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City of Key West
Sea Level Rise Policy

Task Order 1-21, Stormwater Boundary Conditions and Design Criteria

First Presentation to City Commission

September 1, 2021

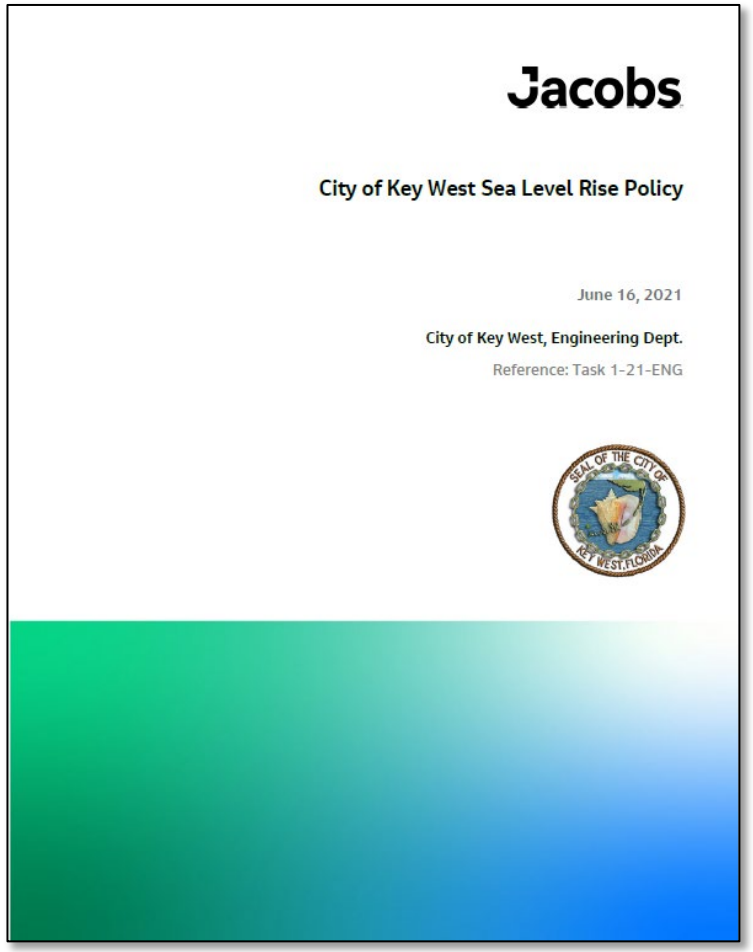
Agenda

1. Opening Remarks
2. SLR Policy Drivers
3. SLR Policy Overview
4. Stormwater Boundary Conditions
5. Minimum Design Elevations
6. Other Considerations & Next Steps
7. Closing Remarks
8. Q&A

Photo: Key West Island News (Extreme tide event)

Sea Level Rise Policy: Drivers & Overview

- **Informs stormwater masterplan being updated now.**
  - Establishes future boundary conditions.
- **Informs design of critical City infrastructure:**
  - Includes: roads, stormwater pump stations, wastewater treatment, and coastal/tidal barriers.
  - Establishes planning horizon (e.g., 2050 vs 2070).
  - Selecting SLR projections (e.g., NOAA Int. High vs High SLR curve).
  - Supports messaging for City leadership, elected officials to community.
  - Supports City's leadership in planning for future, today.



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State of Florida Adaptation Planning Process

1. Set Context
2. Vulnerability Assessment
3. Adaptation Strategies
4. Implementation Plan

Figure 11. Public participation points during the Adaptation Planning Process.

[Florida Adaptation Planning Guidebook](#)

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Common Terms

- Boundary Condition:

  This elevation is considered the base water level as “normal conditions” that is input into H&H model with additional rainfall inputs, to evaluate flood potential and stormwater system conveyance performance against selected LOS.

- Level of Service (LOS):

  Design storm that the stormwater system is designed to convey/manage (e.g. 5-year vs 10-year, 24-hour) applied to buildings, roads and other infrastructure.

- King Tide (Annual High Tide event)

  Seasonal high tide observed, usually occurring in fall (Sept-Nov.).

- Vertical Datums:

  NAVD88 datum is used on new FEMA flood maps. (NGVD29 is used for current FEMA maps)

- FEMA FIRM (flood insurance rate map) effective date 2005
  - Base flood elevation (BFE) 6-13 feet NGVD29
  - Draft FIRM maps under review, issued Dec. 2019. BFE: 6-13 feet NAVD88

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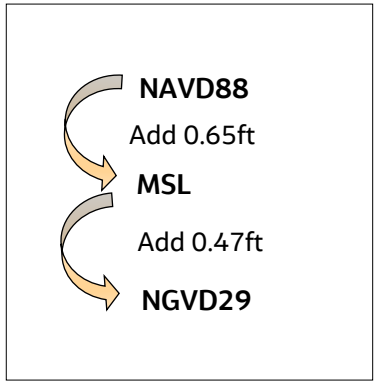
Key West Vertical Datums & Conversions

Datum	Descriptions	Present Epoch (1983-2001) ft NAVD88	Jacobs- Calculated Epoch (2002-2020) ft NAVD88
HAT	Highest Astronomical Tide	0.9	1.1
MHHW	Mean Higher High Water	0.05	0.26
NAVD88	**North American Vertical Datum**	**0.00**	**0.00**
MHW	Mean High Water	-0.24	-0.03
MSL	**Mean Sea Level**	**-0.87**	**-0.65**
NGVD29	National Geodetic Vertical Datum	-1.35	-1.12
MLW	Mean Low Water	-1.52	-1.29
MLLW	Mean Lower Low Water	-1.76	-1.52

Datum Source: NOAA Tide Gauge 8724580, Key West.

Sample Conversions (updated epoch)



Datum	Descriptions
Epoch	The specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values (e.g., mean lower low water, etc.) for tidal datums.
MHHW	The average of the higher high-water height of each tidal day observed over the National Tidal Datum Epoch.
MHW	The average of all the high-water heights observed over the National Tidal Datum Epoch.
MLLW	The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch.
MLW	The average of all the low water heights observed over the National Tidal Datum Epoch.
MSL	The arithmetic mean of hourly water elevations observed over a specific 19-year tidal epoch
NAVD88	A fixed reference for elevations determined by geodetic leveling. The datum was derived from a general adjustment of the first-order terrestrial leveling nets of the United States, Canada, and Mexico.
NGVD29	(Superseded with NAVD88) A fixed reference adopted as a standard geodetic datum for elevations determined by leveling. The year indicates the time of the general adjustment. The geodetic datum is fixed and does not take into account the changing stands of sea level.

Source: https://tidesandcurrents.noaa.gov/publications/glossary2.pdf

This document summarizes the existing vertical datums. Not to be used for design guidelines.

Flood Types

Baseline WSE (water surface elevation) for Boundary Conditions

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Sea Level Rise Projections, (NOAA 2017) Key West

	NOAA 2017				
	Int-Low	Intermediate	Int-High	High	Extreme
2020	0.0	0.0	0.0	0.0	0.0
2030	0.5	0.6	0.8	0.8	1.0
2040	0.7	0.9	1.2	1.4	1.6
2050	0.9	1.3	1.7	2.1	2.5
2060	1.1	1.6	2.3	3.0	3.6
2070	1.3	2.1	3.1	4.1	5.0
2080	1.4	2.6	3.9	5.4	6.5
2090	1.6	3.2	4.9	6.7	8.2
2100	1.8	3.7	5.9	8.2	10.0

Source: USACE SLR Calculator

Notes:

1. SLR Projections were adjusted to reflect a 2020 baseline: presented as (change in water levels in feet).
2. New SLR projections are due out from NOAA in 2022; increases from 2017 projections are anticipated.
3. These projections will be added to Tidal datums for application on City infrastructure projects.

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Determining Minimum Design Elevations

- **Asset Criticality**
  - Public services and facilities that support health and safety for the community.
- **Asset Service Life (planning horizon)**
  - Short service life (<30 years)
    - Electrical and mechanical equipment
    - Roads
  - Medium service life assets: (30-50 years)
    - Some buildings, sea walls, pipes
  - Long Service life assets (>50+ years)
    - Concrete structures
- **Asset Flood Sensitivity**
  - Potential for damage when submerged.

Photo courtesy of Jason Bird

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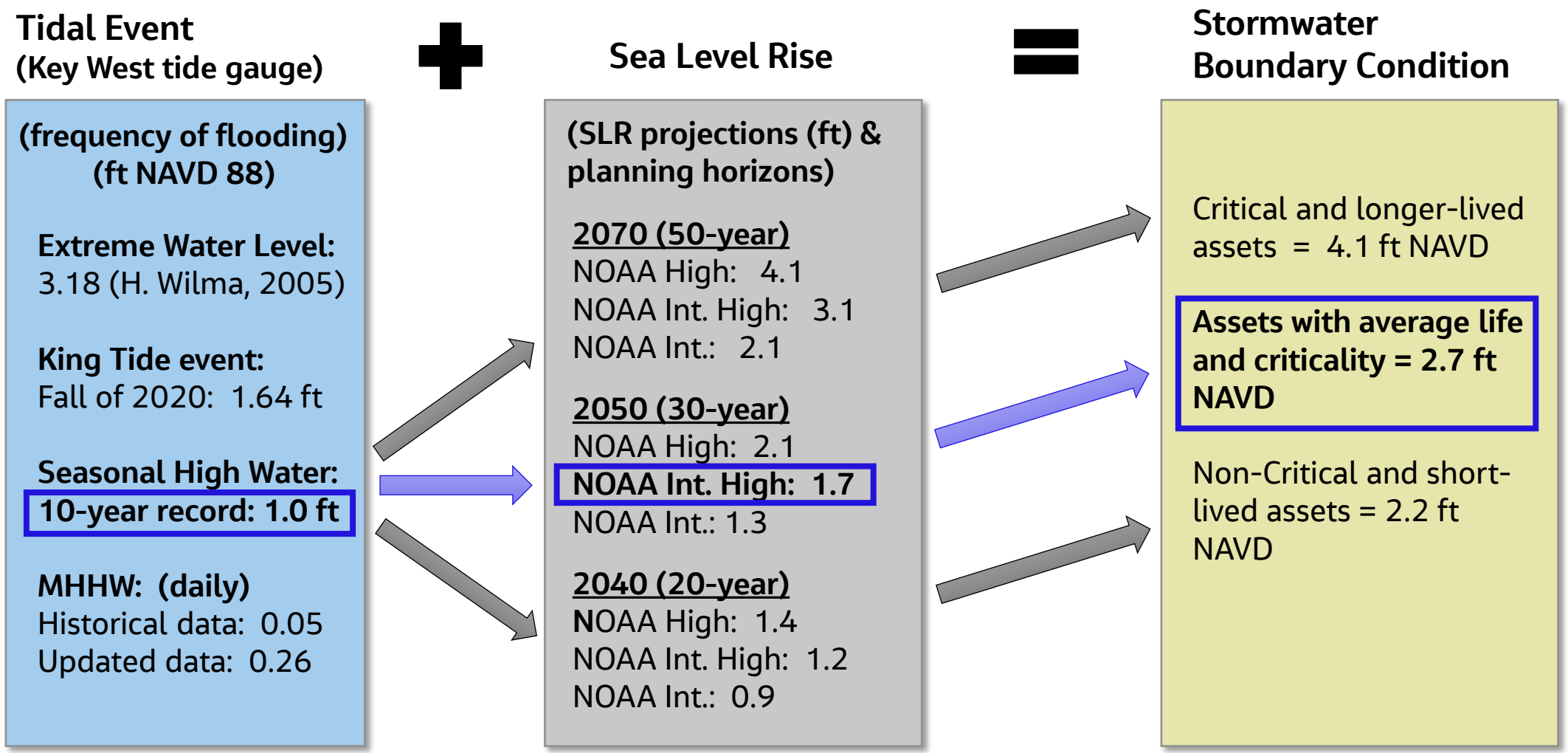
Stormwater: Future Baseline Boundary Conditions



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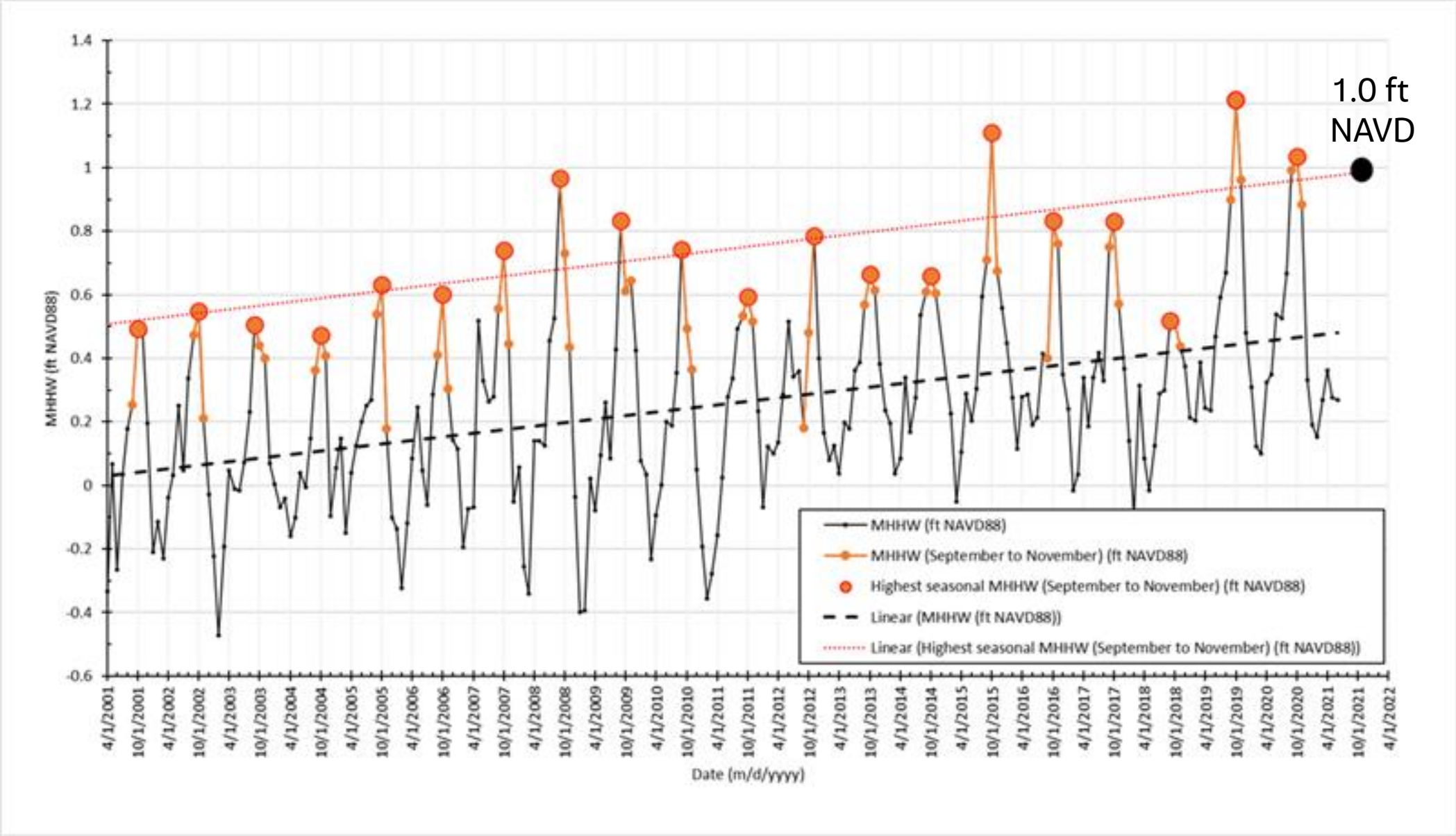
Seasonal High Water Surface Elevation (Historical Analysis)



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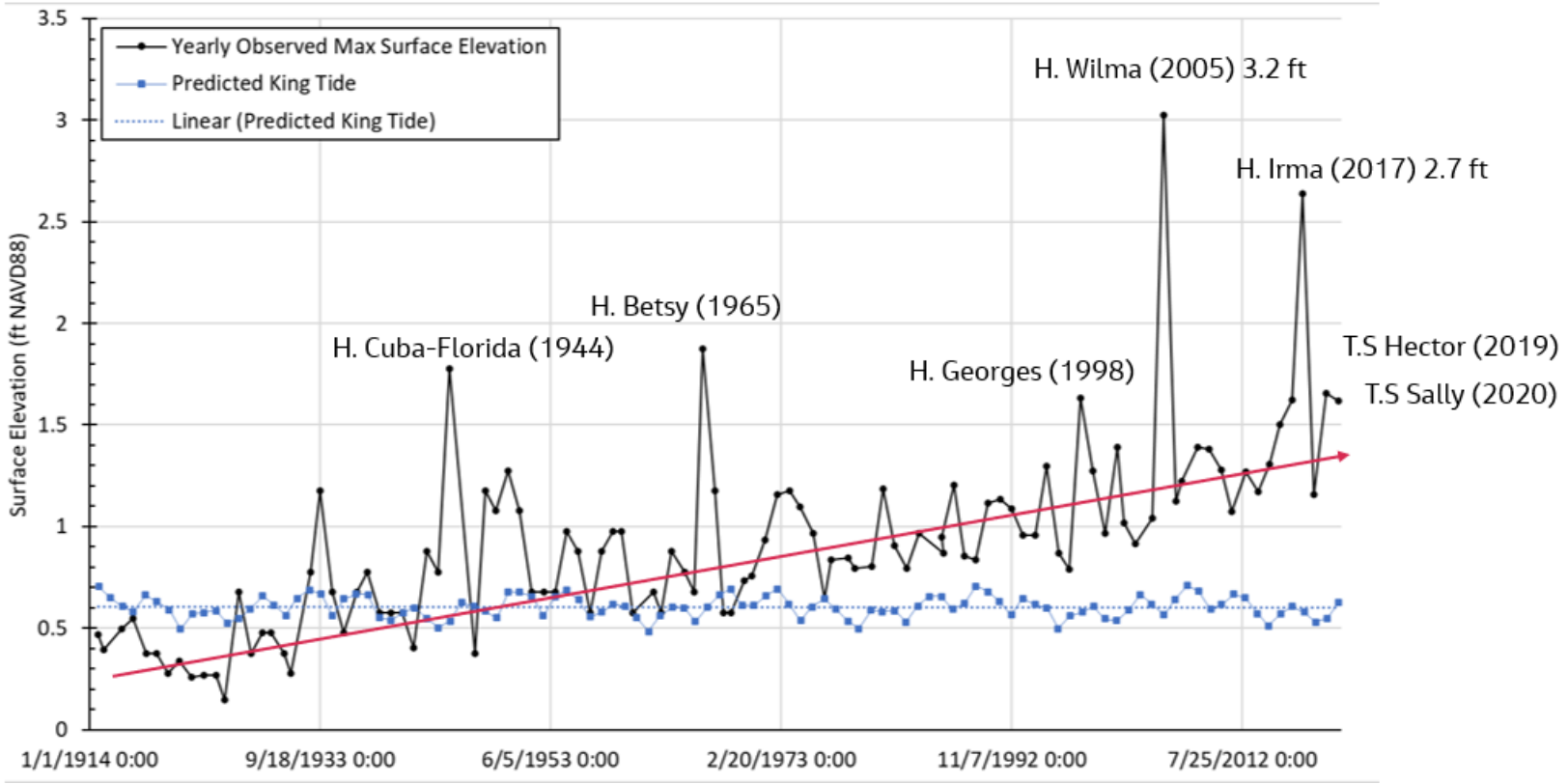
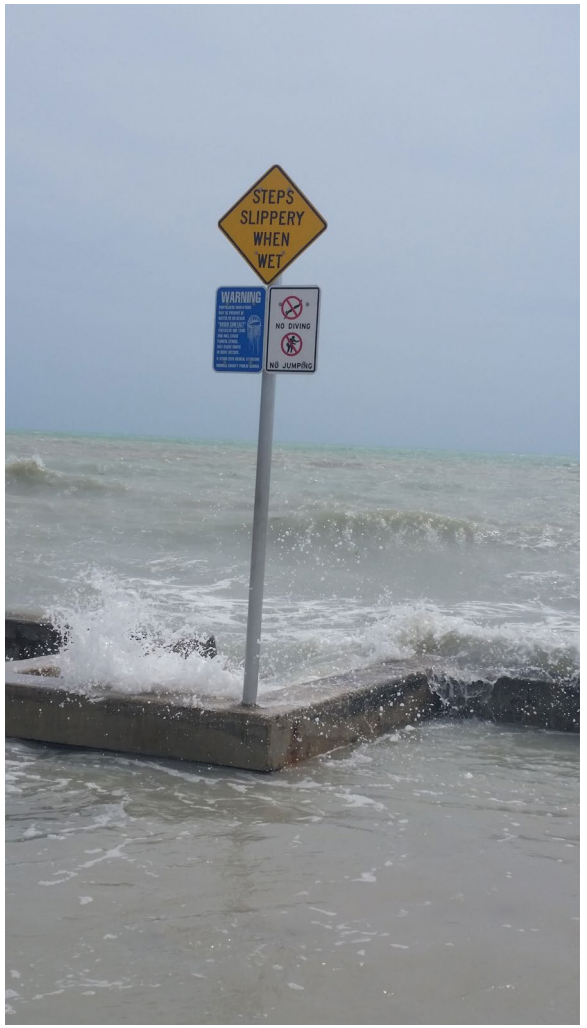
The Issue: Increasing Key West Flood Threat

Increasing frequency and severity of **flooding** adversely affects residents, businesses, quality of life and the economy.





Picture of Tidal Flooding, courtesy of Alison Higgins

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Proposed Minimum Design Elevations

Asset Type	State Regulation	Current Ordinance/Policy	Design Elevation Equations (may be adjusted for future projects)	Recommended Minimum Design Elevations (NAVD88)*
Reference High Water Event (for comparison)	MHHW (average annual daily high tide) based on current 19-year epoch			**0.26 ft**
	Seasonal High Water (average of Sept.-Oct. high water) based on recent 10-year record			**1.0 ft**
	Hurricane Wilma storm surge (2005)			**3.2 ft**
Stormwater system	n/a	MHHW boundary condition 0.05 ft NAVD	Seasonal High Water (1.0 ft) + 30-yr SLR (int. high) 1.7 ft	Future Tidal Boundary Condition = **2.7 ft**
Roads	n/a	none	Seasonal High Water (1.0 ft) + 20 yr SLR (int-high) (1.2 ft) + 1.0 ft road thickness	**3.2 ft** (edge of pavement) (Road hardening is anticipated on all City roads)
Tidal barriers	n/a	none	Seasonal High Water (1.0 ft) + 50 yr SLR (int-high) 3.0 ft + 1.0 ft freeboard	**5.0 ft** (top of wall elev.)
Pump Stations (sanitary & storm)	BFE +1 ft for non-critical equipment (2-ft for V-zones & critical facilities)	Adoption of State Regulations	BFE + 2.0 ft for all critical facilities and equipment sensitive to flooding (addition of SLR optional)	**Elev. = BFE + 2.0 ft** (Varies by location)
Wastewater treatment				

Notes:
1. Consider capital planning cycle/when projects will be implemented + anticipated asset service life, to determine planning horizon.
2. Consider that FEMA FIRM BFE will change with new maps, by approx. +2-3 ft.
3. Similar design considerations are anticipated to apply to water distribution, electric distribution and communication systems, but are not owned or operated by the City of Key West.
4. * Where minimum design elevations cannot be met, alternative measures using adaptive design techniques should be incorporated into the design.

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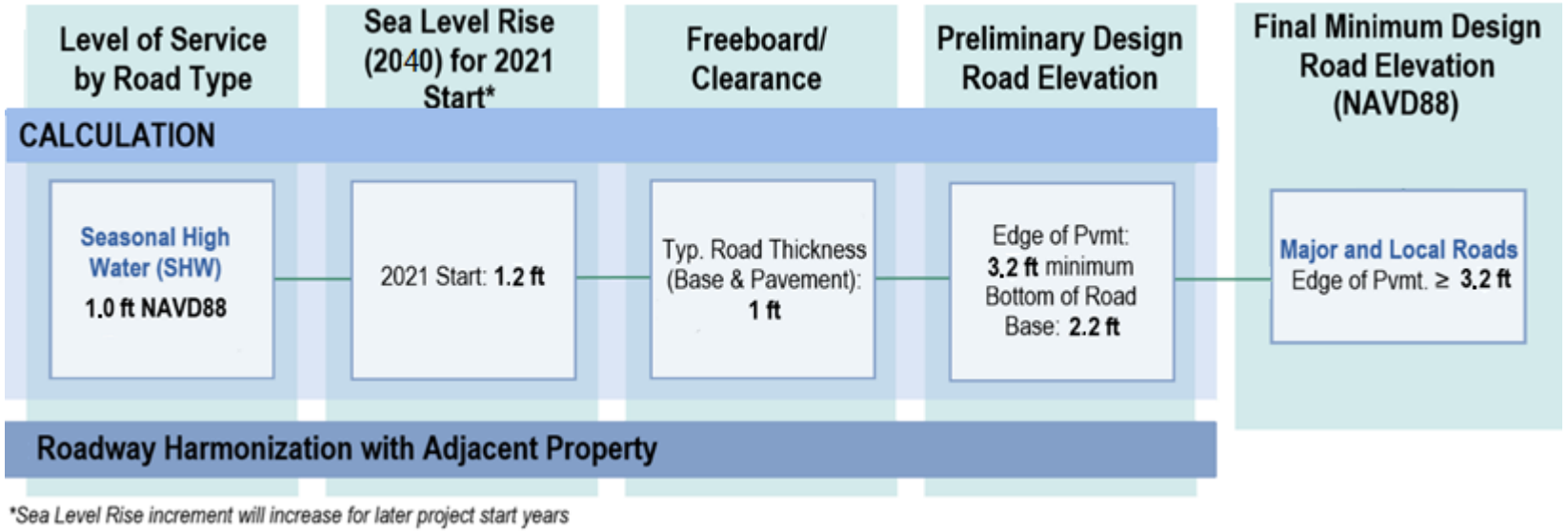
Proposed Minimum Road Design Elevations

Policy Priorities:

- Varies by road classification and function.
- Maintain flexibility in policy to meet needs.
- Mitigate flooding on roadway.
- Protect road base from saturation from high groundwater conditions.
- Maintain access (ADA and vehicle) for adjacent properties.



Note: Road base course hardening is anticipated for all City road projects.

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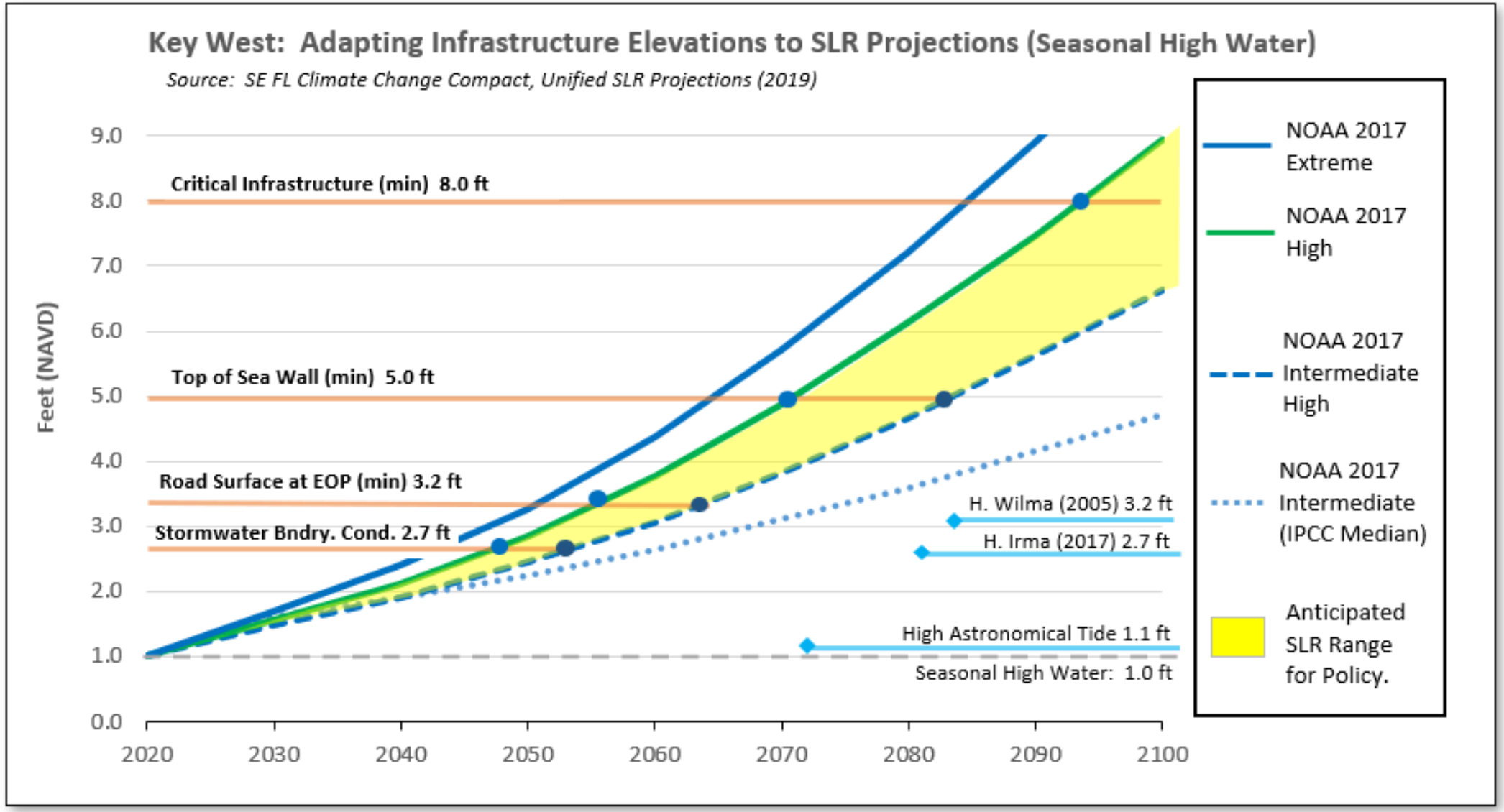
Proposed Minimum Design Elevations: SLR Comparison



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Other Considerations & Next Steps

- Adoption of SLR Policy for public infrastructure projects.
- Incorporate into ongoing stormwater masterplan update and City design guides/manuals for capital projects.
- Review for possible inclusion in City Land Development Regulations.
- Complete vulnerability assessment to inform capital needs.
- Review and update as new information becomes available.
- Consider potential implications of revised FEMA flood map BFEs.
- Leverage available state/federal funding to implement.

Photo courtesy of Jason Bird

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Thank you

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