Waterfront Implementation Project

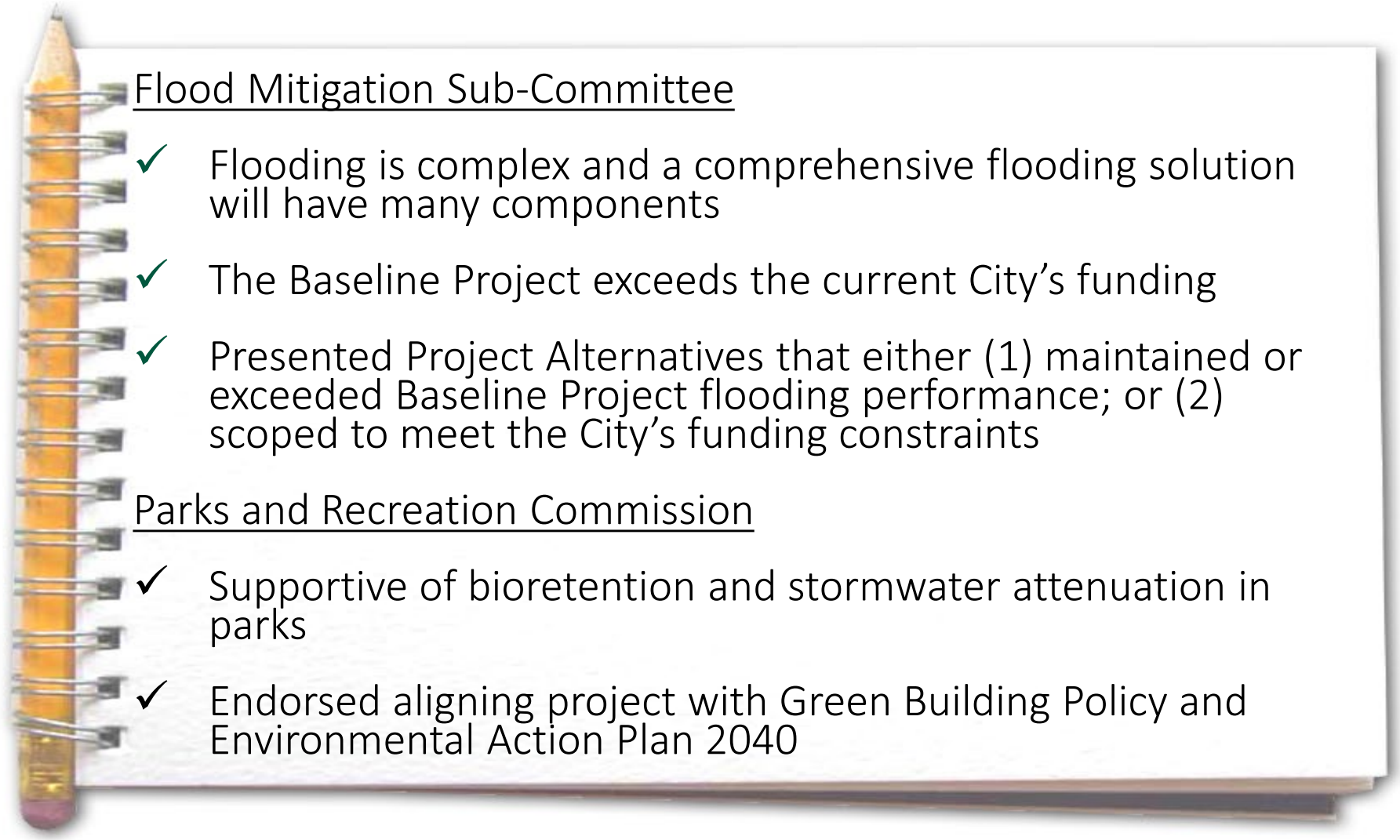
Waterfront Commission Flood Mitigation Subcommittee – Work session

November 15th, 2021

Matthew Landes, PLA, ISA

Department of Project Implementation, Division Chief / Waterfront Program Manager

Recap of Last Meetings



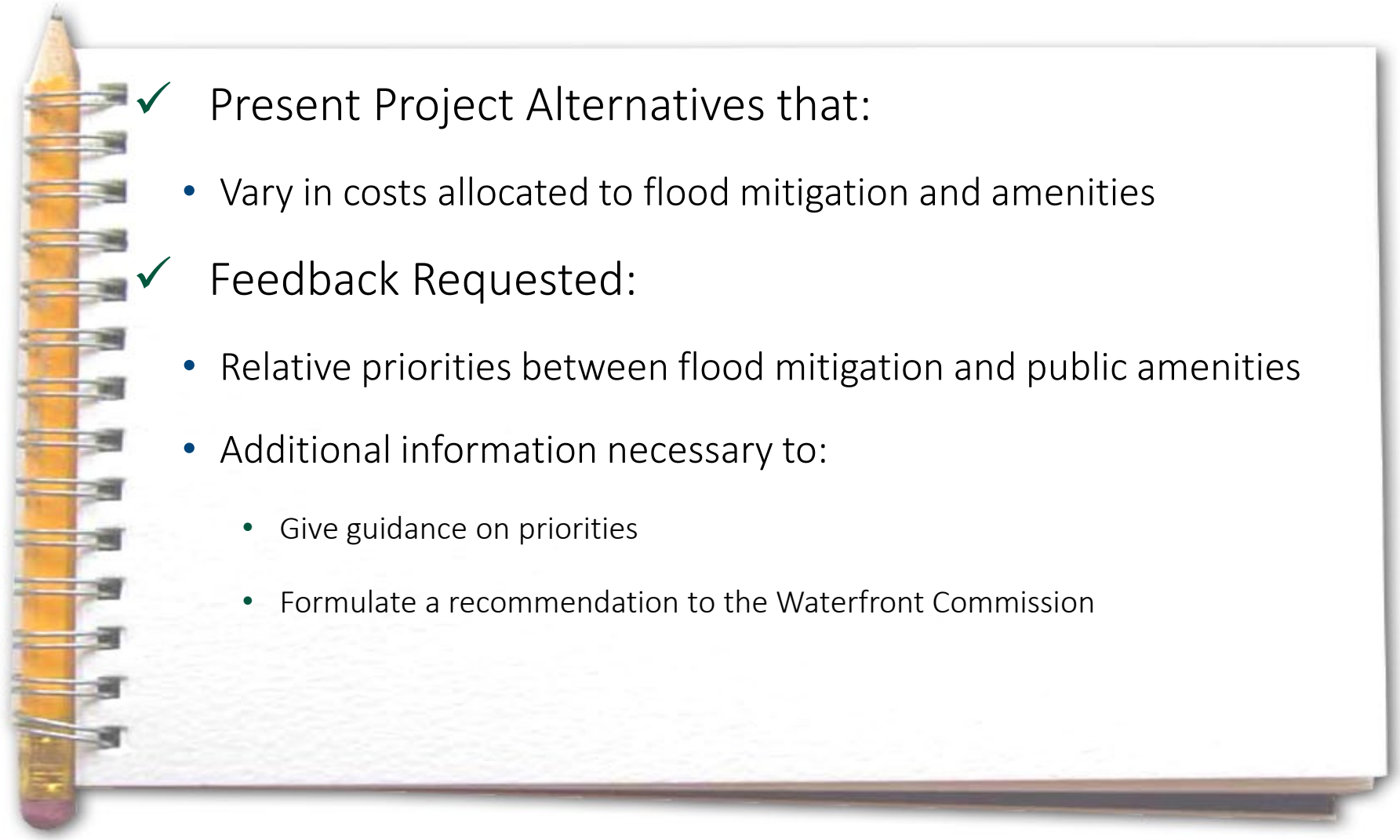
Flood Mitigation Sub-Committee

- ✓ Flooding is complex and a comprehensive flooding solution will have many components
- ✓ The Baseline Project exceeds the current City's funding
- ✓ Presented Project Alternatives that either (1) maintained or exceeded Baseline Project flooding performance; or (2) scoped to meet the City's funding constraints

Parks and Recreation Commission

- ✓ Supportive of bioretention and stormwater attenuation in parks
- ✓ Endorsed aligning project with Green Building Policy and Environmental Action Plan 2040

Meeting Objectives



- ✓ Present Project Alternatives that:
  - Vary in costs allocated to flood mitigation and amenities
- ✓ Feedback Requested:
  - Relative priorities between flood mitigation and public amenities
  - Additional information necessary to:
    - Give guidance on priorities
    - Formulate a recommendation to the Waterfront Commission

Overview

- Project Need
- Project Alternative Summaries
- Next Steps

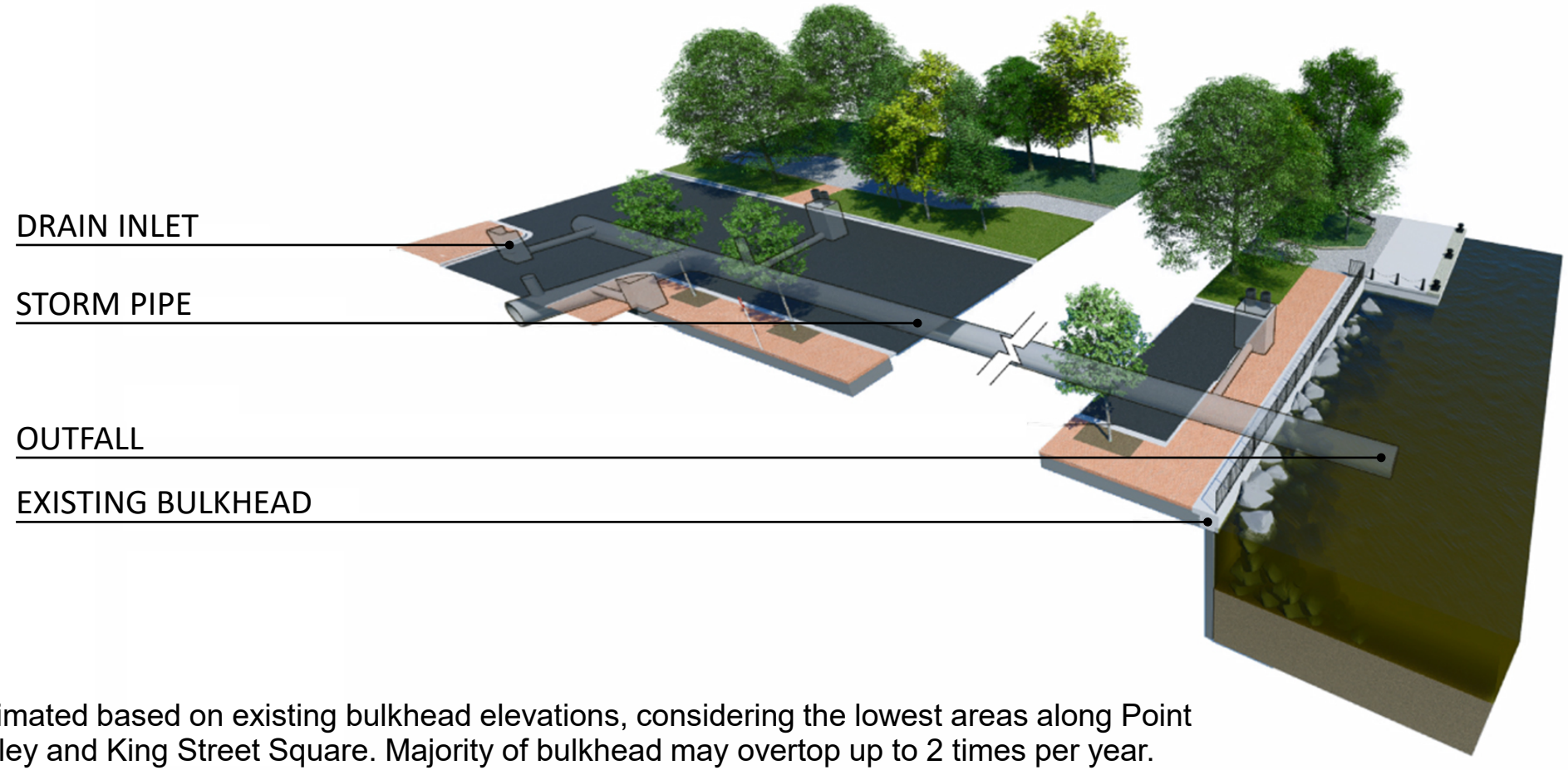
Project Need

A Variety of Flooding Sources in Old Town…

BACKFLOW
of River Outfalls
60 times per year

OVERTOPPING
of Bulkhead
30 times per year*

INUNDATION
of Storm Sewers
10 times per year



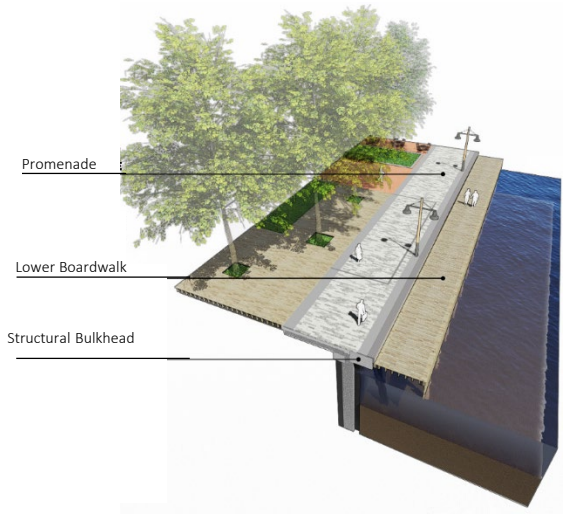
*Estimated based on existing bulkhead elevations, considering the lowest areas along Point Lumley and King Street Square. Majority of bulkhead may overtop up to 2 times per year.

Requires an Integrated Solution to Mitigate Flooding

BACKFLOW
of River Outfalls

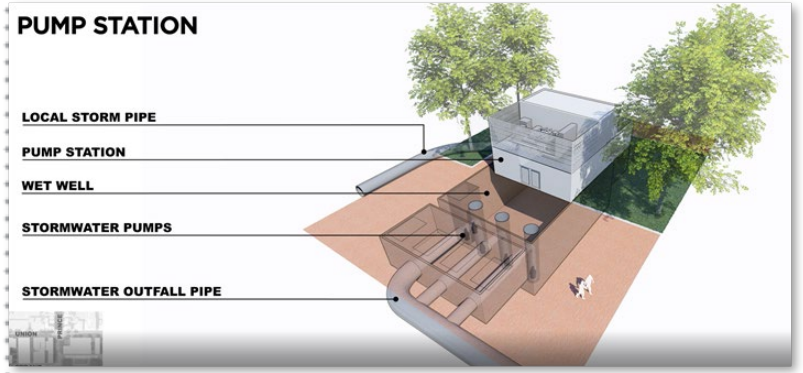
Requires backflow prevention on outfalls.

OVERTOPPING
of Bulkhead



Requires a higher-level protecting storm surge barrier.

INUNDATION
of Storm Sewers



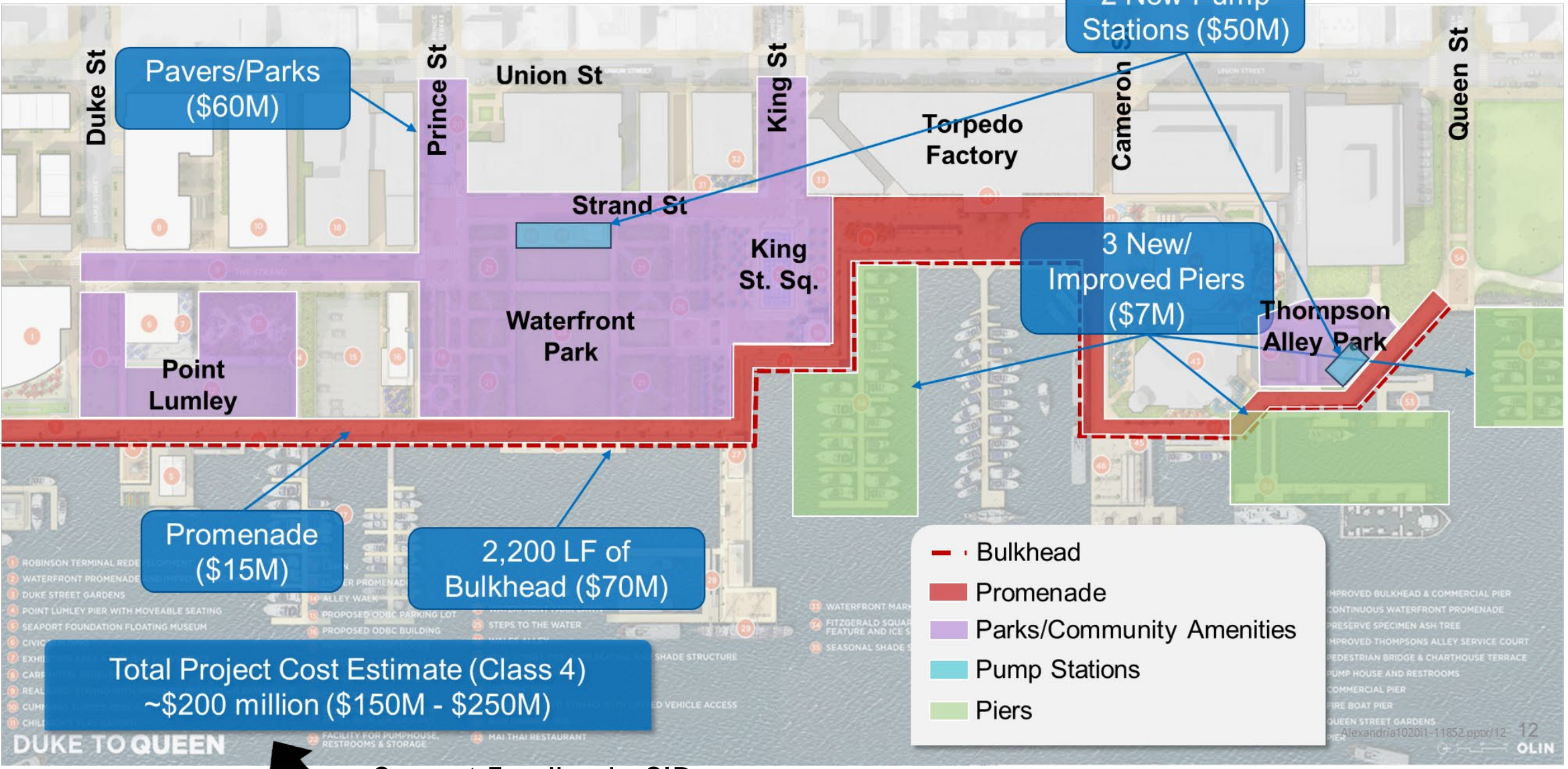
Requires new/larger inlet structures, new/larger storm sewer pipes, and pumping.

1. Backflow: Backflow prevention can be considered an interim, immediate solution as well as a permanent solution part of the larger WFI Project. Images provided by Red Valve.
2. Overtopping: Storm surge protection can be provided (in part) by a bulkhead. The existing bulkhead can be rehabilitated and raised to the protected height and/or replaced and reconstruction to protected height. Storm surge protection can also be provided by other physical flood barriers. Image from March 19, 2019. White Paper Graphics (Olin).
3. Inundation: Image from April 15, 2019. Alexandria Waterfront Pump House / Pavilion Development (Olin)

Goals and Objectives

- Mitigate stormwater flooding:
  - New civil infrastructure (inlets, pipes, storage, pumps, etc.):
    - Size based on a conservative baseline storm
    - Reasonably account for climate change projections through 2100
    - Eliminate capacity issues
- Eliminate backflow of Potomac River into streets
- Address most frequent overtopping of bulkhead/shoreline
- Policy and Regulatory Compliance
- Deliver on goals of Waterfront Small Area Plan
- Replace aging/failed bulkhead/shoreline (where feasible and affordable)

// Baseline Project



Total Project Cost Estimate (Class 4)
~$200 million ($150M - $250M)

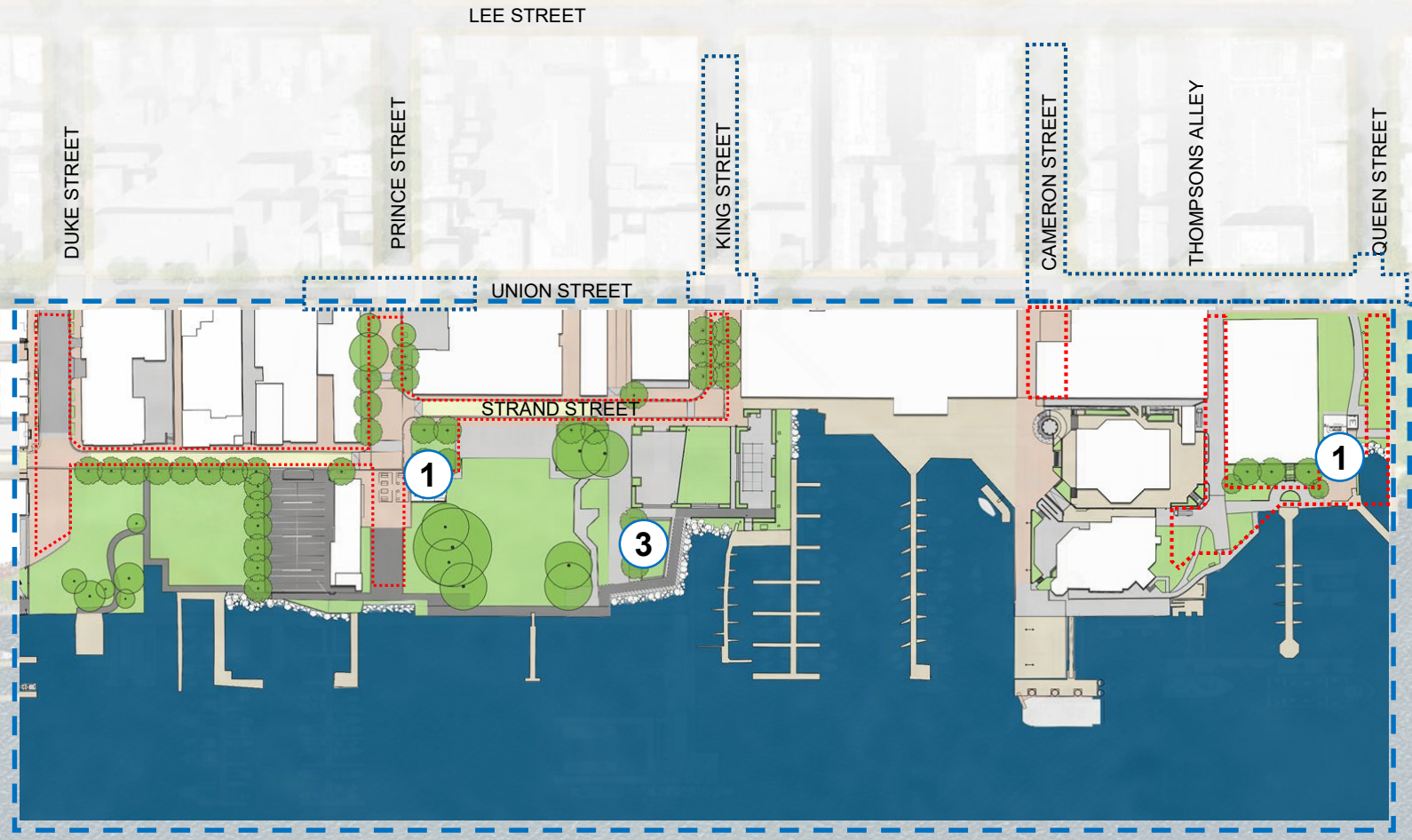
Current Funding in CIP

$102M

Project Alternatives

// Cost Based Option – 1

Mitigates Rainfall Flooding; Defers Shoreline and Park Improvements



LEGEND

1 PUMP STATION

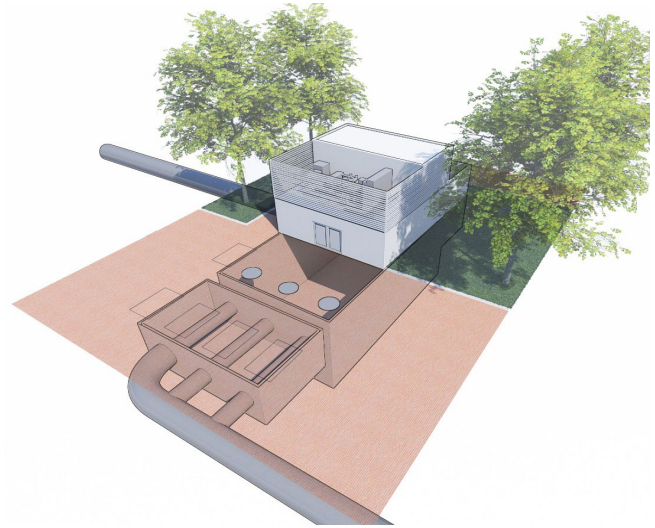
2 UNDERGROUND STORMWATER DETENTION CHAMBERS

3 RETAIN WATERFRONT PARK AT KING STREET

STREETSCAPE AND STORMWATER INFRASTRUCTURE IMPROVEMENTS (COMMON ELEMENT PAVING)

STORMWATER INFRASTRUCTURE IMPROVEMENTS (MATERIALS TO MATCH EXISTING)

// Project Elements

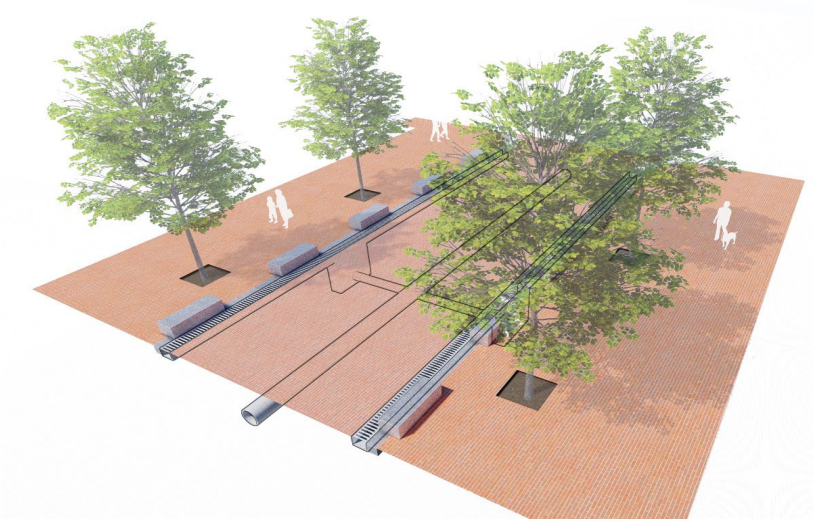


PUMP STATIONS

- Utilitarian structure housing stormwater pumps and associated mechanical and electrical equipment
- No city storage or amenity space
- Thompsons Alley PS capacity reduced by 95%

UNDERGROUND DETENTION

Stormwater storage chambers sited under existing parkspaces



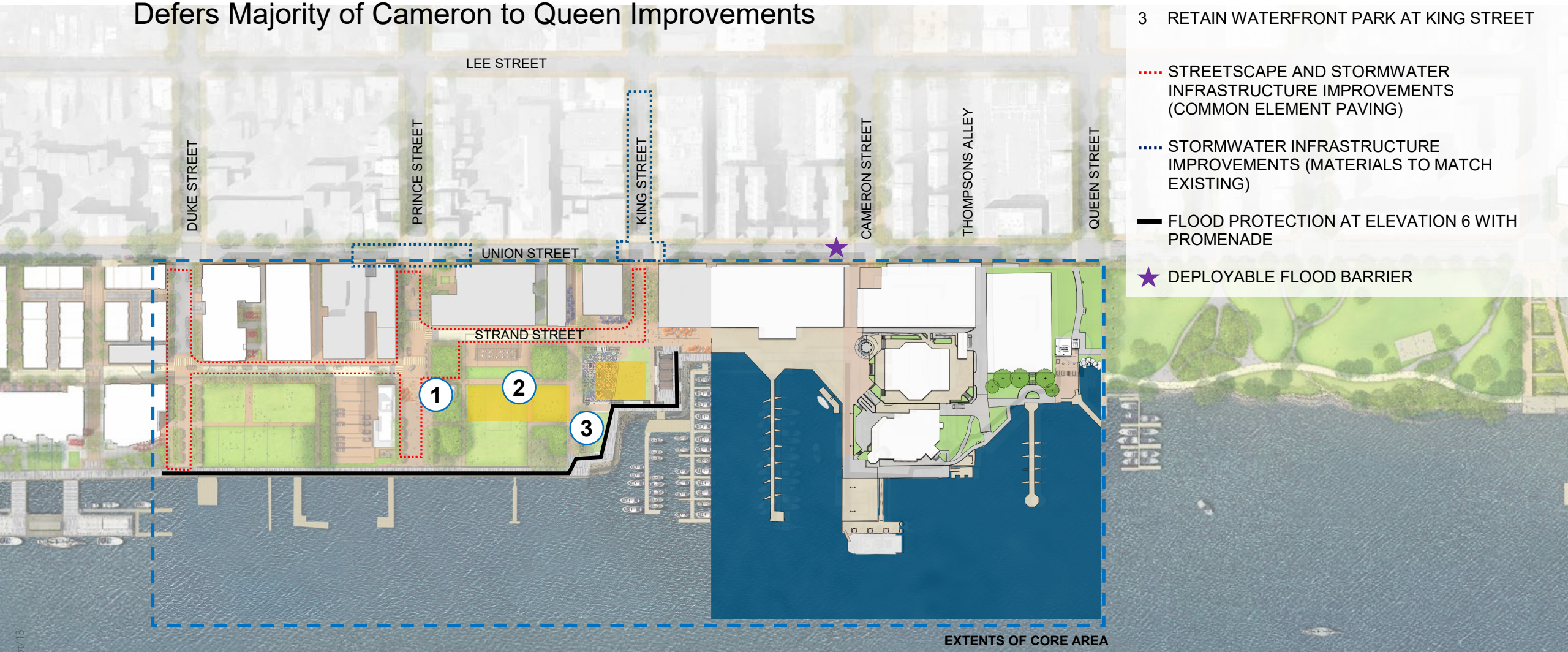
STREETSCAPE AND STORMWATER INFRASTRUCTURE IMPROVEMENTS

- New and upsized stormwater inlets and conveyance pipes
- Common elements paving proposed for streets within the core area only. All others to match existing materials

Cost Based 1

// Cost Based Option – 2

Prioritizes Southern Project Area Improvements; Defers Majority of Cameron to Queen Improvements



LEGEND

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STREETSCAPE AND STORMWATER INFRASTRUCTURE IMPROVEMENTS (COMMON ELEMENT PAVING)

STORMWATER INFRASTRUCTURE IMPROVEMENTS (MATERIALS TO MATCH EXISTING)

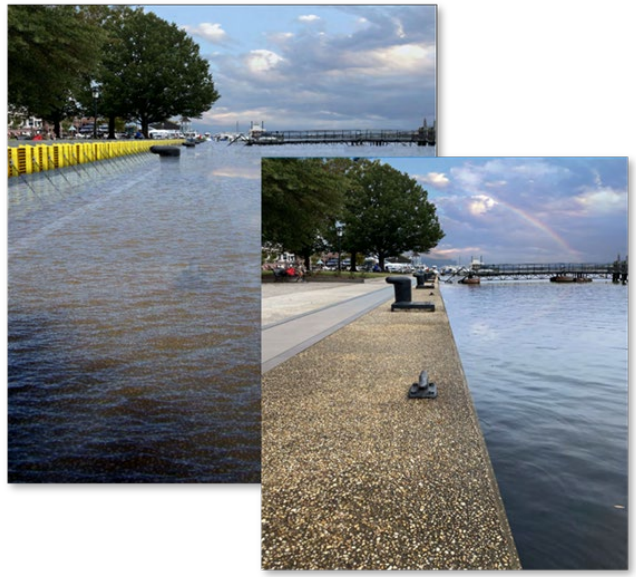
FLOOD PROTECTION AT ELEVATION 6 WITH PROMENADE

DEPLOYABLE FLOOD BARRIER

// Project Elements

*In addition to Option 1

FreeView Flood Barrier

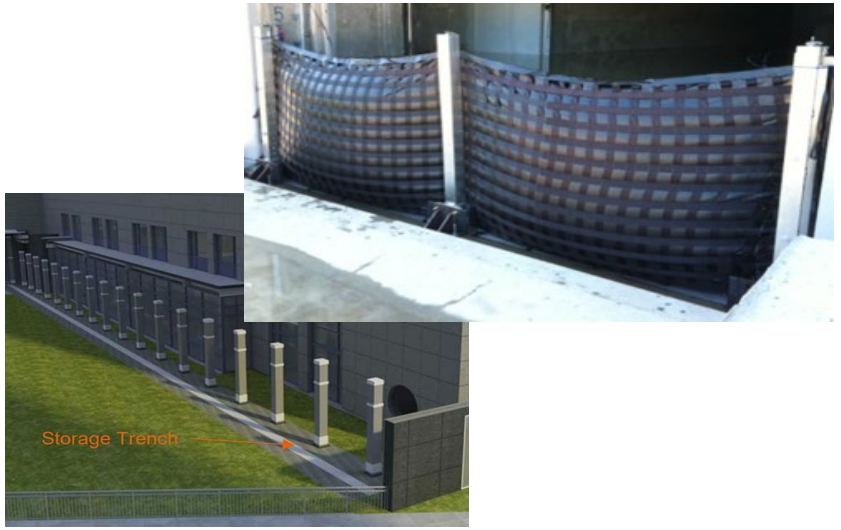


Passive or active 2ft high deployable barrier across N. Union Street from Torpedo Residences to Factory

Stop Log Planks

Stow away for safekeeping and deploy in advance of storm across building flood pathways

Flex-Wall



Concealed on-site storage and flexible membrane flood barrier across building flood pathways

Cost Based 2

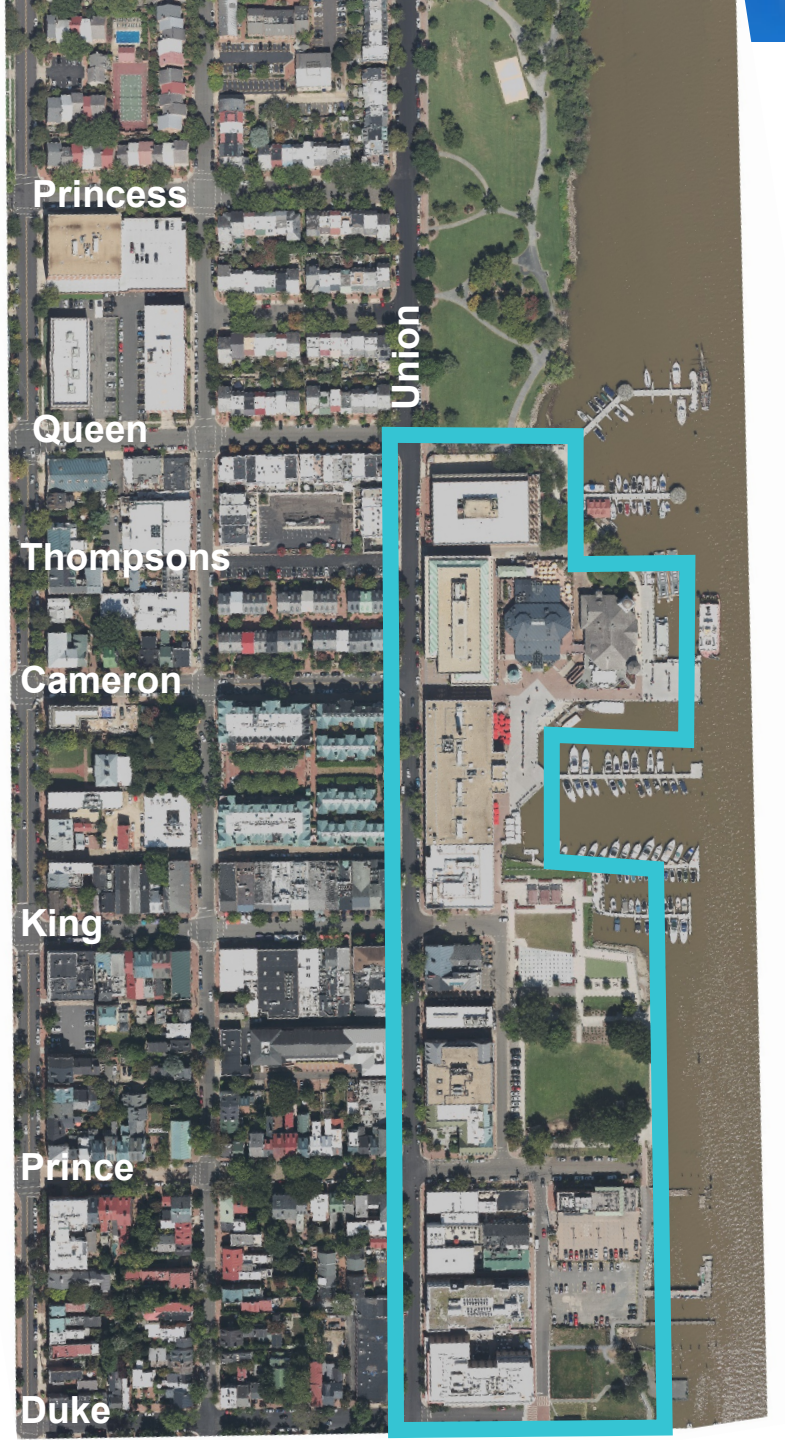
1. FreeView: Provided by FloodBreak.
2. Stop Log Planks: Sourced photo from https://www.psfloodbarriers.com/wp-content/uploads/sites/4/2016/09/YMCA-of-Fredrick.jpg
3. Flex-Wall: Provided by ILC Dover

Rainfall-Runoff Flooding Performance

Existing Conditions

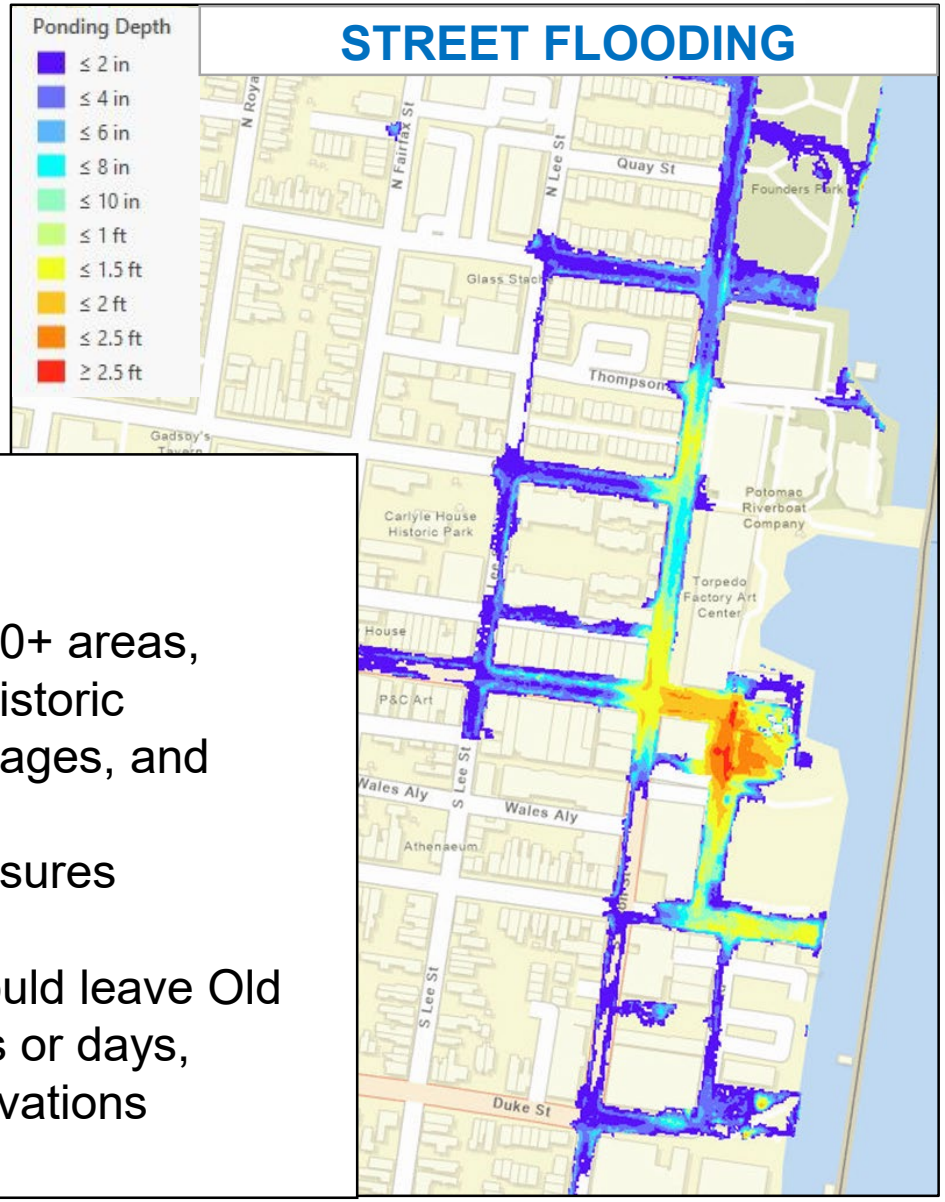
Key Inputs

- Design Storm Rainfall Conditions, which accounts for climate change predictions through 2100
- Existing infrastructure system is undersized for today's storm and is tidally influenced
- Existing topography shows low-lying roadway elevations and finished floors



Existing Conditions

STREET FLOODING



BUILDING FLOODING

Key Results

- Predicted flooding at 10+ areas, including designated historic structures, parking garages, and residential front lawns
- Traffic impacts and closures
- Safety concerns
- Stagnant water that could leave Old Town flooded for hours or days, depending on river elevations

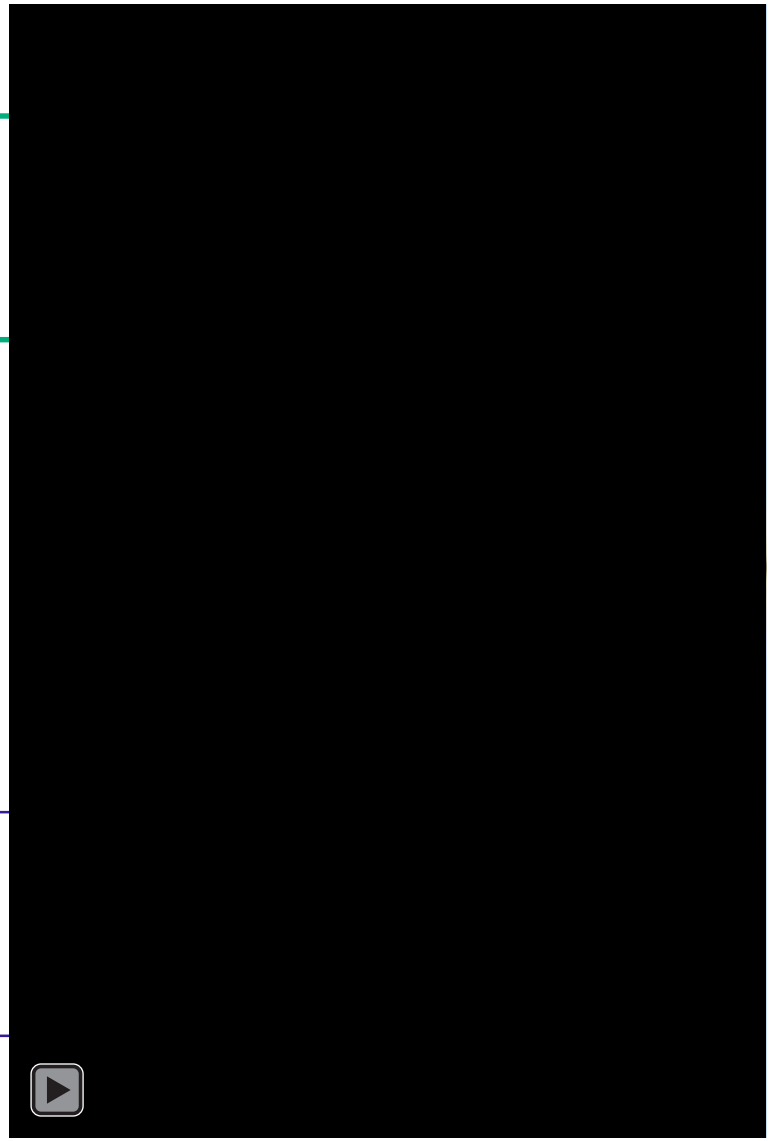
Existing Conditions

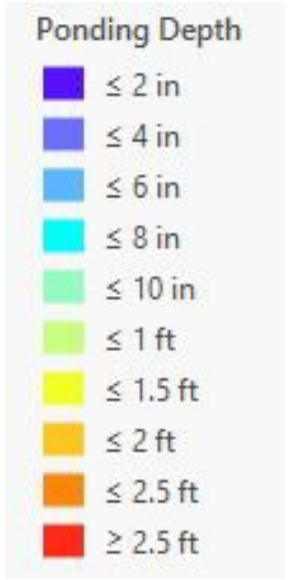
Northern Project Area

Can be managed by Thompsons Alley PS

Southern Project Area

Can be managed by Waterfront Park PS





STORM CONDITIONS: 10-year return period
City of Alexandria Intensity Duration Frequency Curve
Peak Rainfall Intensity = 5 inches/hour
Time of Concentration = 5 minutes
Total Storm Duration = 2 hours
Potomac River = El + 3.6-ft (constant)

Filename: ppt/1

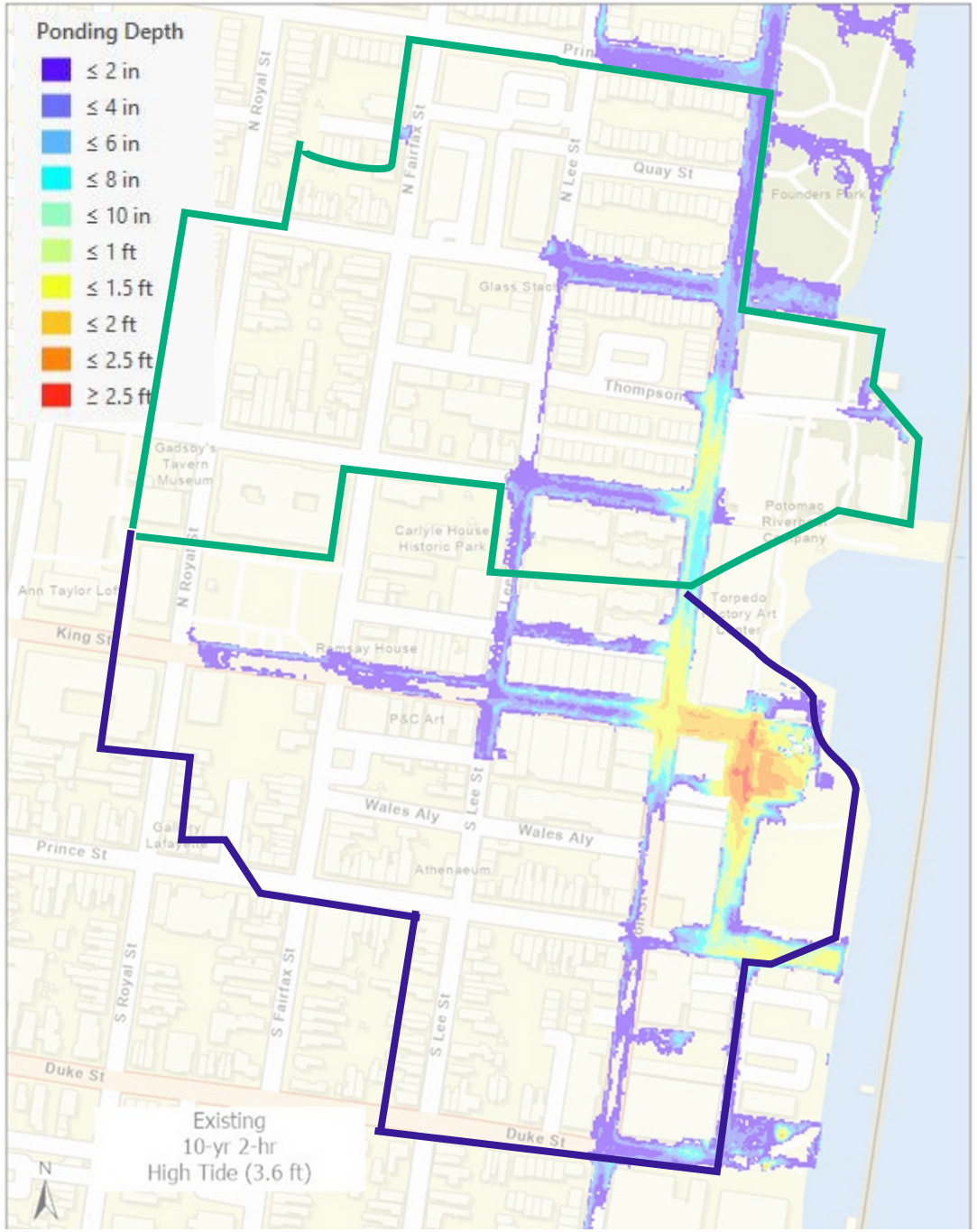
Option 1

Priority

Manage all stormwater runoff that currently discharges from the Duke to Queen Street outfalls

Key Inputs

- Design Storm Rainfall Conditions, which accounts for climate change predictions through 2100
- Stormwater infrastructure improvements including new inlets/pipes, underground chambers at Founders Park, and 2 new pumping stations



Option 1

Key Results under Design Storm Conditions

- No predicted flooding to buildings
- Minimal/no impact to vehicular and pedestrian traffic.
- Minimal flooding impact with up to 4” of runoff along curb-line and managed < 1hr after storm ends.

Option 2

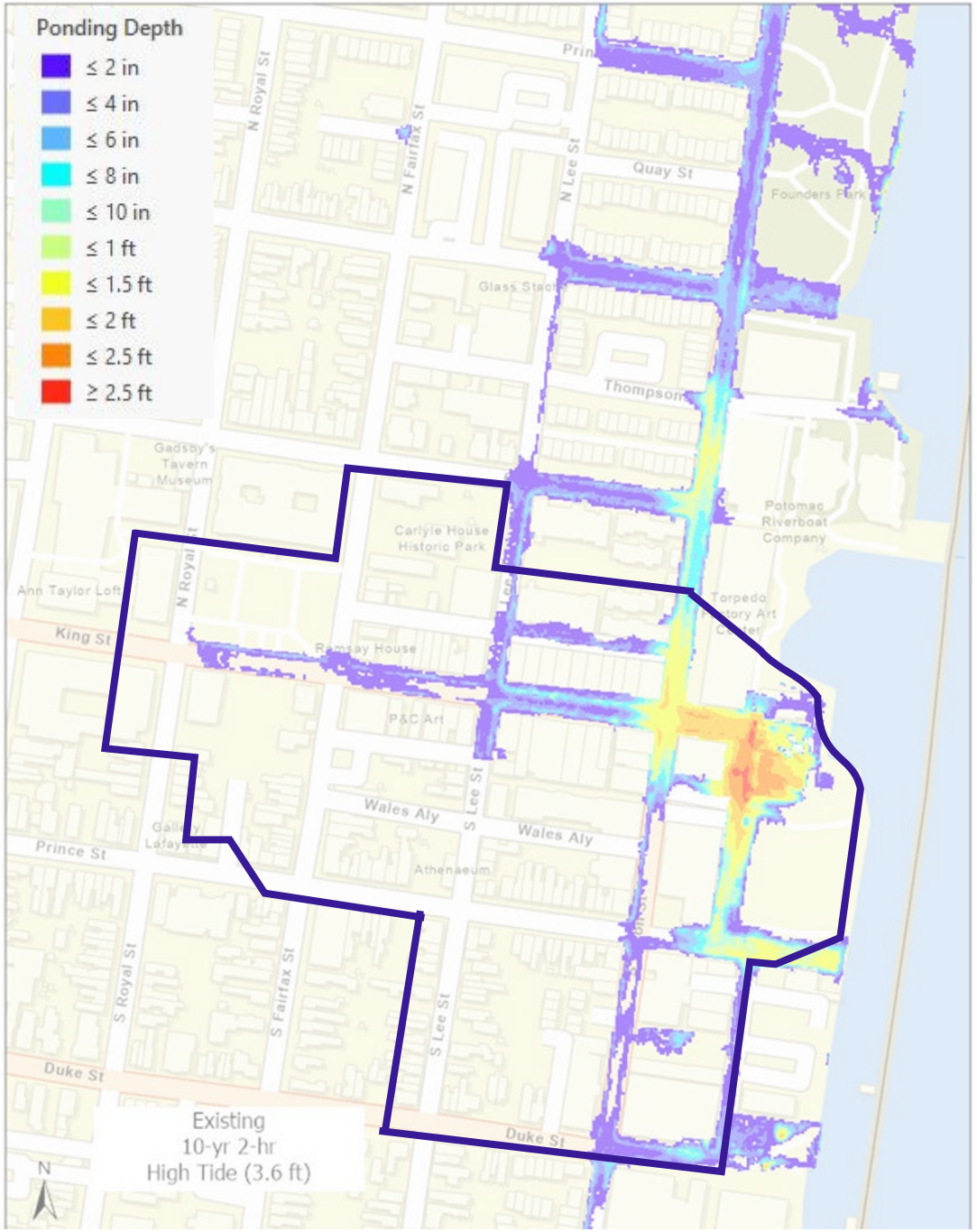
Priority

Manage all flooding sources from Duke to King Street outfalls

Building level protection for vulnerable flood pathways from King to Queen

Key Inputs

- Design Storm Rainfall Conditions, which accounts for climate change predictions through 2100
- Stormwater infrastructure improvements including new inlets/pipes, underground chambers at Waterfront Park, and 1 new pumping station

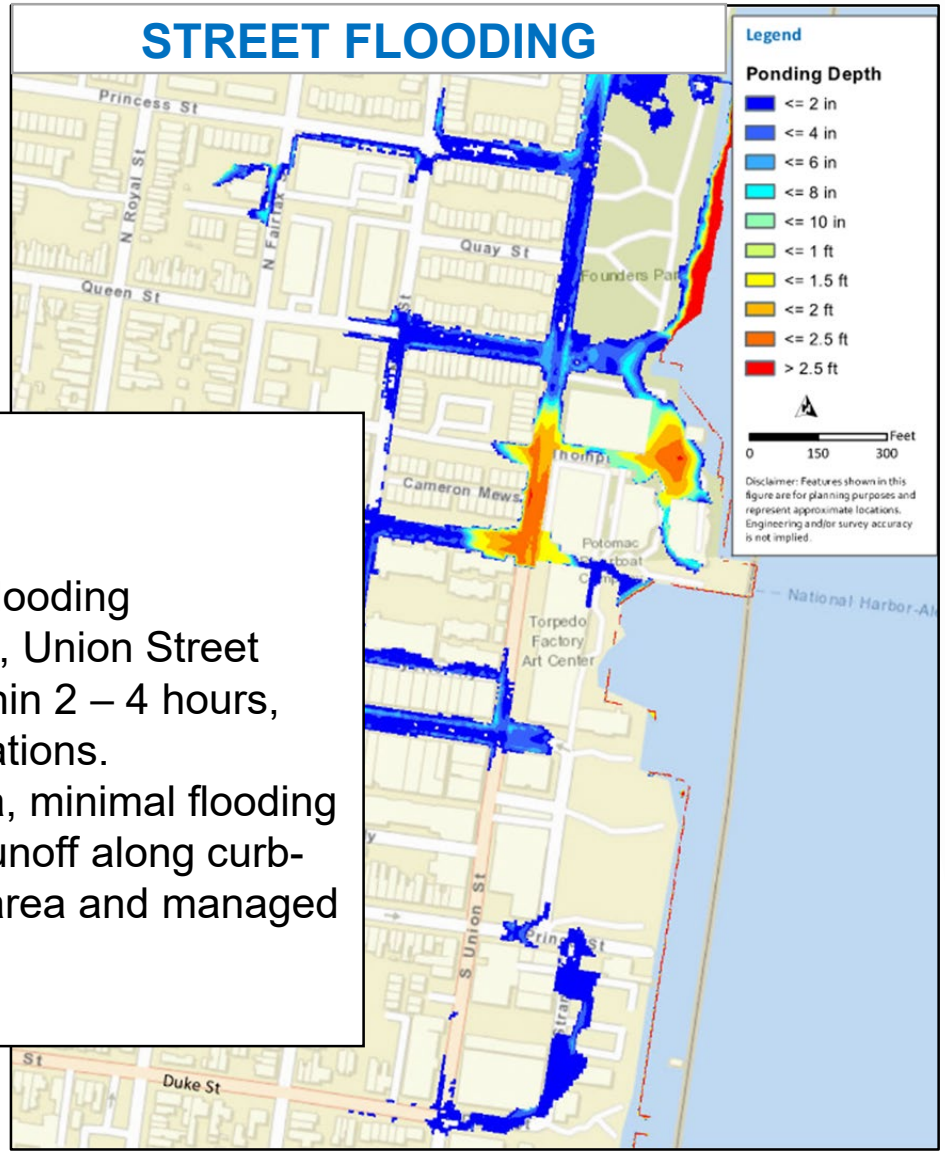


Option 2

Key Results

- Roadway and property flooding
- In Northern Project Area, Union Street flooding is managed within 2 – 4 hours, depending on river elevations.
- In Southern Project Area, minimal flooding impact with up to 4” of runoff along curb-line in southern project area and managed < 1hr after storm ends.

STREET FLOODING



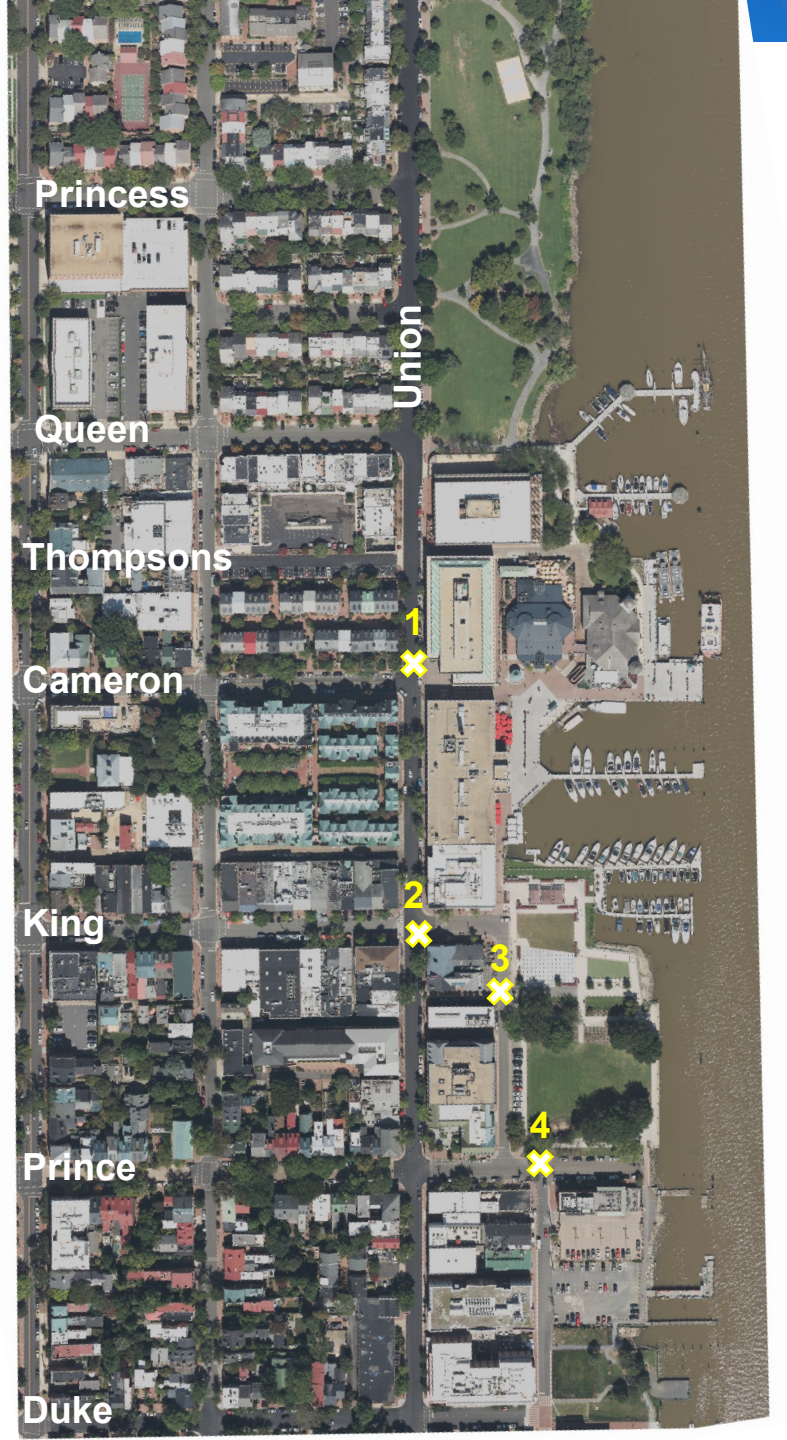
BUILDING FLOODING

Comparative Summary of Alternatives under design storm conditions

"Hot Spots"	Existing DEPTH / DURATION	Opt. 1 DEPTH / DURATION	Opt. 2 DEPTH / DURATION
1	1.2ft 2:00	-	2.5ft 2:15
2	1.5ft 2:30	0.4ft 0:10	0.5ft 0:20
3	4.0ft 6:00	-	-
4	1.2ft 6:00	-	-

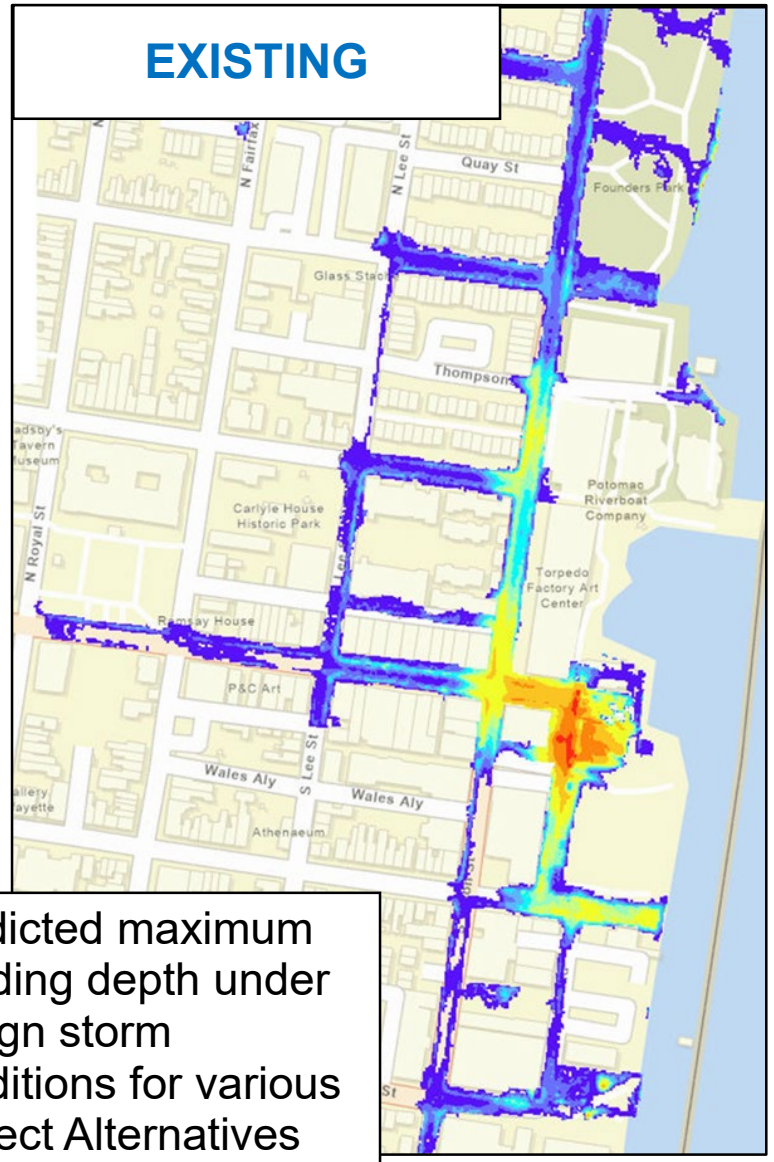
Key

- Maximum Floodwater Depth (ft) (at high tide condition)
- Total Duration of Floodwater Presence (hh:mm)



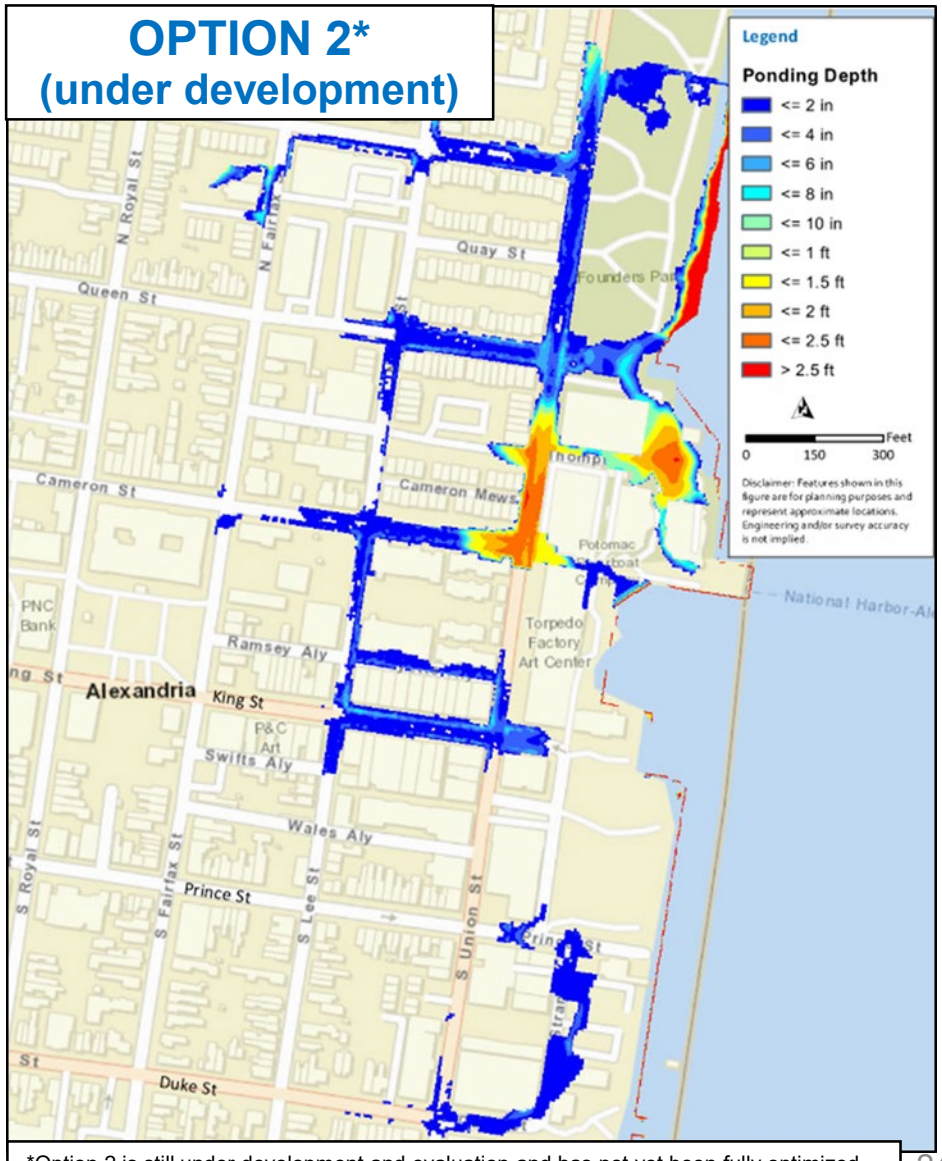
Comparative Summary of Alternatives

EXISTING



OPTION 1

OPTION 2* (under development)



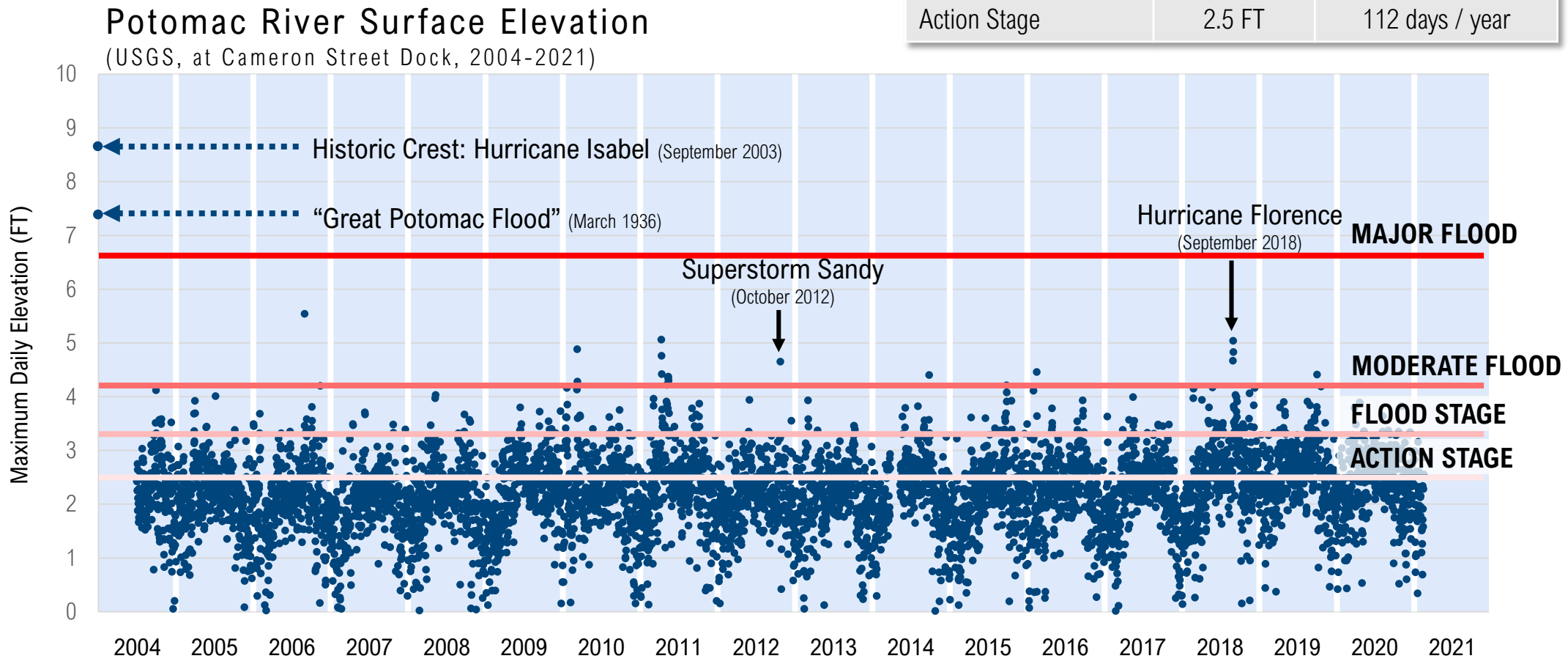
Predicted maximum ponding depth under design storm conditions for various Project Alternatives

*Option 2 is still under development and evaluation and has not yet been fully optimized. Building level-protection needs/options will need to be analyzed. Additional stormwater infrastructure improvements may be possible

Riverine Flood Protection

Historic high tides in the Potomac River

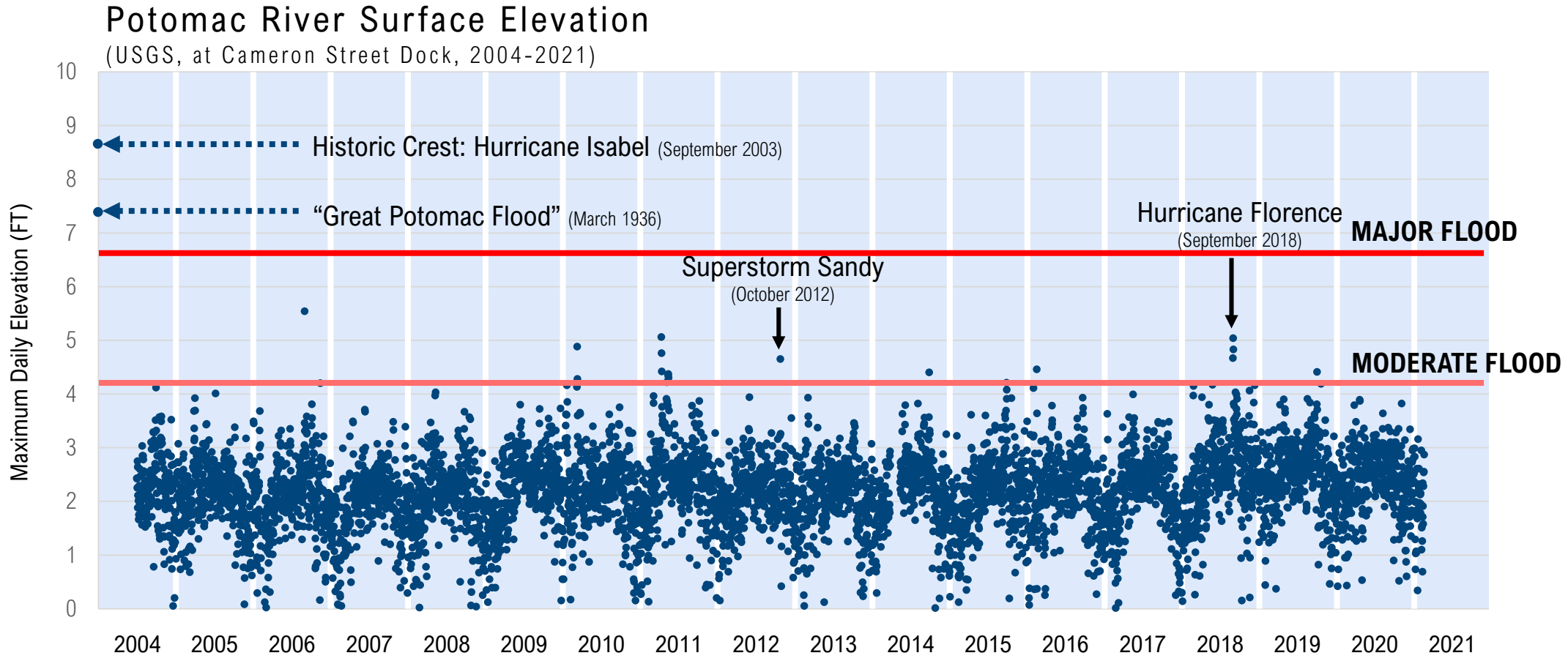
Stage (as defined by NOAA)	Elevation	Frequency of Occurrence
Major Flood	6.6 FT	Twice in history
Moderate Flood	4.2 FT	2 days / year
Flood Stage	3.3 FT	16 days / year
Action Stage	2.5 FT	112 days / year



NOTES: Data from USGS 0165258890 Potomac River at Cameron St Dock at Alexandria, VA. Estuary or ocean water surface elevation above NAVD 1988, feet.

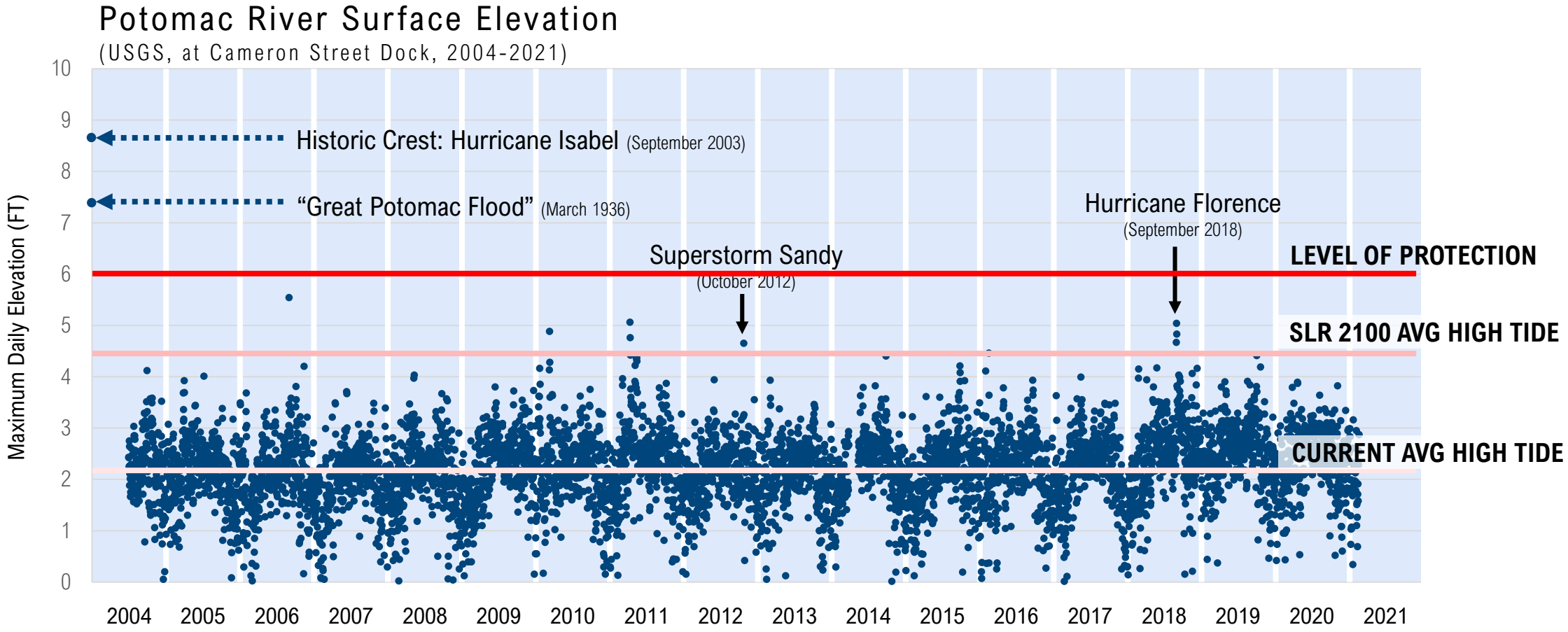
Historic high tides in the Potomac River

Stage (as defined by NOAA)	Elevation	Frequency of Occurrence	Predicted Frequency of Occurrence for 2100
Major Flood	6.6 FT	Twice in history	<1x / year
Moderate Flood	4.2 FT	2 days / year	200 days / year



NOTES: Data from USGS 0165258890 Potomac River at Cameron St Dock at Alexandria, VA. Estuary or ocean water surface elevation above NAVD 1988, feet.

A 6.0ft level of protection eliminates all river flooding except for 2 events on record and accounts for sea level rise conditions through project lifecycle



NOTES: Data from USGS 0165258890 Potomac River at Cameron St Dock at Alexandria, VA. Estuary or ocean water surface elevation above NAVD 1988, feet. Average high tide is El. +2.18ft.
Sea level rise data is from Wood, David. October 2020. Review of Recent Research on Climate Projections for the Chesapeake Bay Watershed. Chesapeake Stormwater Network. This is the Mid-Atlantic sea level rise projections for mid-level emissions scenario, which corresponds to 2-ft.

Cost Breakdowns

Option 1 Cost Breakdown

Community Priorities	Estimated Total Cost	Project Elements
Flood Mitigation • Storm Sewer Upgrades • Pump Stations • Riverine Protection	 $20M $55M $0	• Interim tide gate at King and Prince Street • New and upsized inlets and stormwater piping • Two stormwater pumping stations • Underground stormwater detention chambers • Allowance for critical shoreline stabilization efforts
Riverfront Promenade	-	Not included. Existing condition to remain.
Plaza at the foot of King Street	$2M	• Material upgrades to make permanent park • Actual improvements worth ~$600K
Street and Park Improvements	$18M $2M	• Street pavers – Strand St. & Prince/King St. ends • Waterfront Park and Founders Park restoration
Total Estimated Project Cost (AACE Cost 4)	**Low: $80M High: $120M**	

Note: Subsurface conditions under parks are unknown and ongoing field investigations will inform the Class 3 Cost Estimate at the next iteration.

Option 1 Risks and Considerations

- No river overtopping protection which typically occurs up to 15 times per year at King St Square and Point Lumley.
  - Landscape-based flood protection options may be feasible/affordable, depending on further development of scope and costs by Design-Build Team
  - Alternatively, overtopping protection could be phased in at a later date with additional funding
- Ongoing subsurface conditions and bulkhead condition assessment will help refine cost estimate for next iteration.
- Option 1 does not allocate funds to the following:
  - Repairing and/or replacing segments of the bulkhead that are in poor condition.
  - Promenade
  - Waterfront Park or Point Lumley Improvements
  - King Street Pier
  - Additional Piers/Marina improvements

Option 2 Cost Breakdown

Community Priorities	Estimated Total Cost	Project Elements
Flood Mitigation • Storm Sewer Upgrades • Pump Stations • Riverine Protection	 $15M $25M $20M	• Interim tide gate at King and Prince Street • New and upsized inlets and stormwater piping from Duke to King Street • Waterfront Park stormwater pumping stations • Underground stormwater detention chambers • Riverine flood protection from Duke to King Street
Riverfront Promenade	$7M	• Promenade with pavers from Duke to King Street
Plaza at the foot of King Street	$2M	• Material upgrades to make permanent park • Actual improvements worth ~$600K
Street and Park Improvements	$18M $12M	• Street pavers – Strand St. & Prince/King St. ends • Full Waterfront Park improvements (per baseline) • Full Point Lumley improvements (per baseline)
Total Estimated Project Cost (AACE Cost 4)	**Low: $80M High: $120M**	

Option 2 Risks and Considerations

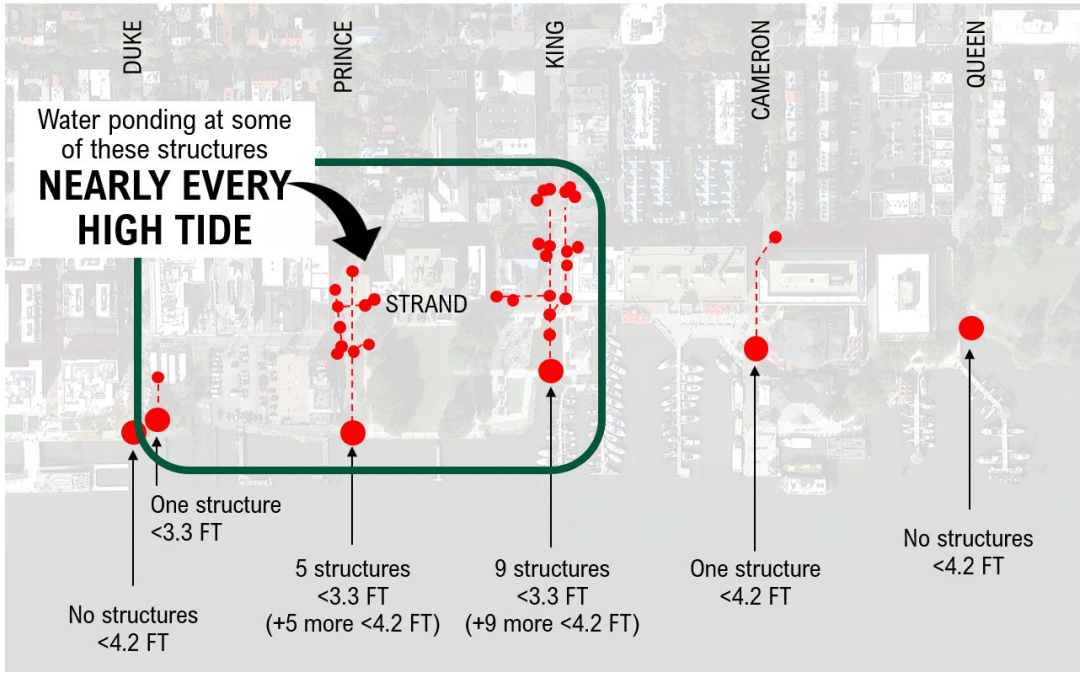
- Ongoing coordination efforts with deployable flood barrier vendors to assess feasibility, installation, and ease of operations.
- Deployable flood barrier at Cameron / Union St and building level protection at critical flood pathways, e.g., parking garages and the Torpedo Factory Loading Dock are not included in cost estimate and require further evaluation.
- No flooding improvements in ROW in Northern Project Area (Cameron to Queen St).
- Ongoing field investigations will help refine cost estimate for next iteration
- Option 2 does not allocate funds to the following:
  - Repairing and/or replacing segments of the bulkhead that are in poor condition from Torpedo Factory to Queen Street
  - Promenade, programming and park improvements from Torpedo Factory to Queen Street
  - Lower-level promenade with direct access to river
  - King Street Plaza (per Olin Plan)
  - King Street Pier
  - Additional Piers/Marina Upgrades

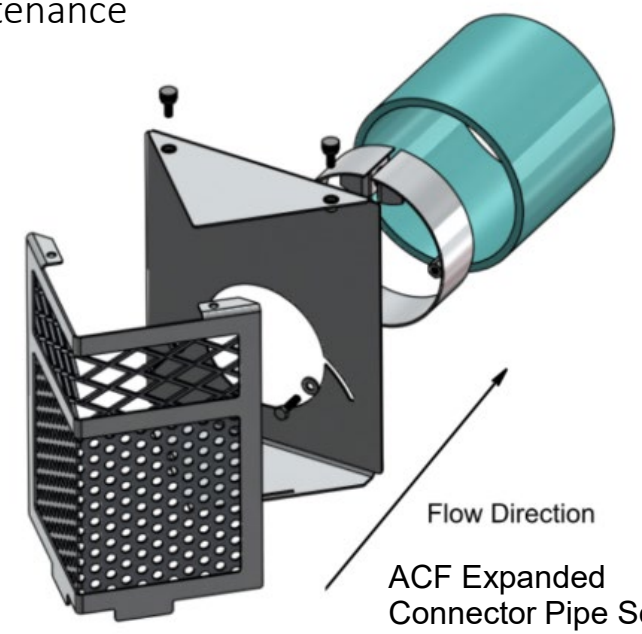
Next Steps

Quick Win Strategy

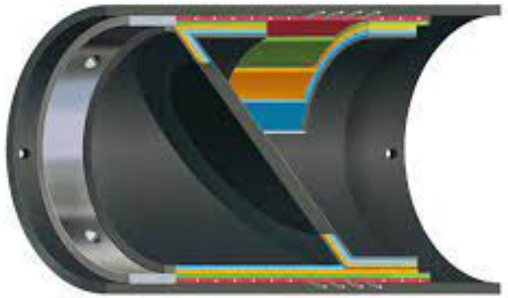
FY22 Rapid Deployment Control Measures:

- Installation of Backflow Prevention Solutions
  - Install at the terminus of the King Street and Prince Street Outfalls
  - Require upstream pretreatment and ongoing maintenance
  - Minimal disturbance to the Project Area during installation and maintenance





ACF Expanded Connector Pipe Screen



Red Valve Tideflex Valve

Immediate Next Steps

- **Ongoing field investigations**
  - Geotechnical testing and structural analysis
  - Survey
- **Evaluation and Refinement of Project Alternatives**
  - Community feedback
  - Field investigation data reports and engineering design recommendations
- **External funding opportunities**
  - FEMA – VDEM Building Resilient Infrastructure and Communities (BRIC) Program – Submitted on November 10th
  - DCR - Virginia Community Flood Preparedness Fund – Submitted on November 5th
- **Next Sub-Committee Meeting – Target mid-December**

// Stakeholder Engagement Plan

- In 2014, City Council endorsed the Waterfront Plan:
  - Set Budget ($102M)
  - Set Priorities
- In first quarter 2022, we'd like to go back to City Council with Flood Mitigation Subcommittee and Waterfront Commission's endorsement on:
  - Priorities - Recognizing that we cannot achieve all priorities with current funding, have community priorities changed?
    - All stormwater protection in first phase vs southern-half plus bulkhead and promenade?
    - Deliver Strand and Duke/King St improvements vs additional investment in King St Square?

Community priorities:

1. Flood mitigation
2. Riverfront promenade
3. Plaza at the foot of King Street
4. Park improvements

// Stakeholder Engagement Plan

At the next Subcommittee meeting, we will be prepared to review

At the next Subcommittee meeting, we will expect Subcommittee to select a preference toward

Following meeting, we are asking for Subcommittee recommendation to Waterfront Commission

Refine and present two concepts based on today's feedback
- Order of magnitude costs
- Ranking of project priorities including various amenities
- Operational approach

Cost 1
Stormwater Management

Cost 2
Duke to King St

No change to CIP budget

$100M Solution Priorities

Acknowledge
BUDGET

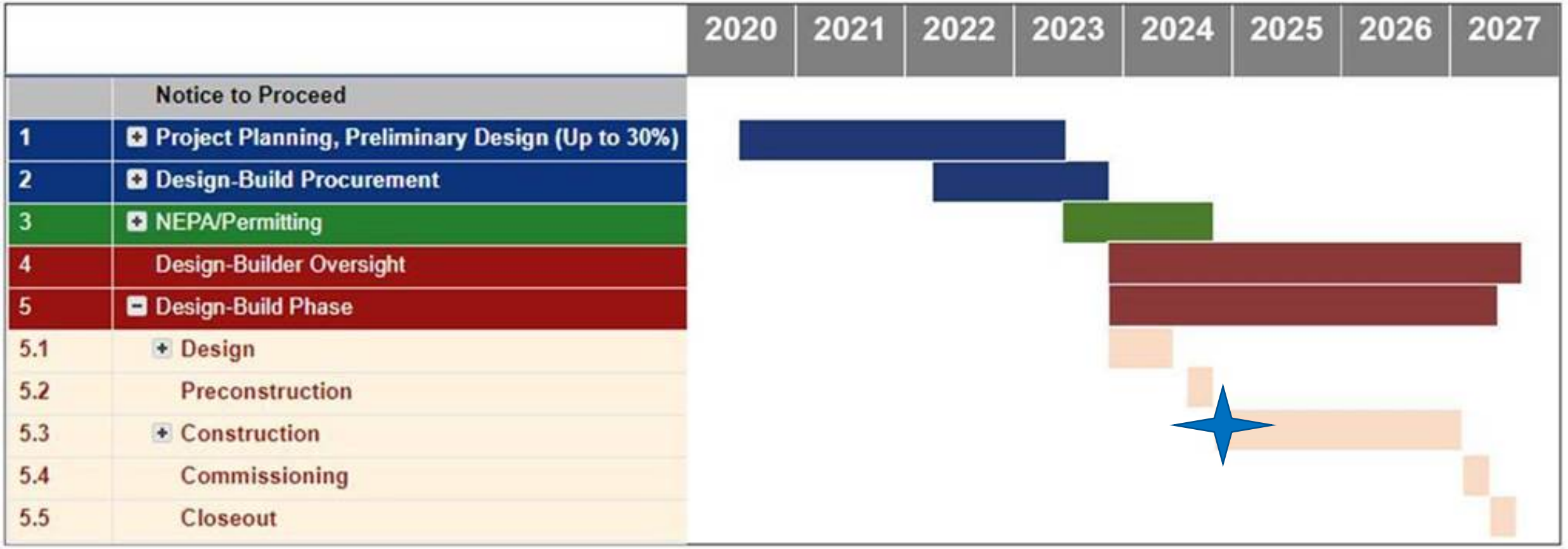
Endorse
PRIORITIES

Scoping to Budget

ITEMS ESTIMATED TO BE WITHIN BUDGET:	$
UTILITIES - PUMP STATION #1	$$$$$
UTILITIES - PUMP STATION #2	$$$$$
UTILITIES - STORM SEWER	$$$$
UTILITIES - DRY	$$$
UTILITIES - WET	$$
RESTORATION OF PARKS	$$$
RESTORATION OF ROW	$$
TOTAL DIRECT COSTS	$$$$$$$
PRIORITIZED ITEMS NOT CURRENTLY WITHIN BUDGET:	**$**
STRUCTURAL BULKKEAD	$$$$$
PROMENADE	$$$
KING STREET SQUARE IMPROVEMENTS	$$$
WATERFRONT PARK IMPROVEMENTS	$$
MARINA IMPROVEMENTS	$$$
POINT LUMLEY IMPROVEMENTS	$$
KING STREET PIER	$$$
ADDITIONAL PIERS	$$$
TOTAL ADDITIONAL COST	$$$$$$$

ITEMS ESTIMATED TO BE WITHIN BUDGET:	$
UTILITIES - PUMP STATION #1	$$$$
UTILITIES - PUMP STATION #2	$$$$
UTILITIES - STORM SEWER	$$$
UTILITIES - DRY	$$$
UTILITIES - WET	$$
RESTORATION OF PARKS	$$$
RESTORATION OF ROW	$$
STRUCTURAL BULKKEAD	$$$
PROMENADE	$$
KING STREET SQUARE IMPROVEMENTS	$$$
TOTAL DIRECT COSTS	$$$$$$$
PRIORITIZED ITEMS NOT CURRENTLY WITHIN BUDGET:	**$**
WATERFRONT PARK IMPROVEMENTS	$$
MARINA IMPROVEMENTS	$$$
POINT LUMLEY IMPROVEMENTS	$$
KING STREET PIER	$$$
ADDITIONAL PIERS	$$$
TOTAL ADDITIONAL COST	$$$$$$$

Timeline



Construction will commence AFTER City's 275th birthday celebration

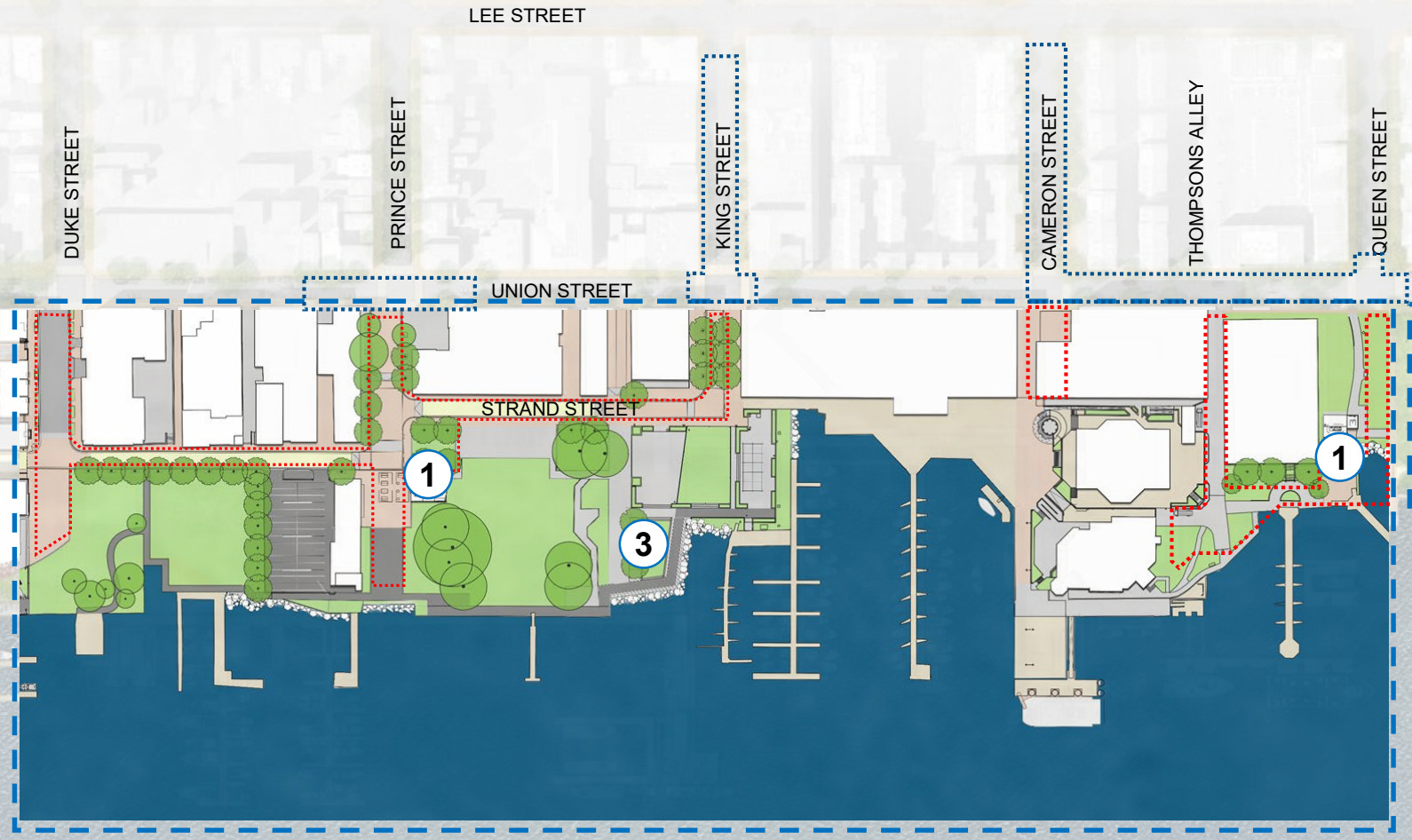
Open Discussion

Cost Based Option - 1

Addresses flooding due to rainfall runoff with improved streetscape and stormwater infrastructure and pump stations within the City's CIP budget of $100M.

// Cost Based Option – 1

Mitigates Rainfall Flooding; Defers Shoreline and Park Improvements



LEGEND

1 PUMP STATION

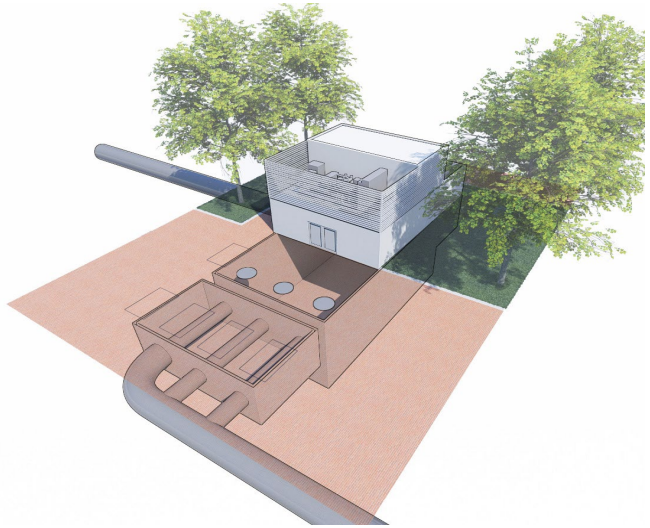
2 UNDERGROUND STORMWATER DETENTION CHAMBERS

3 RETAIN WATERFRONT PARK AT KING STREET

STREETSCAPE AND STORMWATER INFRASTRUCTURE IMPROVEMENTS (COMMON ELEMENT PAVING)

STORMWATER INFRASTRUCTURE IMPROVEMENTS (MATERIALS TO MATCH EXISTING)

// Project Elements

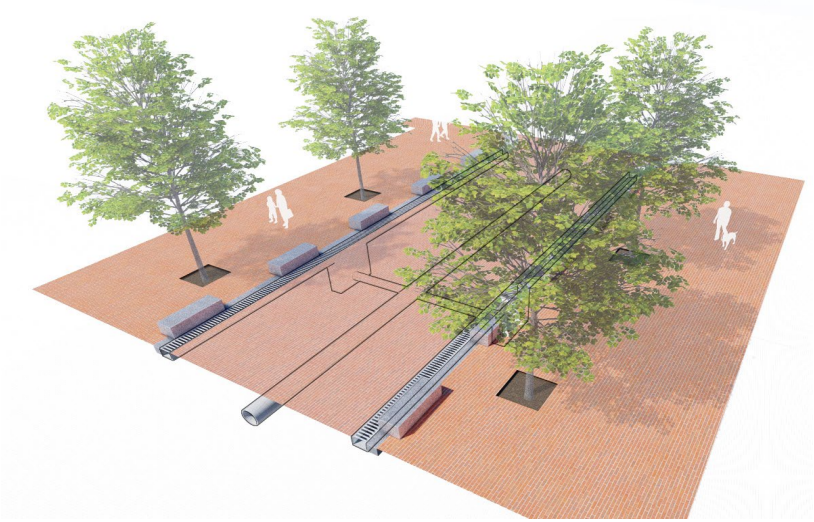


PUMP STATIONS

- Utilitarian structure housing stormwater pumps and associated mechanical and electrical equipment
- No city storage or amenity space
- Thompsons Alley PS capacity reduced by 95%

UNDERGROUND DETENTION

Stormwater storage chambers sited under existing parkspaces



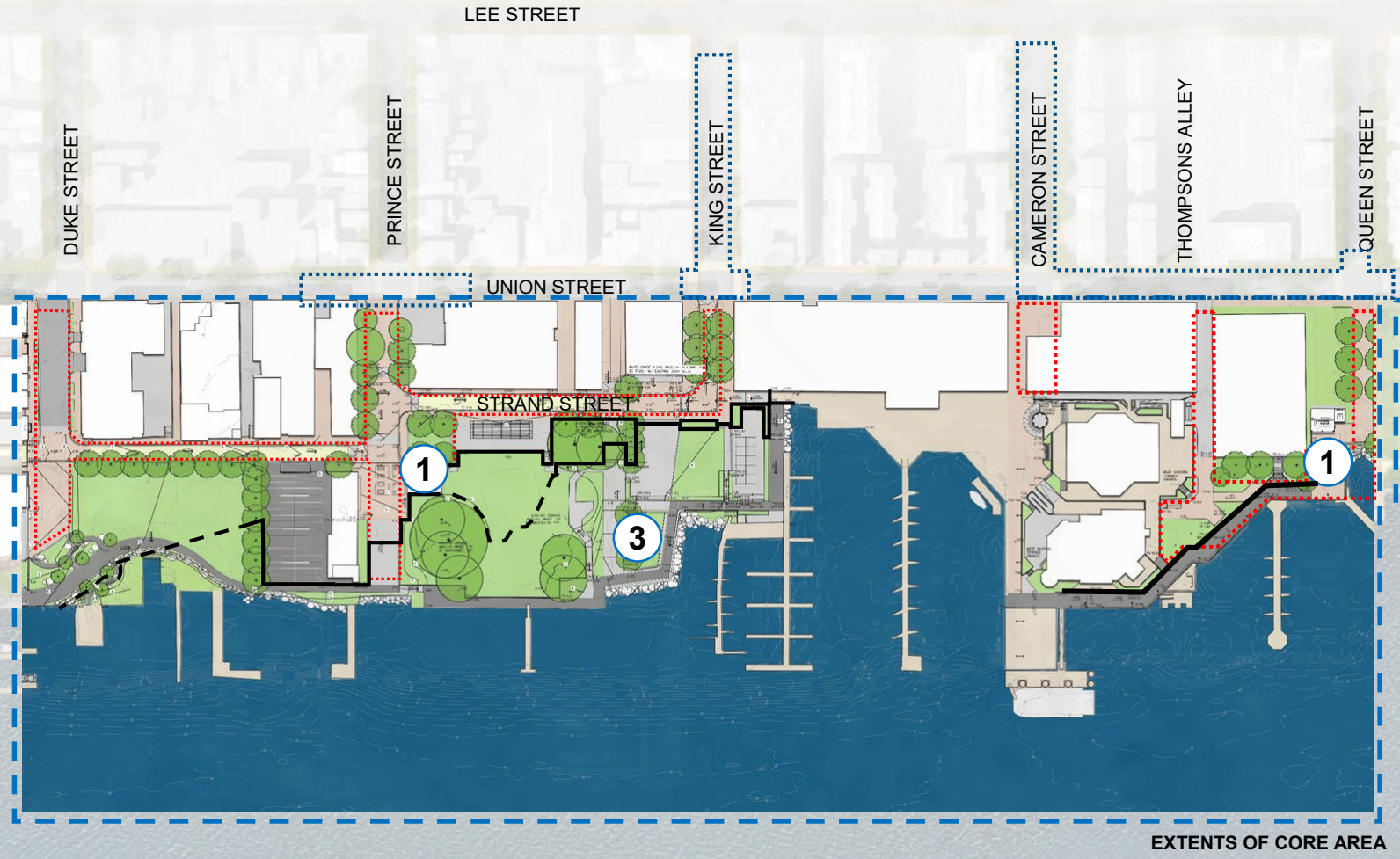
STREETSCAPE AND STORMWATER INFRASTRUCTURE IMPROVEMENTS

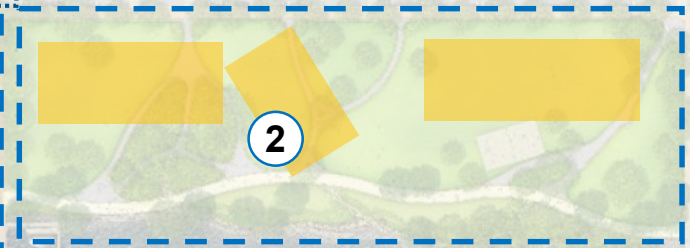
- New and upsized stormwater inlets and conveyance pipes
- Common elements paving proposed for streets within the core area only. All others to match existing materials

Cost Based 1

// Cost Based Option - 1

Add-On A: Landscape Based Flood Protection (Strand)





LEGEND

1 PUMP STATION

2 UNDERGROUND STORMWATER DETENTION CHAMBERS

3 RETAIN WATERFRONT PARK AT KING STREET

STREETSCAPE AND STORMWATER INFRASTRUCTURE IMPROVEMENTS (COMMON ELEMENT PAVING)

STORMWATER INFRASTRUCTURE IMPROVEMENTS (MATERIALS TO MATCH EXISTING)

LANDSCAPE FLOOD PROTECTION AT ELEVATION 6

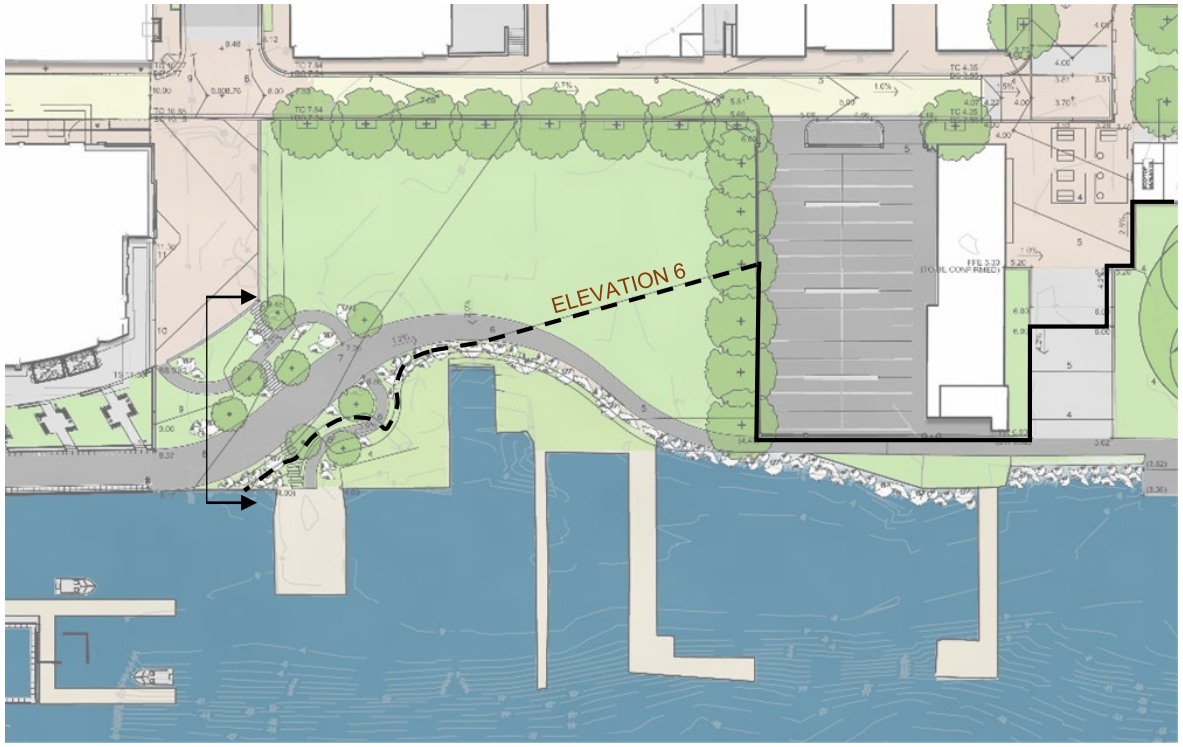
// Cost Based Option - 1

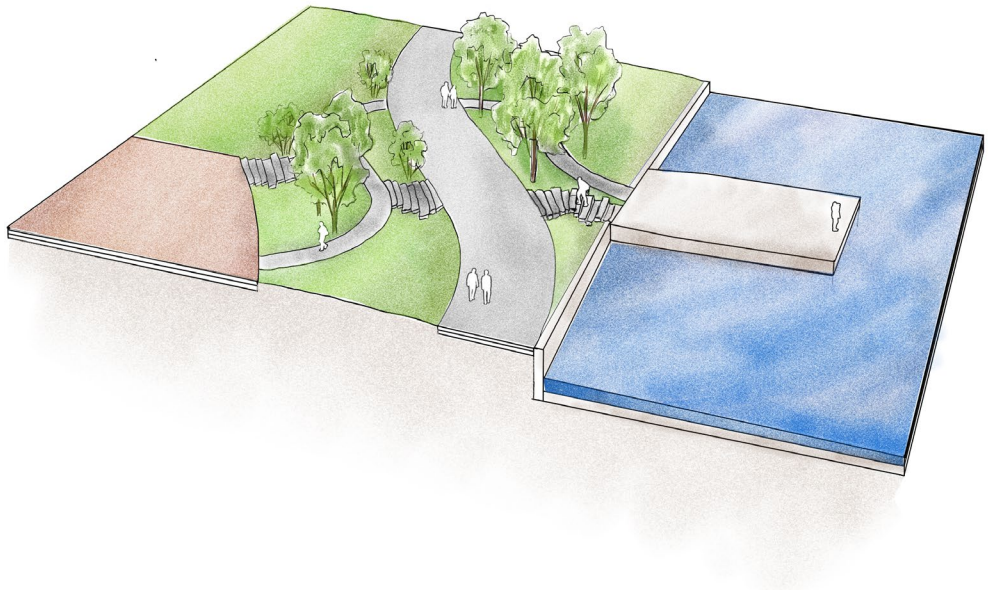
Add-On A: Landscape Based Flood Protection (Strand)

Point Lumley Park Improvements

- Extension of green space with new hardscape and landscape improvements
- New waterfront promenade
- Connection to Robinson Landing and Waterfront development to the north

KEY PLAN





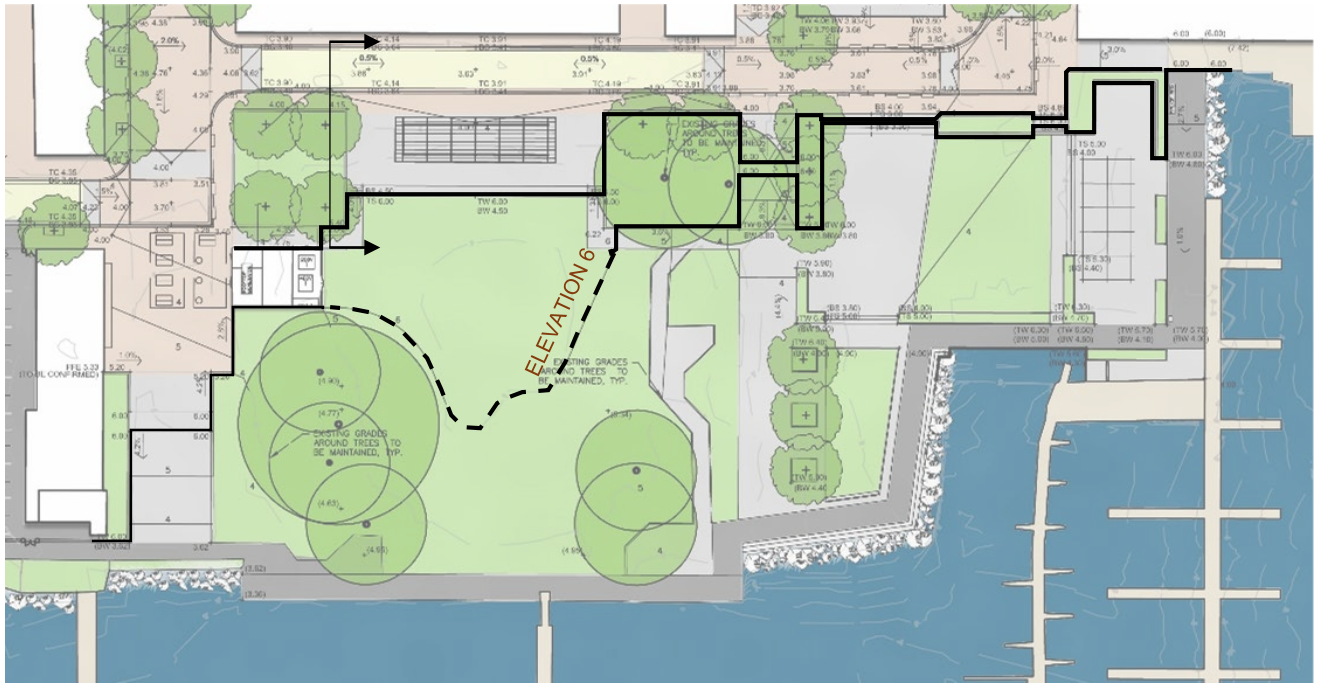
// Cost Based Option - 1

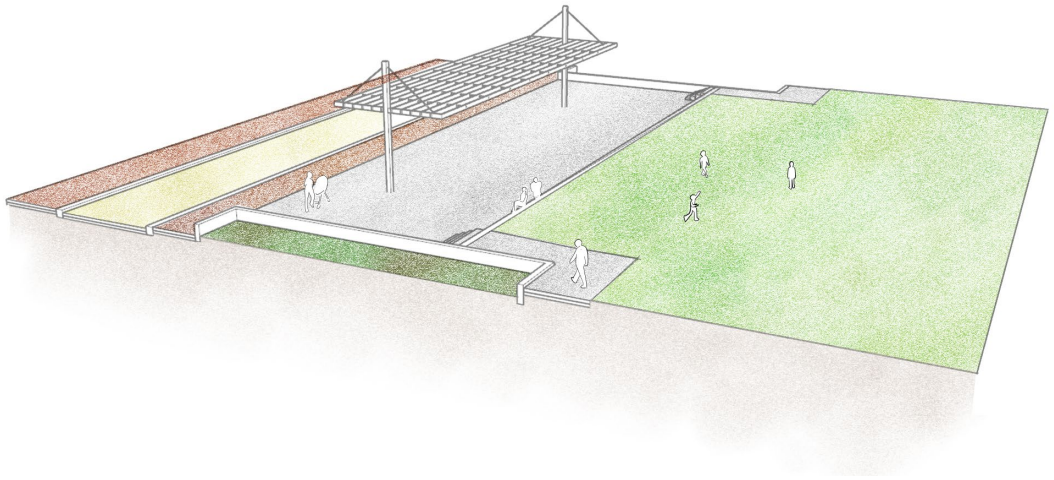
Add-On A: Landscape Based Flood Protection (Strand)

Waterfront Park and King Street Sq Improvements

- Incorporates stairs, ramps, and ha-ha walls
- Pump station

KEY PLAN





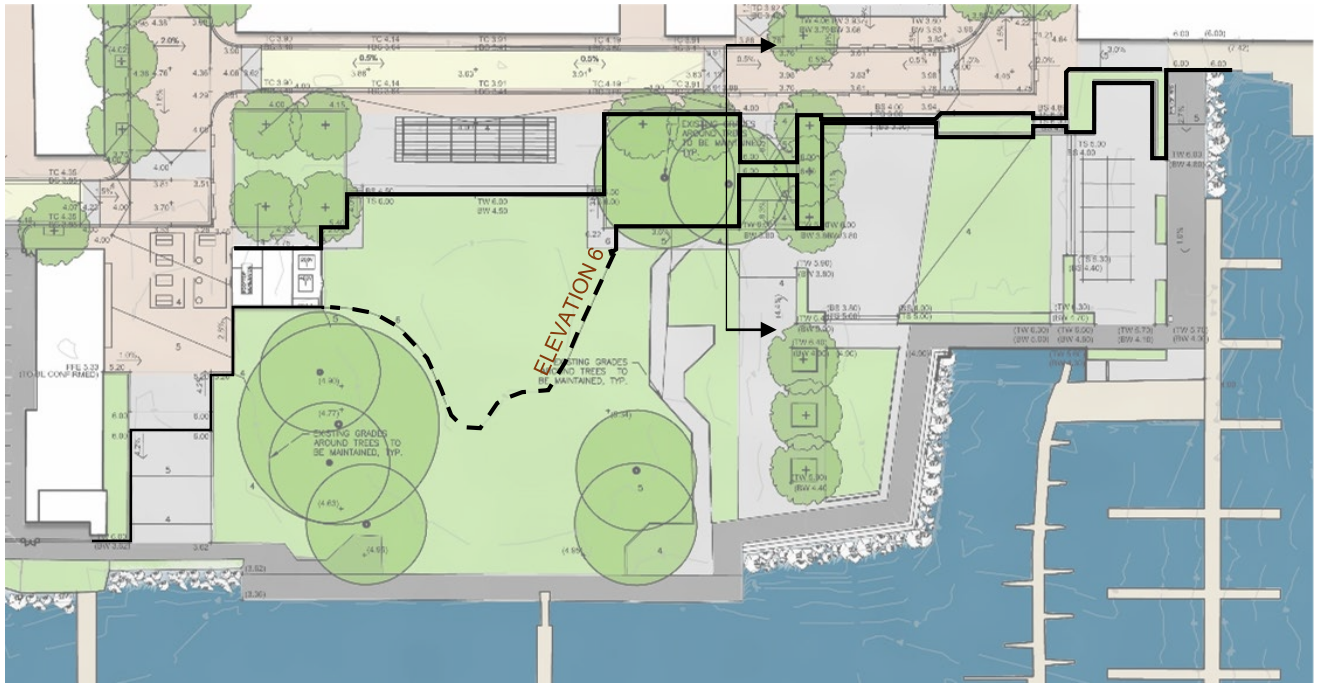
// Cost Based Option - 1

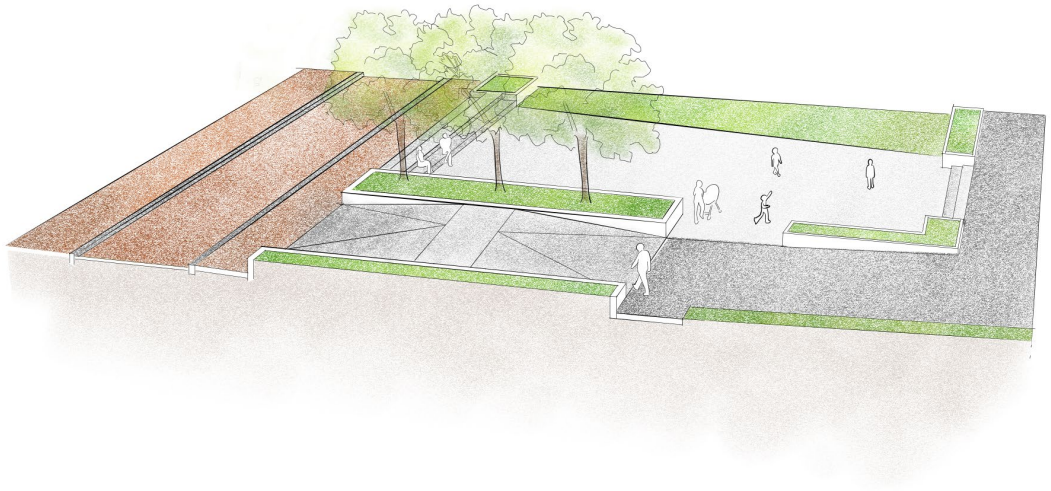
Add-On A: Landscape Based Flood Protection (Strand)

Waterfront Park and King Street Sq Improvements

- Incorporates stairs, ramps, and ha-ha walls
- Pump station

KEY PLAN





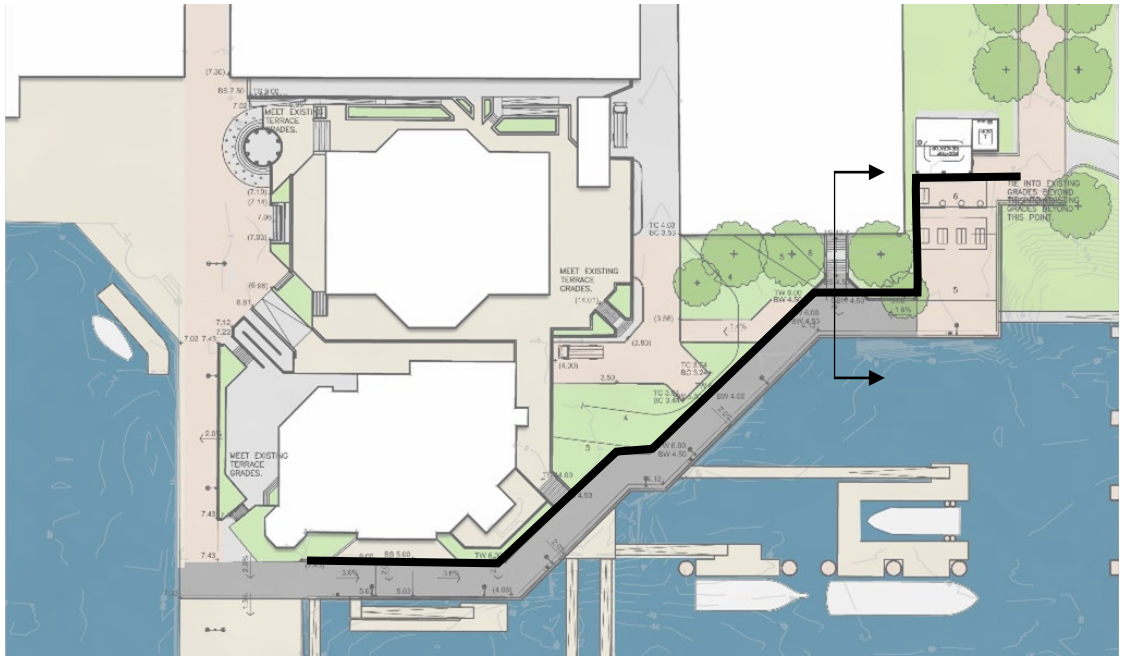
// Cost Based Option - 1

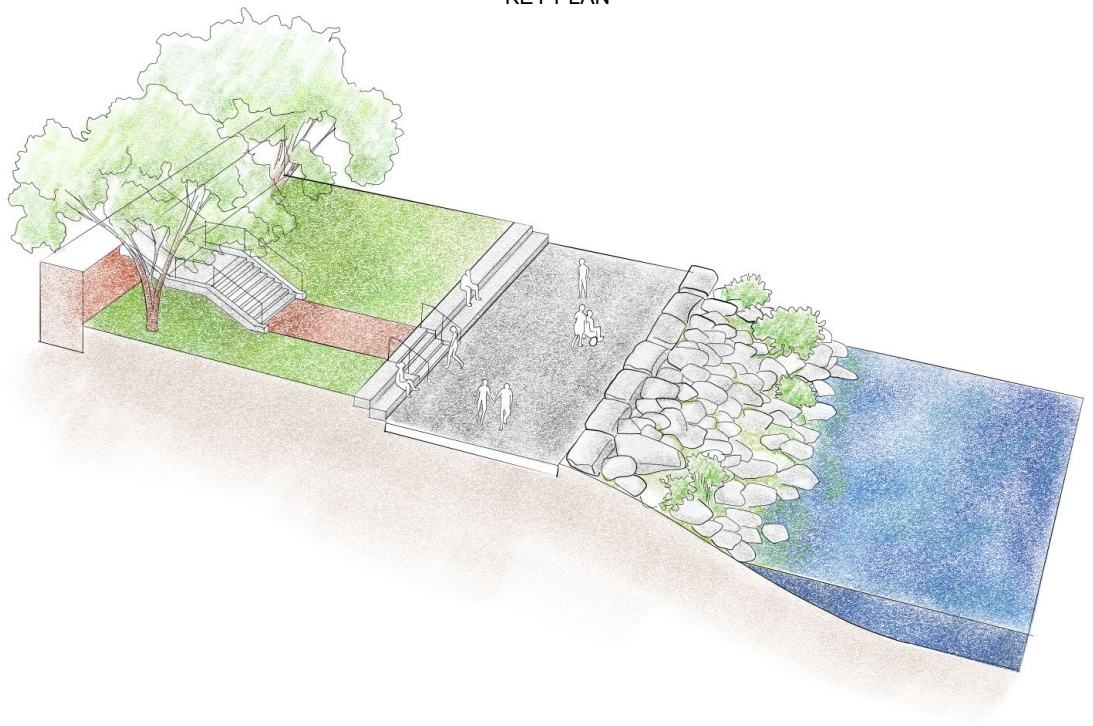
Add-On A: Landscape Based Flood Protection (Strand)

Thompsons Alley Improvements

- Ha-ha wall to promenade
- Pump Station
- Maintain existing waterfront promenade

KEY PLAN

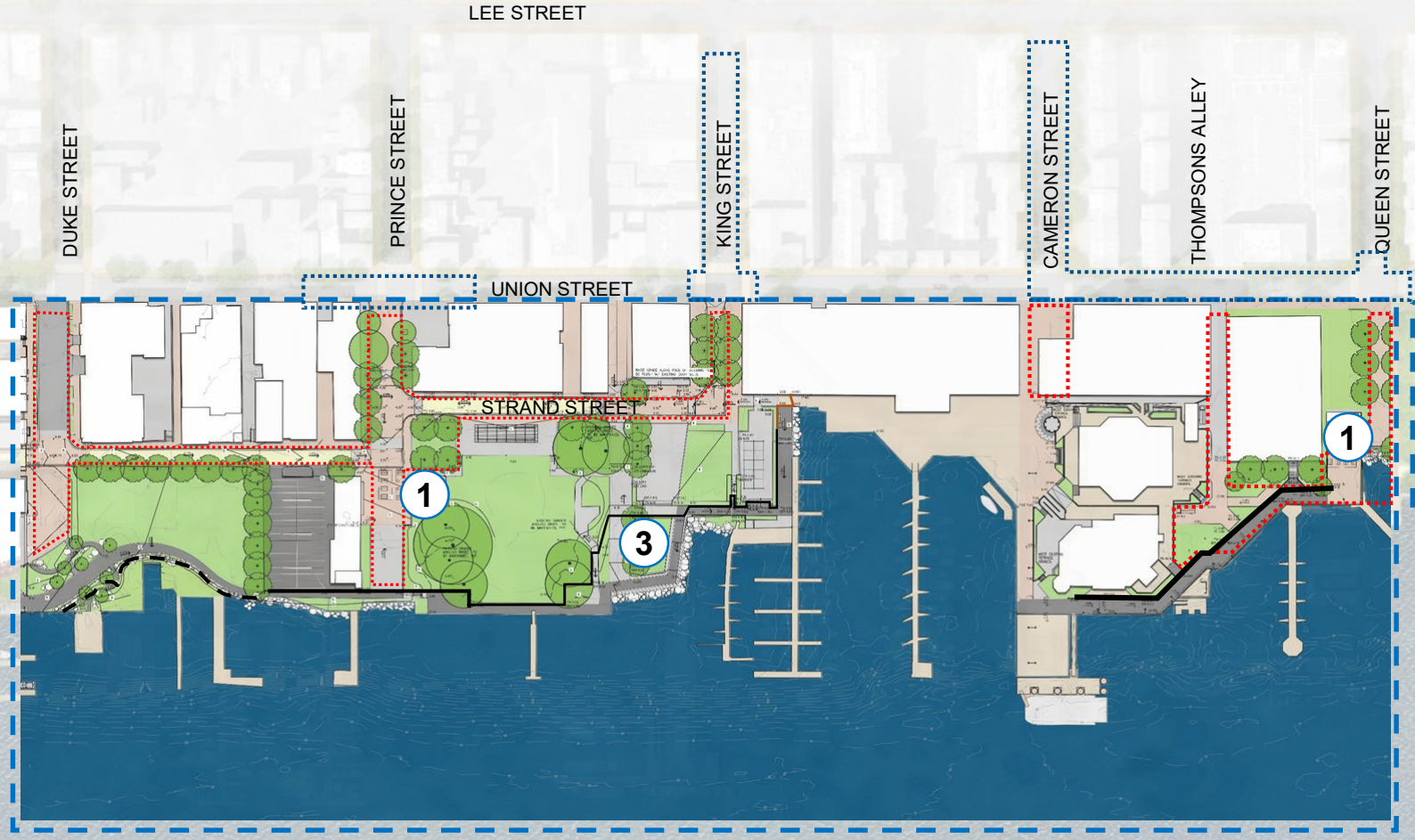


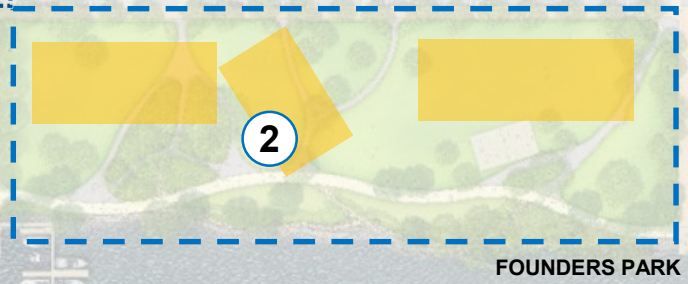


// Cost Based Option - 1

Add-On B: Landscape Based Flood Protection (River)

LANDSCAPE ELEMENTS PROVIDE 6' ELEVATION FLOOD PROTECTION





LEGEND

1 PUMP STATION

2 UNDERGROUND STORMWATER DETENTION CHAMBERS

3 RETAIN WATERFRONT PARK AT KING STREET

STREETSCAPE AND STORMWATER INFRASTRUCTURE IMPROVEMENTS (COMMON ELEMENT PAVING)

STREETSCAPE STORMWATER INFRASTRUCTURE IMPROVEMENTS (MATERIALS TO MATCH EXISTING)

LANDSCAPE FLOOD PROTECTION AT ELEVATION 6

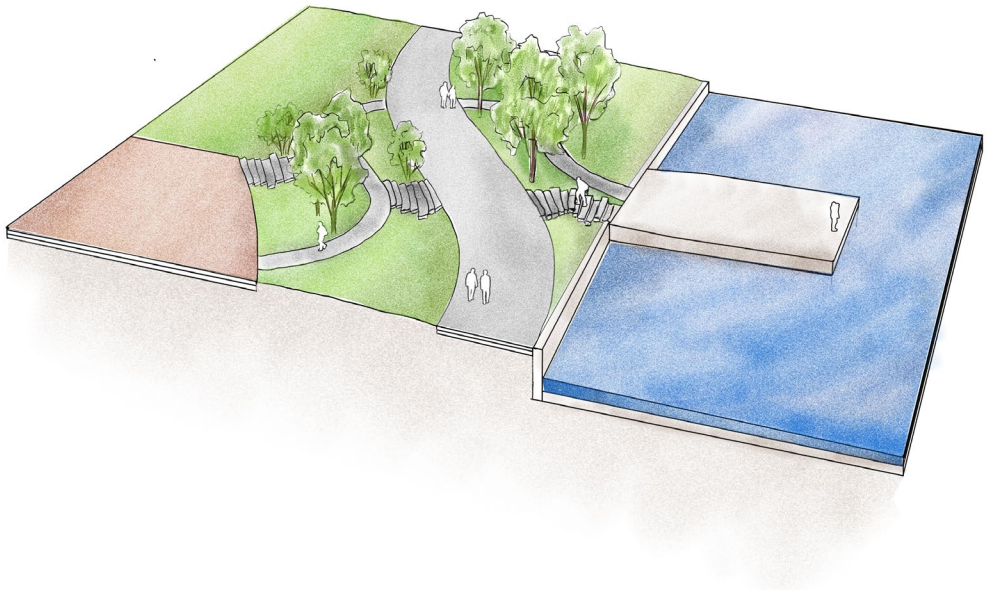
// Cost Based Option - 1

Add-On B: Landscape Based Flood Protection (River)

Point Lumley Park Improvements

- Extension of green space with new hardscape and landscape improvements
- New waterfront promenade
- Connection to Robinson Landing and Waterfront development to the north

KEY PLAN



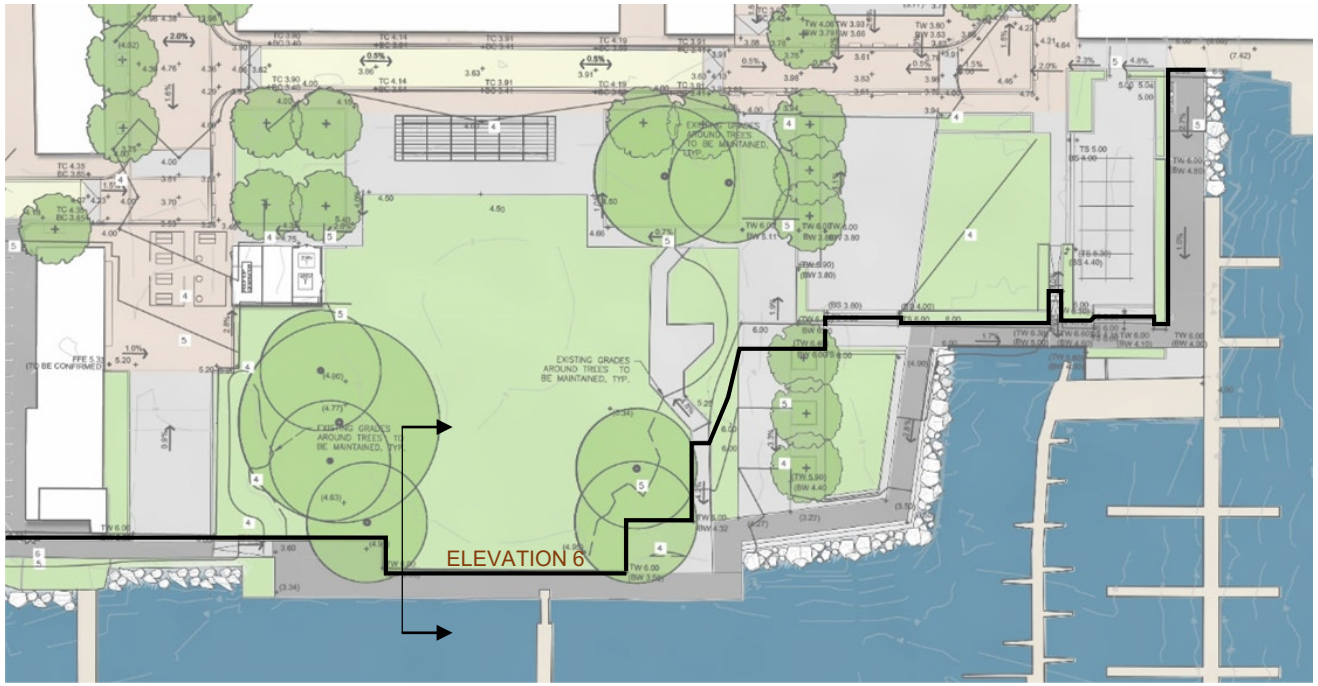
// Cost Based Option - 1

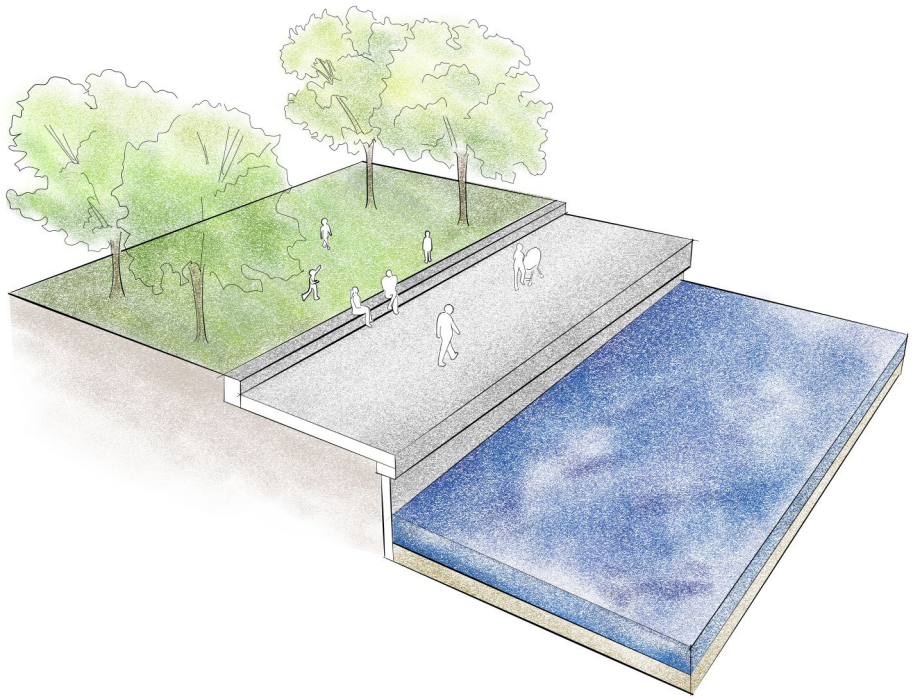
Add-On B: Landscape Based Flood Protection (River)

Waterfront Park and King Street Sq Improvements

- Stairs, ramps, and ha-ha walls
- Pump Station
- Maintain current waterfront promenade

KEY PLAN





// Cost Based Option – 1 With Add-On A or B

- Address all flooding priorities and goals within existing CIP funding

BACKFLOW
of River Outfalls

INUNDATION
of Storm Sewers

OVERTOPPING

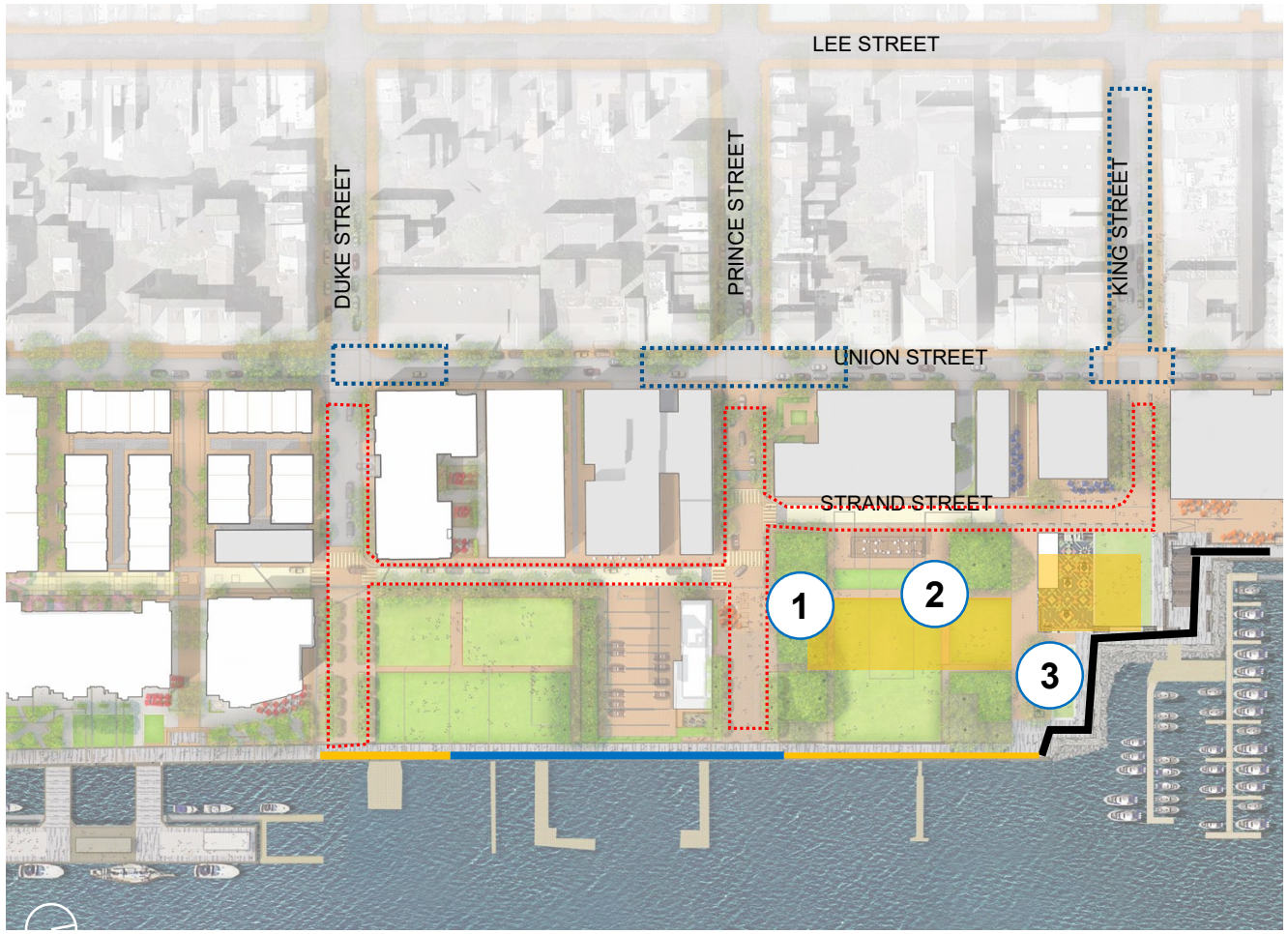
- **New landscape-based flood barrier at or near the existing shoreline**
- **New waterfront promenade at Point Lumley** and connection to existing promenade across Waterfront with minimal changes
- **Some landscape and hardscape park upgrades**; material improvements to make interim Waterfront Park a permanent park space
- Underground storage adds water quality benefits

Cost Based Option - 2

Prioritizes all elements of flood mitigation from Duke St to King St. Potential to realize the Core Area Waterfront Plan at Point Lumley, Waterfront Park, and King Street Square within the City's CIP budget of $100M.

// Cost-Based Option – 2

Duke to King Improvements;
Defers Northern Catchment Improvements



KEY PLAN

LEGEND

1 PUMP STATION

2 UNDERGROUND STORMWATER DETENTION CHAMBERS

3 RETAIN WATERFRONT PARK AT KING STREET

STREETSCAPE AND STORMWATER INFRASTRUCTURE IMPROVEMENTS (COMMON ELEMENT PAVING)

STORMWATER INFRASTRUCTURE IMPROVEMENTS (MATERIALS TO MATCH EXISTING)

LANDSCAPE FLOOD PROTECTION AT ELEVATION 6

REUSE EXISTING BULKHEAD TO ACHIEVE ELEVATION 6

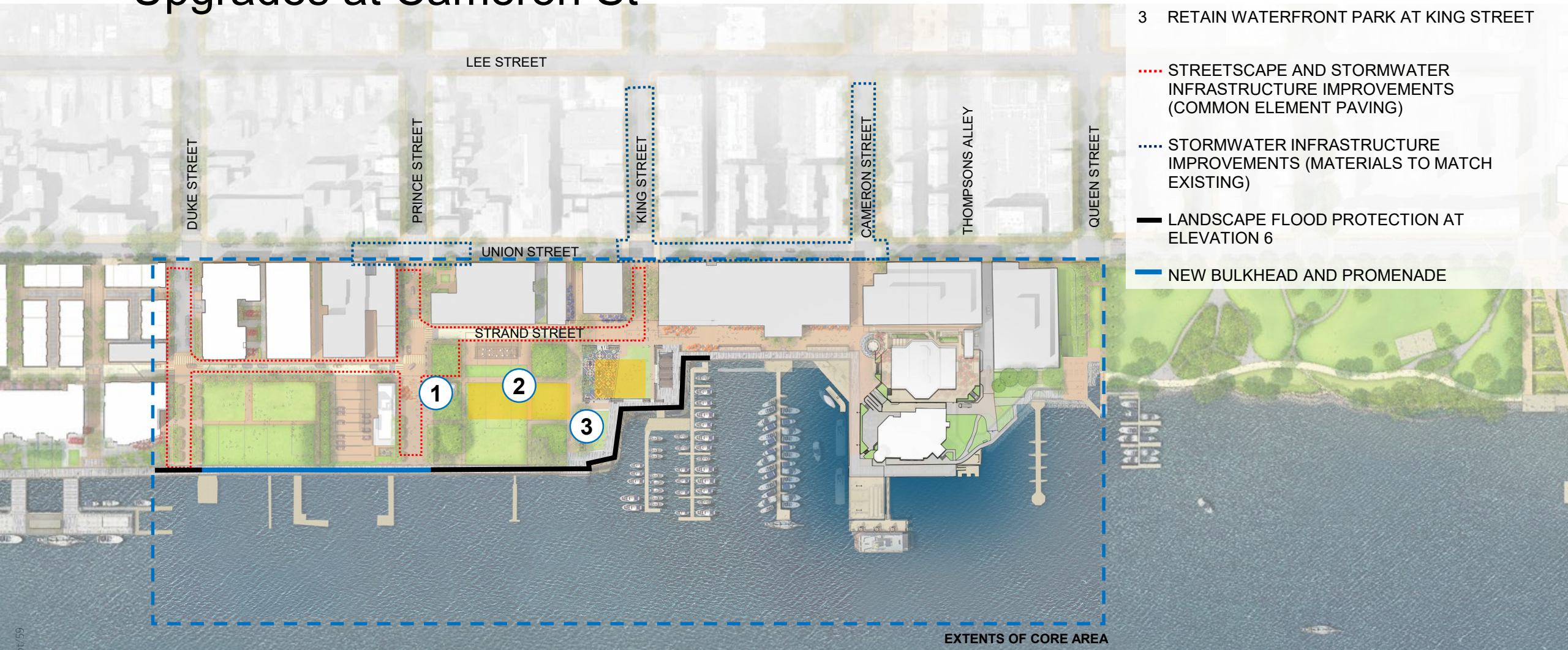
NEW BULKHEAD WITH PROMENADE

// Project Expectations

- Does not meet flood mitigation goals from Duke to King Street

- No improvements north of King to Queen Street, including stormwater infrastructure and pumping stations, new bulkhead or Thompsons Alley Park

// A Potential for Improvement Adds Stormwater Upgrades at Cameron St



LEGEND

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STORMWATER INFRASTRUCTURE IMPROVEMENTS (MATERIALS TO MATCH EXISTING)

LANDSCAPE FLOOD PROTECTION AT ELEVATION 6

NEW BULKHEAD AND PROMENADE

Revised Cost-Based 2

// A Potential for Improvement Redirects More Street Flooding due North along Union St

LEGEND

1 PUMP STATION

2 UNDERGROUND STORMWATER DETENTION CHAMBERS

3 RETAIN WATERFRONT PARK AT KING STREET

STREETSCAPE AND STORMWATER INFRASTRUCTURE IMPROVEMENTS (COMMON ELEMENT PAVING)

STORMWATER INFRASTRUCTURE IMPROVEMENTS (MATERIALS TO MATCH EXISTING)

LANDSCAPE FLOOD PROTECTION AT ELEVATION 6

NEW BULKHEAD AND PROMENADE

DEPLOYABLE FLOOD BARRIER

GRADING IMPROVEMENTS (MATERIALS TO MATCH EXISTING)

Revised Cost-Based 2