

Vulnerability Assessments and Infrastructure Resilience – Case Study

Bethune Point Water Reclamation Facility (BPWRF) in
Daytona Beach

February 8, 2024

PRESENTERS

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BACKGROUND

FACILITY IMPACTED

- Hurricane Matthew, October 2016 – Category 2
 - Facility power was disrupted
 - Emergency generator failed
 - Disruption of UV disinfection process.
 - 14 million gallons of wastewater flowed into Halifax
- Hurricane Irma, September 2017 – Category 2
 - Produced storm surge that came within 6 inches of MCC room doorway
- Both events arrived at less than high tide



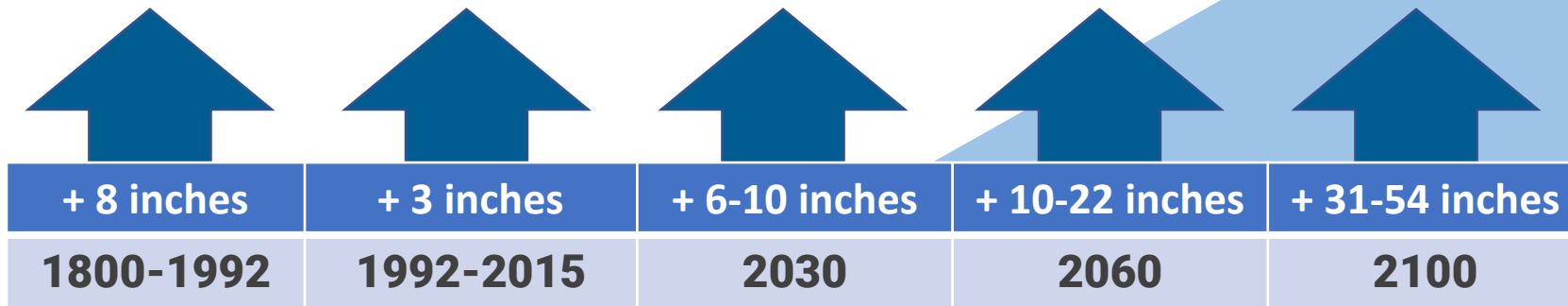
City made the decision to evaluate the facility for **climate vulnerability** and to create a road to resilience.



RISING SEA LEVELS

Daytona Beach, FL

The Rise of Mean Sea Level – Historic and Future Projections



STORM SURGE

Saffir-Simpson Hurricane Wind Scale

CATEGORY 1
(74 - 95 MPH)



CATEGORY 2
(96 - 110 MPH)



CATEGORY 3
(111 - 130 MPH)



CATEGORY 4
(131 - 155 MPH)



CATEGORY 5
(156 MPH AND OVER)



Source: <https://www.yourconroenews.com/news/article/What-is-a-Hurricane-9483325.php>

Hurricane Winds

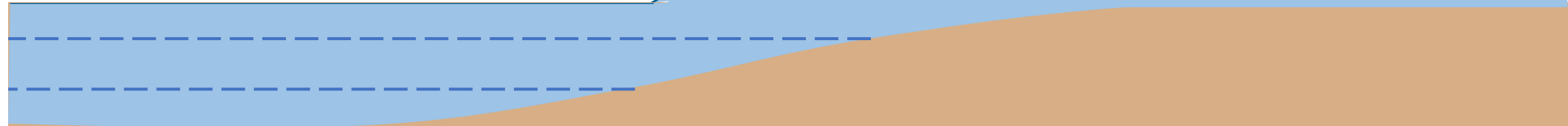


Storm Surge



High Tide

MHHW + SLC



SEA LEVEL RISE & STORM SURGE ANALYSIS

NOAA Tide Station: 8721120



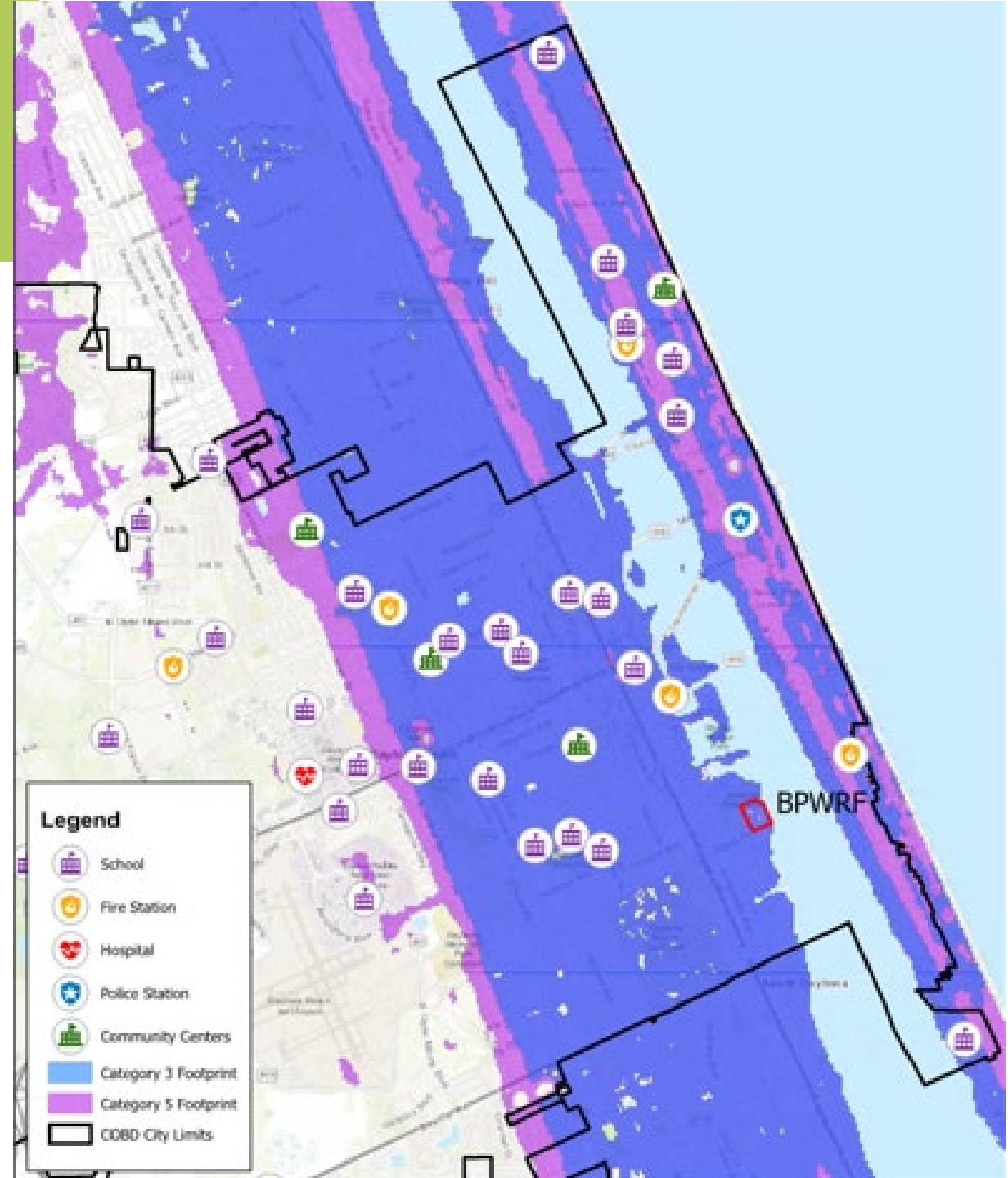
Sea Level Rise Predictions



National Storm Surge Hazard Maps (Sea, Lake, and Overland Surges from Hurricanes [SLOSH])



SLR & Storm Surge Footprint and Elevations



FACILITY CLIMATE ADAPTATION PLANNING*



1. Understand projected impacts and challenges
 - Use appropriate NOAA Projected SLR Curve
 - Determine service life of facility
 - Determine event to be evaluated
 - Determine flooding evaluation
2. Identify thresholds for failure or damage
 - Evaluate projected impact
3. Assess risk
4. Determine adaptation options
5. Implement and monitor



STEP 1

SEA LEVEL RISE AND STORM SURGE PREDICTIONS FOR BPWRF

Year	2020	2030	2050	2070	2100
Sea Level Rise (feet) ¹	0.72	1.21	2.49	4.4	8.4
Intracoastal Waterway MHHW Tide Elevation ²	-0.22 ³				
MHHW Tide Elevation ² including SLR	.50	.99	2.27	4.18	8.18
Category 1 Hurricane Storm Surge + SLR Elevation ^{2,4}	6.30	6.79	8.07	9.98	13.98
Category 2 Hurricane Storm Surge + SLR Elevation ^{2,4}	8.29	8.78	10.06	11.97	15.97
Category 3 Hurricane Storm Surge + SLR Elevation ^{2,4}	13.42	13.91	15.19	17.10	21.10
Category 4 Hurricane Storm Surge + SLR Elevation ^{2,4}	20.16	20.65	21.93	23.84	27.84
Category 5 Hurricane Storm Surge + SLR Elevation ^{2,4}	24.01	24.50	25.78	27.69	31.69

¹ SLR projections were obtained from NOAA 2017 high projection curve.

² Elevations in feet are referenced to NAVD88.

³ Appendix A provides more information regarding the determination of this elevation.

⁴ Mean elevation within limits of the BPWRF.



BPWRF Site Plan



CRITICAL INFRASTRUCTURE EXAMPLES



Electrical Gear/MCCs



Pumps, Motors and Control Panels



Diesel Generators



Blowers, Motors and Control Panels



Clarifiers



STEPS 2 & 3

WRF DAMAGE THRESHOLDS

Critical Equipment	Critical Damage Elevation ¹	Category Hurricane (2020 MHHW+ SLR)	Notes	WRF Inoperable After Water Recedes ²	Criticality ³
Plant Lift Station	5.1	1	Pump motor submerged	No	Low
Influent Pump Station	5.3		Power Panel/Disconnect Switch submerged	Yes	High
UV Disinfection Area	5.8		UV Bank Panels submerged	Yes	High
Denitrification Filters	5.8		Power supply submerged	Long-Term Yes	High
Switch Gear Building	5.9		Generator Control Panel submerged	Yes	High
Control Building	5.9		Finish floor elevation	No	Low
Effluent NPW Pump Building	6.0		Reuse motors submerged	No	Low
Blower Area	6.3		Control panel submerged	Yes	High
UV Generator Building Area	6.4	2	Transformer submerged	Long-Term Yes	High
RAS Pump Station No. 2 (Clarifiers 3, 5, & 6)	7.4		RAS Motors submerged	Yes	High
WRWRF Connect	7.6		Reuse Main Valve Control Panel submerged	No	Low
MCC-2	7.6		Panels submerged	Yes	High
MCC-3	7.9		VFDs submerged	Yes	High
RAS Pump Station No. 1 (Clarifiers 1, 2, & 4)	8.0		RAS Motors submerged	Yes	High
Final Clarifiers	8.0		Clarifiers inundated	Yes	High
Pretreatment Structure	8.1		Screening & Grit Remover Control Panel submerged	Long-Term Yes	Low
Mobile Generator	9.2	3	Generator submerged	Yes	High
Clarified Liquid Pump Station	9.8		Control panel submerged	Yes	High
Clarifier Splitter Boxes	9.9		Splitter inundated	Yes	High
Aeration Tank 3 & 4	11.4		Tank inundated	Yes	High
Clearwell	12.9	4	Tank inundated	No	Low
Aeration Tank 1 & 2	18.9		Tank inundated	Yes	High
First Anoxic Tank 2	20.4	5	Tank inundated	Yes	High
Anaerobic Tank	24.1		Tank inundated	Yes	High
First Anoxic Tank 1	24.5	N/A	Tank inundated	Yes	High

¹ Elevations in feet in reference to NAVD88

² "Yes" means damage to equipment renders WRF unable to maintain treatment within 12 hours. "Long-Term Yes" means damage to equipment renders WRF unable to maintain treatment after multiple days

³ "Low" – WRF can treat incoming wastewater to effluent standards, "Medium" – Solids processing treatment out of operation, but WRF can treat incoming wastewater to effluent standards, "High" – WRF unable to treat incoming wastewater to permitted effluent limits

ESTIMATED DAMAGE COSTS* FOR CRITICAL EQUIPMENT (STEP 2)

Critical Equipment	Electrical Component Replacement Costs	Complete Equipment Replacement Costs
Plant Lift Station	\$60,000	\$200,000
Influent Pump Station	\$240,000	\$1,500,000
UV Disinfection Area	\$570,000	\$3,800,000
Denitrification Filters	\$470,000	\$4,300,000
Switch Gear Building	\$200,000	\$200,000
Control Building	\$200,000	\$200,000
Effluent NPW Pump Building	\$80,000	\$400,000
Blower Area	\$420,000	\$2,400,000
UV Generator Building Area	\$400,000	\$400,000
RAS Pump Station No. 2 (Clarifiers 3, 5, & 6)	\$120,000	\$500,000
WRWRF Connect	\$80,000	\$200,000
MCC-2	\$3,300,000	\$3,300,000
MCC-3	\$3,400,000	\$3,400,000
RAS Pump Station No. 1 (Clarifiers 1, 2, & 4)	\$120,000	\$500,000
Final Clarifiers	\$240,000	\$7,700,000
Pretreatment Structure	\$460,000	\$2,800,000
Mobile Generator	\$300,000	\$300,000
Clarified Liquid Pump Station	\$360,000	\$2,400,000
First Anoxic Tank 2	\$100,000	\$100,000
Anaerobic Tank	\$100,000	\$100,000
First Anoxic Tank 1	\$100,000	\$100,000

* 2020 Construction Estimate



STEP 4

PROTECTION OPTIONS EVALUATED



Option 1: Do Nothing (Baseline)

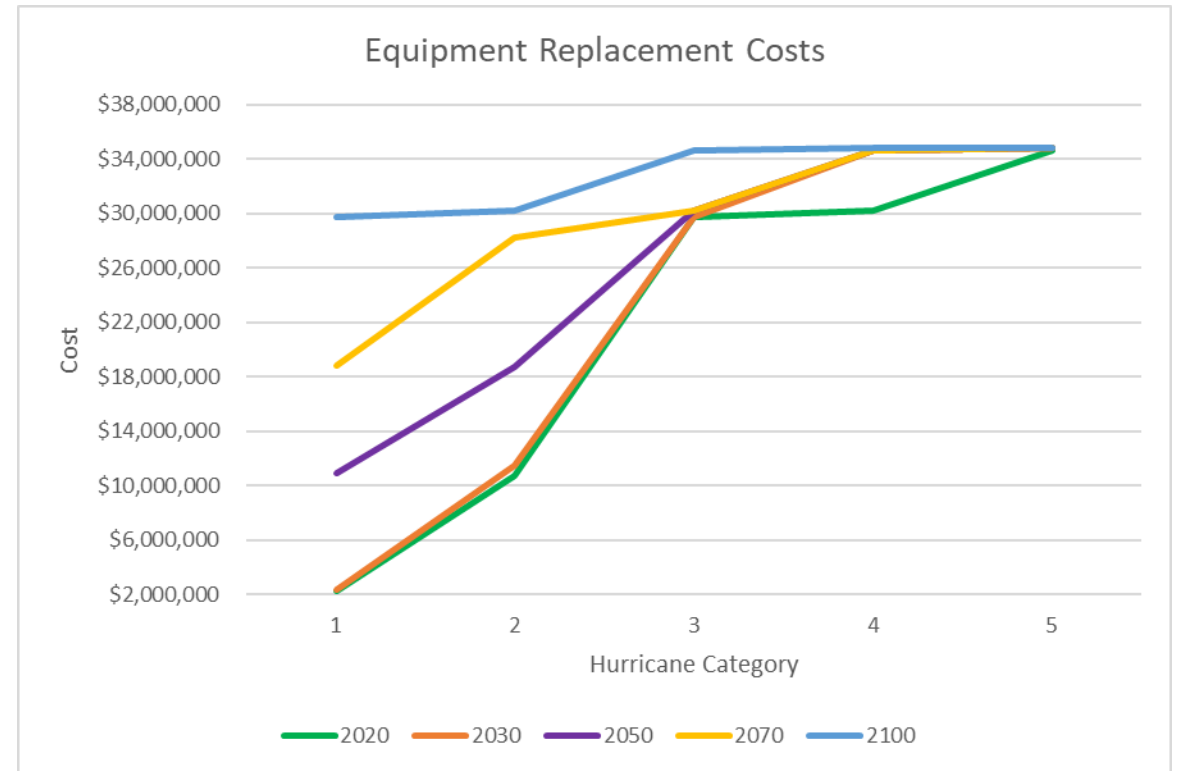
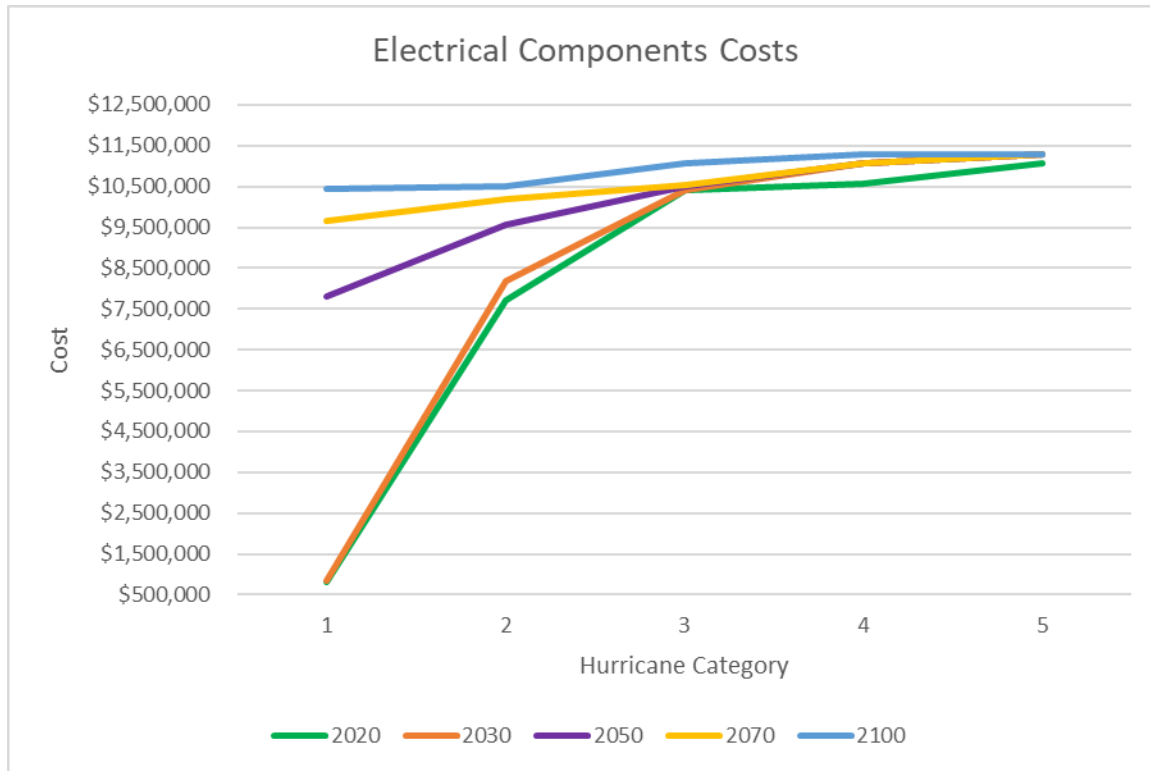
Option 2: Deployable Barriers

Option 3: Perimeter Berm Wall Options

Option 4: Convert BPWRF to Pump Station and Pump to Expanded Westside Regional WRF



OPTION 1 – DO NOTHING (BASELINE)



OPTION 2 – “DEPLOYABLE” FLOOD PROTECTION EXAMPLES



Flood Planks

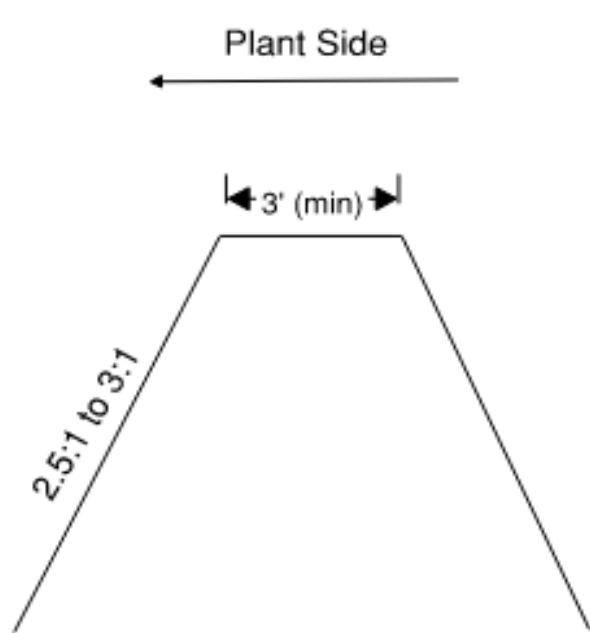
Sliding Flood Gates



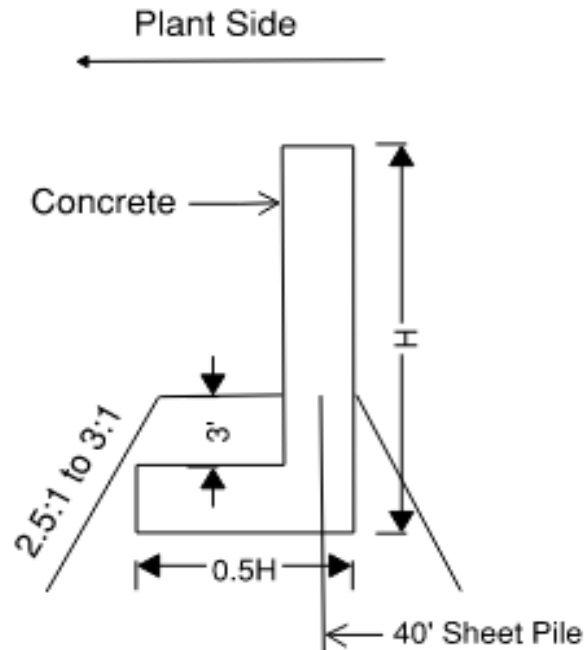
Deployable Protection Example – Up to Cat. 2, Year 2050



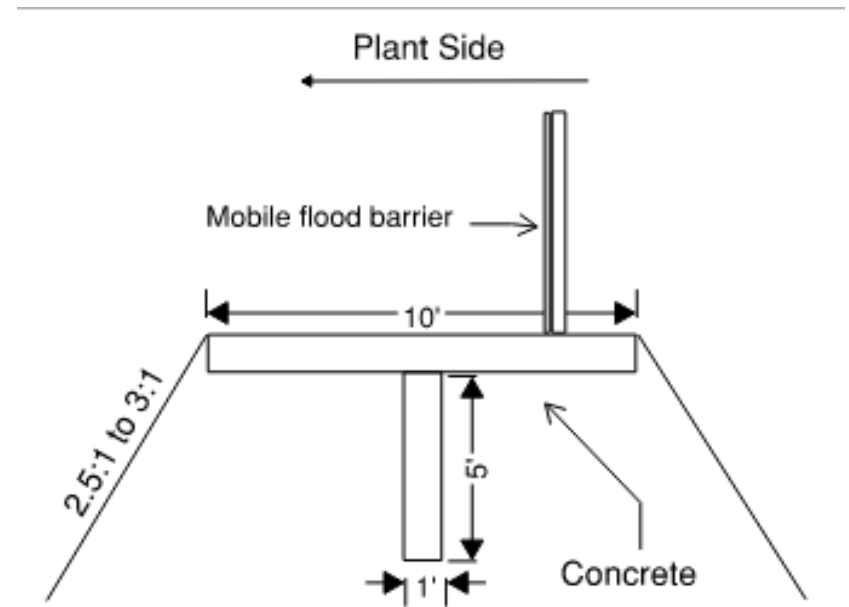
OPTION 3 – BERM WALL FLOOD PROTECTION EXAMPLES



Earthen Berm (Type A)



Parapet Wall (Type B)

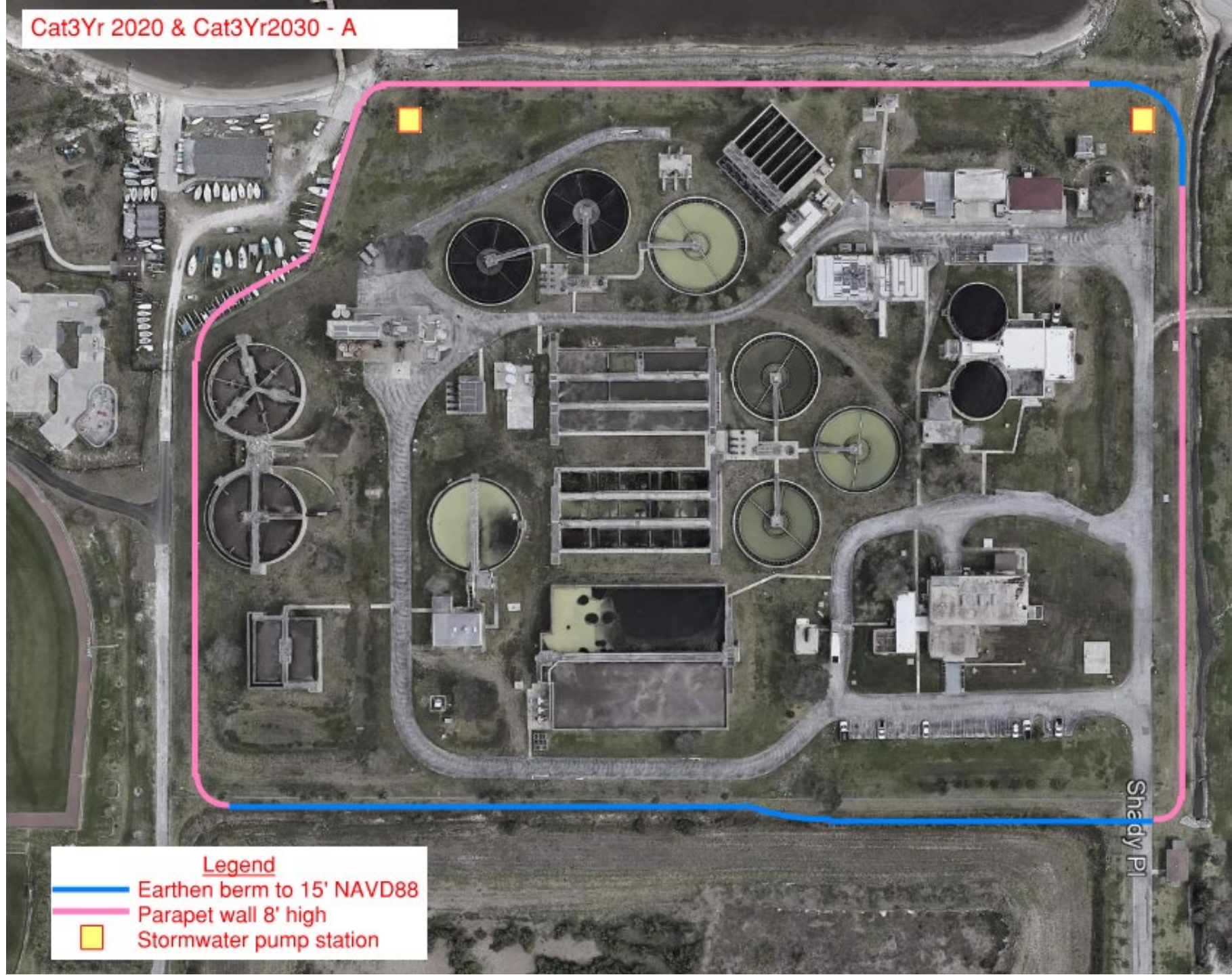


Mobile Flood Barrier (Type C)

Berm Cross-Sections



Berm Wall Protection Example – Cat 3, Year 2030 and Greater



BENEFIT COST RATIO

OPTION 1

BCR: 0

OPTION 2

Category 2, Year 2050
Benefit: \$18.7M
Cost: \$12M
BCR: 1.6

OPTION 3

Category 3, Year 2050
Benefit: \$30.2M
Cost: \$13.5M
BCR: 2.2

OPTION 4

Category 5, Year 2100
Benefit: \$34.8M
Cost: \$340.5M
BCR: 0.1



RECOMMENDATION

Target Event: 2050

- Provides approximately 30 years of projected “worst case” surge protection

Option: Option 3 Perimeter Wall with Stormwater Pumping System

- Highest B/C ratio
 - 2030 Cat. 3=2.4/Cat. 5=1.7
 - 2050 Cat. 3=2.2/Cat. 5=1.7
- Allows facility protection today against Cat. 5 storm surge
- Provides baseline protection that can be built upon should SLR accelerate
- Defers construction costs to a point in the future where they maybe needed, only if needed



NEXT STEPS!

- ✓ 1. Discuss resilience measures with City staff through a workshop. **COMPLETE**
2. Seek funding for resilience measures.
3. Based on workshop, develop plan with appropriate funding for design and installation.
4. Step resilience measures as appropriate to meet SLR/Surge projections.
5. Monitor actual SLR vs. projected SLR.
6. Adjust plan as necessary moving forward.



QUESTIONS?



CONTACT US



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