Saving 450 Years of History in the Nation's Oldest City: A Look at Flood Mitigation Projects

Presented at:
The Florida Stormwater Association Annual Conference
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Presented by:
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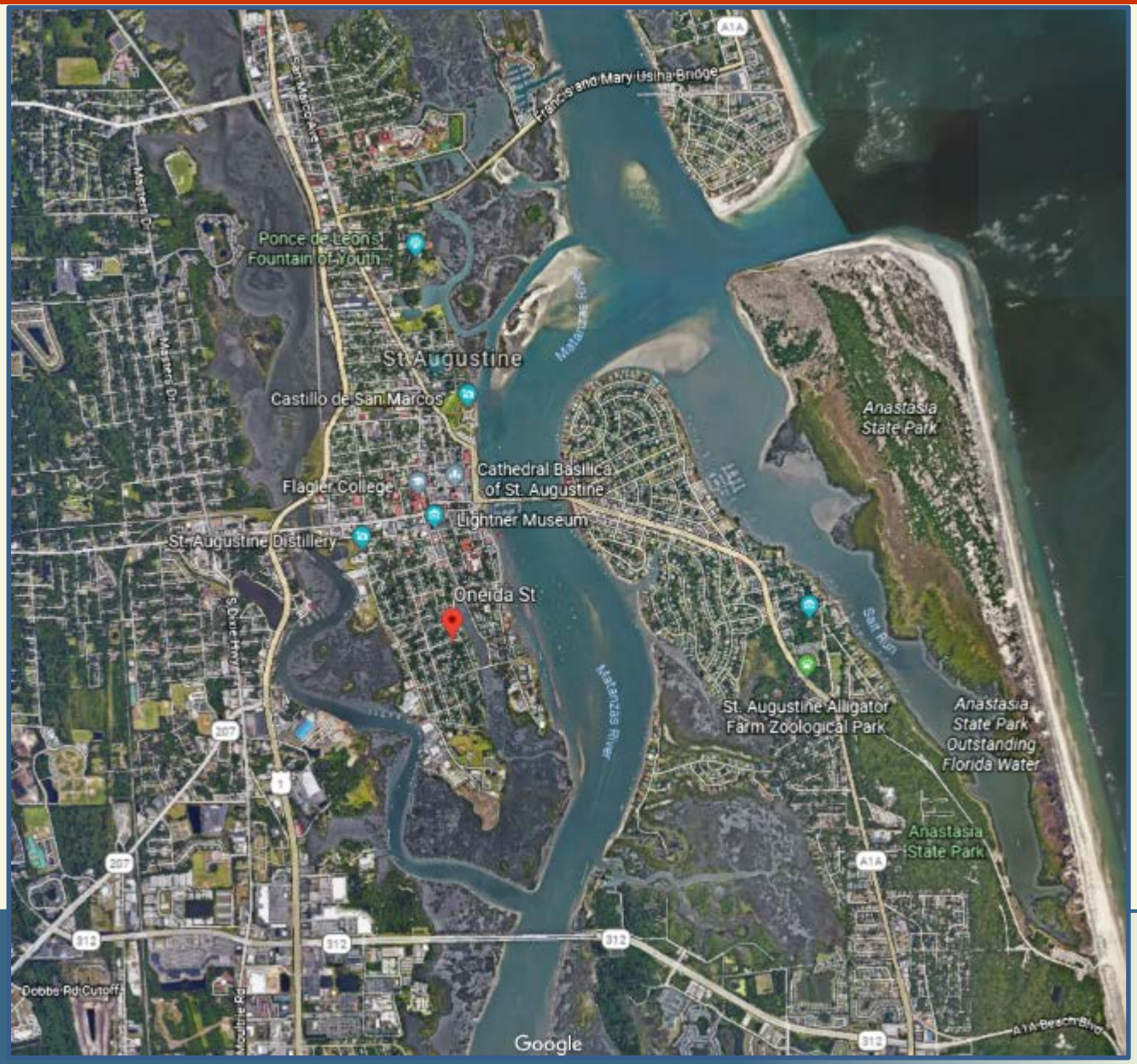
Introduction



- St. Augustine is the oldest continuously occupied settlement of European and African-American origin in the United States
- Beautiful beaches, coastal location, outdoor recreation
- Historical buildings, architecture, history
- It is a popular vacation and tourism destination

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Background

- Infrastructure vulnerable to nuisance tidal flooding, storm surge, nor'easters
- The City participated in a community resilience initiative with FL Dept. Economic Opportunity (FDEO, 2015-2017):
  - Coastal Vulnerability Assessment
  - Adaptation Plan
- Three types of coastal flooding:
  - Mean Higher High Water (MHHW)
  - **Nuisance flooding**
  - 1% annual chance (i.e. 100-year flood)

Hurricanes Matthew and Irma

Hurricane	Category	High Water Mark*	Impact to Avenida Menendez Seawall
Matthew 10/7/2016	3	7 NAVD88 (5:48 PM)	Crested (as designed), reduced flooding impacts, no damages reported to the wall
Irma 9/11/2017	1 /TS	6.75 NAVD88 (5:26 AM)	Crested (as designed), reduced flooding impacts, flap gate was removed from outfall (minimal damage)

*Matthew – surveyed and USGS rapid deployment gage
*Irma – peak tide stage height

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Other Damage – Hurricane Irma

- High water mark, 45 inches above St. Francis Street
- Entry of surge through south (Lake Maria Sanchez)
- Less damage (flood) but more debris (widespread)

Hurricane Matthew – Davis Shores

- Photograph taken in Davis Shores neighborhood – post Hurricane
- Map showing FEMA Claims from Hurricane Matthew

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Summary of Mitigation Projects

Project Name	Project Type	Schedule
Avenida Menendez Seawall*	Flood Mitigation (Category 1 storm surge)	Completed
Davis Shores Tide Check Valves	**Flood Mitigation (nuisance flooding)**	**FY 2018**
Macaris Stormwater Outfall Resiliency Retrofit	Flood Mitigation (nuisance flooding)	FY 2019
Master Stormwater Outfall Resiliency Retrofit Plan	Flood Mitigation (nuisance flooding)	FY 2019 – Master Plan 10 Years (80+ Outfalls)
Lake Maria Sanchez Flood Mitigation and Drainage Improvement Project*	Flood Mitigation (Category 1 storm surge), nuisance flooding and SLR (2050)	Phase 1 (design and permitting) – 2018 Phase 2 (construction) – 2019-2020

* Denotes FEMA Project

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Summary of Mitigation Projects

Project Name	Project Type	Schedule
Pump Station Flood Proofing*	Flood Mitigation	Design – 2018-2019 Construction – 2019-2020
Resiliency Scorecard	Resiliency Planning	FY2018
WWTP Flood Proofing/Hardening*	Flood Mitigation (in preliminary design)	Design – 2018 Construction – 2019-2020
Flood Mitigation at Avenida Menendez – Connectivity Project*	Flood Mitigation (Category 1 storm surge)	HMGP Application – 2018 Design – 2018-2019 Construction – 2020-2021
Comp Plan Update (Perils of Flood category - Historic Preservation – SLR)	Flood mitigation and resiliency	Update currently underway, 2 year process

* Denotes FEMA Project

Davis Shores

Tide Check Valve

Program –

Flood Mitigation Project

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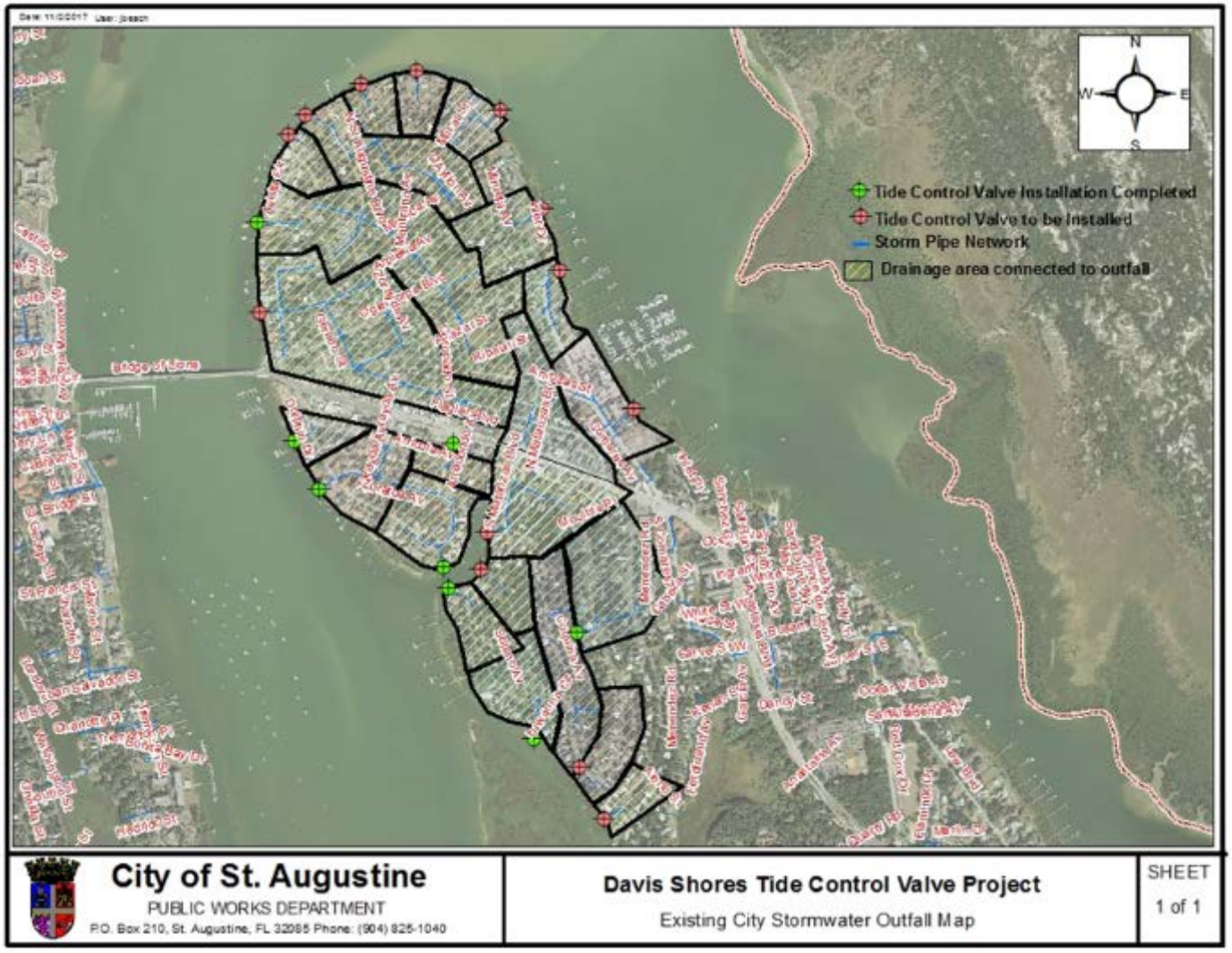
Existing Stormwater Outfall Map for Davis Shores



- 21 total outfalls (represented by green and red dots)
  - 17 outfalls as part of SJRWMD cost share
- "Blue" lines are storm pipe network
- Cross-hatched areas represent drainage areas connected to outfalls

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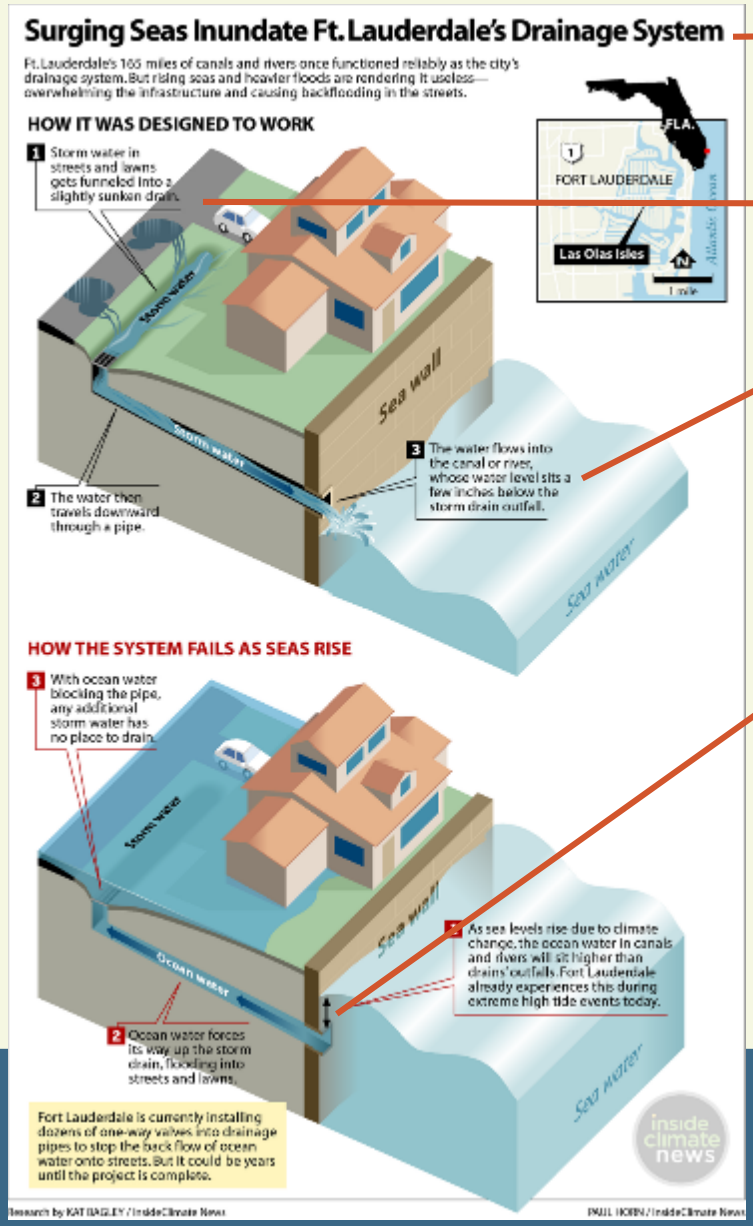
Example of Existing City Outfall – High vs. Low Tide

- The City's stormwater system will gravity discharge through its underground pipe network and into the Matanzas Inlet or Salt Run when the tides are low (or below) the bottom of the outfall pipe. As the tide rises, especially during higher than normal tide events, the salt water can back up and into the pipe network, and in extreme conditions, cause street flooding.

Schematic showing how the City Drainage System Works [3]



The City of St. Augustine's drainage system functions similarly to the City of Ft. Lauderdale's system.

During rainfall events, stormwater is collected within the streets either through a drainage swale or drainage inlet.

Under low tide conditions, stormwater can gravity discharge through the existing pipe and into the Matanzas River or Salt Run.

During high tide events, sea water can enter into the pipe network and cause street flooding. If rainfall also occurs during this time, it becomes "trapped" and cannot gravity drain until the tide falls, this can worsen street flooding conditions.

Source: Inside Climate News[3]

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Recent Nor'easter + "King Tide" Effects

- In addition to tidal flooding events, if weather conditions persist concurrently with tidal flooding (such as rainfall or Nor'easter winds), this can significantly amplify the flooding effects. It is not uncommon during these Nor'easter events, that the winds push tide water further up into the storm water collection system, resulting in more extensive road flooding.

Documented King Tide + Nor'easter Conditions – October 2017

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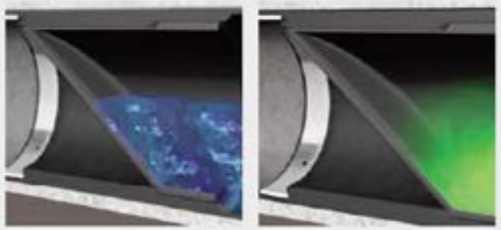
Example of Non-functioning Outfall Valve

- The City has several locations where there are non-functioning valves
- Once these valves reach their life expectancy, they must be replaced
- Documented tidal street flooding where either there is no valve or a non-functioning valve
- New design option – valve that is located inside the pipe (or “in- line”)
- Two types of in-line valves the City is testing

Types of Valves being Tested to Reduce Nuisance Flooding



For an animated demonstration of the CheckMate® in operation, please visit: http://www.tideflex.com/checkmate

One type of tide check valve, Tideflex CheckMate Inline Check Valve[6] will allow stormwater to drain out under lower tide conditions. During high tide, the valve will prevent sea water from backing up into the stormwater pipe network.

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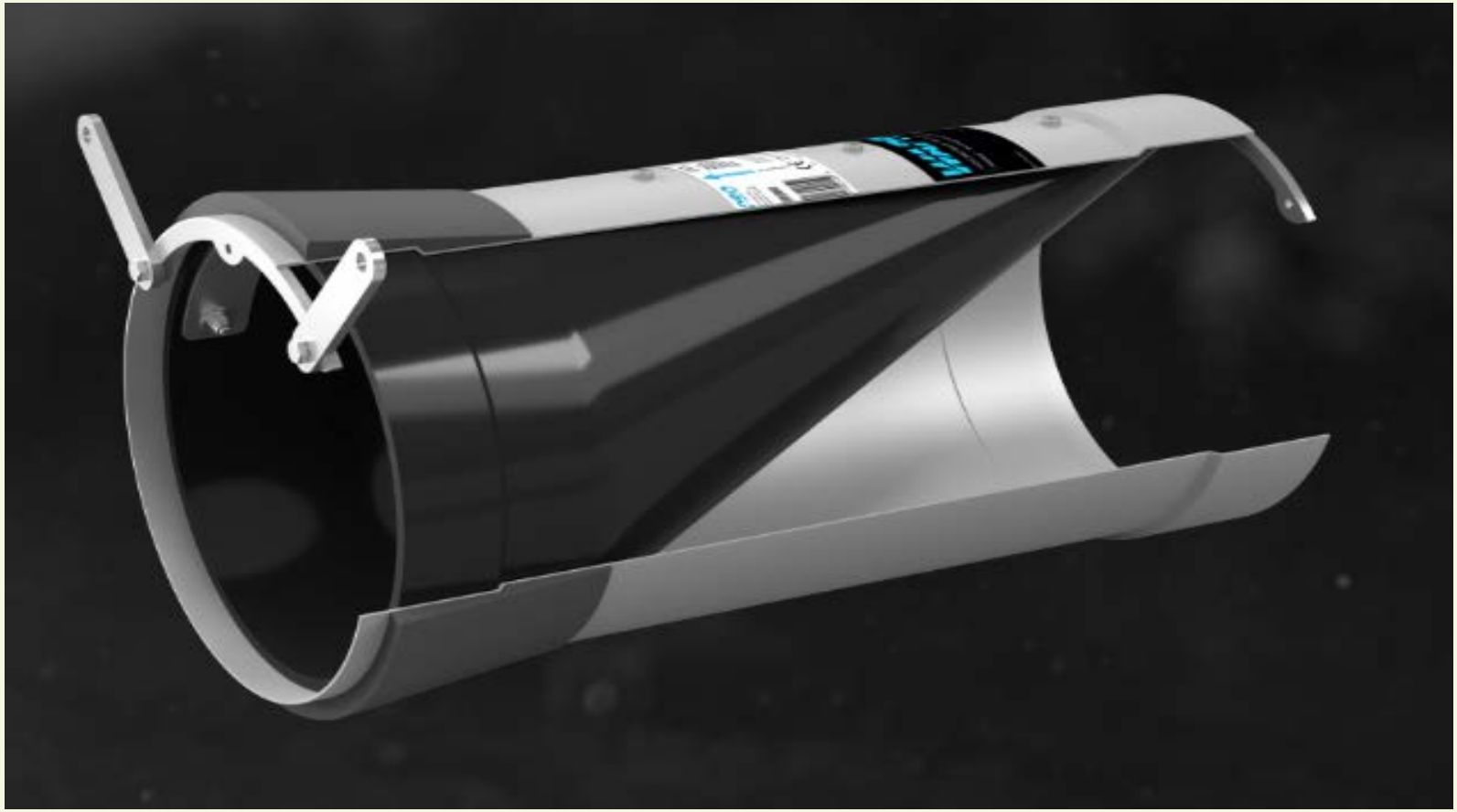
Types of Valves being Tested to Reduce Nuisance Flooding



Another type of tide check valve, WAPRO Wastop Inline Check Valve[5] functions similarly to the Tideflex but is manufactured out of different material and has a lower head loss differential.

Types of Valves being Tested to Reduce Nuisance Flooding

Comparison between Valve Types (24-inch)		
Manufacturer	WaPro – WaStop Inline Check Valve	Tideflex Checkmate Inline Check Valve
Valve Cost	$6,930	$4,692
Warranty	2 years (materials/workmanship) 25+ years (life expectancy)	1 year (materials/workmanship) 25+ years (life expectancy)
Operation and Maintenance	Site specific conditions can determine frequency	Site specific conditions can determine frequency
Installation	More manpower required but tighter seal/fit	Can expand the ring to accommodate the pipe
Manufacturing Timeframe/Availability*	4 weeks*	8-10 weeks*

***If the size is in stock or has to be manufactured**

Project specific constraints can determine which valve is selected

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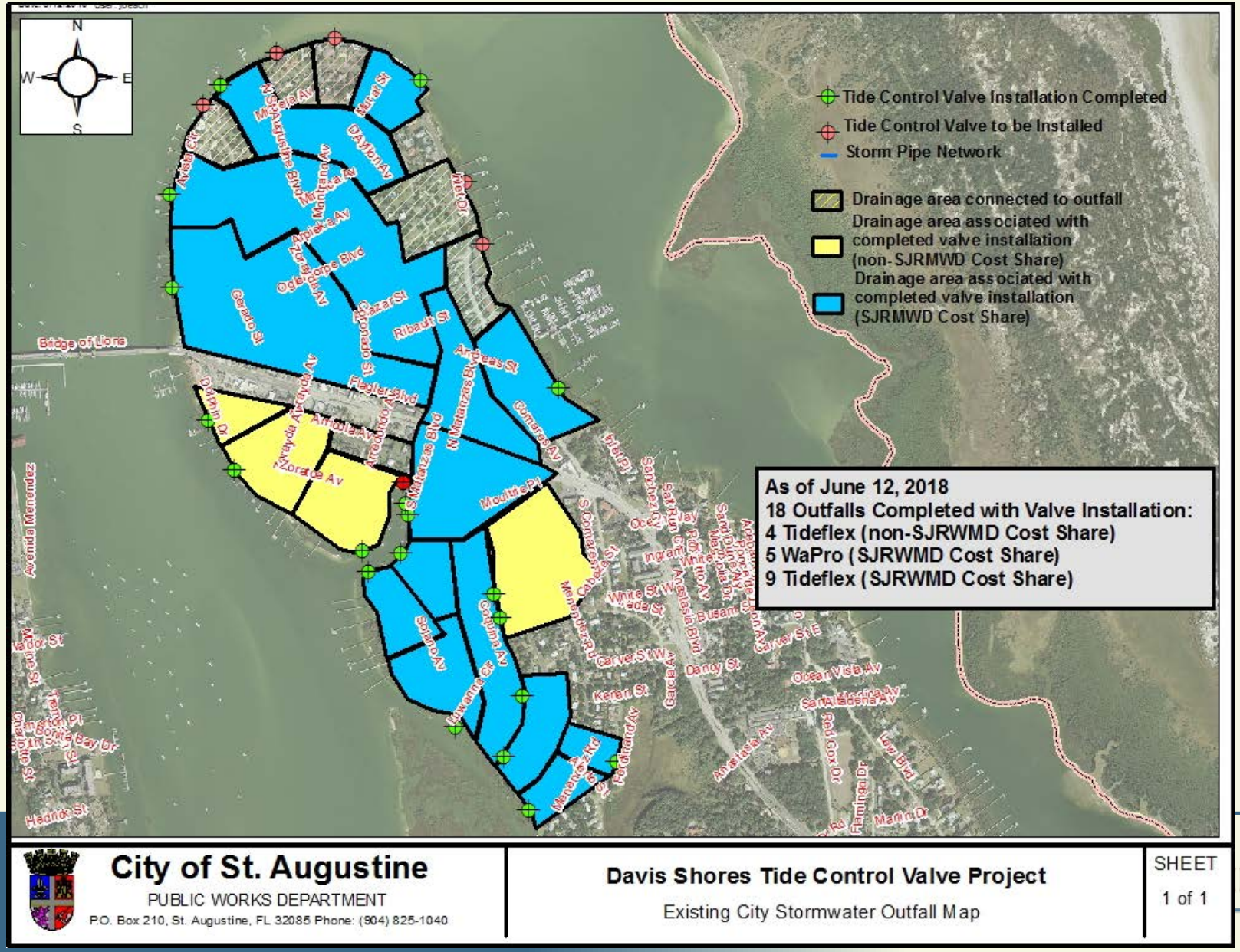
Installed Valves To Date – Project Map



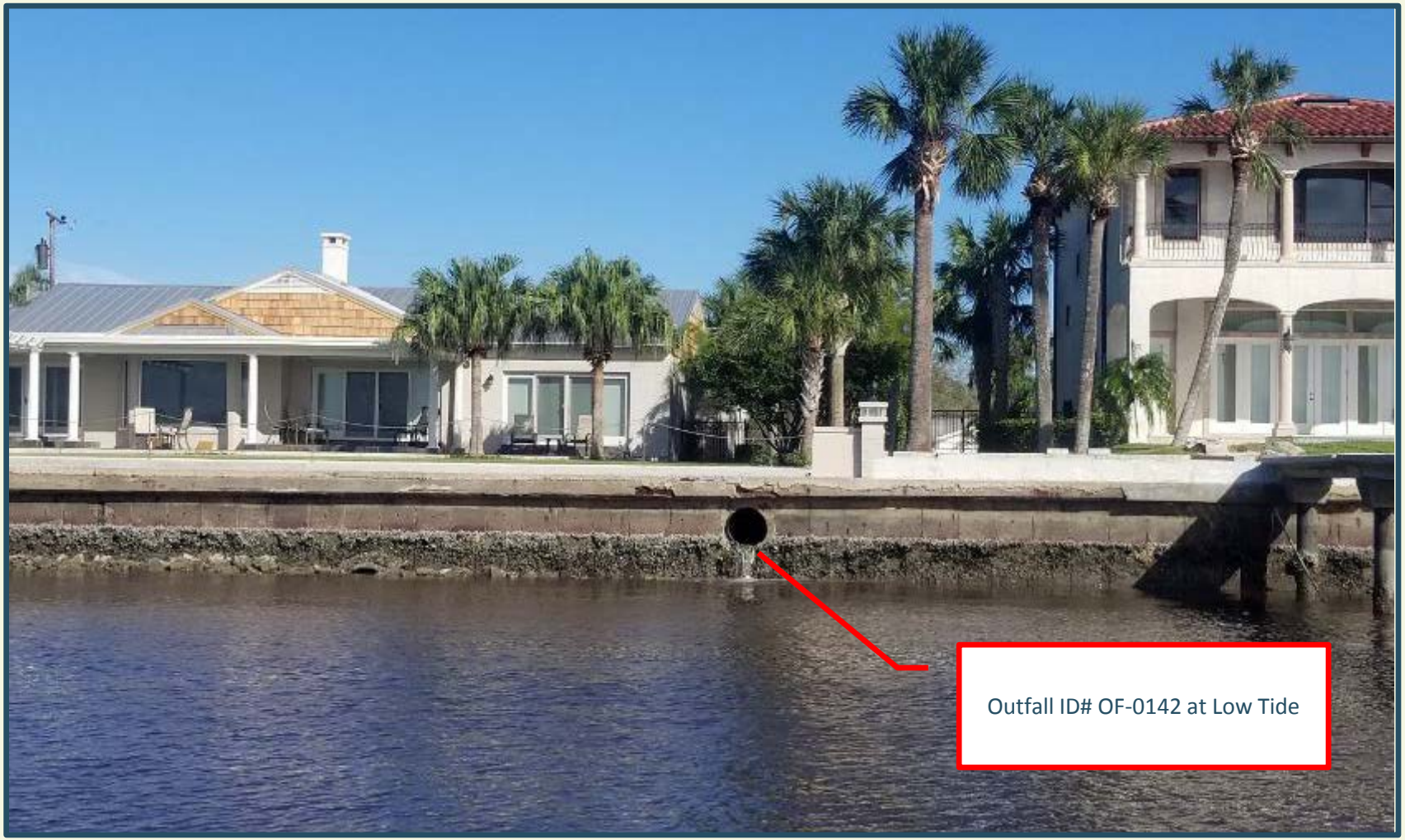
Installed Valves – Before and After

Installed Valves – Before and After

OF-0117 (Before): street flooding during King Tide event (October 2017) due to non-functioning valve

OF-0117 (After): no street flooding during King Tide event (December 2017) - tidal flooding eliminated

Installed Valves – 30 Inch Outfall Pipe at Low Tide



Installed Valves – Stormwater Crew in Action

OF-0142 (After): valve (WaPro) has to be secured and lowered to outfall pipe for installation

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Installed Valves – Stormwater Crew in Action

OF-0142 (After): valve inserted into outfall pipe

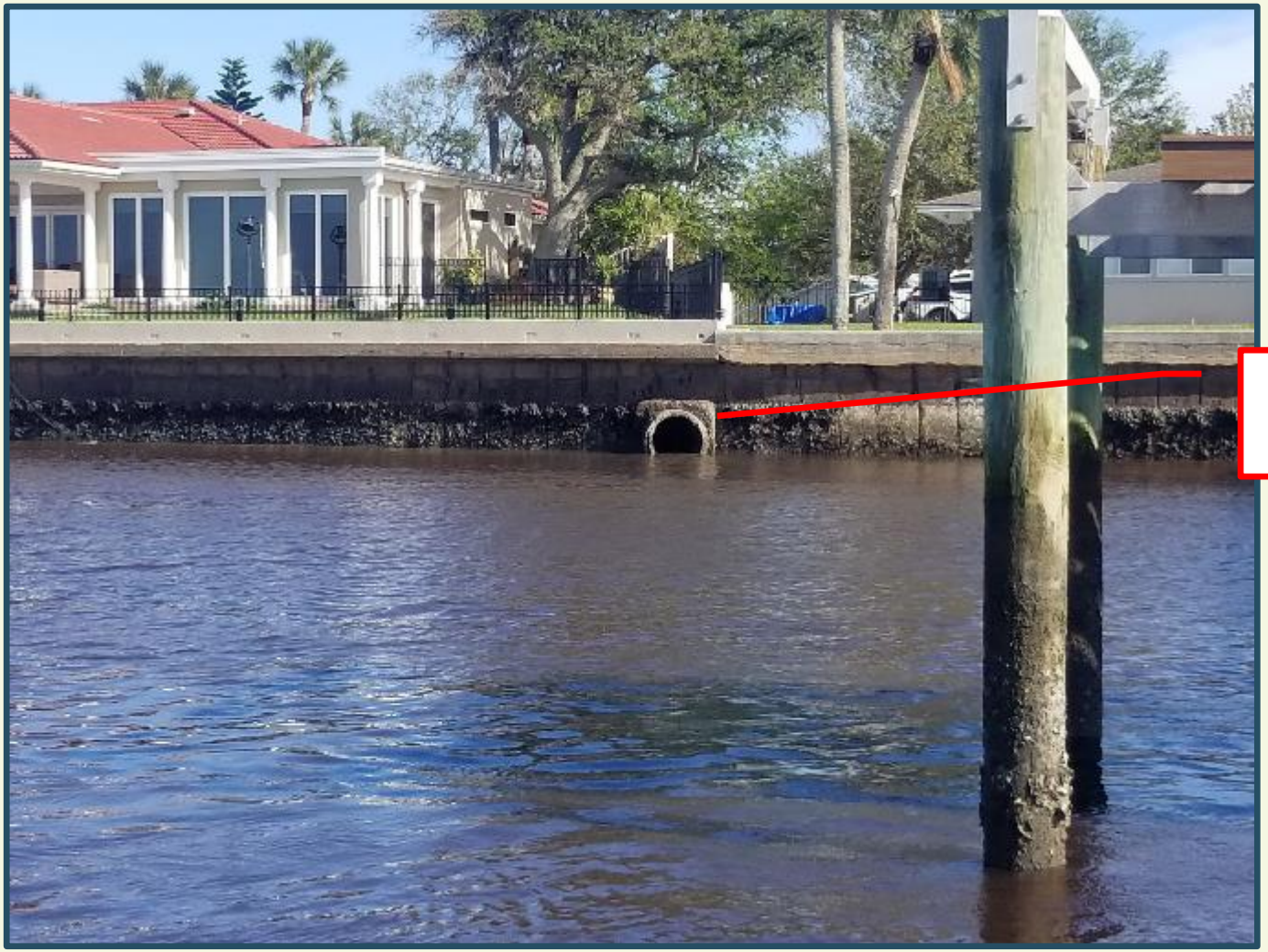
OF-0142 (After): completing valve installation

Installed Valves – Before and After

OF-0142 (Before): street flooding during King Tide event (October 2017) due to no valve in outfall

OF-0142 (After): no street flooding during King Tide event (December 2017) - tidal flooding eliminated

Installed Valves – 36-Inch Outfall Pipe at Low Tide



Outfall ID# OF-0139 at Low Tide

Installed Valves – Before and After

OF-0139 (Before): street flooding during King Tide event (October 2017) due to no valve in outfall

OF-0139 (After): no street flooding during King Tide event (December 2017) - tidal flooding eliminated

Lessons Learned and Other Challenges

- Accessibility - docks, decks and pilings, easements (I thought we had one?)
- The tree trumps the pipe, always…
- Pipe material (clay) – lining and then install the valve
- Stainless steel bolts (yes, they are hard to find)
- Power, extension cord (long enough to reach from road to bulkhead)
- Cleaning and prep of the valves before taking measurements (barnacles, oyster growth)
- CCTV the pipes to identify any potential issues (cracks, blockage etc.)
- Working around the tides….
- Buried pipe or blockage (oysters/barnacles, sediment, mangroves)
- Public outreach very important (website/social media, commission presentations, HOA meetings etc.)
- Be sure installation has a good fit; test the valves and troubleshoot
- Outfalls not owned by the City (FDOT)

Lessons Learned – Accessibility (outfall under deck)

- Deck over the outfall pipe with no clearance
- Cut “hatch” into the deck
- Had to re-set the valve (back hoe)

Lessons Learned – Tight Fit during Installation

- Not a tight seal with the valve during installation
- Still had street flooding during high tide
- Remove the old pipe/liner
- Reset the valve

Lessons Learned – Accessibility (under dock with piling conflict)

- 36-inch outfall under an existing dock
  - Damaged in both hurricanes
  - Reconstructed then silted in the outfall
  - City contracting out to clean out the front to install the valve
  - Initially had WaPro but switched to Tideflex due to dock piling conflict

Lessons Learned – Silted in Discharge and Oyster Growth

OF-0141 (Before): 70% Blockage

OF-0141 (After): 0% Blockage

OF-0141 (After): Removal of silt at end of discharge pipe

City contracted with Gator Dredging for this work

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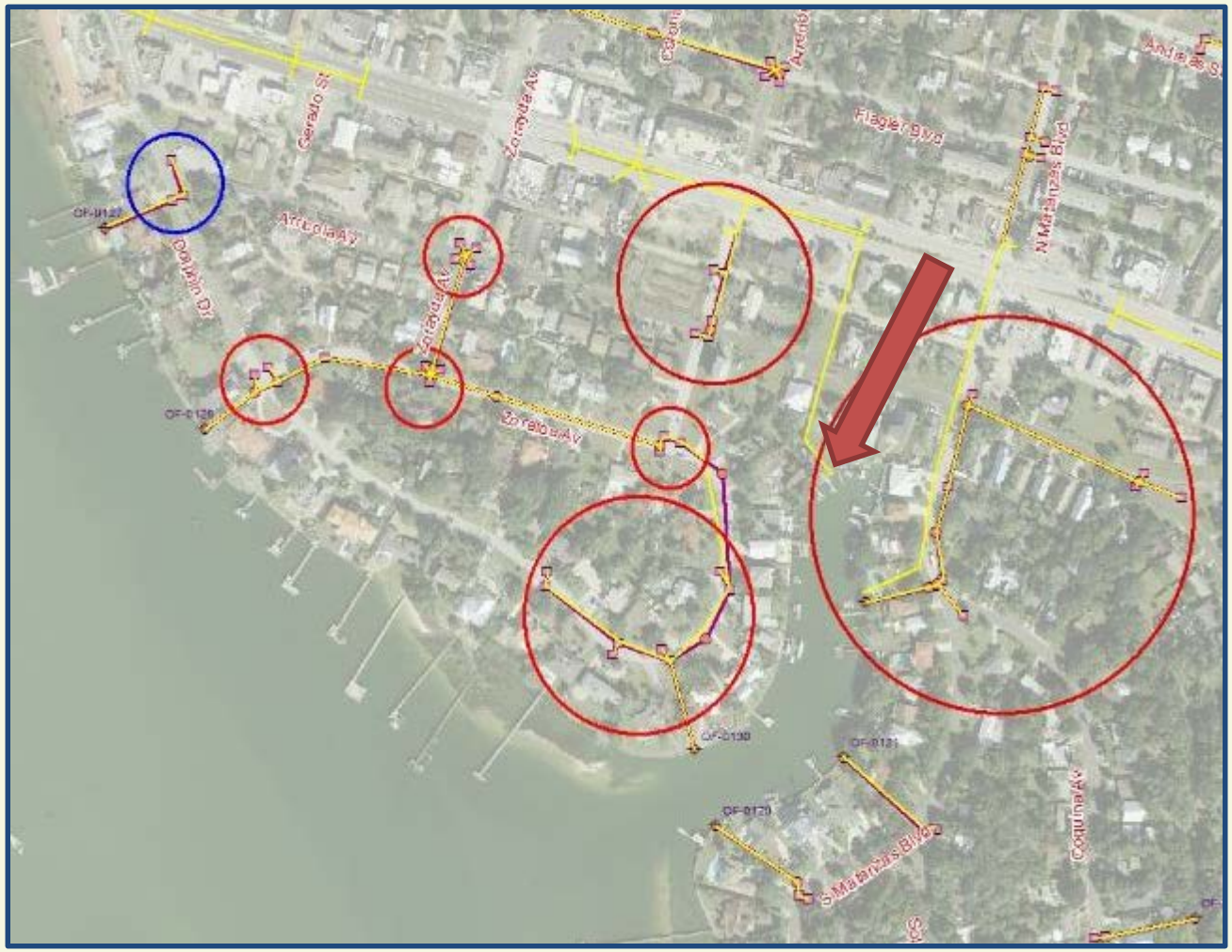
Lessons Learned – Working Around the Tides

OF-0142 (After): Crew installing valve into outfall pipe

OF-0142 (After): Crew securing valve with straps onto outfall pipe

Lessons Learned - Limitations of the Tide Check Valves



If the system is "breached" there will be street flooding:

1. Overtopping of the bulkhead or lowest elevation
2. Entry into storm system where there is no valve
3. Once it enters the streets, it flows to other areas

City does not own all of the outfalls (FDOT coordination)

Lessons Learned - Limitations of the Tide Check Valves – Overtopping

King Tide + Nor'easter Conditions – January 2, 2018

- High tide at 5.8 feet (City Docks)
- Winds – sustained 20 + mph
- Added **2-feet** to high tide elevation

Lessons Learned - Limitations of the Tide Check Valves – Not all Valves Installed

Flooding from Outfall without Valve

- City does not own or control outfall (FDOT) – additional coordination
- Once it enters the streets (low, flat elevations) flooding is widespread

Lessons Learned – In House Installation Where Possible

Cost Comparison	24-inch In House Install	30-inch In House Install	30-inch Contractor Install
Materials (tools, straps, bolts, riprap for outfall)	$430	$430	$30,609
Valve Cost (WaPro)	$6,930	$10,068	
Labor (can vary, depending on preparation, cleaning, CCTV and install)	$1,318 (4 man crew + resetting valve – add'l equipment and labor)	$570 (4 man crew)	
Subtotal	$8,678.18	$11,068	$30,609
Cost Savings	**$21,930.82**	**$19,541**	
% Cost Savings	**72%**	**64%**	

Lessons Learned – Public Outreach is Critical

Reduction of "sunny day flooding" on the rise

As part of cost share funding from the St. Johns River Water Management District, the City of St. Augustine has begun the process of retrofitting existing storm pipe outfalls with new "tide check" valves throughout Davis Shores.

In its history, damage caused by flooding has greatly affected the city, specifically the low-lying areas of Davis Shores. Whether from catastrophic hurricanes, sea level rise or sunny day flooding, this ever present concern has been a priority for the longevity of the city, its residents, visitors and infrastructure.

During sunny day, temporary tidal flooding events, sea water enters the city's stormwater drainage system, backing up and into the streets, creating street flooding. In the Davis Shores community there are approximately 21 outfalls that collect the stormwater from the streets and discharge through the existing pipe system into either the Matanzas River or Salt Run. As of November 20, eight valves have been installed.

But the valves have limitations. If rainfall occurs during a high tide event, where the valves are shut, the rainwater will not be able to drain until the tide falls leaving freshwater (rainwater) in the street as opposed to salt water. The city is monitoring the performance of the recently installed valves during recent "king tides" and northeasterly wind events to verify they are working properly.Before Hurricane Irma, in an effort to inhibit tide water from backing up into the storm drainage system, the city installed four of these tide flow preventer valves into existing pipes. These valves allow stormwater to drain out under normal, low tide conditions. View/Download a comprehensive presentation of this project here.

It is anticipated that the valve installation will be completed by the end of January 2018 at a cost of approx
of which up to one-third will be reimbursed by the St. Johns River Water Management District.

- Managing Expectations of the Project (what it can and cannot do)
- Periodic updates on schedule and progress
- Outreach through social media, website (video), radio announcements/interviews, Neighborhood Association meetings, presentations to the Commission

In Summary

- Great success has been documented where the valves have been installed (elimination of nuisance tidal flooding)
- Significant cost savings with self performance and end-of-pipe install (where possible/practical):
  - $20,000 per outfall on average savings
  - Can control schedule and prioritize
- Public Outreach is important
- Next steps
  - Macaris Outfall Retrofit (60-inch and 30-inch pipes)
  - Master Stormwater Outfall Resiliency Retrofit Plan (prioritize remaining 80+ outfalls)

References and Recognition

1. Erik Bojnansky (March 9, 2017). "Sea levels are rising, so developers and governments need to band together: panel". The Real Deal. Retrieved March 10, 2017.
2. "What is nuisance flooding?". National Oceanic and Atmospheric Administration. Retrieved December 13, 2016.
3. "Rising Seas Pull Fort Lauderdale, Florida's Building Boomtown, Toward a Bust: The Venice of America is expecting its population to grow by a third, but it already can't handle the impacts of climate change.". By Katherine Bagley, InsideClimate News. March 3, 2016. https://insideclimatenews.org/news/01032016/ft-lauderdale-climate-change-global-warming-rising-sea-level
4. "Coastal Flooding – the Fort Lauderdale Tidal Valve Program". A presentation provided by Elkin Diaz, MBA, PE, PMP LEED Green Associate Senior Project Manager. Public Works Department, City of Fort Lauderdale.
5. Wapro - Wastop Inline Check Valve. http://www.wapro.com/en-us/content/wastopr-inline-check-valve
6. Tideflex Technologies - Tideflex Checkmate Ultraflex Slip-in Inline Check Valves. http://www.redvalve.com/tideflex/tideflex-products/checkmate-inline-check-valve/

The Public Works Department would like to recognize the following entities associated with this project:

- St Johns River Water Management District – Cost Share Funding
- Geosyntec Consultants
- Red Valve Company – Tideflex Technologies
- WaPro – Wastop Inline Check Valve
- Gator Dredging
- City of Ft. Lauderdale
- City of St. Augustine Staff:
  - Stormwater crew (Freddy Torres, Daryl Wiervba, Sheppard Raines)
  - Rick Stevens and Steve Wright (Solid Waste)
  - Paul Williamson and Melissa Wissell (Public Affairs)
  - Merin Dunn (City Clerk Office)
  - City of St. Augustine - Municipal Marina

Questions Regarding this Project:

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Also information available on the City's website at:
www.citystaug.com