway. Diverting those higher flows southward to Cocoplum Waterway would reduce flow and stages along the more flood prone segments of Myakkahatchee Creek.

- Other Miscellaneous Improvements

  Canals and structures throughout the area will be reviewed for opportunities to increase conveyance.

External Flow Diversion

- Connection to Deer Prairie Slough

  Stormwater flows could be diverted westward to the adjacent Deer Prairie Slough watershed, reducing flow through the City. Several variations could be considered, including gravity and pumped diversions both with and without added storage facilities.

- Enhanced Discharges Along Southern Boundary to Port Charlotte – Tidal Outfalls Only

  Structures located within the Cocoplum Waterway and discharging beneath Hillsborough Boulevard could be improved to facilitate increased discharges into the adjacent Port Charlotte conveyance system. Additional conveyance capacity would effectively divert stormwater southward and may reduce flooding throughout the southern portion of the City.

Offsite Storage

- Constrain Inflows to City with Increased Upstream Floodplain Storage

  Raise existing earthen berms on the northwest City boundary at the intersection of Big Slough canal with R-36 and R- 580 waterways. Also, raise earthen weirs farther north at the intersection of Big Slough canal and Power Line Road. Improvements would leave the Big Slough canal as the only conveyance system into the western portion of the City. Inflows would be reduced, dropping peak stages along Myakkahatchee Creek.

- Creation of Upstream Detention, Reservoirs, or Joint Use Facilities

  One or more detention ponds, reservoirs, or joint-use facilities could be constructed to provide offsite upstream stormwater detention. The facilities would reduce inflow rates and thus peak stages along Myakkahatchee Creek.

Acquisition

- Purchase of Flood Prone Lands and/or Flood Prone Structures

  Some communities turn to property acquisition to mitigate flood risk by establishing permanent, public open space and to get homeowners in flood-prone areas permanently out of harm's way. In North Port, many lots have already been acquired on the west side of the Myakkahatchee Creek to serve as a linear park. Additional acquisition may be considered to remove other lands and/or structures from the 100-year floodplain. Removal of those properties would reduce future flood-related damages but would not impact flood levels.

<u>Additional Data Needs to Support Hydraulic Evaluation</u>

No additional data needs were identified during the meeting. Additional information will be gathered during subsequent meetings, such as regarding the Deer Prairie Slough restoration project. Field survey will be postponed until needed during Task 1.8.1 Finalize Recommended Plan and Project Deliverables.

Attachment 1: Team Meeting – Discussion Sheets

The following one-page descriptions of potential solutions were distributed for review and discussion at the December 20, 2016 team meeting.

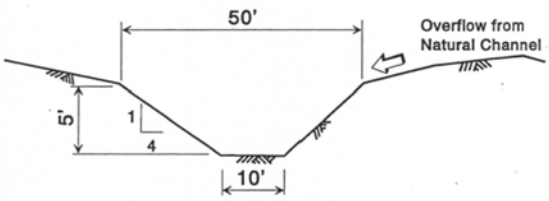
Increased Conveyance Capacity - Parallel Relief Channel Construction

Description and Potential Performance Improvement: A new, parallel canal could be constructed from the northern City boundary to Price Boulevard along Tier 1 and Tier 2 lots that have been acquired on the west side of the Myakkahatchee Creek. The additional conveyance may reduce flow rate and thus peak stages along the main channel from start to end of the parallel relief channel.

Prior Work Performed: The relief channel under consideration by CDM (1993) would have reached from the northern boundary of the city to the Snover waterway. The relief channel was conceived to act as a parallel conveyance for peak storm flows and be integrated into a linear park system along the Big Slough. CDM proposed that the channel would be about be 5 feet deep, have gentle grassed side slopes, and would be dry except during extreme storm events. The concept was brought forward as a main component of the 1993 master plan for improvements but was never constructed, apparently due to environmental permitting issues.

Constraints on Implementation: While the relief channel would be constructed within Tier 1 and Tier 2 lots that have been (or are being) acquired by the City, not all lands are currently in City ownership. Also, no improvements were proposed by CDM at the Tropicaire or I-75 crossings to accommodate reconfiguration of the main and parallel relief channels, and this may be a point of greater focus by DES given concerns that hydraulic deficiencies at those two crossings may have contributed to past flooding. Construction impacts to existing wetlands would likely be significant and require mitigation. Depending on the design of the parallel relief channel, it is possible that some wetlands would be created by the project, but it is unlikely that impacts would be entirely offset by the channel design and at least some wetland mitigation would need to be performed offsite. Also, depending on design performance, any reduction in flow attenuation along the main channel may result in higher flows downstream of the relief channel, which would need to be addressed by other means (i.e., downstream improvements).

Data Needs for Evaluation: none – DES will employ the existing watershed model, terrain information, and parcel ownership data to perform a feasibility evaluation of this flood reduction concept.



Parallel Relief Channel (as Conceived by CDM, 1993)

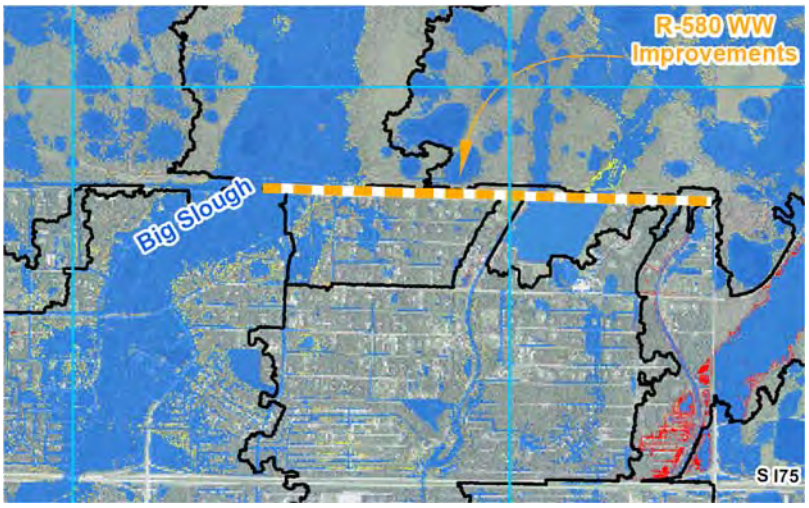
Diversion of Flow within North Port Drainage System - Channel Improvements along R-580

Description and Potential Performance Improvement: The R-580 waterway's bottom profile could be reconfigured, creating a more uniform and hydraulically efficient conveyance way. Improvement of the R-580 Waterway would induce more flow eastward from Big Slough along the City's northern boundary toward Creighton Waterway, resulting in reduced flows and flood stages in Myakkahatchee Creek.

Prior Work Performed: The channel improvements under consideration by Ardaman (2014) assumed a flat ditch along its entire length at elevation 15.0 feet, NAVD. The current bottom sags to elevation 15.0 feet at its mid-point and reaches 17.7 feet and 23.0 feet at its western and eastern ends, respectively. Results indicated small improvements (peak stage reductions) near Big Slough. However, inducing additional flow through Creighton Waterway caused additional flooding near I-75.

Constraints on Implementation: While channel improvements would be contained within existing right of way boundaries along the R-580 waterway, construction access may require additional temporary easements. There would likely be temporary construction impacts to existing wetlands. Subsurface conditions are not well-defined and there may be unknown utility conflicts or other issues that will need to be addressed by the waterway improvement design. Also, depending on hydraulic performance, any increase in conveyance capacity of the waterway may result in higher stages and flows downstream along the Creighton Waterway which would need to be addressed by other means (i.e., additional downstream improvements).

Data Needs for Evaluation: none – DES will employ the existing watershed model, terrain information, and parcel ownership data to perform a feasibility evaluation of this flood reduction concept.



R-580 Waterway Improvements (as Conceived by Ardaman, 2014)

Increase Conveyance Capacity - Channel Improvements along R-24 and R-32

Description and Potential Performance Improvement: Dredging of the R-24 and R-32 waterways could add two to three feet of depth, creating more hydraulically efficient conveyance ways downstream of Price Boulevard. Improvement of the waterways would induce more flow eastward toward Big Slough and reduce flooding along Price Boulevard and on some local streets located north of the R-32 canal.

Prior Work Performed: The channel improvements under consideration by Ardaman (2014) assumed dredging 2,300 feet of R-24 canal and 1,800 feet of R-32 canal to add approximately 2 to 3 feet of depth; and installing one extra parallel 36-inch pipe at an existing culvert crossing located between an Indian burial ground and the R-32 canal. Results indicated that West Price Boulevard would not overtop during the 25-year storm event and flooding would be reduced on some local streets (Dundee Ave, Surf Ave, and San Salvador Road) located north of R-32 canal. The model predicted that the 100-year maximum stage at West Price Boulevard will be reduced from 18.2 to 17.5 feet NAVD88. West Price Boulevard would still overtop by 0.2 feet over the crown of the road at the lowest section during the 100-year storm event. However, the road would be passable per City of North Port LOS criteria. Model results also indicated that there will be no adverse impacts in downstream areas.

Constraints on Implementation: While channel improvements would be contained within existing right of way boundaries along the R-24 and R-32 waterways, construction access may require additional temporary easements. There would likely be temporary construction impacts to existing wetlands. Subsurface conditions are not well-defined and there may be unknown utility conflicts or other issues that will need to be addressed by the waterway improvement design. It should be noted that the City is not allowed to disturb the 50-foot wide drainage right-of-way through the Indian burial ground.

Data Needs for Evaluation: none – DES will employ the existing watershed model, terrain information, and parcel ownership data to perform a feasibility evaluation of this flood reduction concept.

R-24 and R-32 Waterway Improvements (as Conceived by Ardaman, 2014)

Increased Conveyance Capacity - Increased Culvert Capacity of R-36 Canal at I-75

Description and Potential Performance Improvement: The existing R-36 canal culvert crossing at I-75 is comprised of two (2) 7.5' x 6' box culverts and could be improved by placing additional parallel box culverts to provide greater conveyance capacity. Increasing the capacity of the R-36 Canal at I-75 may reduce water levels in upstream areas.

Prior Work Performed: Ardaman's 2014 existing condition model results indicated that more than two feet of head difference occurs across this structure during the 100-year storm event. Under proposed BMP conditions, model results indicated that a peak stage reduction of up to 0.6 feet occurs upstream of the crossing. However, a stage increase of approximately 0.6 feet was found to result in downstream areas. Mitigation of flooding in downstream areas was beyond the scope of Ardaman's evaluation. It is notable that by reducing peak stage upstream of I-75 reduced discharges were observed from the R-36 Canal westward into the adjacent Deer Prairie Slough watershed for the proposed BMP condition. The reduced westward overflow causes an increased volume to remain within the North Port area. It may be possible to mitigate downstream stage increases by discharging westward to Deer Prairie Slough north of I-75 at lower elevations while matching existing condition peak flow rates.

Constraints on Implementation: Any conveyance improvements beneath I-75 would comprise a major undertaking. While culvert improvements would likely be contained within existing road right of way boundaries, construction access may require additional temporary easements. There would likely be temporary construction impacts to existing wetlands. Subsurface conditions are not well-defined and there may be unknown utility conflicts or other issues that will need to be addressed by the design. Depending on hydraulic performance, and as noted above, increase in capacity of the crossing may result in higher stages and flows downstream of I-75 which would need to be addressed by other means (i.e., adjustments to flows toward Deer Prairie Slough and/or additional downstream improvements).

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.

R-36 Canal Culvert Crossing Improvements at I-75 (as Conceived by Ardaman, 2014)

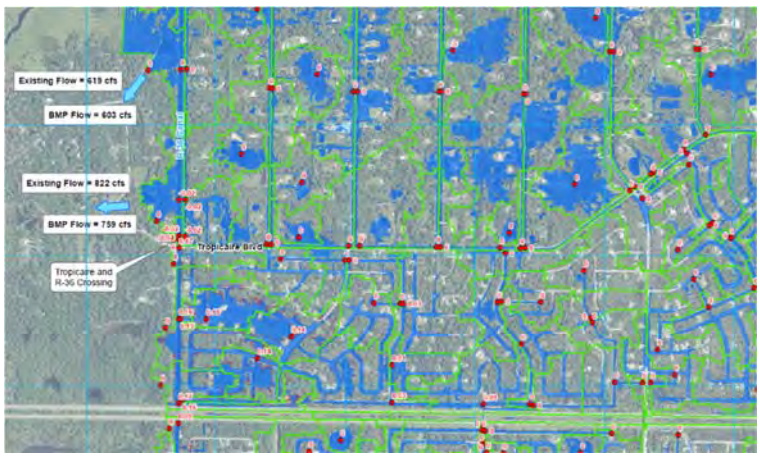
Increased Conveyance Capacity - Increased Culvert Capacity of R-36 Canal at Tropicaire

Description and Potential Performance Improvement: The existing R-36 canal culvert crossing at Tropicaire is comprised of two (2) 5-foot diameter RCP culverts and could be improved by placing additional culverts to provide greater conveyance capacity. Increasing capacity of the R-36 Canal at Tropicaire may reduce upstream water levels, particularly in association with other R-36 improvements.

Prior Work Performed: Ardaman's 2014 existing condition model results indicated that up to three feet of head difference occurs across this structure during various storm events. Under proposed BMP conditions, model results indicated a peak stage reduction of approximately 0.8 feet upstream of the crossing. However, a stage increase of up to 1.1 feet was found to result in downstream areas. Mitigation of flooding in downstream areas was beyond the scope of Ardaman's evaluation. During all events, discharges from the R-36 canal westward into the adjacent Deer Prairie Slough watershed were observed north of Tropicaire Boulevard. The proposed BMP results in a reduction of those discharges to Deer Prairie Slough and a resulting increased total volume remaining within the North Port area. It may be possible to mitigate downstream stage increases resulting from culvert improvements by discharging westward to Deer Prairie Slough at lower elevations while matching existing condition peak flow rates.

Constraints on Implementation: While culvert improvements would likely be contained within existing road right of way boundaries, construction access may require additional temporary easements. There would likely be temporary construction impacts to existing wetlands. Subsurface conditions are not well-defined and there may be unknown utility conflicts or other issues that will need to be addressed by the design. Depending on hydraulic performance, and as noted above, increase in capacity of the crossing may result in higher stages and flows downstream of Tropicaire which would need to be addressed by other means (i.e., adjustments to flows toward Deer Prairie Slough and/or additional downstream improvements).

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.



R-36 Canal Culvert Crossing Improvements Tropicaire (as Conceived by Ardaman, 2014)

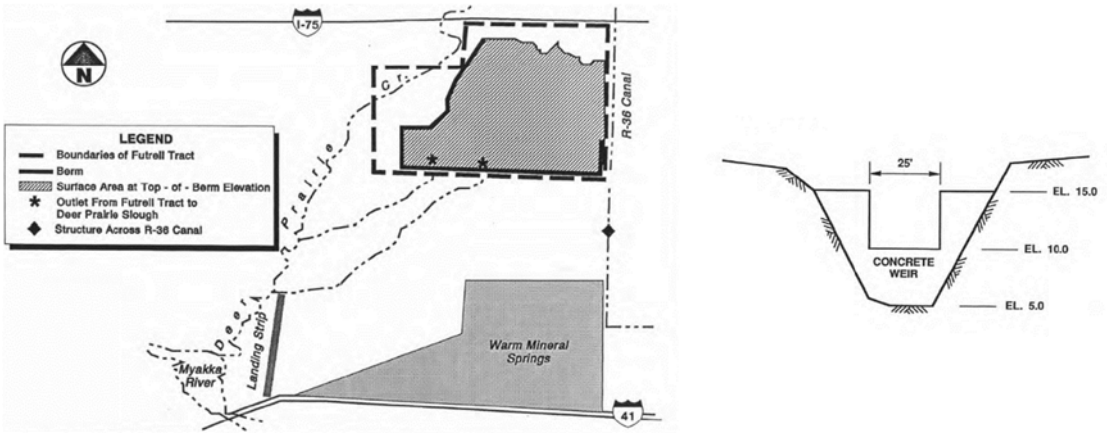
Flow Diversion Away from North Port Drainage System - Connection to Deer Prairie Slough

Description and Potential Performance Improvement: Stormwater flows could be diverted westward to the adjacent Deer Prairie Slough watershed, reducing flow through the City. Several variations could be considered, including gravity and pumped diversions both with and without added storage facilities.

Prior Work Performed: CDM (1993) considered a diversion plan which called for a pumping station and weir near Price Boulevard on the R-36 canal to convey stormwater to a bermed storage area on the Futrell tract. Release from the tract to Deer Prairie Slough would be at the existing rate and would take a week to drain down under 25-year/24-hour storm conditions. CDM's diversion channel option called for two weirs to convey stormwater to a channel located south of the Futrell tract, directly connected to Deer Prairie Slough. The weir discharge rate would closely match the pumping capacity and would also discharge only under storm conditions. Ardaman (2014) contemplated two earthen overflow weirs to enhance the R-36 waterway connectivity with Deer Prairie Slough canal and R-36 canal capacity was doubled by replacing its existing cross-section with a 60-foot bottom width trapezoidal channel with 4:1 side slopes. Each of the prior concepts had similar outcomes in reducing flooding along the R-36 canal.

Constraints on Implementation: A range of technical and non-technical issues would need to be addressed in order to implement a diversion into Deer Prairie Slough. This BMP would involve construction of new facilities, maintenance activities, real estate acquisition, and would likely require detailed hydrologic and hydraulic evaluation of the Deer Prairie Slough watershed to support statewide environmental resource permitting. For a storage component, impacts to existing wetlands could be significant and require mitigation. Also, depending on design performance, any increase in rate or volume of flow to Deer Prairie Slough would need to be addressed, and outcomes would need to be proven compatible with the ongoing Deer Prairie Slough Restoration Project.

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.



Diversion to Deer Prairie Slough, Pumped with Storage on Futrell Tract (as Conceived by CDM, 1993)

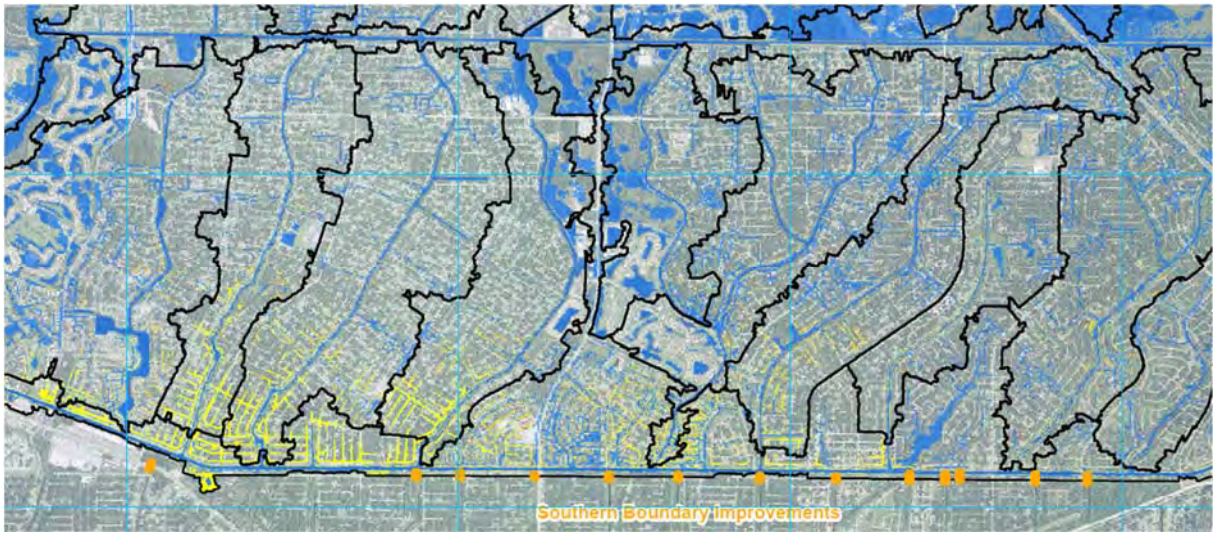
Increased Conveyance Capacity - Enhanced Discharges Along Southern Boundary to Port Charlotte

Description and Potential Performance Improvement: Structures located within the Cocoplum Waterway and discharging beneath Hillsborough Boulevard could be improved to facilitate increased discharges into the adjacent Port Charlotte conveyance system. Additional conveyance capacity would effectively divert stormwater southward and may reduce flooding throughout the southern portion of the City.

Prior Work Performed: This alternative was evaluated by Ardaman (2014) for information purposes, as it is understood that allowing additional flows into Port Charlotte may not be desirable. Six lateral weirs along the Cocoplum waterway and thirteen structures beneath Hillsborough Boulevard were doubled in size. Results indicated that improvements relative to house flooding were not significant. However, roads experienced a considerable flood reduction between Sumter Boulevard and Atwater Drive.

Constraints on Implementation: Enhancing the southerly flow of stormwater out of North Port would involve conveyance improvements, construction of new structures and/or reconditioning of existing structures, maintenance activities, real estate acquisition, and evaluation of receiving waters through hydrologic and hydraulic modeling. As the receiving water system is comprised of both controlled and tidal canals, additional channel and/or structural improvements may need to be made in downstream areas to mitigate the impacts of the diversion.

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.



Diversion for Enhanced Discharge to Port Charlotte (as Conceived by Ardaman, 2014)

Diversion of Flow within North Port Drainage System - R-36 Improvements to South of WCS-101

Description and Potential Performance Improvement: A whole series of improvements could be made to canal segments and structures to enhance the overall conveyance capacity of the R-36 waterway system. The additional stormwater conveyance capacity may induce higher westward flow out of Big Slough at the north boundary of the City. Diverting those higher flows southward to WCS-101 would reduce flow and stages along the more flood prone segments of Myakkahatchee Creek.

Prior Work Performed: Improvements to the complete R-36 system have not been evaluated, although local improvements to portions of that system have been evaluated in a piecemeal fashion.

Constraints on Implementation: Channel improvements along the R-36 waterway may require additional right of way acquisition, and construction access may require additional temporary easements. There would likely be temporary construction impacts to existing wetlands. Subsurface conditions are not well-defined and there may be unknown utility conflicts or other issues that will need to be addressed by the waterway improvement design. Also, depending on hydraulic performance, any increase in conveyance capacity of the waterway may result in higher stages and flows downstream of WCS-101 which would need to be addressed by other means (i.e., additional downstream improvements).

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.

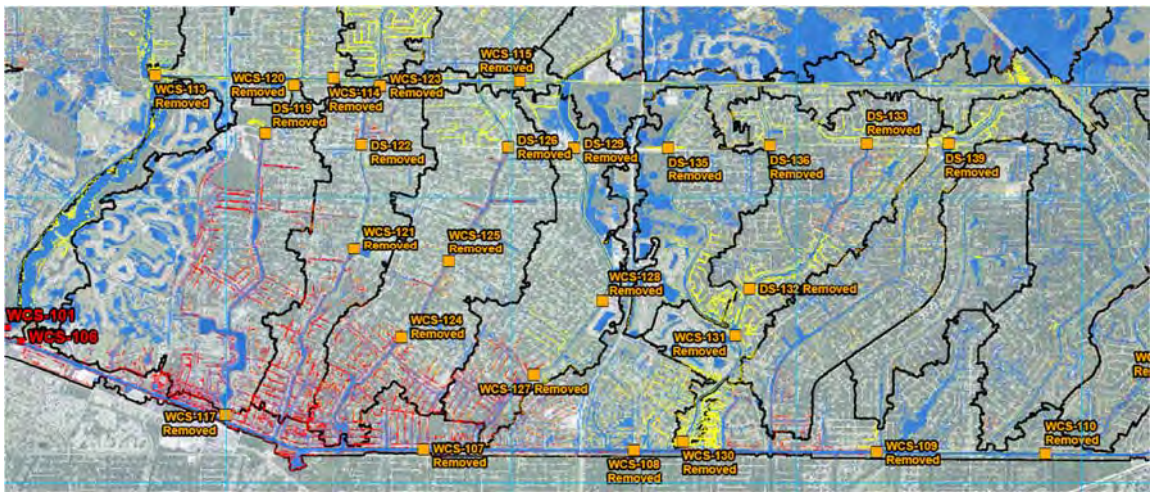
Diversion of Flow within North Port Drainage System - Snover Waterway to Cocoplum Waterway

Description and Potential Performance Improvement: Improvements could be made to existing structures along Snover Waterway and beneath Price Boulevard to increase flow through canals that connect with Cocoplum Waterway. The additional conveyance capacity may induce higher eastward flow out of Big Slough into Snover Waterway. Diverting those higher flows southward to Cocoplum Waterway would reduce flow and stages along the more flood prone segments of Myakkahatchee Creek.

Prior Work Performed: Specific improvements to the Snover-Cocoplum system have not been explicitly evaluated. Ardaman (2014) did evaluate overall system capacity assuming no losses due to water control structures or drop structures (i.e., water control structures and drop structures were removed). Results of that evaluation provide an indication that flood stages could be reduced north of Price Boulevard and along Bass Point waterway but operational controls or mitigation would be required to avoid or address increased flooding between South Toledo Boulevard and South Sumter Boulevard.

Constraints on Implementation: Structure improvements along Snover Waterway and Price Boulevard should be performed within existing right of way, but construction access may require temporary easements. There would likely be temporary construction impacts to existing wetlands. Subsurface conditions are not well-defined and there may be unknown utility conflicts or other issues that will need to be addressed by the design. Also, depending on hydraulic performance, any increase in conveyance capacity of the affected system may result in higher stages and flows in flood prone areas downstream which would need to be addressed by other means (i.e., additional downstream improvements).

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.



Diversion of Flows Southward, by System-wide Structure Removal (as Conceived by Ardaman, 2014)

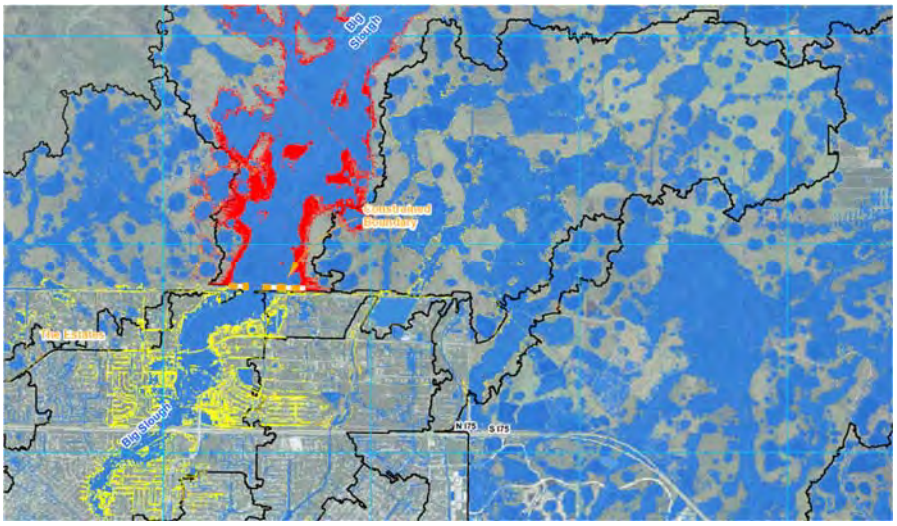
Storage – Constrain Inflows to City with Increased Upstream Floodplain Storage

Description and Potential Performance Improvement: Raise existing earthen berms on the northwest City boundary at the intersection of Big Slough canal with R-36 and R- 580 waterways. Also, raise earthen weirs farther north at the intersection of Big Slough canal and Power Line Road. Improvements would leave the Big Slough canal as the only conveyance system into the western portion of the City. Inflows would be reduced, dropping peak stages along Myakkahatchee Creek.

Prior Work Performed: Ardaman developed this BMP concept to constrain the rate and volume of water coming from offsite areas through the Big Slough canal prior to entering the City in the Estates area. Results indicated approximately 0.5 feet flood stage reduction near the Big Slough canal from the City's northern boundary to just south of I-75. However, flood stages increase approximately 1.0 foot in offsite areas north of the R-36 and R-580 waterways. Variations on the concept could consider performance under smaller storm events (Ardaman focused on the 100-year event) and installation of a flow control structure at the northern boundary.

Constraints on Implementation: Offsite lands where floodplain storage is increased are not currently in City ownership, and acquisition or easements would be required. Depending on the extent of modifications required, it is possible that wetlands would be impacted by raising berms. Hydroperiod impacts to upstream existing wetlands would need to be evaluated.

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.



Constrained Inflows and Increased US Floodplain Storage (as Conceived by Ardaman, 2014)

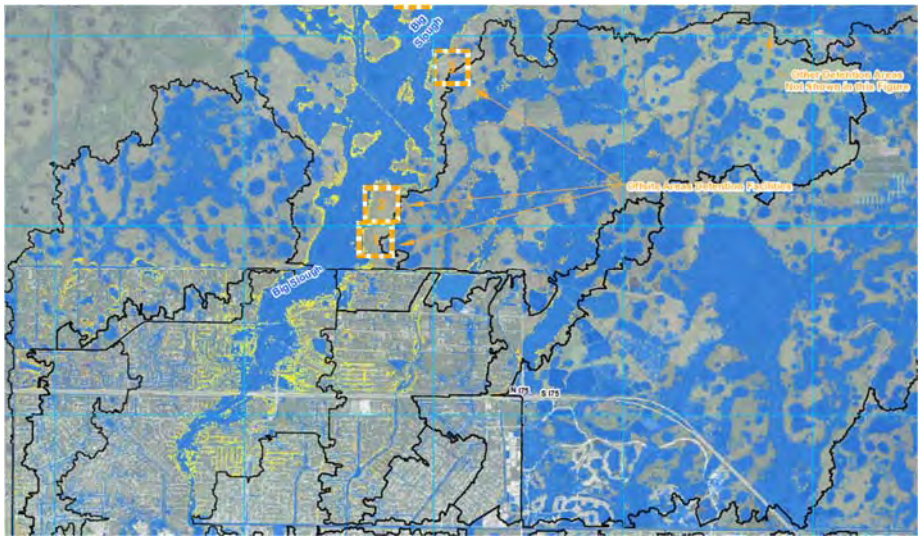
Storage – Creation of Upstream Detention, Reservoirs, or Joint Use Facilities

Description and Potential Performance Improvement: One or more detention ponds, reservoirs, or joint-use facilities could be constructed to provide offsite upstream stormwater detention. The facilities would reduce inflow rates and thus peak stages along Myakkahatchee Creek.

Prior Work Performed: CDM (1993) considered upstream detention consisting of a berm designed to detain flood waters north of the city and slowly release those waters after the peak flows had passed. Six foot berms were proposed with a total storage capacity of 4,000 acre feet and 1 foot of freeboard. Little flood reduction was evident when compared to the other alternatives and the amount of land necessary to achieve little benefit restricted the viability of this alternative. Ardaman developed a concept for creation of seven (7) individual 100-acre detention facilities located on upland sites along Big Slough canal. Each stormwater detention area was linked to the Big Slough canal by a 500-foot weir and held a volume of about of 600 acre-feet for a total of 4,200 ac-ft of storage. Results indicated relatively small reduction in water surface elevations on the order of 0.1 to 0.6 feet along Big Slough.

Constraints on Implementation: Land acquisition and cost of construction will certainly be constraining factors. Construction impacts to existing wetlands could be significant and require mitigation.

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.



Upstream Detention Storage (as Conceived by Ardaman, 2014)

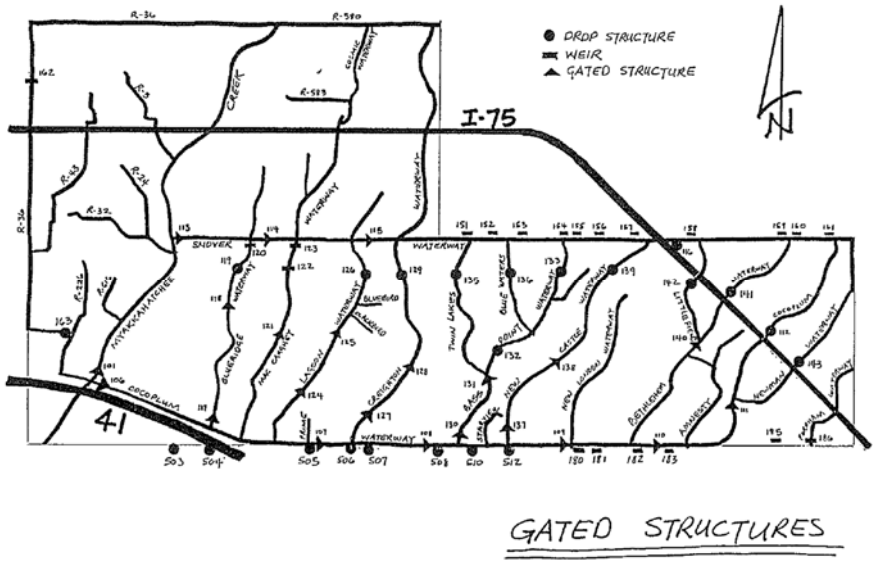
Operational – Drawdown and Other Changes to Schedule of Gate Operations

Description and Potential Performance Improvement: Modifications could be made to existing gate operation schedules to facilitate early drawdown and/or redirection of flows within the North Port drainage system. Creation of initial storage capacity and re-routing of flows may relieve pressure on some flood-prone areas including Myakkahatchee Creek, particularly under lesser storm events.

Prior Work Performed: Ardaman (2014) investigated several concepts associated with gate operations including system-wide and localized (R-36 Canal) drawdown. Generally, drawdown was found to be ineffective in lowering 100-year flood elevations. However, a more rigorous evaluation of gate operations to both draw down initial water levels and re-route flows under a variety of storm event scenarios has not specifically been performed, and gate operation schedule changes may prove more effective when combined with other structural modifications to the system in order to obtain a greater flood reduction benefit or mitigate impacts of other improvements.

Constraints on Implementation: Changes to the operational schedule should consider factors beyond flood control performance, including but not limited to environmental, water supply, and aesthetic impacts of canal drawdown. Evaluations should consider drawdown using existing infrastructure as well as identify infrastructure improvements to expedite drawdown, and such infrastructure improvements may present additional constraints on implementation.

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.



Locations of Gated Structures (City of North Port, 2005)

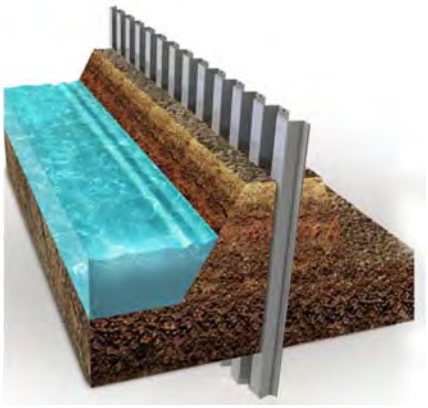
Floodproofing – Including Large-scale Concepts such as Raising Roads and Flood Barrier Walls

Description and Potential Performance Improvement: Floodproofing of existing infrastructure can reduce recurrent damages in areas where flood elevations cannot be cost-effectively reduced by other means. Floodproofing is any combination of structural and non-structural additions, changes, or adjustments to structures which reduce or eliminate flood damage to property, facilities, structures and their contents. In the context of this project, we include raising of flood prone roads and installation of flood walls to protect flood prone areas as examples of large-scale floodproofing. Flood proofing can be included along with other designs. For example, a permanent or temporary flood barrier wall could be incorporated into the linear park flow diversion concept to increase the level protection provided in that footprint.

Prior Work Performed: Ardaman (2014) investigated raising approximately 1,900 feet of West Price Boulevard to an elevation above the predicted 100-year flood stage. Model results indicated no adverse impacts or increase in stages upstream or downstream of the improvement for any modeled storm event. Cost and right-of-way requirements to raise the road were not addressed. Preliminary testing of other flood proofing concepts (e.g., raising roads and homes in flood prone areas located adjacent to Myakkahatchee Creek) was performed, but findings were not well-documented.

Constraints on Implementation: Floodproofing can often be accomplished within existing right of way, although construction access may require additional temporary easements and there can be impacts to existing wetlands. Subsurface conditions are not well-defined and there may be unknown utility conflicts or other issues that will need to be addressed by the floodproofing improvement design. Also, depending on hydraulic performance, any large-scale flood proofing of facilities such as raising of roads may result in higher stages upstream unless sufficient storage or flow capacity is provided in the design.

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.



Raising of Road (as Conceived by Ardaman, 2014) and Barrier Wall (as illustrated by Crane Materials International, 2016)

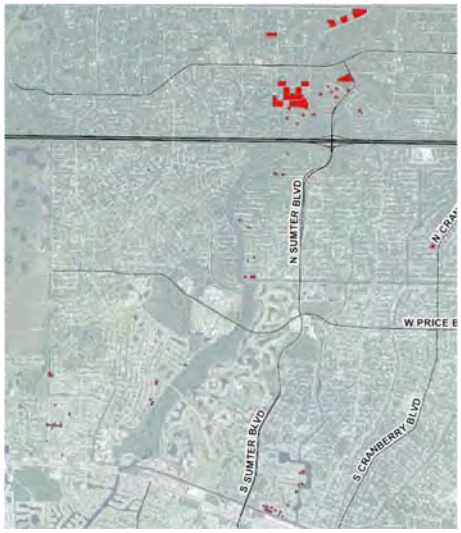
Acquisition – Purchase of Flood Prone Lands and/or Flood Prone Structures

Description and Potential Performance Improvement: Some communities turn to property acquisition to mitigate flood risk by establishing permanent, public open space and to get homeowners in flood-prone areas permanently out of harm's way. In North Port, many lots have already been acquired on the west side of the Myakkahatchee Creek to serve as a linear park. Additional acquisition may be considered to remove other lands and/or structures from the 100-year floodplain. Removal of those properties would reduce future flood-related damages but would not impact flood levels.

Prior Work Performed: CDM's preliminary evaluation (1993) considered that purchase of flooded lands would preclude flooding damage by preventing development of the property but would not prevent roadway flooding. Based upon their preliminary analyses, purchase of flooded lands was removed from consideration. Ardaman (2012) recommended that the City of North Port purchase habitable structures in which flooding is predicted in the 100-year event, as purchasing the affected properties may be more cost effective than implementing other BMPs. About 100 parcels were identified to be surveyed and for finished floor elevations to be compared with modeled 100-year event flood stages, to determine which properties are damaged in the 100-year event.

Constraints on Implementation: Constraints are related to cost, funding, and property availability. Property acquisition is generally performed through voluntary buyout programs presented to homeowners in neighborhoods that have been subject to repeated flooding. As such, acquisition depends upon having willing sellers and reaching an agreement on fair market value of properties. For eligible communities, FEMA typically funds a portion of the cost of property acquisition with the municipality contributing the remaining amount.

Data Needs for Evaluation: none – DES will employ the existing available watershed model, terrain information, and parcel ownership data to perform an evaluation of this flood reduction concept.



Properties to be Surveyed for Finished Floor Elevation (as Identified by Ardaman, 2014)

Attachment 2: Team Meeting – Comments on Potential Solutions

Summary of meeting minutes from December 20, 2016 team meeting

Increased Conveyance Capacity - Parallel Relief Channel Construction

Meeting comments: Staff indicated that this project would need to show promise with properties acquired to date or with additional properties which could reasonably be expected to be acquired by means other than eminent domain.

Diversion of Flow within North Port Drainage System - Channel Improvements along R-580

Meeting comments: Staff was interested in seeing this concept brought forward in the master plan, noting that they cannot currently control the amount of water entering the system during a large storm event. DES was directed to look at existing gate schedules or improvements, as well as installation of gates on the MacCaughey and Lagoon Waterway crossings that could assist with making the flow diversion and improve flood control performance under smaller events.

Increase Conveyance Capacity - Channel Improvements along R-24 and R-32

Meeting comments: Staff directed DES to remove this concept from the master plan – outside current areas of interest, already evaluated sufficiently in prior analyses, and provides local improvements which may be better addressed through future raising of Price Boulevard.

Increased Conveyance Capacity - Increased Culvert Capacity of R-36 Canal at I-75

Meeting comments: None (see discussion on R-36 Improvements to South of WCS-101).

Increased Conveyance Capacity - Increased Culvert Capacity of R-36 Canal at Tropicaire

Meeting comments: None (see discussion on R-36 Improvements to South of WCS-101).

Flow Diversion Away from North Port Drainage System - Connection to Deer Prairie Slough

Meeting comments: Staff inquired whether it is possible to determine how much stormwater historically moved into Deer Prairie Slough from the Big Slough and City of North Port systems prior to construction of canals by GDC. DES staff indicated that a rough calculation could be made but that it wouldn't have much of an effect on decision making. Rather, we should gather and review available information on the Deer Prairie Slough restoration project and coordinate with District staff on potential offsite inflow restoration. City staff requested that the District share any reports that are available and identify individuals to contact for a January follow-up meeting. DES staff inquired as to the status of the Futrell tract and City staff indicated that the District did not look favorably on using the tract for a reservoir. Additional District staff could be invited to attend the follow-up meeting to discuss alternate uses of the Futrell tract that might be of mutual benefit.

Increased Conveyance Capacity - Enhanced Discharges Along Southern Boundary to Port Charlotte

Meeting comments: City staff asked DES to focus on the two tidal canals (Apollo and Jupiter waterways) for enhanced discharge. The city replaced dilapidated metal pipes and gates in 2007. Staff indicated that they receive water level complaints in the Cocoplum and Toledo Blade waterways and they would like for DES to look at enhanced discharge from the Cocoplum Waterway.

Diversion of Flow within North Port Drainage System - R-36 Improvements to South of WCS-101

Meeting comments: Team agree to include this concept in the master plan, understanding that it also encompasses improvements to existing culverts at Tropicaire and I-75. During prior analysis, some coordination was held with FDOT and concept was shelved because of downstream impacts which were beyond the scope of that earlier analysis. Window of opportunity may have closed with FDOT on near-term improvements at I-75. One concern is whether the downstream infrastructure can handle the increased flow without substantial modification. Staff pointed out that the WCS-101 structure is tidally influenced and suggested evaluation should consider worst case tidal conditions.

Diversion of Flow within North Port Drainage System - Snover Waterway to Cocoplum Waterway

Meeting comments: Staff indicated that there may be an opportunity to store more water in the existing canal system for smaller events by raising gates. DES pointed out that the Panacea community discharges to some of those canals and that raising levels may have adverse impacts on those upstream stormwater management systems.

Storage – Constrain Inflows to City with Increased Upstream Floodplain Storage

Meeting comments: The team agreed that prior work focused mainly on larger storm events and that this project may be able to achieve benefits for smaller storms with upstream impacts that might be successfully mitigated.

Storage – Creation of Upstream Detention, Reservoirs, or Joint Use Facilities

Meeting comments: Staff indicated that the City Manager recently toured (and is interested in developing facilities similar to) the Celery Fields in Sarasota County and inquired as to whether additional District funding might be available in the project combined flood reduction and water quality benefits. Staff also pointed out that operating and maintaining multiple offsite reservoirs (six were considered in the prior evaluation) would be challenging.

Operational – Drawdown and Other Changes to Schedule of Gate Operations

Meeting comments: The team agreed that City staff have a firm grasp on gate operations, by virtue of working with the system for decades including during large flood events, and an evaluation of wholesale changes to gate operations is not needed. Localized changes to allow diversions (as part of other concepts listed here) may still be made.

Floodproofing – Including Large-scale Concepts such as Raising Roads and Flood Barrier Walls

Meeting comments: City staff indicated that raising roads out of the floodplain, pumping for stormwater control, and installation of flood barriers were not appealing options for large-scale flood reduction. These concepts, including raising roads, may be considered (as part of other concepts listed here).

Acquisition – Purchase of Flood Prone Lands and/or Flood Prone Structures

Meeting comments: City staff indicated that acquisition should be considered as part of the master plan.

Appendix G

Tasks 1.5 and 2.3 Big Slough Flood Reduction Study, Evaluate Performance of Selected Set of Alternatives

DeLoach Engineering Science, PLLC., May 2017

MEMORANDUM

To: Elizabeth Wong, PE (City of North Port)
From: Dave DeLoach, PE; Trillian Baldassari, PE
Copy: Rod Ghioto, PE
File: 16-00400-00

Subject: Tasks 1.5 and 2.3 Big Slough Flood Reduction Study, Evaluate Performance of Selected Set of Alternatives

May 21, 2017

Hydraulic Performance of Alternatives to Achieve Flood Reduction

A set of alternatives was previously identified by the project team from among numerous potential solutions considering expected performance, constraints on implementation, and other factors. Those selected alternatives have been combined and incorporated into the Big Slough watershed model to allow for an initial screening-level review of hydraulic performance. This memorandum summarizes work performed to incorporate the alternatives into the model, summarizes hydraulic performance for the mean annual, 10-year, and 100-year 24-hour storm events, and presents a synopsis of take-aways from the associated April 28, 2017 team meeting to discuss hydraulic performance.

Alternatives may be applicable to either Task 1 Myakkahatchee Creek at I-75 and Jockey Club areas or Task 2 regional flood reduction objectives, or both. Thus, work performed and information presented in this memorandum addresses the following elements of the Project Plan (Task 1.5 and Task 2.3).

- Task 1.5 Evaluate Hydraulic Performance of Selected Set of Alternatives
  - Perform Hydraulic Analyses
  - Summarize Hydraulic Performance
  - Meeting to Review and Discuss Performance of Alternatives
  - Identify Preferred Plan(s) of Improvements
- Task 2.3 Evaluate Hydraulic Performance of Selected Set of Alternatives
  - Perform Screening-Level Hydraulic Analyses
  - Summarize Hydraulic Performance
  - Meeting to Review and Discuss Performance of Alternatives
  - Identify Preferred Plans for Regional Improvements

Alternatives Considered

A project team meeting was held on December 20, 2016 to (1) discuss potential solutions to achieve flood reduction and (2) select a set of alternatives for initial hydraulic evaluation. Some flood reduction concepts, including raising roads out of the floodplain, pumping for stormwater control, and installation of flood barriers, were rejected by the project team as they were not appealing options for large-scale flood reduction. A more complete discussion regarding initial selection of alternatives is provided in the January 30, 2017 memorandum on Task 1.4 completion.

The following set of alternatives was selected by the team for initial hydraulic evaluation.

- Internal Flow Diversion and Increased Conveyance Capacity
    - Parallel Relief Channel Construction
    - Channel Improvements along R-580
    - R-36 Improvements to South of WCS-101
    - Snover Waterway to Cocoplum Waterway
    - Other Miscellaneous Improvements
- External Flow Diversion
    - Connection to Deer Prairie Slough
    - Enhanced Discharges Along Southern Boundary to Port Charlotte – Tidal Outfalls Only
- Offsite Storage
    - Constrain Inflows to City with Increased Upstream Floodplain Storage
    - Creation of Upstream Detention, Reservoirs, or Joint Use Facilities
- Acquisition
    - Purchase of Flood Prone Lands and/or Flood Prone Structures

Incorporation of Storage and Conveyance Alternatives into Big Slough Watershed Model

Selected alternatives were combined and incorporated into the Big Slough watershed model to allow for an initial screening-level review of hydraulic performance. The attached tables describe changes made to model elements to represent conceptual improvements. The tables also include notes on limitations and the manner in which alternatives were incorporated.

Hydraulic Performance

Proposed condition simulations were performed for the mean annual, 10-year, and 100-year 24-hour storm events, with stages and flows compared to the existing condition. Flood inundation areas for each simulation were mapped and used to depict areas removed from the floodplain. Flood reduction concepts are generally effective in reducing flood levels in the watershed, particularly in the I-75 study area, given assumptions and simplifications made while developing the screening-level models. Potential adverse impacts can also be seen in the model results. These initial storm event simulation results provide general information on potential performance characteristics of the flood reduction concepts. A more refined plan may not result in these same reductions, and preliminary model results and flood mapping should not be construed as a proposed future watershed condition.

Team Meeting

A Team Meeting was held on April 28 to discuss plan concepts and preliminary hydraulic performance. A copy of the presentation is attached and, for brevity, the reader is referred to that presentation for viewing of preliminary model results. The following summarizes notable points that were raised during the team meeting and the important issues that will be addressed as the project moves forward.

- Refinement and future performance evaluations of structure modifications at the upstream inflow point (to constrain and reduce inflows to the City of North Port) should consider a wider range of control elevations and results used by the District for decision-making on allowable changes to area, depth, and duration of inundation in upstream District lands.
- Refinement and future performance evaluations of the R-36 conceptual plan for improvements should consider channel widening with and without structure improvements providing additional conveyance beneath Tropicaire and I-75.
- Refinement of the R-36 conceptual plan for improvements should include matching pre/post discharge rates westward into the Deer Prairie system, so as to minimize increased flows downstream in the City of North Port. Preliminary modeling did not make full use of available discharge capacity to the west. No increase in rate of discharge to the Deer Prairie system should be considered, at this time.
- Refinement of the R-36 conceptual plan for improvements should consider (and preferably conform to) existing rights-of-way and drainage easements. City of North Port can provide existing ROW information as depicted on drainage system as-builts. However, acquisition of additional drainage easements along the western boundary from Sarasota County is not out of the question.
- Refinement of the R-36 conceptual plan for improvements should look more closely at existing bridge crossings and available right-of-way for channel enlargement to its confluence with R-226 and further downstream to Myakkahatchee Creek.
- Two culvert locations on the west boundary of Jockey Club should be evaluated and recommendations made regarding sufficiency and/or modifications needed to reduced flooding in the Jockey Club area (considering any increase in water levels that may result from the R-36 improvements and associated re-routing of flows).
- Refinement and future performance evaluations of the parallel bypass canal should include a more accurate representation of the combined conveyance, and should eliminate double accounting of conveyance as a result of overlapping open channel cross sections. A request has been made to the District for cross section source data, cross section extents, surveyed point locations, conveyance way boundaries, etc., from the District's North Port/Big Slough WMP project files (including intermediate deliverables).
- Only two Price Boulevard drop structures are scheduled to be replaced with the widening project. City of North Port will identify those structures and the other remaining structures will be revised to again match the existing condition model configuration. Future performance evaluations will include the two identified structures as operable gates.

Identification of the Preferred Plan

Based upon the Project Team's review and discussion of preliminary hydraulic evaluation results, the following set of alternatives are recommended for further development of the "preferred plan" of improvements to achieve flood reduction.

- Internal Flow Diversion and Increased Conveyance Capacity
    - Parallel Relief Channel Construction
        - Option 1 – Tier 1 only, reduced width, deeper excavation
        - Option 2 – Tier 1 only, full width, shallower excavation
        - Option 3 – No parallel relief channel
    - Channel Improvements along R-580
        - Option 1 – Constrained width, remains within existing available ROW
        - Option 2 – Unconstrained width, requires ROW or easement acquisition
        - Option 3 – No R-580 channel improvements
    - R-36 Improvements to South of WCS-101
        - Option 1
            - Constrained width, remains within existing available ROW
            - No additional culvert capacity beneath Tropicaire or I-75
        - Option 2
            - Unconstrained width, requires ROW or easement acquisition
            - Additional culvert capacity beneath Tropicaire and I-75
        - Option 3
            - No R-36 Improvements
    - Snover Waterway to Cocoplum Waterway Improvements, as needed to mitigate impacts
    - Price Boulevard Structures and Other Miscellaneous Improvements, as planned by City
- External Flow Diversion
    - Connection to Deer Prairie Slough – maintain pre/post, no increased offsite discharge
- Offsite Storage
    - Constrain Inflows to City with Increased Upstream Floodplain Storage
        - Option 1 – No structure overflow up to 5-year event
        - Option 2 – No structure overflow up to 10-year event
- Acquisition
    - Purchase of Flood Prone Lands and/or Flood Prone Structures, as needed
    - Acquisition of Additional Drainage Easements, as needed

The above concepts and options will be further refined and combined into a small number of candidate plans. Hydraulic performance of the candidate plans will be evaluated using the Big Slough watershed model. The project team will select a plan of improvements from among the candidate plans, based on performance. The preferred plan will then be finalized and evaluated for costs and benefits, etc.

Reduce Inflow			
Flood Reduction Concept: Raise existing earthen berms on the northwest City boundary at the intersection of Big Slough canal with R-36 and R- 580 waterways. Also, raise earthen weirs farther north at the intersection of Big Slough canal and Power Line Road. Improvements would leave the Big Slough canal as the only conveyance system into the western portion of the City. Inflows would be reduced, dropping peak stages along Myakkahatchee Creek.			
Notes: Additional configurations to be evaluated as part of preferred plan evaluation. Field visit required to better understand and conceptualize configuration.			
Reach ID	Waterway	Structure	Description of Model Revision
RB0620B			Change to Bridge w/, 150' control at 24.0, 4' notch at 17.5
RB0620C			Change to Culvert Riser, 25'control at 24.0
W13208_W W4701_W W4707_W			Raise weir sub-elements above 5-year flood to 25.0001

Channel Improvements along R-580			
Flood Reduction Concept: The R-580 waterway's bottom profile could be reconfigured, creating a more uniform and hydraulically efficient conveyance way. Improvement of the R-580 Waterway would induce more flow eastward from Big Slough along the City's northern boundary toward Creighton Waterway, resulting in reduced flows and flood stages in Myakkahatchee Creek.			
Notes: Enlargement of the R-580 canal reflects preliminary sizing performed by Ardaman & Associates, Inc. during the prior Big Slough WMP project. Node bottom elevations associated with this channel were adjusted to provide a uniform slope from the Big Slough canal eastward to Creighton Waterway.			
Reach ID	Waterway	Structure	Description of Model Revision
RP0003 RP0010A RP0016 RP0020 RP0030 RP0040A RP0050 RP0060 RP0070 RP0080 RP0090	R-580		Widen channel to 60ft bottom width trapezoidal

R-36 Improvements to South of WCS-101			
Flood Reduction Concept: A whole series of improvements could be made to canal segments and structures to enhance the overall conveyance capacity of the R-36 waterway system. The additional stormwater conveyance capacity may induce higher westward flow out of Big Slough at the north boundary of the City. Diverting those higher flows southward to WCS-101 would reduce flow and stages along the more flood prone segments of Myakkahatchee Creek.			
Notes: Enlargement of the R-36 canal reflects preliminary sizing performed by Ardaman & Associates, Inc. during the prior Big Slough WMP project. Improvements to conveyance structures located beneath Tropicaire and I-75 were included with the R-36 canal layout for initial screening. Additional work will be performed to evaluate system performance without those culvert improvements.			
Reach ID	Waterway	Structure	Description of Model Revision
RB5695B RR3010 RR3020 RR3025 RR3030 RR3040 RR3050 RR3060 RR3070 RR3080 RR3090 RR3100 RR3110 RR3120 RR3125 RR3130 RR3140 RR3150 RR3220 RR3230 RR3250 RR3270 RR3290 RR3300 RR3310 RR3320 RR3330 RR3340 RR3350 RR3360 RR3370 RR3190 RR3200	R-36		Widen channel to 60ft bottom width trapezoidal
RR3160A			Increase Capacity (from 1 to 2 weir notches)
RR0170A			Increase Capacity (from 1 to 2-60" culverts)
RR0170B			Increase Capacity (from 1 to 2-60" culverts)
RR3160B			Increase Capacity (from 1 to 2 weir notches)
RR3160C		WCS 162	Increase Capacity (from 1 to 2 gates)
RR3210A RR3210B RR3380A RR3380B RR3380C RR3420A RR3420B RR3420C			Increase Capacity (from 1 to 2 bridges)

BYPASS			
Flood Reduction Concept: A new, parallel canal could be constructed from the northern City boundary to Price Boulevard along Tier 1 and Tier 2 lots that have been acquired on the west side of the Myakkahatchee Creek. The additional conveyance may reduce flow rate and thus peak stages along the main channel from start to end of the parallel relief channel.			
Notes: Placement into the model network did not account for overlapping of proposed bypass cross sections with existing cross sections describing the Big Slough/Myakkahatchee Creek conveyance system. Conceptual designs and the model will need to be refined (and overlap removed) if it is decided to continue with the bypass alternative in the preferred plan of improvements.			
Reach ID	Waterway	Structure	Description of Model Revision
RBY0020 RBY0030 RBY0060 RBY0070 RBY0100 RBY0110 RBY0140 RBY0150 RBY0160 RBY0190 RBY0220	Big Slough		New Channel, 60ft bottom width trapezoidal
RBY0010			New Weir, 200ft at 15.75ft, 2ft above bottom
RBY0030X			New Weir, 200ft at 17.67, 5ft above bottom
RBY0040			New Weir, 200ft at 14.72ft, 2ft above bottom
RBY0050			New Weir, 200ft at 14.72ft, 2ft above bottom
RBY0070X			New Weir, 200ft at 17.37ft, 5ft above bottom
RBY0080			New Weir, 200ft at 15.5ft, 2ft above bottom
RBY0090			New Weir, 200ft at 13.9ft, 2ft above bottom
RBY0110X			New Weir, 200ft at 15.14ft, 5ft above bottom
RBY0120			New Weir, 200ft at 11.48, 2ft above bottom
RBY0130			New Weir, 200ft at 11.48, 2ft above bottom
RBY0150X			New Weir, 200ft at 14.13, 5ft above bottom
RBY0160X			New Weir, 200ft at 12.46, 5ft above bottom
RBY0170			New Weir, 200ft at 5.38, 2ft above bottom
RBY0180			New Weir, 200ft at 5.38, 2ft above bottom
RBY0200			New Weir, 200ft at 4.05, 2ft above bottom
RBY0210			New Weir, 200ft at 4.05, 2ft above bottom
RBY0230			New Weir, 200ft at 3.25, 2ft above bottom

Snover Waterway to Cocoplum Waterway			
Flood Reduction Concept: Improvements could be made to existing structures along Snover Waterway and beneath Price Boulevard to increase flow through canals that connect with Cocoplum Waterway. The additional conveyance capacity may induce higher eastward flow out of Big Slough into Snover Waterway. Diverting those higher flows southward to Cocoplum Waterway would reduce flow and stages along the more flood prone segments of Myakkahatchee Creek.			
Notes: Controls set to reflect current operations of other area structures, specifically based on water surface elevation of Myakkahatchee Creek at Tropicaire Boulevard. All four (4) Price Boulevard structures were assumed to be replaced. City direction followed that only two (2) of the structures are scheduled to be replaced and future model revisions will reflect that case.			
Reach ID	Waterway	Structure	Description of Model Revision
RE0040A RE0040B RE0040C	Blueridge	DS 119	2 5ft gates added, 10ft of weir removed from riser
RI0030A	Creighton	DS 129	6 5ft gates added, 30ft of weir removed from riser
RI0030B			
RI0040A RI0040B RI0040C			Replaced with RI0040D (removes riser from culverts)
RI0040D			New culverts to replace RI0040A/B/C
RD0030A RD0030B RD0030C	Lagoon	WCS 126	2 5ft gates added, 10ft of weir removed from riser
RS5430A RS5430B RS5430F	Snover	WCS 115	Updated to reflect proposed condition

Miscellaneous Planned Improvements			
Flood Reduction Concept: Canals and structures throughout the area will be reviewed for opportunities to increase conveyance.			
Notes: Revisions to reflect ongoing work at City of North Port to refurbish the existing system. Changes made using conceptual-level design information provided by the City. Como Water Control Structure provides structural connection from the Cocoplum Waterway to a Port Charlotte canal system outfall where there is currently a berm located on the south side of the Cocoplum Waterway.			
Reach ID	Waterway	Structure	Description of Model Revision
RC0900A RC0900D RC0900H RC0900I	Cocoplum	WCS 106	Updated to reflect proposed condition (by others)
RC0600B RC0600C	Como	Como WCS	Disabled, replaced with culvert riser
RC0600D			New gated WCS (4-5' gates, split between two barrels)
RS5430A RS5430B RS5430F	Snover	WCS 115	Updated to reflect proposed condition

Appendix H

Tasks 1.6 and 2.4 Big Slough Flood Reduction Study, Refine and Summarize Preferred Plan(s) for Improvement (interim status report)

DeLoach Engineering Science, PLLC., October 2017

MEMORANDUM

To: Elizabeth Wong, PE (City of North Port)
From: Dave DeLoach, PE; Trillian Baldassari, PE
Copy: Rod Ghioto, PE
File: 16-00400-00

Subject: Tasks 1.6 and 2.4 Big Slough Flood Reduction Study, Refine and Summarize Preferred Plan(s) for Improvement (interim status report)

October 3, 2017

Development of a Preferred Plan for Improvement

The Big Slough Flood Reduction Study plan for improvement will be comprised of: internal flow diversion and increased conveyance capacity; external flow diversion; offsite storage; and property acquisition. Those plan components were selected by the Project Team based on review of preliminary hydraulic evaluations of alternatives and have been merged into a small number of distinct Candidate Plans. The project team will compare and select one plan from among the Candidates and that Preferred Plan will be finalized and evaluated for hydraulic performance, estimated costs, and flood reduction benefits.

This interim status report introduces eight Candidate Plans, summarizes their hydraulic performance for the mean annual, 10-year, and 100-year 24-hour storm events, provides preliminary cost and flood reduction benefit information, and presents a synopsis of take-aways from the August 8, 2017 team meeting to discuss hydraulic performance and plan development.

Candidate Plans may be applicable to either Task 1 Myakkahatchee Creek at I-75 and Jockey Club areas or Task 2 regional flood reduction objectives, or both. Thus, work performed and information presented in this memorandum address the following elements of the Project Plan (Task 1.6 and Task 2.4).

- Task 1.6 Refine Preferred Plan(s) of Improvement
  - Evaluate Site Conditions and Design/Permitting Constraints of Preferred Plan(s)
  - Refine Preferred Plan(s) to Address Site Conditions and Design/Permitting Constraints
  - Perform Hydraulic Analyses of Refined Plan(s)
  - Perform Cost-Benefit Analysis of Refined Plan(s)
  - Meeting to Review and Discuss Refined Plan(s)
  - Select Recommended Plan (**on-going**)

- Task 2.4 Summarize and Present Preferred Plan(s) for Regional Improvements
    - Screening-Level Hydraulic Model Pre/Post and Result Tabulations
    - Conceptual-Level Drawings and Plan Descriptions
    - Site Conditions and Design Constraints
    - Relevant Permitting Requirements (**on-going**)
    - Opinion of Probable Cost (**on-going**)
    - Planning-Level Report and Mapping (**on-going**)

Plan Components and Candidate Plan Development

The following set of alternatives was considered by the team for initial hydraulic evaluation.

- *Offsite Storage.* Flood reduction would be achieved in part by construction of a fixed water control structure at the north boundary to limit high flows entering the City. Low flows will remain unchanged as a four-foot opening in the upstream face of the structure would extend fully to the existing channel bottom.
- *Internal Flow Diversion and Increased Conveyance Capacity.* Flood reduction would be achieved in part by construction of a parallel relief (bypass) channel alongside Myakkahatchee Creek within Tier 1 lots that have been acquired by the City of North Port, and through widening of the R-36 canal. Wide and Narrow options were considered for each channel improvement concept.
- *External Flow Diversion.* Flood reduction would be achieved in part through higher discharges westward to Deer Prairie Slough. Large increases are considered infeasible as SWFWMD has already restored the slough system and likely will not permit higher inflows to the slough. Therefore, the Preferred Plan will be adjusted to meet pre/post discharge rates and District staff will be asked at an upcoming coordination meeting if those rates can be increased.
- *Additional drainage improvements* may be achieved through upsizing R-36 culverts at Tropicaire, structure replacement during the widening of Price Boulevard, and improvements to the R-580 canal. The effect of Price Boulevard improvements will be localized. Widening of the R-36 and R-580 canals is expected to require additional and perhaps extensive downstream drainage system improvements to eliminate bottlenecks in other flood prone areas of the City.
- *Acquisition* would reduce losses through purchase of flood prone lands and/or structures.

Eight scenarios are presented in this memorandum as Candidate Plans which incorporate various configurations of the “Offsite Storage” and the “Internal Flow Diversion and Increased Conveyance Capacity” concepts described above. While other configurations were evaluated (e.g., offsite storage with flow control set at a lower, 10-year event peak, stage), their performance was not distinctive nor superior to those presented here, and so those scenarios were not advanced as Candidate Plans.

Once a Preferred Plan is selected from among these eight Candidate Plans, other alternative components can again be considered during finalization of the stormwater plan. For example, discussion with District land management staff may allow for adjustments to the offsite inflow control as well as external flow diversions to Deer Prairie Slough. These final plan modifications may have a small (but not insignificant) impact on performance which will be accounted for in final performance and benefit/cost evaluations.

Candidate Plan Descriptions and Performance

A total of eight candidate plans were evaluated. Each candidate plan was comprised of one or more of the following drainage system improvement components, as indicated in the Scenario matrix of Table 1. For example, Scenario 6A is comprised only of a "High Control" to reduce inflows at the northern city limit.

Inflow

- Existing. No hydraulic control of inflow from upstream offsite areas.
- Low Control. 150-foot concrete weir with crest at elevation 24.0 feet for overtopping of high flows. 4-foot wide slot open to existing channel bottom to allow normal low flows, unimpeded.
- High Control. 150-foot concrete weir with crest at elevation 25.5 feet for overtopping of high flows. 4-foot wide slot open to existing channel bottom to allow normal low flows, unimpeded.

R-36

- Existing. No improvements to existing ditch along northwestern and western city boundary.
- Narrow. Widen ditch to maximum extent possible within existing drainage easement/right of way.
- Wide. Widen ditch to 60-foot bottom with 4:1 side slopes, with easement acquisition as-needed.

R-580

- Existing. No improvements to existing ditch along northern city boundary east of Big Slough Canal.
- Narrow. Widen ditch to maximum extent possible within existing drainage easement/right of way.
- Wide. Widen ditch to 60-foot bottom with 4:1 side slopes, with easement acquisition as-needed.

Bypass

- Existing. No bypass. All flow carried within Big Slough Canal/Myakkahatchee Creek and floodplain.
- Narrow. Excavate bypass ditch with 20- to 50-foot bottom 4:1 side slopes for high flow diversion.
- Wide. Excavate bypass ditch with 50-foot bottom 4:1 side slopes for high flow diversion.

Proposed condition simulations were performed for the mean annual, 10-year, and 100-year 24-hour storm events. Flood reduction performance of the eight Candidate Plans (Scenarios 6A through 6H) were compared to the existing condition (Scenario 5). Table 1 presents the Candidate Plans (Scenario matrix) and summarizes flood reduction performance in terms of: area of flood reduction (in acres); length of roadway flood reduction (in miles); and number of flood-impacted parcels reduction (for where the floodplain intersects a portion of a parcel and where the floodplain overlays a parcel's centroid).

Scenario 6B, comprised of offsite inflow control, a wide bypass, and wide R-36 channel improvements, reduces flooding on more property and roadway than all other Candidate Plans. However, a substantial level of flood reduction is also achieved with scenarios 6D, 6F, and 6H, all of which employ the wide bypass, at lower overall cost and higher BCRs. The wide bypass component provides the majority of flood reduction benefits in each of the four best-performing Candidate Plans, with some added improvement resulting from various configurations of R-36 improvements and offsite inflow control.

Scenario Matrix		5	6A	6B	6C	6D	6E	6F	6G	6H
Inflow	Existing	x					x	x	x	x
	Low Control									
	High Control		x	x	x	x				
R-36	Existing	x	x					x	x	
	Narrow				x	x	x			x
	Wide			x						
R-580	Existing	x	x	x	x	x	x	x		x
	Narrow								x	
	Wide									
Bypass	Existing	x	x				x		x	
	Narrow				x					
	Wide			x		x		x		x
Prel. Estimated Combined Cost		**$ -**	**$ 750,000**	**$ 32,667,000**	**$ 11,714,000**	**$ 19,446,000**	**$ 7,825,000**	**$ 10,871,000**	**$ 2,462,000**	**$ 18,696,000**
Estimated Annualized Cost			**$ 54,345**	**$ 2,367,046**	**$ 848,795**	**$ 1,409,054**	**$ 566,998**	**$ 787,711**	**$ 178,396**	**$ 1,354,709**
Flood Reduction (acres)	2.33-year	-	22	243	156	213	53	176	24	184
	10-year	-	63	377	204	323	58	212	14	223
	100-year	-	68	450	239	338	106	190	11	184
Road Flood Reduction (miles)	2.33-year	-	0.6	6.7	4.2	6.38485	1.2	5.7	0.7	5.9
	10-year	-	2.9	14.4	8.9	12.969	3.5	9.1	1.1	9.4
	100-year	-	3.5	20.8	9.6	14.055	4.5	9.2	1.6	9.3
Parcels Reduction (touch)	2.33-year	-	22	792	433	726	119	598	7	613
	10-year	-	118	960	515	868	182	554	-33	546
	100-year	-	253	1338	643	958	292	630	34	591
Parcels Reduction (centroid)	2.33-year	-	14	240	144	235	36	225	17	226
	10-year	-	46	408	158	330	26	228	-8	242
	100-year	-	48	399	156	319	47	226	-43	217
Prel. Estimated Annualized Benefit*			**$ 113,147**	**$ 1,327,153**	**$ 734,929**	**$ 1,226,504**	**$ 191,732**	**$ 1,060,727**	**$ 66,076**	**$ 1,081,500**
Est. Benefit/Cost Ratio (BCR)			**2.08**	**0.56**	**0.87**	**0.87**	**0.34**	**1.35**	**0.37**	**0.80**

** For initial discussion purposes only. Components used to develop a preliminary estimate of project benefits are subject to further review.*

Table 1: Candidate Plan Performance Summary

Preliminary Estimates of Candidate Plan Benefits

Screening-level estimates of project benefits (flood damage reduction) presented in Table 1 were developed to allow initial comparisons of rough Benefit to Cost Ratio (BCR) values across Candidate Plans. Benefits considered cost avoidance for road repair and for residential structure damages through flood reduction across design storms with mean annual, 10-year, and 100-year return periods.

While these estimates are satisfactory for initial comparisons of Candidate Plans, the assumptions made relative to what constitutes project benefits and their per-flood-event values will be discussed further with City and District staff prior to development of a BCR for the final Preferred Plan.

Example Benefit Calculation

Rough calculations were performed to develop preliminary order of magnitude estimates of annualized benefits which can be compared across Candidate Plans to aid in selecting a Preferred Plan.

# of events considered: 3, with mean annual, 10-year, and 100-year recurrence

annual probability of occurrence: 2.33-year = 0.429, 10-year = 0.1, and 100-year = 0.01

measurable benefit units:

- reduction in feet of flooded roadway
- reduction in number of parcels intersected by floodplain
- reduction in number of parcels w centroid intersected by floodplain (implies greater damages)

benefit unit values accrued by flood reduction:

- $62,400 per mile of roadway flood averted (assumes 4 inundation events per roadway repair)
- $250 per parcel per event averted (parcel intersecting floodplain with minor cost to owner)
- $6300 per parcel per event averted (parcel centroid intersecting floodplain, 15% res. structures)

The annualized benefit is computed as the product of each “measurable benefit unit” times “benefit unit values” multiplied by “probability of occurrence”, summed across “number of events considered”

Example, for Scenario 6F:

(6.4 mi * $62,400 + 726 parcels * $250 + 235 parcels * $6,300) * 0.429 [mean annual]
+ (13.0 mi * $62,400 + 868 parcels * $250 + 330 parcels * $6,300) * 0.1 [10-year]
+ (14.1 mi * $62,400 + 958 parcels * $250 + 319 parcels * $6,300) * 0.01 [100-year]
= $884,572 + $310,656 + $31,276
= $1,226,504

Preliminary Estimates of Candidate Plan Costs

Preliminary estimates of probable design and construction costs were developed to allow reasonable comparisons across Candidate Plans. Estimated costs for Scenarios 6A through 6H are presented in Table 1. Also provided are preliminary Equivalent Annualized Costs of construction (no maintenance, etc.) for each Candidate Plan, assuming a 7% annual interest rate and 50-year life of project.

Construction costs were based upon RS Means 2017, Heavy Construction Costs, with a factor of 0.95 applied to adjust Ft. Myers/Sarasota construction costs from national averages. The overriding cost item related to channel widening and/or bypass construction is expected to be for grading and earthwork, which is estimated at $13.25 per cubic yard of material removed. No accounting was made for land acquisition or easements which would substantially increase costs associated with Scenario 6B only. No accounting was made for erosion control or structural interconnections which will increase costs across all projects fairly uniformly, but are highly dependent on final plan configuration.

Cost calculations were performed to develop preliminary order of magnitude estimates of probable construction costs, which can be compared across Candidate Plans to aid in selecting a Preferred Plan. Once the Preferred Plan is selected and refined, a more rigorous cost calculation will be expanded to cover those items that were not included in the preliminary estimate.

Preliminary Benefit Cost Evaluation

A ratio of annualized benefits to annualized costs was calculated and that BCR assigned to each Candidate Plan for rough comparison to aid in selecting a Preferred Plan. Based on the screening-level estimates of Candidate Plan benefits, Scenarios 6A, 6D, 6F, and 6H appear to be in an acceptable range for consideration. Once a Preferred Plan is selected and refined, a more rigorous annualized benefit calculation will be expanded to cover mean annual, 5-, 10-, 25-, 50-, and 100-year events with selection of measurable benefit units and assignment of benefit unit values coordinated more closely with City staff.

The more rigorous final benefit and cost values for the Preferred Plan will be used to determine a BCR for the proposed flood reduction project, providing a basis for decision-making by administrators and commissioners at the City of North Port as well as to support the City of North Port's application for cooperative funding through the SWFWMD CFI program.

Flood Inundation

Flood inundation areas for each simulation were mapped to depict areas removed from the floodplain. As shown in Figures 1 through 16, flood reduction scenarios 6B, 6D, 6F, and 6H are more effective in reducing flood levels in the watershed, particularly in the I-75 study area, than other Candidate Plans. Candidate Plans may also result in increased flooding in downstream areas. Plan refinements and additional improvements will be developed for the selected Preferred Plan to relieve downstream bottlenecks and accommodate increased flows that result from the wider R-36 or addition of the Bypass.

Team Meeting

A Team Meeting was held on August 9, 2017 to discuss plan refinement (including evaluation of project constraints), hydraulic analyses of the refined plan, preliminary costs, and development of conceptual level drawings. Attendees included: Elizabeth Wong, Chuck Speake, Julie Bellia, Monica Bramble (City of North Port); Jezabel Pagan Garcia (Southwest Florida Water Management District); and David DeLoach, Trillian Baldassari (DeLoach Engineering Science).

The PowerPoint and PDF (Preliminary Draft of Conceptual-Level Drawings) presented at the meeting are attached. The following summarizes notable points raised during the team meeting and important issues that will be addressed as the project moves forward.

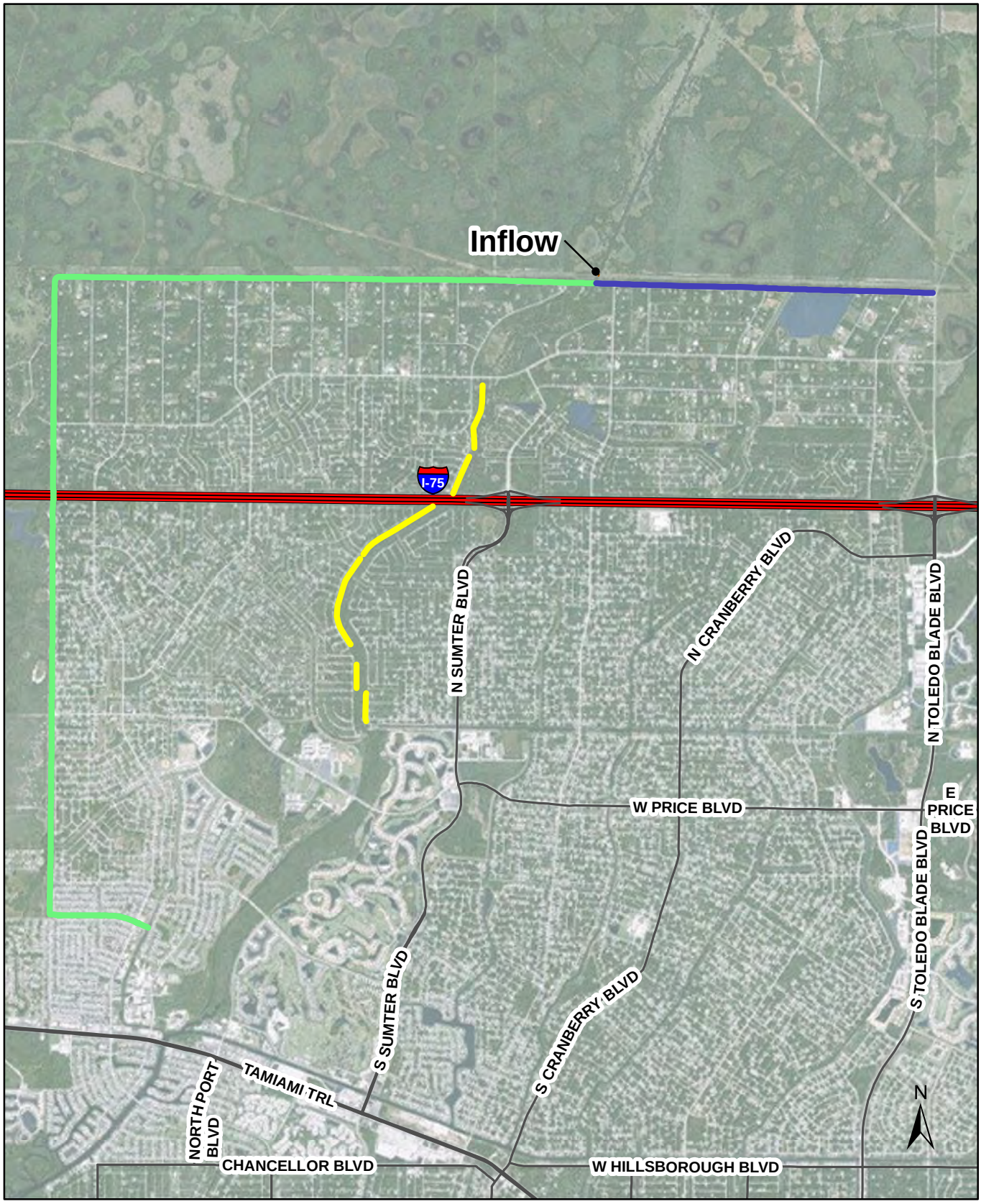
- DES presented conceptual level design drawings for expansion of R-36 (narrow and wide) and the new Bypass Canal (narrow and wide). Included are plan and profile sheets depicting project extents, cross section sheets depicting excavated sections for channel widening and bypass construction, and structure detail sheets depicting the proposed inflow control structure. Drawings will continue to be updated as the Preferred Plan is refined. Elizabeth requested that delivered AutoCAD files be compatible with AutoCAD 2008.
- DES presented a preliminary engineer's opinion of probable cost for expansion of R-36 (narrow and wide), construction of a Bypass Canal (narrow and wide), and construction of a fixed concrete weir to allow normal inflows but restrict high flood flows entering from offsite lands.
- Monica would like to see acreage of floodplain removed as part of the cost/benefit analysis.
- Elizabeth suggested that alternatives be evaluated separately. *(see Scenarios 6A, 6E, and 6F)*
- Big Slough has recently been cleaned from Price Boulevard to Snover Waterway, with plans to continue working northwards. Elizabeth will send photos of pre/post. DES will review roughness assumptions used in the model.
- Discussion to be included in the final report: date LiDAR was flown and reason for not including improvements to R-580 in further plan development.
- City and District staff will coordinate a meeting with the SWFWMD's Land Management Department. Monica would like to receive a documented response regarding sending additional water to Deer Prairie Slough.
- City staff will coordinate a meeting with the City's Parks Department. DES will demonstrate the benefit of the Bypass on Tier 1/Tier 2 Lots for use by the Parks Department.
- DES will provide tabulated benefit (floodplain removed) for each alternative evaluated separately. (*see Scenarios 6A, 6E, and 6F*)

Identification of the Preferred Plan

Based upon the Project Team's review and discussion of preliminary hydraulic evaluation results, a set of alternatives were advanced for development of improvements to achieve flood reduction through internal flow diversion and increased conveyance capacity, external flow diversion, offsite storage, and acquisition. Those concepts were refined and combined into a small number of Candidate Plans for evaluation of hydraulic performance, preliminary cost estimates, and screening-level benefit estimates.

This interim report, meetings, and team discussion provides a basis for evaluation of the Candidate Plans. The Project Team will select from among these Candidate Plans and the Preferred Plan will be finalized and evaluated more rigorously for permittability, costs, and benefits.

Note: This is an interim report describing a preliminary work product. Some elements of the Candidate Plans are known to result in small, but undesirable increases in water levels in certain areas. From a practical standpoint, it is inefficient to develop Candidate Plans while at the same time eliminating all such increases. For example, scenarios which include upgrades of the Tropicaire R-36 culvert crossing may have an adverse impact on areas between Tropicaire and I-75, depending on the magnitude of discharges to the west (into Deer Prairie Slough) and other elements of the stormwater plan. If a plan is found to be desirable (notwithstanding the increases) then additional improvements may be considered to eliminate increases. The final Preferred Plan will address undesirable increases and incorporate changes to eliminate adverse impacts.



BMP Location

Waterway

- Bypass
- R-36
- R-580

BMP LOCATION MAP

CITY OF NORTH PORT, FL

DELOACHes

Notes:

Project: 16-00400-00	**Date:** 10/03/2017	**Author:** CGG

Projection: Projection: NAD83 StatePlane Florida West HARN

Path: Q:\16-00400-00\ArcGIS\ArcLayouts\20171003 - BMP Location Exhibit\20171003 - BMP Location Map.mxd