Fort Lauderdale: Building Resiliency in the Face of Climate Change

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City of Fort Lauderdale
Agenda

- Intro to Fort Lauderdale
- Challenges of Climate Change and Sea Level Rise
- A Strategy to Deal with Change
  - Level of Service
  - Comprehensive Master Plan
  - Seawall Ordinance
  - Expedient Measures
- Funding Storm Water Projects
Fort Lauderdale
The Venice of America

Area: 38.6 square miles
Land: 34.7 square miles
Water: 3.8 square miles
Canals and Waterways: 165 miles
Population: 176,000
Flooding in Fort Lauderdale

**Storm Flooding**
(Mostly West of US-1)

**Tidal Flooding**
(Mostly East of US-1)
Risk to Roads, Homes, and People

(Tidal Flooding Mostly East of US-1)
Existing Stormwater System

Current stormwater system includes:

- 1,009 outfalls
- 8,241 inlets
- 20 plus tidal control valves
- Over 170 miles of buried infrastructure
- Four stormwater pump stations
  - 236 Southwest 2nd Avenue
  - 100 North New River Drive
  - 351 Southeast 25th Avenue
  - 411 Coconut Isle
Sea Level Rise and The Future

Unified Sea Level Rise Projection
(Southeast Florida Regional Climate Change Compact, 2015)

<table>
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<th>Year</th>
<th>IPCC AR5 Median (inches)</th>
<th>USACE High (inches)</th>
<th>NOAA High (inches)</th>
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<td>2100</td>
<td>31</td>
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Graph showing the relative sea level rise near Key West, FL from 1992 to 2100.
The Challenge

- High groundwater table
- Low-lying residential streets
- Sea level rise
- Low and deteriorating seawalls
- Aging infrastructure
- Absence of stormwater infrastructure
- Lack of green space
The Challenge: High Tides and King Tides

- High groundwater table
- Low-lying residential streets
- Sea level rise
- Low and deteriorating seawalls
- Aging infrastructure
- Absence of stormwater infrastructure
- Lack of green space

Diagram:
- Storm water
- Sewage
- LOW TIDE
The Challenge

High and King Tides and SLR

- High groundwater table
- Low-lying residential streets
- Sea level rise
- Low and deteriorating seawalls
- Aging infrastructure
- Absence of stormwater infrastructure
- Lack of green space
The Challenge

High & King Tides, SLR, Storm Surge

- High groundwater table
- Low-lying residential streets
- Sea level rise
- Low and deteriorating seawalls
- Aging infrastructure
- Absence of stormwater infrastructure
- Lack of green space
Developing an Overarching Strategy

- Decide on Levels of Service
- Develop Comprehensive Master Plan
- Determine Funding Strategy
- Build It
- Operate and Maintain
Level Of Service (LOS) Road Crown

- The primary purpose for choosing a LOS criteria is to protect public safety/property and enhance quality of life
- Roads need to be passable for emergency and evacuation traffic
- A higher LOS will result in increased public safety, enhanced quality of life, and decreased property damage and land erosion

Existing LOS
5-year 24-hour Storm < 3 Inches

Recommended LOS
10-year 24-hour Storm Dry Street

$ $
Existing LOS
Road Crown

5 Year 24 Hour Storm Event = 7.5 inches of Rainfall

- 5 Year 24 Hour - probability of occurrence in a given year is 1 in every 5 storm events
- Criteria has been used since the 1970s
- Insufficient for intense rainfall events over 7.5 inches of rain in a 24 hour timeframe
- Existing neighborhoods in the City do not meet the existing LOS due to the absence of stormwater infrastructure
Future LOS

10 Year 24 Hour Storm Event = 9 inches of Rainfall

- 10 Year 24 Hour - probability of occurrence in a given year is 1 in every 10 storm events
- Adopted by many surrounding communities including Pompano Beach, Coral Springs, etc.
- Higher and less flooded roads for emergency vehicles
- Sufficient for 5 Year 24 Hour storm events which are occurring more often and variation in rainfall

Mostly Dry Streets
<1 inch over road crown during rainy season peak days
Comprehensive Multi-year Stormwater Plan

Phase I (3 year Plan): ($10 million)
- 37 Individual Projects
- Design study for Phase II

Phase II (3-5 year Plan): ($170 million)
- Neighborhoods with validated need for infrastructure
- Upgrade to higher LOS
- Requires additional funding
- Design study for Phase III

Phase III (10 year Plan): ($900 million - $1 billion unfunded)
- Long-term solutions for our changing conditions
- Requires additional funding and procurement process
Stormwater Master Plan Improvement Features

- BIO SWALES
- RECHARGE DRAINAGE WELL
- EXFILTRATION TRENCH
- TIDAL CONTROL VALVES
- PERVIOUS PAVERS & PAVEDRAIN
- SEAWALL REPAIRS & UPGRADES
- STORMWATER PRESERVES
- PUMPING STATIONS
Bioswales

Implemented on NW 14th Street in South Middle River

- Alternative to storm sewer systems
- Utilize natural means to filter out contaminants and mitigate water
- Improved water quality and reduced water quantity compared to piped stormwater systems

Source: water.EPA.gov
Recharge Drainage Well

Implemented on SE 16th Avenue

- Remove stormwater runoff from the surface to lower, permeable zones underground
- Typically used in highly developed urban areas with limited space for other stormwater practices
- Small footprint and not very visible after construction
Exfiltration Trench

- Excavated rock filled trenches with a perforated pipe that distributes stormwater runoff gradually through the void spaces of the rock bed
- Allows runoff to gradually infiltrate into the subsoil
- Improved water quality and reduced water quantity compared to piped stormwater systems.

Tidal Control Valves

Implemented at Riviera Isles and Hendricks Isles

- Backflow prevention devices for high tide control
- Installed inside the outfall structure prior to discharge into a canal or waterway
Tidal Valves

Average Tidal Conditions on Cordova

October High Tide
18” above Avg High Tide

NOAA/ESCC-OPS
Observed Water Levels at 116-1444, Virginia Key FL
From 2010/09/25 00:00 GMT to 2010/09/27 23:09 GMT

Height in feet (MLLW)
Pervious Pavers & Pave Drain

Implemented at Lewis Landing

- Allows stormwater runoff to divert through a porous surface into an underground stone layer beneath the pavers
- Allow runoff to gradually infiltrate into the subsoil
- Helps reduce runoff volumes and are a considerably smaller cost than a traditional storm drain system

Source: T & P Pavers, Inc.

Source: PaveDrain
Seawall Repairs And Upgrades

City has approximately 1.1 million feet of seawall (22,500 ft City owned)

- Protect properties adjacent to canals and waterways from flooding and erosion damage
- Failure of seawalls results in damage to public and private infrastructure worth billions of dollars
- During high tide, sea level rise is overtopping portions of the City’s seawalls
Seawall Ordinance

- Research taking place
- City Commission must approve recommendations
Sec. 47-19.3. - Boat slips, docks, boat davits, hoists and similar mooring devices.

(4)(f) The top surface of a boat slip, seawall or dock shall not exceed five and one-half (5½) feet above NGVD 29, except when the adjacent property is higher than five and one-half (5½) feet above the NGVD 29. *(3.90 feet NAVD 88)*

When above NGVD 29, the top surface may be of the same elevation as the average grade of the upland property abutting the seawall or dock and properties abutting either side of the upland property.

**Our Ordinance sets a Maximum Height.**
Current Maximum Seawall

2.6’ NAVD (4.2’ NGVD)-September 2015 Tide

**NAVD 88 (FT) Condition**
- 3.9 Max seawall height
  (5.5’ NGVD)
- 3.0 2 ft SLR -2060
  (4.5’ NGVD)
- 1.0 Extreme high tide
  (2.6’ NGVD)
- 0.0 Avg high tide
  (1.6’ NGVD)
- -2.3 Avg low tide
  (-0.7’ NGVD)

**95% of current seawalls being constructed to the maximum height**
River Oaks Preserve is an example of a site being implemented

- Reduce flooding by temporarily storing stormwater before discharge into canal or other water body
- A portion can be used for stormwater runoff water quality and quantity
- Boardwalk for recreational use by the Public
Pumping Stations

City currently runs four pumping stations

- Mechanically lifts storm water runoff from a low-lying area to a discharge or outfall location at a higher elevation
- Most cost efficient option for low-lying areas with historical flooding, where gravity outfalls are not economical or feasible

Source: Kiewit
Expedient Measures

Basin Plugs
Sand Berms
Tiger Dams
Traffic Control
Existing Stormwater Rates

Stormwater rates generate annualized revenues of $5.5M:

- $2.0 million for Capital Projects
- $3.5 million for Operations & Maintenance
  - Drainage Well Cleaning - Annually
  - Outfall Tidal Control Valves Cleaning – Annually
  - Catch Basin Tidal Control Valves Cleaning – Semi-Annually
  - Catch Basins Cleaning – Semi-Annually
  - Storm Stations 1 & 2 Inspections – Semi-Weekly
  - Storm Stations 4 & 5 Inspections – Quarterly
  - Catch Basin Pollution Control Devices Cleaning – Quarterly

- 2016 utility fee increase $4.30 to $6.00 per home monthly
- New rate structure for 2017
  - Areas impacted by tidal street flooding pay more
  - Rates need to rise for next 4 years to fund any bond