Regular Workshop – December 12, 2016
Agenda Item 10

Agenda Item: Longbeach Village Drainage Study Update

Presenter: Public Works Director, DMK Associates

Summary: The Town engaged the services of DMK Associates, to conduct an evaluation and assessment of the stormwater system in the Historic Longbeach Village on the North end of the island. This evaluation includes determination of the level of service provided by the existing system and to make recommendations to improve the performance of the overall drainage system for the Village.

Attachments: 12-5-16 Memo, Public Works Director to Manager;
December 2016, DMK Associates Report, Longboat Key Village Stormwater Evaluation and Alternative Analysis

Recommended Action: None, informational only.

M E M O R A N D U M

Date: December 5, 2016

TO: Dave Bullock, Town Manager

FROM: Juan Florensa, Public Works Director

SUBJECT: Longbeach Village Drainage Study Update

The Town engaged the services of DMK Associates, to conduct an evaluation and assessment of the stormwater system in the Historic Longboat Village (Village) on the North end of the island. This evaluation includes determination of the level of service provided by the existing system and to make recommendations to improve the performance of the overall drainage system for the Village.

As a result of a study conducted in 2002, the Town performed drainage improvements to alleviate flooding in the Village. Improvements included the construction of stormwater pipes, drainage inlets, manholes and Tideflex® valves designed to assist in keeping tidal waters from entering the stormwater system.

Sample picture of valve

The design level of service for the project was to keep the crown of the local streets clear from stormwater during a 10 year 24-hour rain event (7 inches of precipitation) coinciding with a tide elevation of 1.5 feet. Although the project helped to improve the historic flooding problems, there are portions of the Village that continue to hold water during high tides and rain events.

DMK Associates was asked to evaluate the performance of the existing stormwater system and make recommendations to the Town to determine potential solutions for this nuisance flooding. The consultant was asked to incorporate the impacts of Sea Level Rise (SLR) in their report.

Kreg Maheu, PE, DMK Associates, is prepared to provide a PowerPoint presentation and discuss the attached report and Evaluation and Alternatives Analysis.

LONGBOAT KEY VILLAGE STORMWATER EVALUATION AND ANALYSIS

PROPOSED CONDITIONS EVALUATION

AND ALTERNATIVES ANALYSIS

DMK ASSOCIATES
ENGINEERS • SURVEYORS

DECEMBER 2016

Table of Contents

Background 2
Existing Conditions Assessment 2
Proposed Conditions Evaluation and Alternatives 2
Cost Benefit Analysis 5
Pump Operating and Renewal/ Replacement Costs 5

Background

As a result of a study conducted in 2002, the Town performed drainage improvements to alleviate flooding in the Longboat Key Village. Improvements included the construction of stormwater pipes, drainage inlets, manholes and Tideflex® valves designed to assist in keeping tidal waters from entering the stormwater system. Although the project helped to improve the historical flooding problems, there are portions of the Village that continue to hold water during high tides and rain events. DMK Associates has been asked to evaluate the performance of the existing stormwater system and make recommendations to the Town of Longboat Key to determine potential solutions for the flooding.

Existing Conditions Assessment

The design documents and construction plans from the previous project in 2002 were obtained from the Town. In those documents were copies of the original ICPR (Interconnected Pond Routing) computer model for the stormwater system. This model was re-created in ICPR using the same modeling parameters and the model was executed. The reported design high water elevations from the previous engineering design were slightly different than the reported design high water elevations in the newly executed model run. It is believed that this is due to updates to the ICPR modeling software.

As part of the previous project, Tideflex® valves were installed on some outfalls to prevent high tides from backing up into the stormwater system and creating a phenomenon called "sunny day" high tide flooding. Flooding of streets and yards can occur even when no rainfall has taken place. Higher than normal tides occur, causing water to back up into the system thereby causing flooding without a rainfall event.

Refinements to the new model were required to reflect the actual conditions in the Village. Using as-built information obtained from the Town, the model was revised to show the correct lengths of pipe, pipe inverts, etc. Tideflex® was contacted and a representative from the company met with DMK and the Town onsite. Headloss vs. Flow data was then received from Tideflex® that would assist in evaluating the effects of the valves on the ICPR model design high water elevations. These charts are located in the appendix. The data from the charts was used to revise the model to add in the headloss effects of the Tideflex® valves. On the outfall pipes where no Tideflex® valves were installed, a "clip" was modeled on the downstream side of the pipe to reflect the affects of encumbrances of the pipe outfalls including but not limited to existing invert elevations, changes in adjacent grade or mangroves that grow in front of the pipe outfalls. The model was then executed to determine the design high water elevations with the effects of the encumbrances or "clips", including as built and Tideflex® information. The complete Existing Conditions Assessment Report was submitted under separate cover.

Proposed Conditions Evaluation and Alternatives

Alternatives were explored to alleviate flooding. A seawall was considered, however this would only help abnormally high "sunny day" tide flooding and would be extremely costly. In addition, Tideflex® valves would also need to be installed on the remaining outfalls to make sure high tides do not back up into the stormwater system. Also, the seawall option would not alleviate flooding that occurs due to regular rainfall events. Also considered was to raise the elevation of the roads. This option would bring

the roads out of the flooding, however would exacerbate the flooding in residential yards by eliminating storage for the flooding.

The best feasible alternative to prevent "sunny day" high tide flooding and also alleviate flooding from rainfall events is to provide some type of "check" valve such as a Tideflex® valve and to pump the stormwater runoff from rainfall events into the bay.

Three (3) Alternatives were evaluated to alleviate flooding from rainfall events, "sunny day" high tide flooding and a combination of the two.

Alternative	**Tideflex® valves**	**Pumps**
Alternative 1	No additional Tideflex® valves	(4) Pumping stations added to outfalls with existing Tideflex® valves
Alternative 2	(4) new Tideflex® valves to (4) existing outfalls that do not have any type of check valve installed	(4) Pumping stations added to outfalls with existing Tideflex® valves (same outfalls as Alternative 1)
Alternative 3	(4) new additional Tideflex® valves to (4) existing outfalls that do not have any type of check valve installed (same outfalls as Alternative 2)	(4) Pumping stations added to outfalls with new Tideflex® valves (same outfalls as Alternative 2)

Alternative	**Benefits**
Alternative 1	Addition of pump systems will alleviate rainfall event flooding and reduce the time in which areas flood where existing Tideflex® valves are installed.
Alternative 2	Alternative 1 benefits along with reducing the number of sunny day high tide flooding events in problematic areas.
Alternative 2	Alternative 1 and 2 benefits along with alleviating rainfall event flooding and reducing the time in which areas flood.

Attached in the appendix are exhibits showing the three (3) alternatives and locations of the proposed improvements. Below is a summary table showing the different Alternatives with the associated benefits as compared to the existing condition elevation and warning elevation. The warning elevation is high point of the road elevation adjacent to the node otherwise known as the crown of the road:

LONGBOAT KEY VILLAGE STORMWATER EVALUATION AND ANALYSIS					
10 YEAR STORM COMPARISON TABLE OF ALTERNATIVE ANALYSIS MODELS					
Node	DMK Existing Max El. (ft)	Alternate 1 Max El. (ft)	Alternate 2 Max El. (ft)	Alternate 3 Max El. (ft)	Warning El. (ft)*
100	3.77	3.77	3.70	1.51	3.00
1000	2.63	1.99	1.99	1.99	2.35
1100	3.46	3.47	3.47	3.47	2.60
1200	2.89	2.89	2.95	1.51	2.20
1300	3.10	3.10	3.17	1.77	2.20
1400	3.24	3.24	3.20	1.84	3.00
1500	2.80	2.53	2.53	2.53	2.10
158	2.74	2.18	2.18	2.18	2.00
1600	2.74	2.36	2.36	2.36	1.90
1700	2.66	1.99	1.98	1.98	2.00
179	2.67	1.96	1.96	1.96	2.50
1800	3.06	3.00	3.00	3.00	2.70
1900	3.32	3.36	3.36	3.36	2.40
200	2.32	1.57	1.57	1.57	2.20
300	3.33	3.33	3.33	3.33	3.22
400	3.03	3.03	3.03	3.03	2.82
500	2.82	2.67	2.67	2.67	2.05
600	3.26	3.29	3.29	3.29	2.40
700	3.21	3.24	3.24	3.24	2.80
800	2.82	2.51	2.51	2.51	2.15
900	2.66	1.89	1.89	1.89	2.00

*Warning Elevation is the crown of adjacent to the Node

	no flooding above the crown of the roadway
	less than 6" flooding above the crown of the roadway
	more than 6" flooding above the crown of the roadway

It should be noted that although the maximum elevations for some of the areas did not decrease entirely below the crown of the road, the depth and duration of flooding was reduced significantly. The reduction of flooding and duration will significantly reduce the standing water in adjacent yards and help reduce incidental “over splash” flooding that occurs when a vehicle travels down the roadway. One known problem area is Node 1600 which is at the intersection of Longboat Key Drive East and Russell Street. Under the existing conditions model, this area floods a maximum of 10” above the crown of the roadway and stays at least above the crown of the roadway for over 5 hours for the 10 year 24 hour storm event. With the addition of a pump station at Node 1600, the flooding is only 4.5” and the duration that the flooding occurs is less than an hour. This is typical for many of the “interior” nodes where friction losses through the stormwater system and the existing Tideflex Valves create restrictions. See the Exhibits for Nodes 1600 and Node 158, which show how the volume and duration of flooding is significantly less.

Cost Benefit Analysis

A cost benefit analysis was performed to evaluate demonstrate the benefits versus the cost for each alternative. The cost estimates are for construction only and do not include final design and permitting, or maintenance and operation costs.

Alternate 1				Benefits
Description	Each	Cost	**Total**	Decreases the elevation for the 10 year design storm for 5 nodes below the crown of the road and reduces flooding to under 6 inches for 4 other nodes.
Pump Stations	4	$150,000	**$600,000**	

Alternate 2				Benefits
Description	Each	Cost		Decreases the elevation for the 10 year design storm for 5 nodes below the crown of the road and reduces flooding to under 6 inches for 4 other nodes. Eliminates "sunny" day high tide flooding for 4 other areas.
Pump Stations	4	$150,000	$600,000	
Tideflex® valves	4	$30,000	$120,000	
		Total	**$720,000**	

Alternate 3				Benefits
Description	Each	Cost		Decreases the elevation for the 10 year design storm for 9 nodes below the crown of the road and reduces flooding to under 6 inches for 4 other nodes. Eliminates "sunny" day high tide flooding for 4 other areas.
Pump Stations	8	$150,000	$1,200,000	
Tideflex® valves	4	$30,000	$120,000	
		Total	**$1,320,000**	

Pump Operating and Renewal/Replacement Costs

Operating and renewal/replacement costs were estimated for the analysis. These costs are only for "hard" costs which include energy costs and equipment replacement and repair costs. It doesn't include the town's "soft" costs such as technician, labor and any administrative costs associated with the operation of the pumps on a daily basis.

Alternative	Pump Operating Costs	Renewal/Replacement Costs	Annual Costs
Alternative 1	$9,271.00	$30,000.00	$39,271.00
Alternative 2	$9,271.00	$30,000.00	$39,271.00
Alternative 3	$18,542.00	$60,000.00	$78,542.00

The pump operating costs are based on a pump efficiency of 63%, an average of 3 hours per day of operation, 4700 gallons per minute (gpm) and $0.15/kwHr. The renewal/replacement costs are based on life cycle costs assuming a pump component life cycle of 10 years and a wet well/piping components life cycle of a 50 years. Because Alternative 3 has twice the number of pumps as Alternates 1 and 2, the costs are double the costs of those alternatives.

Appendix

Exhibit Node 1600

Exhibit Node 158

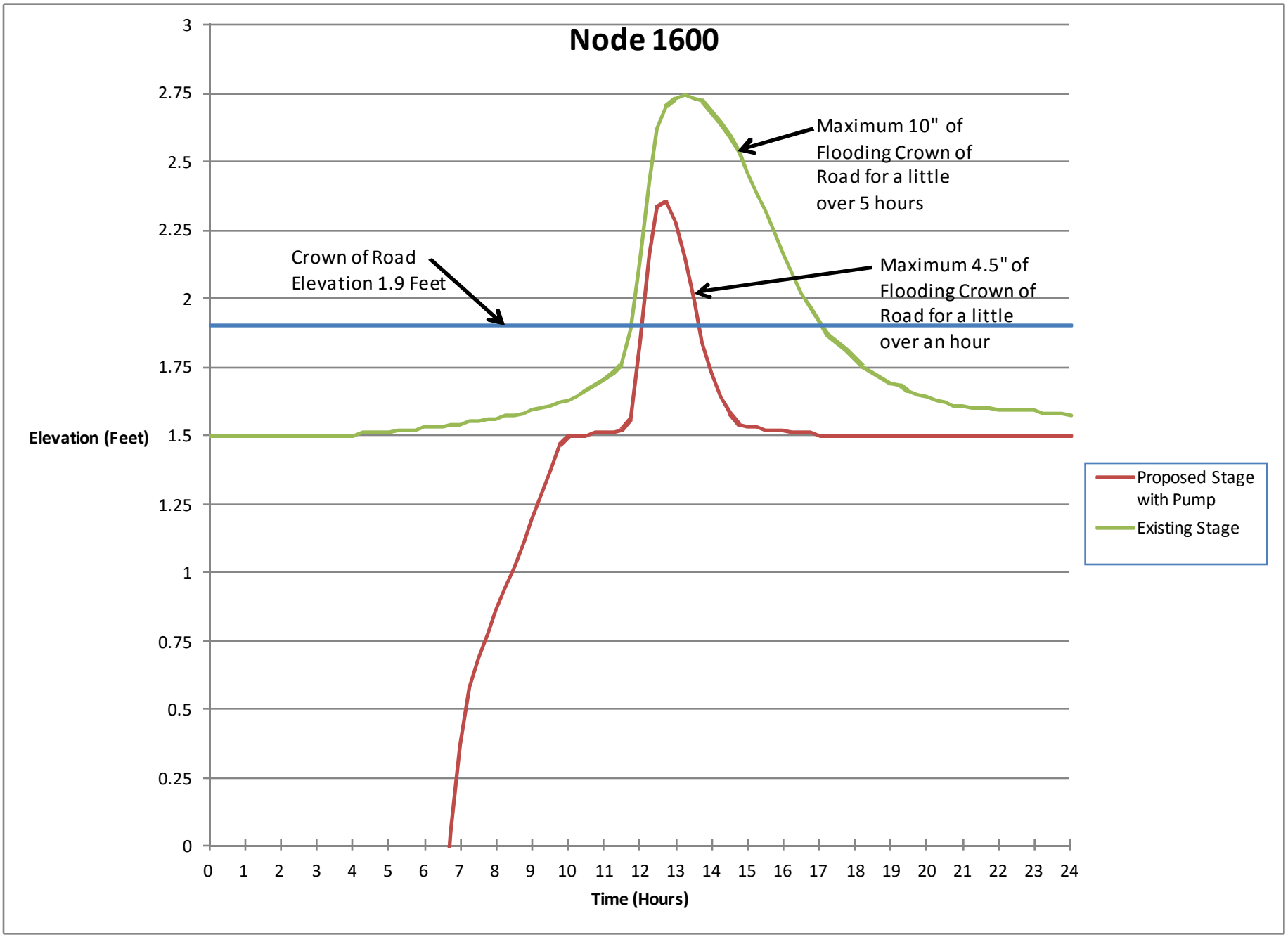
Alternate 1, 2 and 3

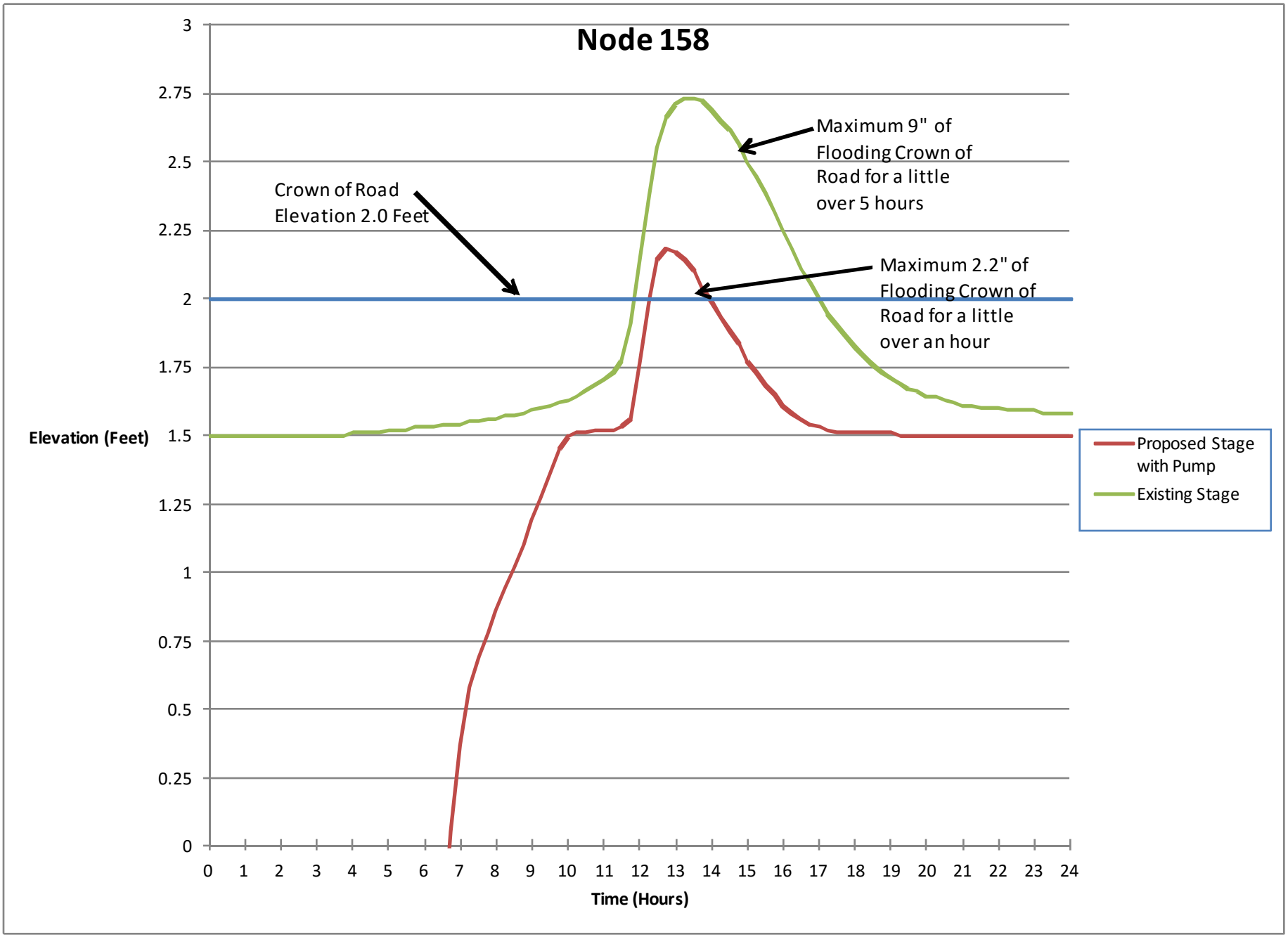
Appendix

Exhibit Node 1600

Exhibit Node 158

Alternate 1, 2 and 3


Node 1600
Maximum 10" of Flooding Crown of Road for a little over 5 hours
Crown of Road Elevation 1.9 Feet
Maximum 4.5" of Flooding Crown of Road for a little over an hour
Elevation (Feet)
Time (Hours)
Proposed Stage with Pump
Existing Stage
3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


Node 158
Maximum 9" of Flooding Crown of Road for a little over 5 hours
Crown of Road Elevation 2.0 Feet
Maximum 2.2" of Flooding Crown of Road for a little over an hour
Elevation (Feet)
Time (Hours)
Proposed Stage with Pump
Existing Stage
3
2.75
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

PRELIMINARY PLANS

THESE PLANS MAY HAVE BEEN REDUCED IN SIZE BY REPRODUCTIONS.
THIS MUST BE CONSIDERED WHEN OBTAINING SCALED DATA.

Drawing name: F:\Projects\2015\15-0101 LBK Village Stormwater System\dwg\15-0101-DRG-ALT-1.dwg Tab: ALT-1 Date Printed: Tue, 04 Oct 2016 - 2:49pm

1

CLIENT: TOWN OF LONGBOAT KEY
LONGBOAT KEY, FLORIDA

PROJECT: THE VILLAGES OF LONG BOATKEY
DRAINAGE STUDY

DESC: ALTERNATIVE 1

X
MARY ANN LIND P.E.
FLA. LIC. NO. 58093
C.A. NO. 3943
DATE:

In accordance with 61G15-30.003 (5) F.A.C., these preliminary engineering documents are not in final form, but are being transmitted to the public agency to receive agency reviews, comments and interpretations. The documents may subsequently be revised by the Engineer to reflect resolution of issues with public agency prior to final action by the agency. Changes, revisions and modifications to a project may prompt additional document submittal for agency approval action on the same project.

NO.	REVISION	DATE	BY

DMK ASSOCIATES
ENGINEERS ■ SURVEYORS
421 Commercial Court, Suites C-D
Venice, Florida 34292
TEL: (941) 412-1293 FAX: (941) 412-1043
Engineering Business No. 3943

Design By: MAL	Drawn By: RMS	Checked By: MAL	Date: 10-04-16
CADD File: 15-0101-DRG-ALT-1.dwg		SCALE: NOTED	Proj. No.: 15-0101

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PRELIMINARY PLANS

DMK ASSOCIATES
ENGINEERS & SURVEYORS
421 Commerce Court Suites C-D
Venice, Florida 34292
TEL: (941) 412-1293 FAX: (941) 412-1043
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NO.	REVISION	DATE	BY

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MARY ANN LIND P.E.
FL. LIC. NO. 58693
C.A. NO. 3943
DATE:

CLIENT: TOWN OF LONGBOAT KEY
LONGBOAT KEY, FLORIDA
PROJECT: THE VILLAGES OF LONG BOATKEY
DRAINAGE STUDY
DESC: ALTERNATIVE 2

2

Drawing name: F:\Projects\2015\15-0101 LBK Village Stormwater System\dwg\15-0101-DRG-ALT-1.dwg Tab: ALT-2 Date Printed: Tue, 04 Oct 2016 - 2:32pm

PRELIMINARY PLANS

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DMK ASSOCIATES
ENGINEERS & SURVEYORS
421 Commerce Court Suites C-D
Venice, Florida 34292
TEL: (941) 412-1293 FAX: (941) 412-1043
Engineering Business No. 3943

Design By: MAL | Drawn By: RMS | Checked By: MAL | Date: 11-08-16
CADD File: 15-0101-DRG-ALT-1.dwg | SCALE: NOTED | Proj. No.: 15-0101

NO.	REVISION	DATE	BY

In accordance with 61G15-30.003 (5) F.A.C., these preliminary engineering documents are not in Final Form, but are submitted for review purposes only. The documents may require revisions and interpretations. The documents may subsequently be revised by the Engineer to reflect resolution of comments and interpretations received from review agencies. Changes, revisions and modifications to a project may present additional document submittal for agency approval action on the same project.

MARY ANN LIND P.E.
FL. LIC. NO. 58693
C.A. NO. 3943
DATE:

CLIENT: TOWN OF LONGBOAT KEY
LONGBOAT KEY, FLORIDA

PROJECT: THE VILLAGES OF LONG BOATKEY
DRAINAGE STUDY

DESC: ALTERNATIVE 3

3

Drawing name: F:\Projects\2015\15-0101 LBK Village Stormwater System\dwg\15-0101-DRG-ALT-1.dwg Tab: ALT-3 Date Printed: Tue, 08 Nov 2016 - 7:31am

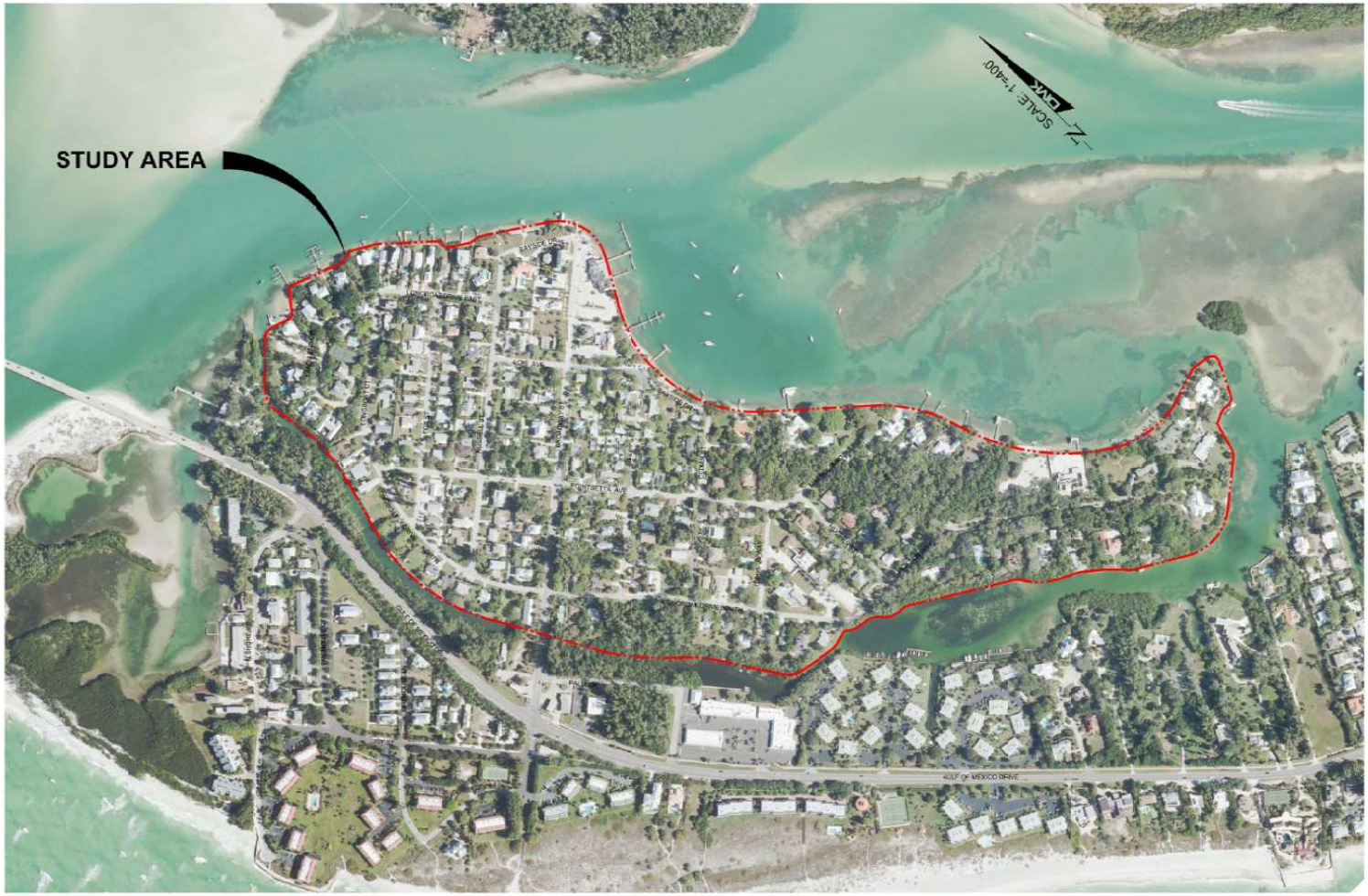
LONGBOAT KEY VILLAGE STORMWATER EVALUATION & ANALYSIS PROJECT UPDATE

DMK ASSOCIATES
ENGINEERS ▪ SURVEYORS

LONGBOAT KEY INCORPORATED
1539 to 1955
FLORIDA

BACKGROUND & HISTORY

LONGBOAT KEY VILLAGE STUDY AREA



SUNNY DAY – NO RAIN HIGH TIDE FLOODING

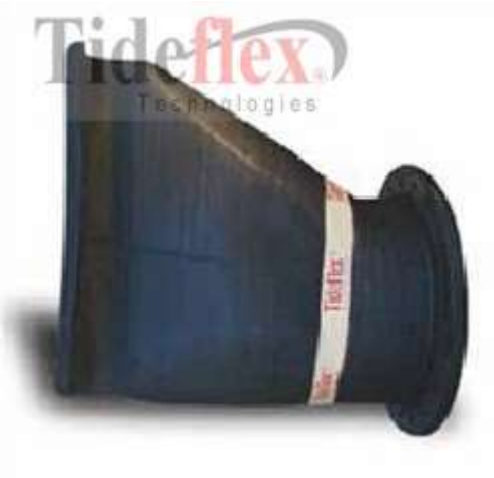
Russell Street and Bayside Drive looking west

Task 1

- DATA ACQUISITION
  - Review of previous study and design improvements completed in 2002
  - Design Level of Service: Crown of roadway above 10 year 24 hour design storm vs. a 1.5 ft. tide
  - Field inspection and verification of maintenance and operation of existing stormwater system

Task 2

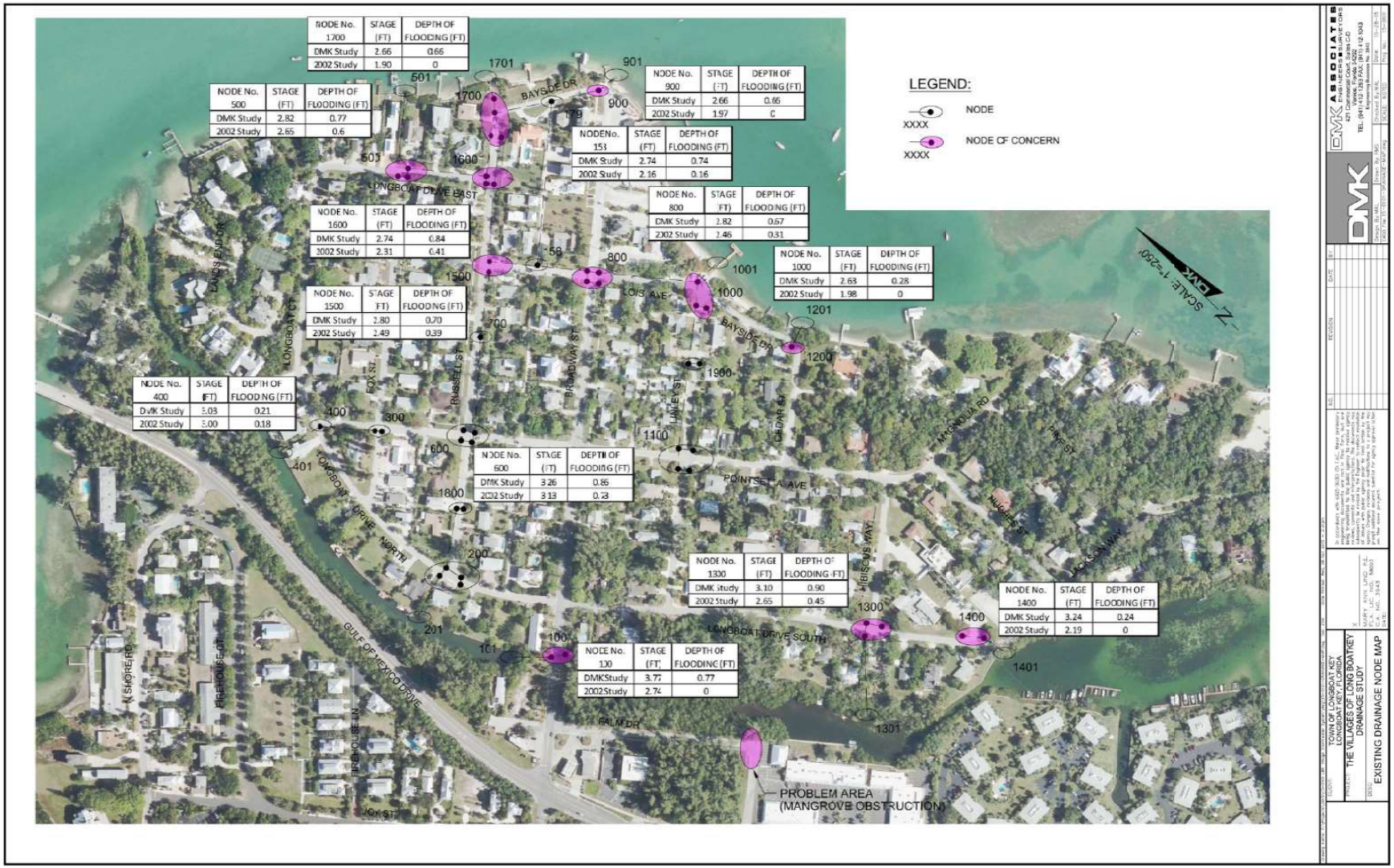
- EXISTING CONDITIONS ASSESSMENT
  - Update previous 2002 stormwater model to determine the differences between the updated model and 2002 model
  - Evaluate effectiveness of Tideflex® Valves
  - Prepare Existing Conditions Report



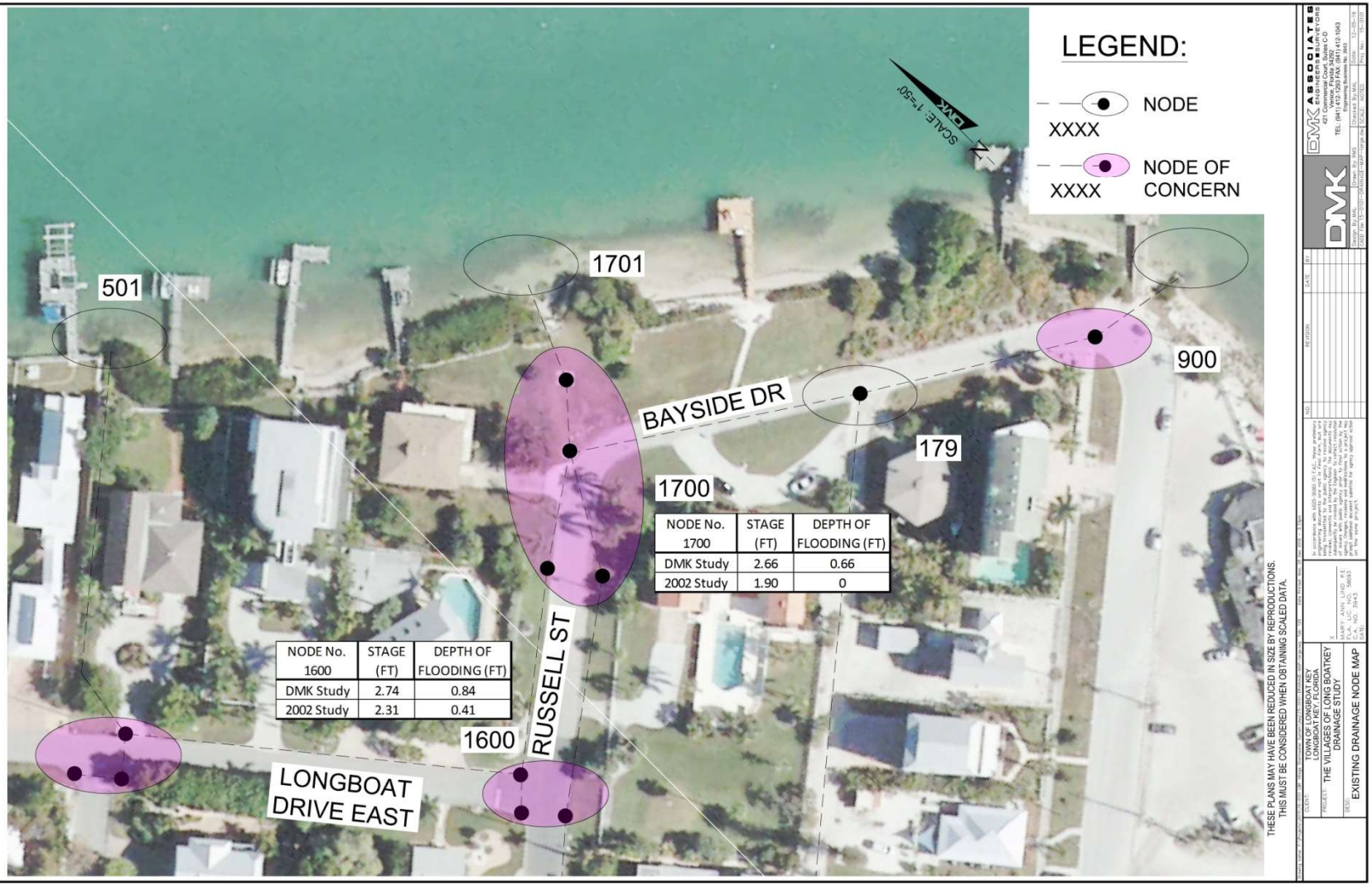
AREAS OF CONCERN

Average Node Increase: 6” +/-
Range: 1”-12” +/-

MODEL DIFFERENCES



MODEL DIFFERENCES



NODE No. 1600	STAGE (FT)	DEPTH OF FLOODING (FT)
DMK Study	2.74	0.84
2002 Study	2.31	0.41

NODE No. 1700	STAGE (FT)	DEPTH OF FLOODING (FT)
DMK Study	2.66	0.66
2002 Study	1.90	0

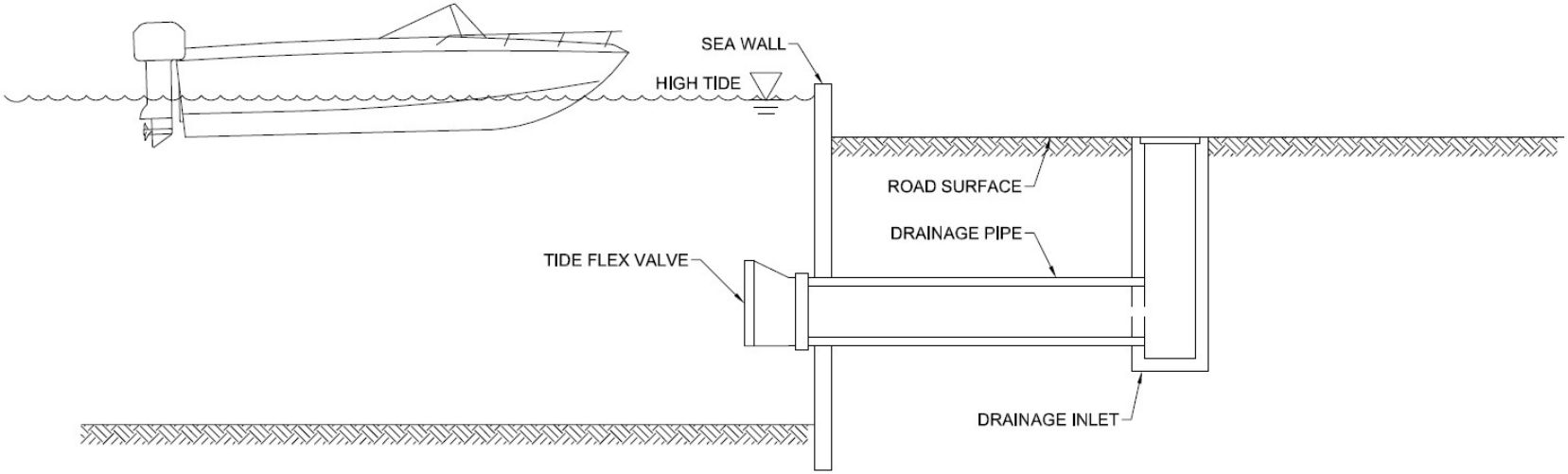
MODEL DIFFERENCES

- Inter-Connected Pond Routing (ICPR) modeling updates
- ICPR model refinements to simulate pipe outfall "clips". The clips are to account for mangrove obstructions in front of the pipe discharge opening.
- Tideflex® Valves "Head" Pressure Restriction

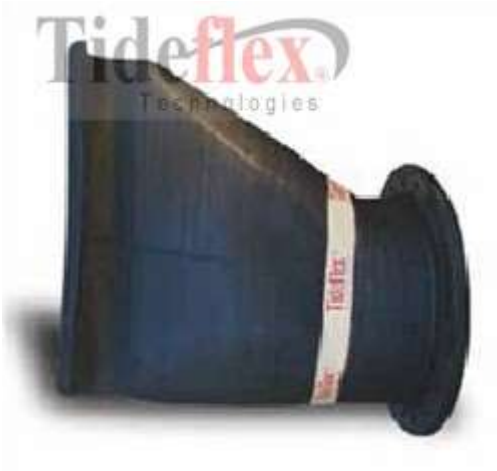
Tideflex® Valves

ADVANTAGES:

- Intention of the valves is to keep high tides from backing up into the streets

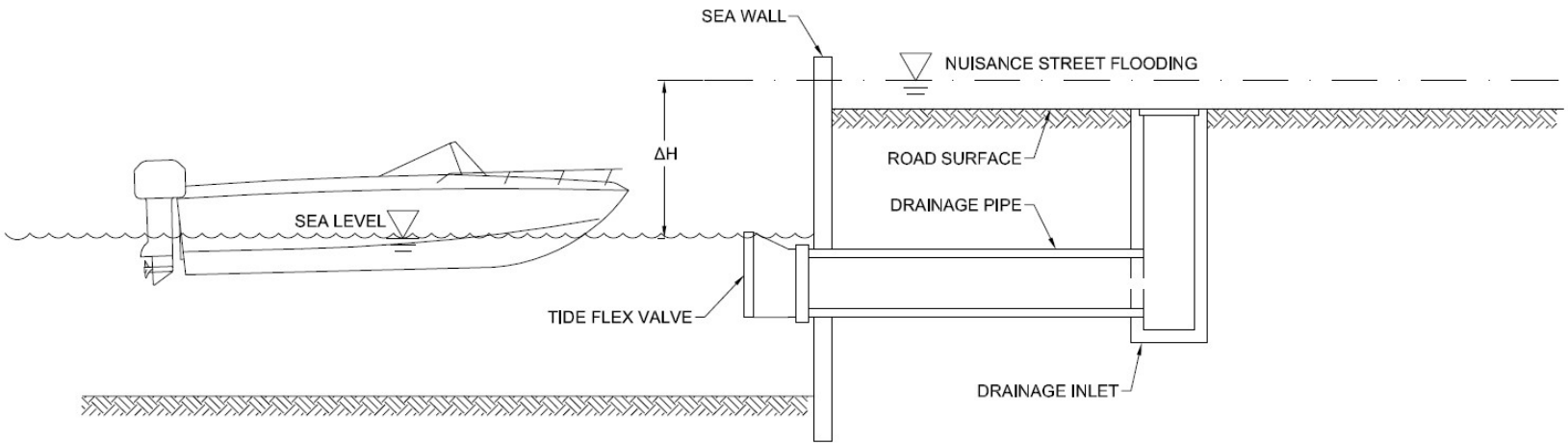


Tideflex® Valves



DISADVANTAGES:

- Requires more energy to force the stormwater through the valves
- Requires more time for the stormwater to drain through the valves because of the effective area opening of the valve



Tideflex® Valve on Longboat Dr N

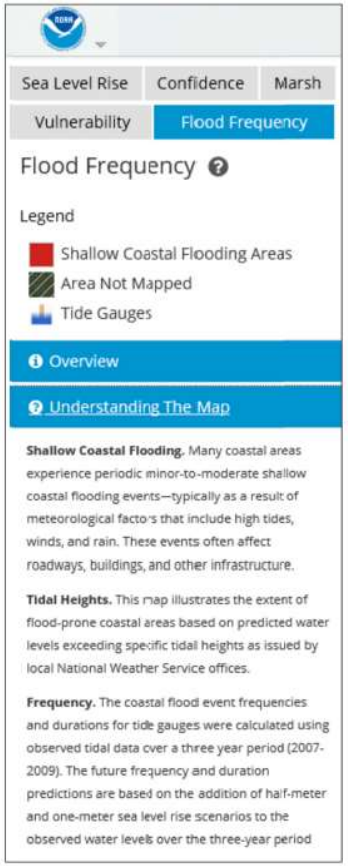
Task 3

- EVALUATION AND ANALYSIS
  - Evaluate the Impact of Sea Level Rise
  - Alternative Analysis
  - Cost Benefit Analysis

IMPACT OF SEA LEVEL RISE

- Since 1950, a 6" +/- Rise in Extreme Water Levels
- Mean Water Levels have increased 3" since 2004 in our area (NOAA)

FLOOD FREQUENCY FOR AN ADDITION OF 1/2 TO 1 METER SEA LEVEL RISE TO OBSERVED WATER LEVELS

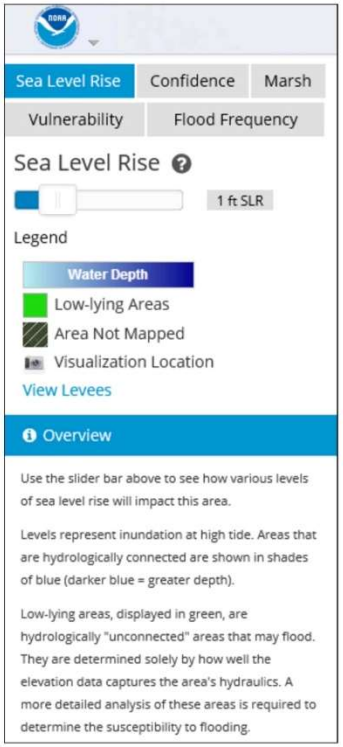


FOR:	TOWN OF LONGBOAT LONGBOAT KEY, FLORIDA	TITLE:	LONGBOAT KEY VILLAGE STORMWATER EVALUATION AND ANALYSIS
DESC:	FLOOD FREQUENCY FIGURE		

DMK ASSOCIATES ENGINEERS ■ SURVEYORS
421 Commercial Court, Suites C-D, Venice, FL 34293
TEL: (941) 412-1293 FAX: (941) 412-1043
C.A. No. 3943

Design By: MAL	Drawn By: RMS	Checked By: MAL	Proj. No.: 15-0101
CADD File: REPORT-FIGURES.dwg		Date: 10-22-15	SCALE: NONE

SEA LEVEL RISE OF 1 FOOT



FOR:	TOWN OF LONGBOAT LONGBOAT KEY, FLORIDA	TITLE:	LONGBOAT KEY VILLAGE STORMWATER EVLALUATION AND ANALYSIS
DESC:	SEA LEVEL RISE FIGURE - 1 FOOT		

DMK ASSOCIATES ENGINEERS ■ SURVEYORS
421 Commercial Court, Suites C-D, Venice, FL 34292
TEL: (941) 412-1293 FAX: (941) 412-1043
C.A. No. 3943

Design By: MAL	Drawn By: RMS	Checked By: MAL	Proj. No.: 15-0101
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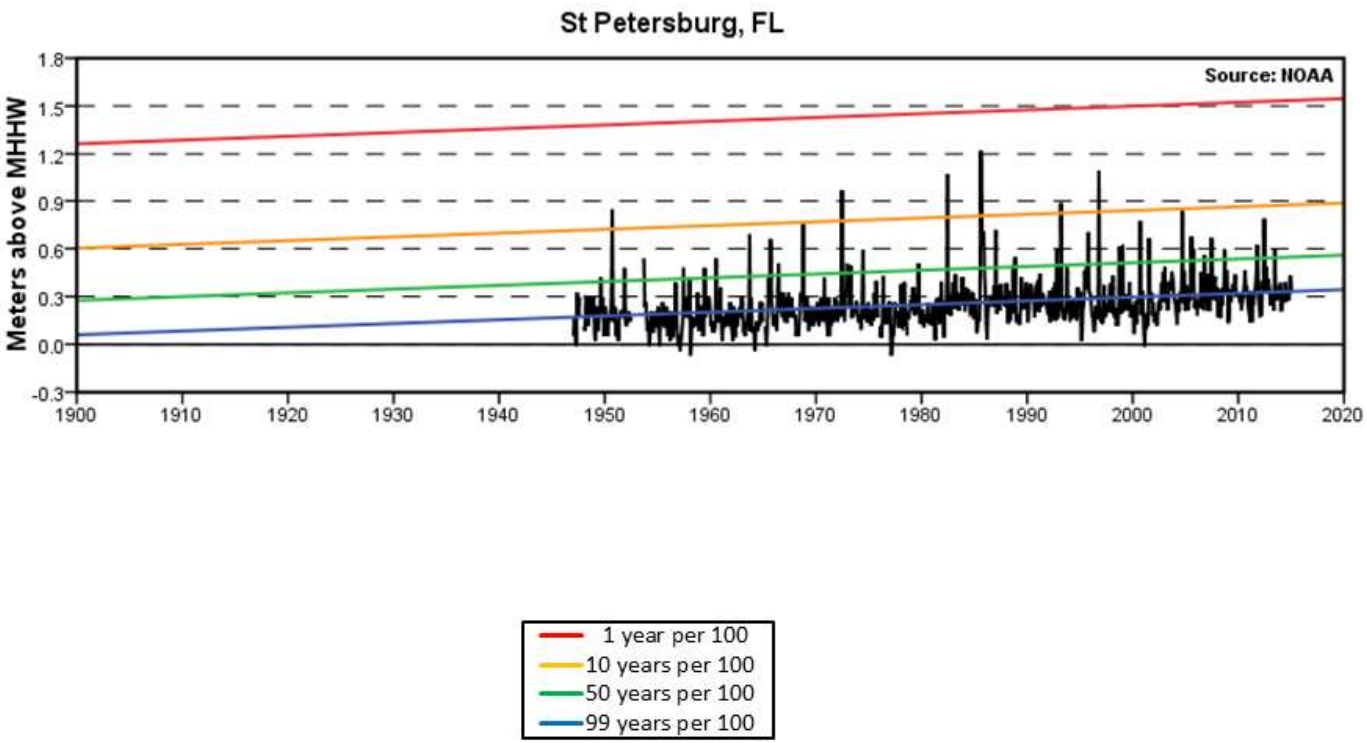
AVERAGE OF 6" RISE OF EXTREME WATER LEVELS OVER A 50 YEAR PERIOD

Extreme Water Levels
8726520 St. Petersburg, FL
Tide Station (NOAA)



ALTERNATIVE ANALYSIS

- Seawalls – are not feasible because it doesn't eliminate flooding from everyday rainfall events and cost prohibitive
- Raise elevations of roadways – eliminates roadway flooding however exacerbates residential yard flooding
- Ditches – not feasible because of high water table and not enough elevation difference to "push" the water out
- Feasible option is to add pump stations and Tideflex® valves or similar product

ALTERNATIVE ANALYSIS

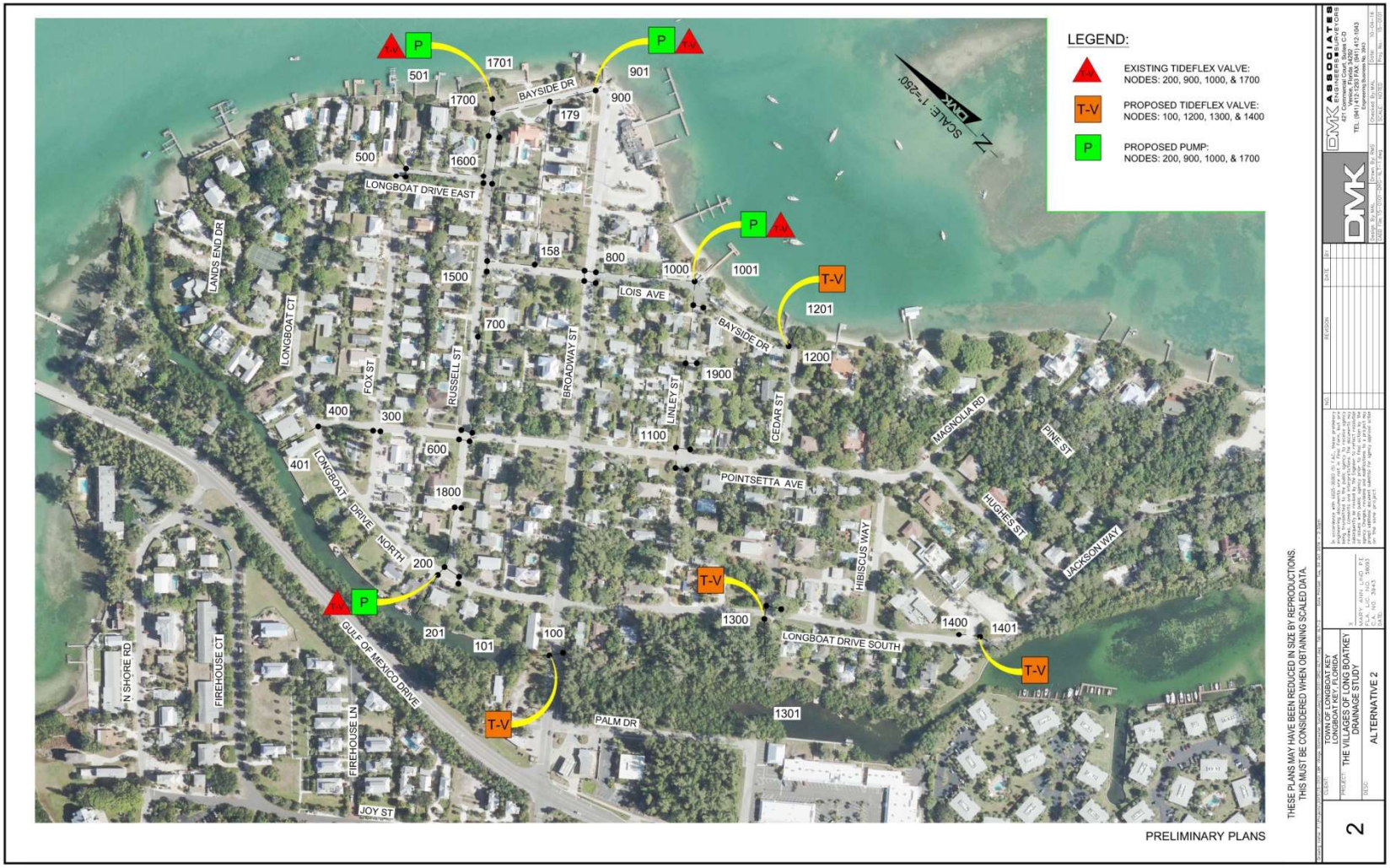
- Alternative 1 adds 4 pumping systems to existing outfalls that currently have Tideflex® valves installed on the ends of the pipes discharging into the bay. The addition of the pump systems will alleviate rainfall event flooding and reduce the time in which these areas flood.

ALTERNATIVE 1

ALTERNATIVE ANALYSIS

- Alternative 2 adds Tideflex® valves to known areas that flooding occurs for both rainfall events and "sunny day" high tide flooding. The addition of the Tideflex® valves on these outfalls will reduce the number of days that high tide flooding occurs.

ALTERNATIVE 2

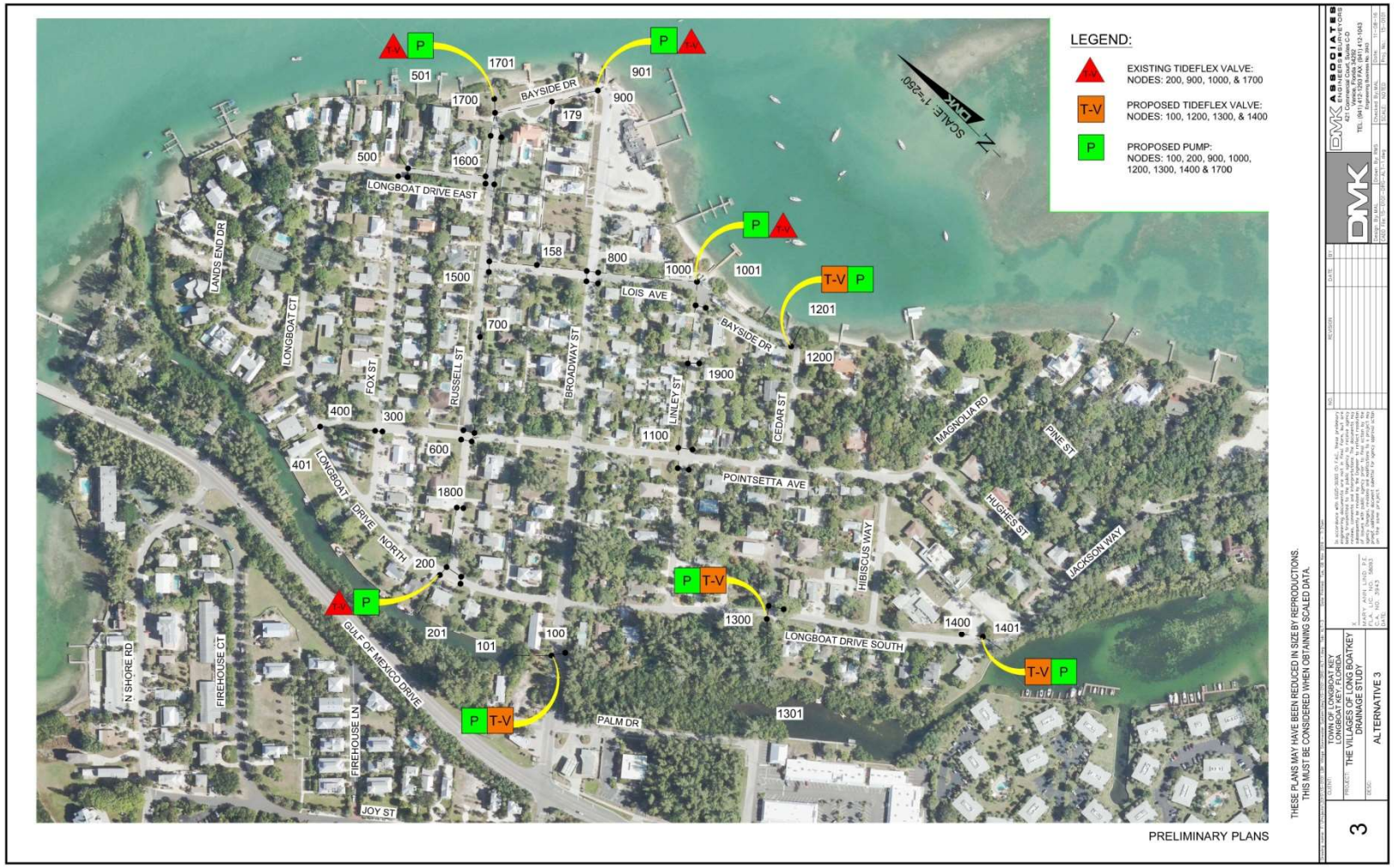


ALTERNATIVE ANALYSIS

- Alternative 3 adds pumping systems to the new Tideflex® valves in Alternative 2.

  As with Alternative 1, the addition of the pump systems will alleviate rainfall event flooding and reduce the time in which these areas flood.

ALTERNATIVE 3



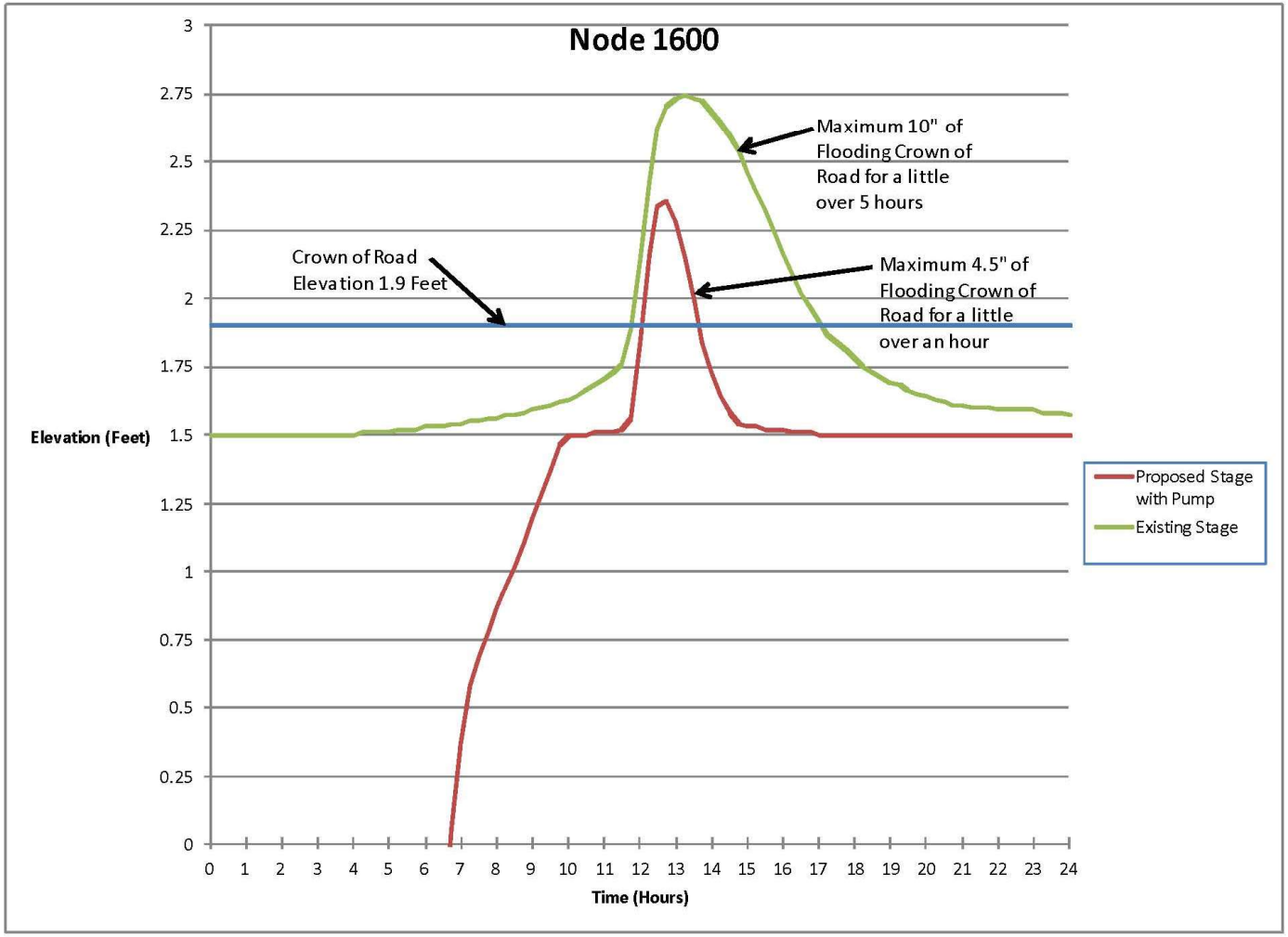
ALTERNATIVE ANALYSIS

LONGBOAT KEY VILLAGE STORMWATER EVALUATION AND ANALYSIS					
10 YEAR STORM COMPARISON TABLE OF ALTERNATIVE ANALYSIS MODELS					
Node	DMK Existing Max El. (ft)	Alternate 1 Max El. (ft)	Alternate 2 Max El. (ft)	Alternate 3 Max El. (ft)	Warning El. (ft)*
100	3.77	3.77	3.70	1.51	3.00
1000	2.63	1.99	1.99	1.99	2.35
1100	3.46	3.47	3.47	3.47	2.60
1200	2.89	2.89	2.95	1.51	2.20
1300	3.10	3.10	3.17	1.77	2.20
1400	3.24	3.24	3.20	1.84	3.00
1500	2.80	2.53	2.53	2.53	2.10
158	2.74	2.18	2.18	2.18	2.00
1600	2.74	2.36	2.36	2.36	1.90
1700	2.66	1.99	1.98	1.98	2.00
179	2.67	1.96	1.96	1.96	2.50
1800	3.06	3.00	3.00	3.00	2.70
1900	3.32	3.36	3.36	3.36	2.40
200	2.32	1.57	1.57	1.57	2.20
300	3.33	3.33	3.33	3.33	3.22
400	3.03	3.03	3.03	3.03	2.82
500	2.82	2.67	2.67	2.67	2.05
600	3.26	3.29	3.29	3.29	2.40
700	3.21	3.24	3.24	3.24	2.80
800	2.82	2.51	2.51	2.51	2.15
900	2.66	1.89	1.89	1.89	2.00

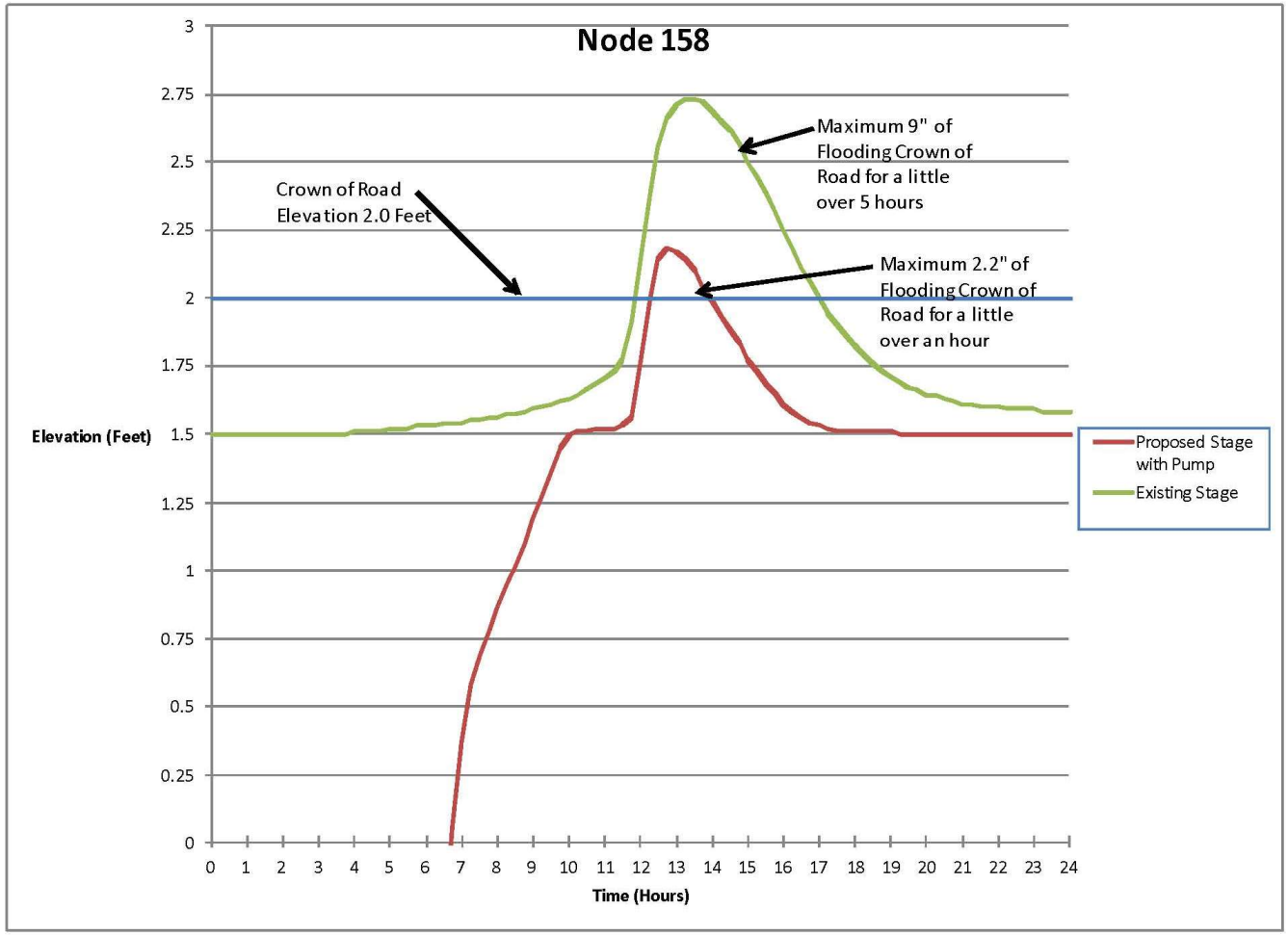
*Warning Elevation is the crown of adjacent to the Node

	no flooding above the crown of the roadway
	less than 6" flooding above the crown of the roadway
	more than 6" flooding above the crown of the roadway

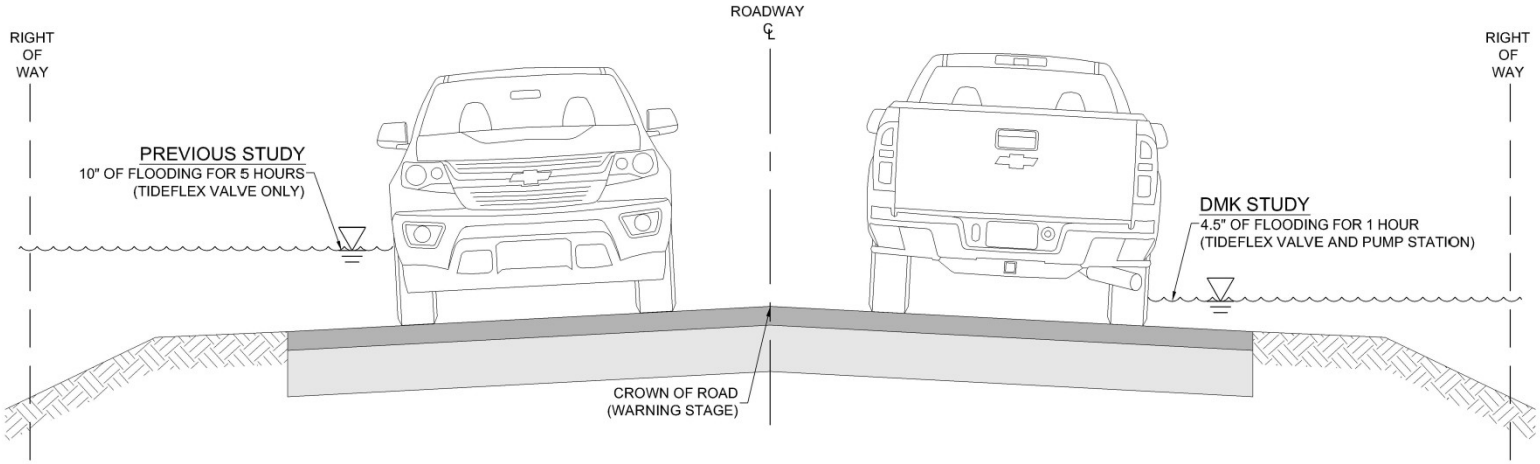
COMPARISON OF MAXIMUM ELEVATION VS. PUMP STATION



COMPARISON OF MAXIMUM ELEVATION VS. PUMP STATION



STUDY DIFFERENCES FOR ROADWAY IMPACTS



COST BENEFIT ANALYSIS

Alternate 1				Benefits
Description	Each	Cost	**Total**	Decreases the elevation for the 10 year design storm for 5 nodes below the crown of the road and reduces flooding to under 6 inches for 4 other nodes.
Pump Stations	4	$150,000	**$600,000**	

Alternate 2				Benefits
Description	Each	Cost		Decreases the elevation for the 10 year design storm for 5 nodes below the crown of the road and reduces flooding to under 6 inches for 4 other nodes. Eliminates "sunny" day high tide flooding for 4 other areas.
Pump Stations	4	$150,000	$600,000	
Tideflex® valves	4	$30,000	$120,000	
		Total	**$720,000**	

Alternate 3				Benefits
Description	Each	Cost		Decreases the elevation for the 10 year design storm for 9 nodes below the crown of the road and reduces flooding to under 6 inches for 4 other nodes. Eliminates "sunny" day high tide flooding for 4 other areas.
Pump Stations	8	$150,000	$1,200,000	
Tideflex® valves	4	$30,000	$120,000	
		Total	**$1,320,000**	

PUMP OPERATING COSTS

Alternative	Pump Operating Costs	Renewal/Replacement Costs	Annual Costs
Alternative 1	$9,271.00	$30,000.00	$39,271.00
Alternative 2	$9,271.00	$30,000.00	$39,271.00
Alternative 3	$18,542.00	$60,000.00	$78,542.00

- Operating costs are based on pump efficiency of 63%
- Average pumping operation of 3 hour per day, 4700 gallons per minute and $0.15/kwHr.
- Renewal/Replacement Costs are based on a pump life cycle of 10 years and wet well/piping components of 50 years
- Alternative 3 is twice the cost of Alternatives 1 and 2 because there are twice the number of pump stations
- Does not include "soft" costs such as design and permitting, technician, labor and any administrative costs associated with the operation of the pumps on a daily basis.

SUMMARY

- No structural flooding will be eliminated for tropical storms or hurricanes. Cannot pump against the storm surge
- The depth and duration of flooding will be reduced for most typical rain events
- Along with the capital and equipment costs, "soft costs" such as design and permitting, labor, technician and admistrative costs should be considered

QUESTIONS & DISCUSSION

End of Agenda Item