Living with Water

Foxhill, Grandview, and Harris Creek
Regional Infrastructure at Risk
Flood Hazard Defined

According to the USACE *Norfolk Coastal Storm Risk Management Study Report*:

“...a significant percentage of the city is susceptible to flooding caused by rainfall, tides, storm surge or different combinations of these three factors. Where precipitation flooding coincides with tidal flooding and/or storm surge, the existing storm drain infrastructure is incapable of conveying runoff downstream, thus exacerbating flooding. **Stacking tides, or high tides that accumulate over several cycles coupled with precipitation flooding, can cause more flooding than a hurricane**”
Forces of Water

- Increased Precipitation
- Storm Surge
- Rising Tides
- Groundwater
- Surface Runoff
Storm Surge and Storm Tide Threat

- Hurricanes and Nor’easters
- Coincidence of Surge and Tides
- Multiple Flood Pathways
- Low Laying Land
- 37% of Hampton Land Area is in 100 Year FEMA Flood Hazard Zone
Storm Tide

6 of the highest tidal events occurred within the last 13 years.

Source: NOAA; Sewells Point Tide Gauge, Norfolk.

Hurricane Isabel Surge

Stacked Nor’easter Tide
**Storm Tide + Sea Level Rise at the Hague, Norfolk**

<table>
<thead>
<tr>
<th>Return Interval</th>
<th>Exceedance Probability</th>
<th>Current Conditions (ft, NAVD88)</th>
<th>1.6 feet of SLR (2040s-2070s)</th>
<th>2.9 feet of SLR (2070s or later)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-year</td>
<td>100%</td>
<td>3.3</td>
<td>4.9</td>
<td>6.2</td>
</tr>
<tr>
<td>10-year</td>
<td>10%</td>
<td>6.3</td>
<td>7.9</td>
<td>9.2</td>
</tr>
<tr>
<td>20-year</td>
<td>5%</td>
<td>7.4</td>
<td>9.0</td>
<td>10.3</td>
</tr>
<tr>
<td>50-year</td>
<td>2%</td>
<td>9.0</td>
<td>10.6</td>
<td>11.9</td>
</tr>
<tr>
<td>100-year</td>
<td>1%</td>
<td>10.1</td>
<td>11.7</td>
<td>13.0</td>
</tr>
<tr>
<td>500-year</td>
<td>0.2%</td>
<td>12.7</td>
<td>14.3</td>
<td>15.6</td>
</tr>
</tbody>
</table>

Probability of damaging floods increases 2 to 5 times with Sea Level Rise:
- Today’s 10% chance floods may occur every year by the 2070’s
  - 10% → 100%
  - 5% → 10%
Storm Tide + Sea Level Rise at the Hague, Norfolk
Beach Road at High Tide
Relative Sea Level Defined

Rising Tides
- Eustatic Global Sea Level Rise:
  - Melting Glaciers
  - Thermal Expansion
  - 1.8 to 3.1 mm/year
- Last Decade
- Last Century

Sinking Land
- Land Subsidence:
  - Geologic (Salisbury Embayment + Chesapeake Bay Meteorite Impact Crater)
  - Decaying Organics
  - Reclaimed Land

Relative Sea Level
- Sewell’s Point:
  - +1.45 Feet/Century
  - One of the largest documented rises in the world
Relative Sea Level Rise for Southeastern Virginia

Source: VIMS Relative Sea Level Rise Projections for Southeast Virginia
“Hope for the Best, Prepare for the Worst”

Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.

Hurricane Joaquin
Thursday October 1, 2015
11 AM EDT Advisory 15
NWS National Hurricane Center

Potential Track Area:
- Day 1-3
- Day 4-5

Current Information:
- Center Location: 23.0 N 79.9 W
- Max Sustained Wind: 125 mph
- Movement SW at 6 mph

Forecast Positions:
- Tropical Cyclone
- Post-Tropical

Sustained Winds:
- D < 39 mph
- S 39-73 mph
- H 74-110 mph
- M > 110 mph

Watches:
- Hurricane
- Trop.Storm

Warning:
- Hurricane
- Trop.Storm

Source: VIMS Relative Sea Level Rise Projections for Southeast Virginia
SLR → 30 Year Mortgage

Source: VIMS Relative Sea Level Rise Projections for Southeast Virginia
SLR → Resilience Project Timeframe

Source: VIMS Relative Sea Level Rise Projections for Southeast Virginia
Shoreline Condition: 2017
Shoreline Condition: 2050
2 Feet of Sea Level Rise at High Tide

380 Buildings Potentially Impacted
Shoreline Condition: 2070
3 Feet of Sea Level Rise at High Tide

1,500 Buildings Potentially Impacted
Shoreline Condition: 2100
5 Feet of Sea Level Rise at High Tide

7,200 Buildings Potentially Impacted
Storm Surge Maximum of the Maximum
Modeled Storm Surge Extent for Planning Purposes
Historic Home Raised above FEMA Flood Zone
Foundation Types

- Raised or Crawl Space
- Basement
- Slab on Grade
- SLR and Flood Risk
Drainage System

SLR and Flood Risk

Drainage Network
Drainage System Overburdened due to Tidal Surge
Drainage System Overburdened due to Tidal Surge
Flooded Roads Cut Off Communities
Flooded Roads Cut Off Communities
Shallow Groundwater
Poorly Infiltrating Soils and Rising Groundwater
Looking to the Past
Historic Roads are Modern Corridors

1907

Today
Reinforce Historic Assets and Commercial Centers
Reinforce Historic Assets and Commercial Centers
Develop High Ground and Transportation Corridors
Dutch Dialogues Virginia
Develop High Ground and Transportation Corridors
Gentilly Resilience District - New Orleans
Innovate Architectural Adaptation
Make It Right - New Orleans
Innovate Architectural Adaptation
IJburg Floating House - Amsterdam
Innovate Architectural Adaptation
Dutch Dialogues Virginia - Newmarket Creek
Retain Rain on the High Ground and Reduce Runoff
Green Infrastructure

Concept 1: Network of rain gardens and bioswales
Concept 2: Perimeter Water Lane
Concept 3: Green Heart

PROJECT SITE
Retain Rain on the High Ground and Reduce Runoff
Wally Pontiff Flood Park - Metairie, Louisiana
Retain Rain on the High Ground and Reduce Runoff
Wally Pontiff Flood Park - Metairie, Louisiana
Drainage Infrastructure can be an Integrated Asset
Westersingel - Rotterdam
Drainage Infrastructure can be an Integrated Asset
Dutch Dialogues Virginia - Newmarket Creek
Raise Roads and Infrastructure
Resilient Bridgeport

EXISTING INDUSTRIAL
RETROFIT CONNECTIONS
PRECAST UTILITY TRENCH
EXISTING SEWER
BOSTWICK AVE
FEMA BFE
VEGETATIVE BUFFER
RAISED DEVELOPMENT
Multifunctional Flood Control
Westzeedijk - Rotterdam
Living Shoreline to Reduce Coastal Erosion
Living Shoreline to Reduce Coastal Erosion
Maintain Marsh and Wetlands with SLR
Workshop Activity

Tell us about flooding events you are experiencing.

Of these events, what are the most important to address?

Brainstorm possible actions for these priorities.