NAVFAC
Naval Facilities Engineering Command

Climate Change Planning Handbook
Installation Adaptation and Resilience

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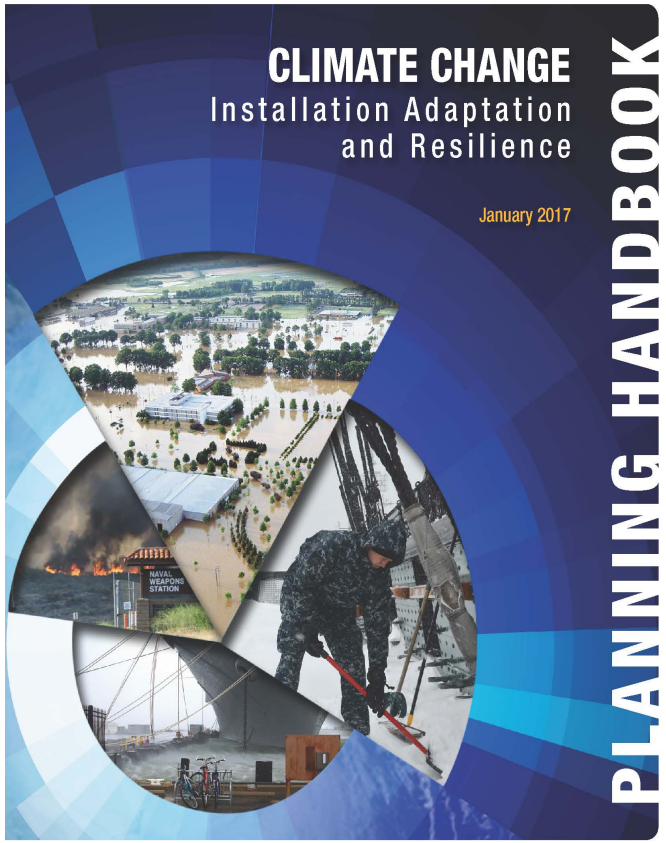
SYMPOSIUM
2018 | Enhancing DoD's Mission Effectiveness

Outline

- About the Handbook
- Highlights of each stage
- Integration of the Results



About the Handbook

Challenges

- Rapid release of new and changing directives outpacing institutional ability to respond
- Myriad of data, models, and report findings difficult to navigate

Objectives

- Provide a structured step-by-step process to help planners understand **how** to incorporate climate change considerations into their plans and projects
- Help planners assess when and what analytical methods, tools and data sets may be helpful during different stages of analysis.

Target Audience

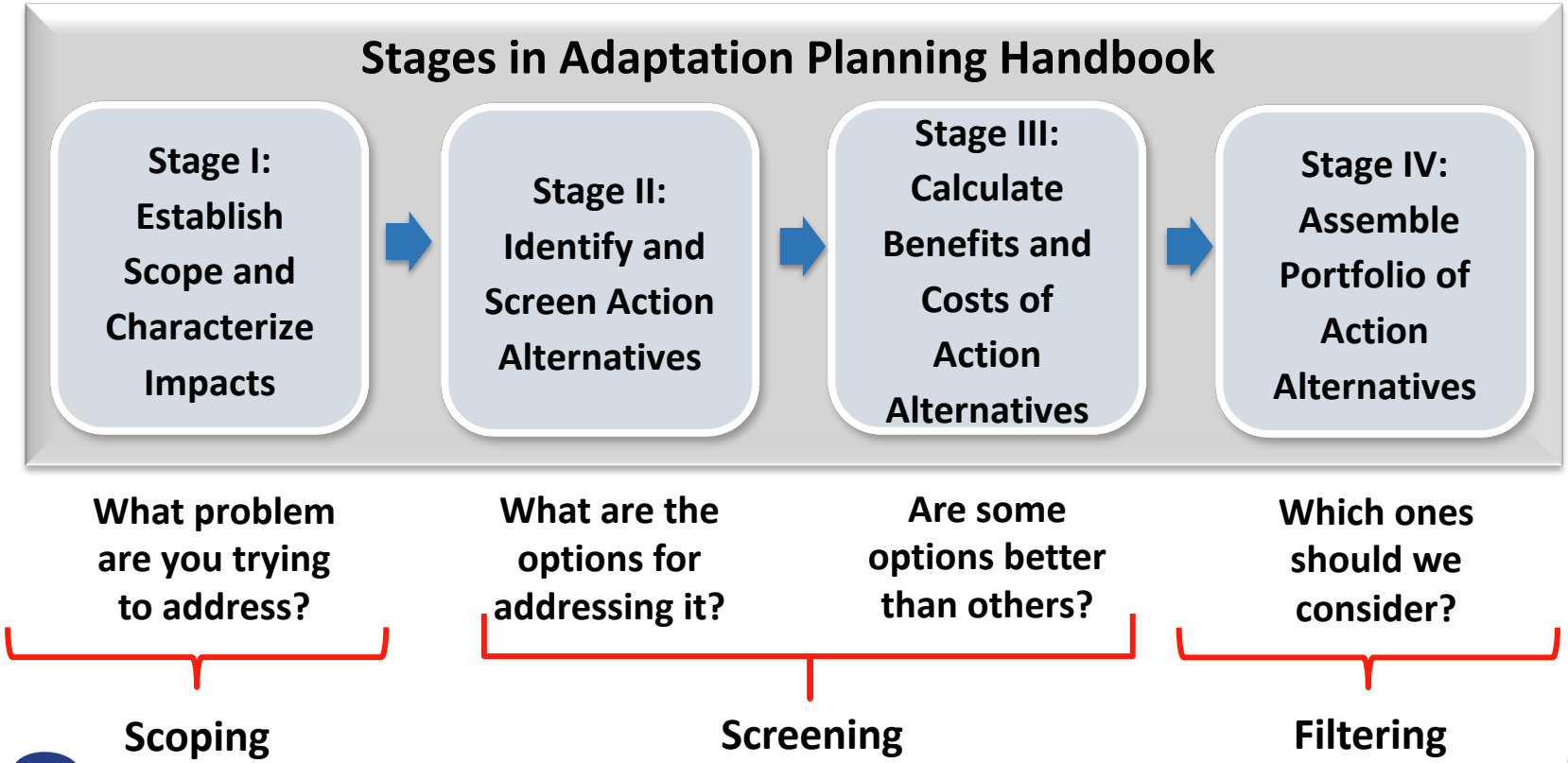
- Installation and facility planners

Intended Use

- Serve as a companion desktop aid throughout the Installation Development Planning process

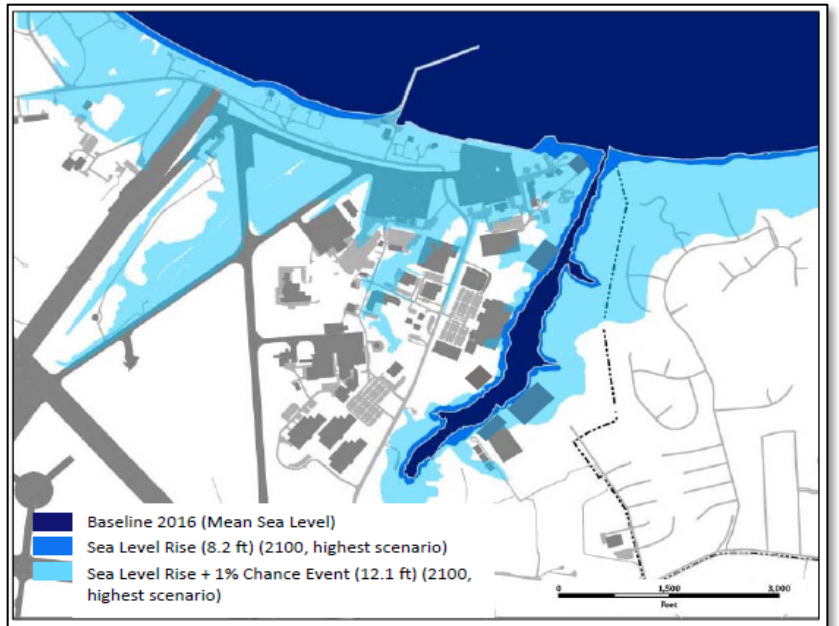
Organization

- Two Parts:
  - Main body: Stable, enduring framework, process driven
  - Appendices: Dynamic, evolving, data driven



Design Features – Illustrations & Worksheets

Process illustrated spatially with notional installation example throughout



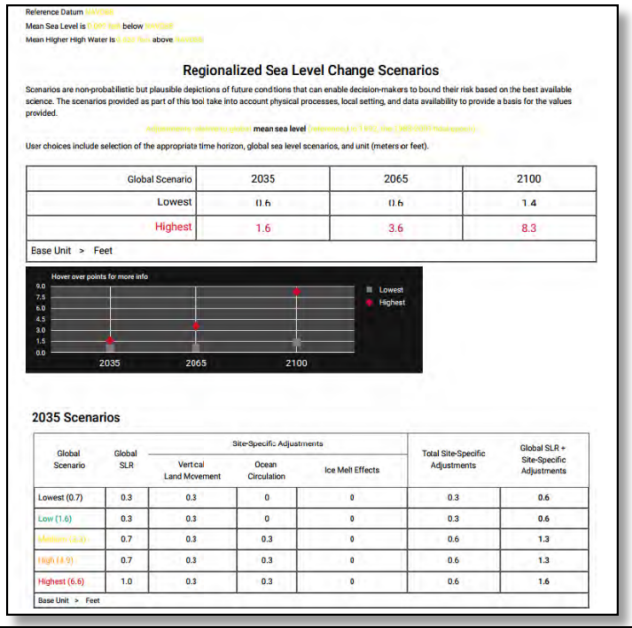
Permanent Inundation Impacts from Sea Level Rise (8.2 ft):

- Loss of 1000 linear feet (LF) of roadway
- Inundation of 80,000 square feet (sq ft) of building basements and 50,000 sq ft of building first floors [Hospital, Headquarters (HQ) Complex, several Research, Development, Test, and Evaluation (RDT&E) facilities]
- Impaired drainage and system outages due to stormwater outfalls #3 and #4 underwater
- Inundation of 125 acres of freshwater marsh

Baseline and Climate data: DoD Regionalized Sea Level Change and Extreme Water Scenarios Database, accessed 9/1/16
Elevation data: USGS Sandy Restoration Hydro Flattened LiDAR DEM, 2015
Modeling performed by G. Wizard on 9/10/16
Note: all figures adjusted to align to reference datum, see Worksheet I.5.

Flooding Impacts when 1% Annual Chance Event (3.9 ft) added to Sea Level Rise (total = 12.1 ft)

- Impacts noted above, plus
- Temporary flooding of: additional 300,000 sq ft of building basements; 200,000 sq ft of building first floors; 3 taxiways with 1.2 M sq ft and aprons with 243,000 sq ft
- Debris accumulation on several roads, limiting access; additional 5,000 LF of roadway subject to wave erosion damage; stormwater outfall #10 would be below flood stage, impairing drainage.



Reference Datum
Mean Sea Level is below
Mean Higher High Water is above

Regionalized Sea Level Change Scenarios

Scenarios are non-probabilistic but plausible depictions of future conditions that can enable decision-makers to bound their risk based on the best available science. The scenarios provided as part of this tool take into account physical processes, local setting, and data availability to provide a basis for the values provided.

mean sea level

User choices include selection of the appropriate time horizon, global sea level scenarios, and unit (meters or feet).

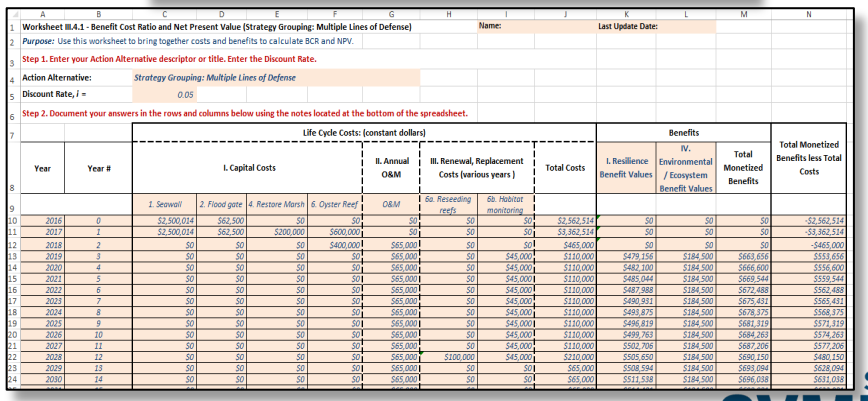
Global Scenario	2035	2065	2100
Lowest	0.6	0.6	1.4
Highest	1.6	3.6	8.3

Base Unit > Feet

2035 Scenarios

Global Scenario	Global SLR	Site-Specific Adjustments: Vertical Land Movement	Site-Specific Adjustments: Ocean Circulation	Site-Specific Adjustments: Ice Melt Effects	Total Site-Specific Adjustments	Global SLR + Site-Specific Adjustments
Lowest (0.7)	0.3	0.3	0	0	0.3	0.6
Low (1.6)	0.3	0.3	0	0	0.3	0.6
Medium (3.0)	0.7	0.3	0.3	0	0.6	1.3
High (4.9)	0.7	0.3	0.3	0	0.6	1.3
Highest (6.6)	1.0	0.3	0.3	0	0.6	1.6

Base Unit > Feet



Worksheet III.4.1 - Benefit Cost Ratio and Net Present Value (Strategy Grouping: Multiple Lines of Defense) Name: Last Update Date:

Purpose: Use this worksheet to bring together costs and benefits to calculate BCR and NPV.

Step 1. Enter your Action Alternative descriptor or title. Enter the Discount Rate.

Action Alternative: *Strategy Grouping: Multiple Lines of Defense*

Discount Rate, *i* = 0.05

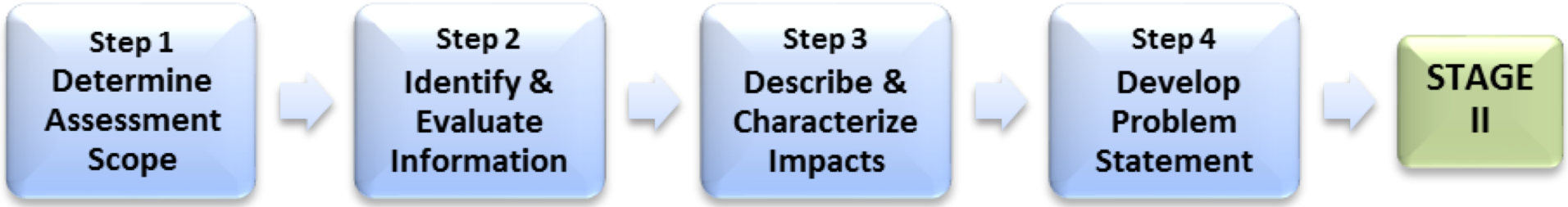
Step 2. Document your answers in the rows and columns below using the notes located at the bottom of the spreadsheet.

		Life Cycle Costs: (constant dollars)								Benefits			
Year	Year #	I. Capital Costs				II. Annual O&M	III. Renewal, Replacement Costs (various years)		Total Costs	I. Resilience Benefit Values	IV. Environmental / Ecosystem Benefit Values	Total Monetized Benefits	Total Monetized Benefits less Total Costs
		1. Seawall	2. Flood gate	4. Restore Marsh	6. Oyster Reef	O&M	6a. Reseeding reefs	6b. Habitat monitoring					
2016	0	$2,500,014	$62,500	$0	$0	$0	$0	$0	$2,562,514	$0	$0	$0	-$2,562,514
2017	1	$2,500,014	$62,500	$200,000	$600,000	$0	$0	$0	$3,362,514	$0	$0	$0	-$3,362,514
2018	2	$0	$0	$0	$400,000	$65,000	$0	$0	$465,000	$0	$0	$0	-$465,000
2019	3	$0	$0	$0	$0	$65,000	$0	$45,000	$110,000	$479,156	$184,500	$663,656	$553,656
2020	4	$0	$0	$0	$0	$65,000	$0	$45,000	$110,000	$482,100	$184,500	$666,600	$556,600
2021	5	$0	$0	$0	$0	$65,000	$0	$45,000	$110,000	$485,044	$184,500	$669,544	$559,544
2022	6	$0	$0	$0	$0	$65,000	$0	$45,000	$110,000	$487,988	$184,500	$672,488	$562,488
2023	7	$0	$0	$0	$0	$65,000	$0	$45,000	$110,000	$490,931	$184,500	$675,431	$565,431
2024	8	$0	$0	$0	$0	$65,000	$0	$45,000	$110,000	$493,875	$184,500	$678,375	$568,375
2025	9	$0	$0	$0	$0	$65,000	$0	$45,000	$110,000	$496,819	$184,500	$681,319	$571,319
2026	10	$0	$0	$0	$0	$65,000	$0	$45,000	$110,000	$499,763	$184,500	$684,263	$574,263
2027	11	$0	$0	$0	$0	$65,000	$0	$45,000	$110,000	$502,706	$184,500	$687,206	$577,206
2028	12	$0	$0	$0	$0	$65,000	$100,000	$45,000	$210,000	$505,650	$184,500	$690,150	$480,150
2029	13	$0	$0	$0	$0	$65,000	$0	$0	$65,000	$508,594	$184,500	$693,094	$628,094
2030	14	$0	$0	$0	$0	$65,000	$0	$0	$65,000	$511,538	$184,500	$696,038	$631,038

Key references, and sample worksheets linked to exercises for each step

Contents for each Stage

Stage I - Workflow Diagram:



Stage Preview:

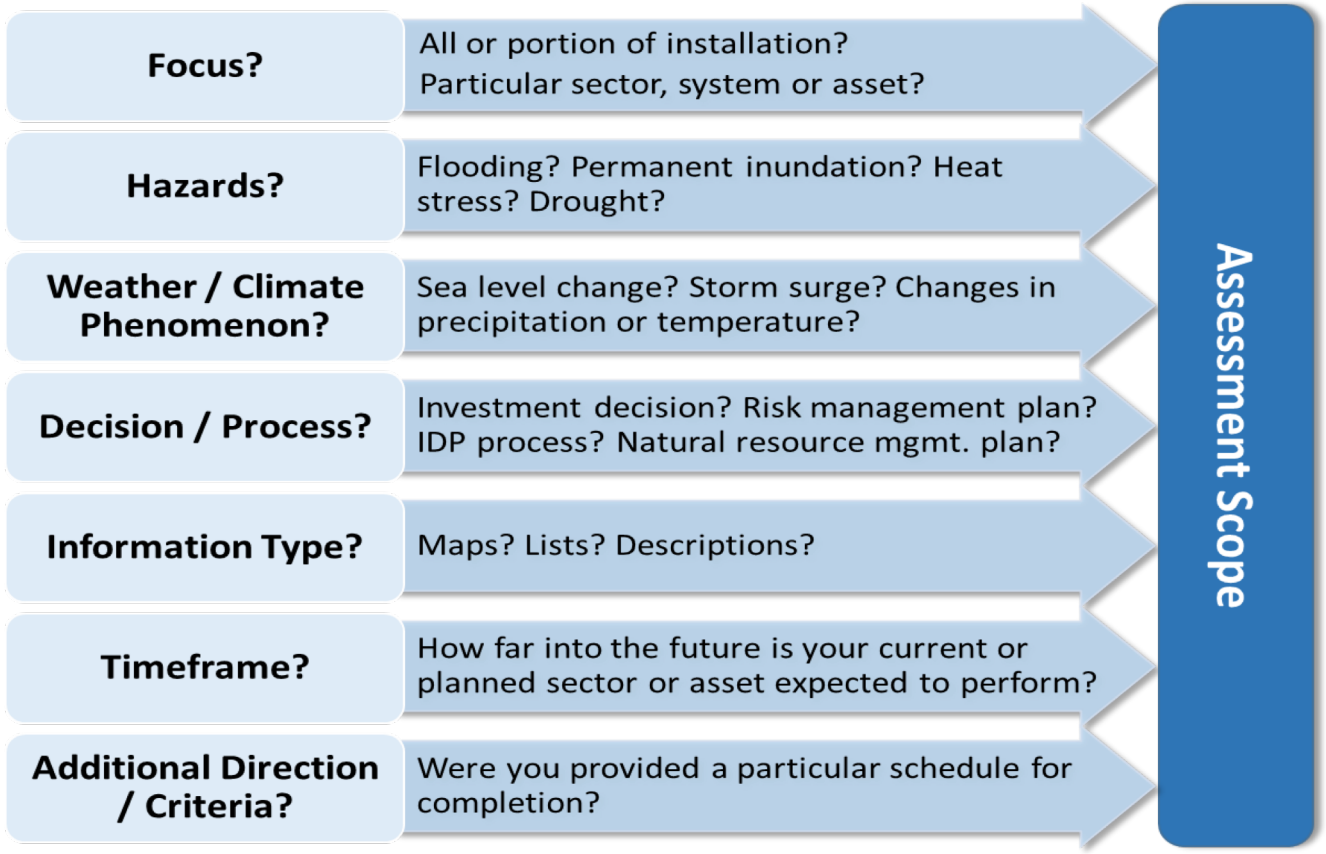
- Introduction
- What you should have before you start
- What resources, skills and tools you may need
- Key concepts you will encounter
- What you will be able to do at the each stage
- Outputs

Step-by-step Instructions:

- Worksheets
- Examples
- Explanations

Stage I - Establish Scope and Characterize Impacts

Step 1
Determine Assessment Scope



EXAMPLE: Given the stated assumptions in Worksheet I.1, determine how we can protect the installation infrastructure from damage due to flooding and permanent inundation over the next 100 years

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Stage II – Identify & Screen Action Alternatives

Tools and Guidance:

- Fact Sheets to assist in identifying alternatives
- Concepts to assist in selecting alternatives
- Worksheet to organize information about alternatives

Stage II – Identify & Screen Action Alternatives

Structural Adaptation Approaches

Off-shore Breakwater

Storm Surge Barrier

Levee

Revetment

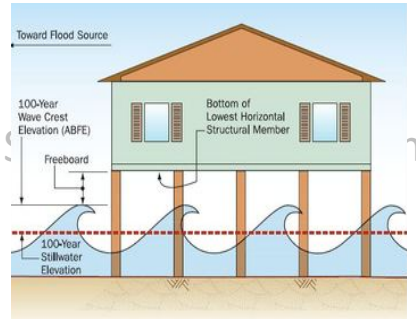
Seawall

Natural and Nature-based Adaptation Approaches

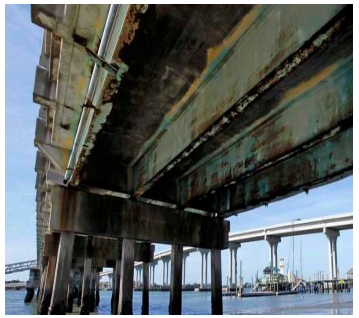
Preserve, Restore, and Mimic Natural Coastal Defenses (Marsh, Mangrove, Beach/Dune, Reef, Barrier Island)

Stage II – Identify & Screen Action Alternatives

Facilities Adaptation Approaches



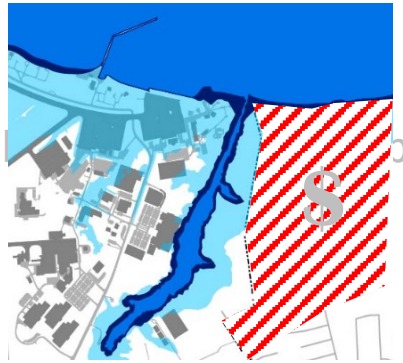
Wet and Dry Flood Proofing



Relocate/Modify Vulnerable Components

Small-scale Structures

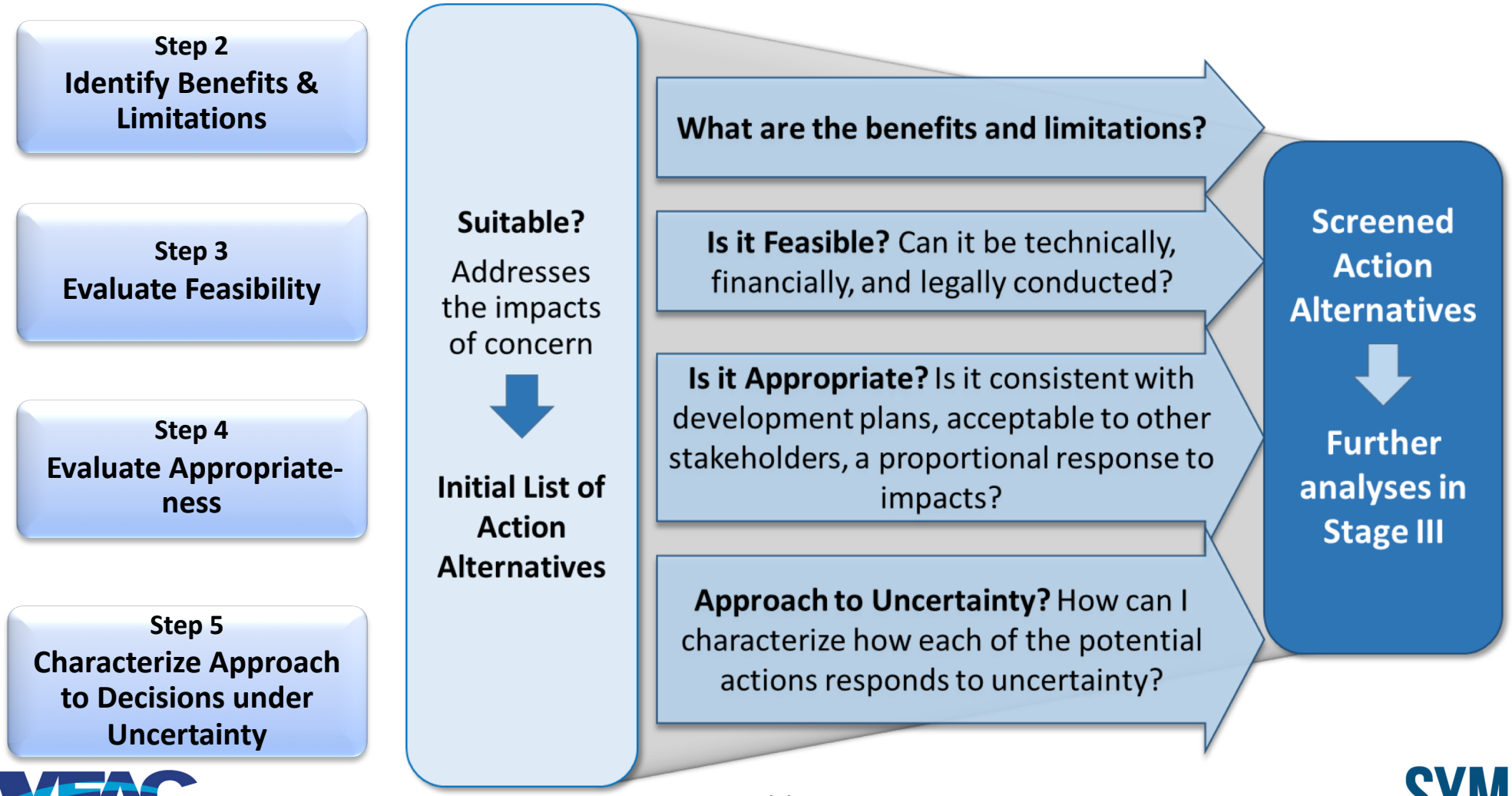
Non-facilities Adaptation Approaches



Land-use, Real Estate, and Community Coordination

Modified Maintenance Routines

Stage II – Identify & Screen Action Alternatives



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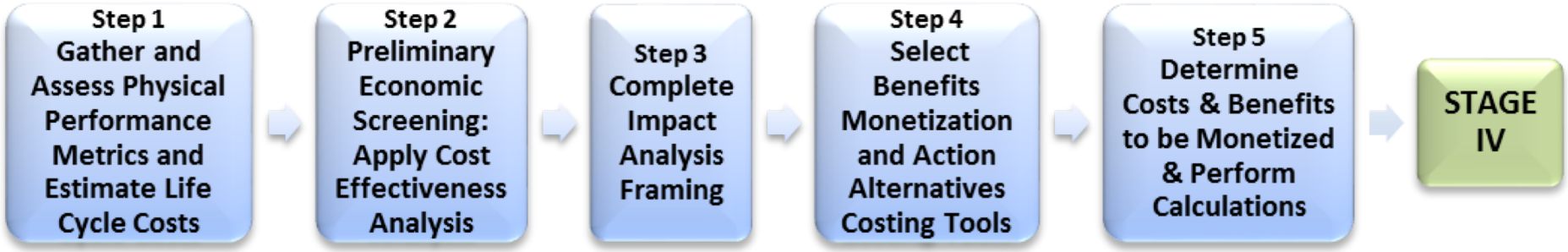
Stage III – Calculate Benefits & Costs of Action Alternatives



What information do I need?

Which options are most cost effective?

What is involved in a deeper level of analysis?

What metrics can be used to distinguish options?

Tools and Guidance:

- Economic Analysis Tools and Resource Fact Sheets
- Conceptual Costing Tools
- Benefit Monetization Tools

Stage III – Calculate Benefits & Costs of Action Alternatives

Step 2
Preliminary Economic Screening: Apply Cost Effectiveness Analysis

- Measures the **relative** merit of the alternatives under consideration
- Helps eliminate from further economic analysis alternatives with higher costs per level of protection.

Cost / Units protected = Cost/Unit

Action Alternatives	NPV Life Cycle Costs of Action Alternatives	Performance Metric (Square feet of buildings protected)	Cost per Unit	
Alt 1 Seawall	*$5,776,874*	*1,200,000*	*$ 4.81*	
Alt 2 Flood gate	*$144,421*	*600,000*	*$0.24*	**Lowest Cost/Unit**
Alt 3 Breakwater	*$6,500,000*	*600,000*	*$10.83*	
Alt 4 Restore Marsh	*$225,438*	*500,000*	*$0.45*	
Alt 6 Oyster reef	*$1,535,642*	*1,200,000*	*$1.28*	
Alt 7 Relocate HQ Complex	*$15,000,000*	*600,000*	*$25.00*	**Highest Cost/Unit**
Alt 8 Increase maintenance of drainage system	*$15,000,000*	*2,250,000*	*$6.67*	

Costs as much as the highest but protects 3 times as many assets

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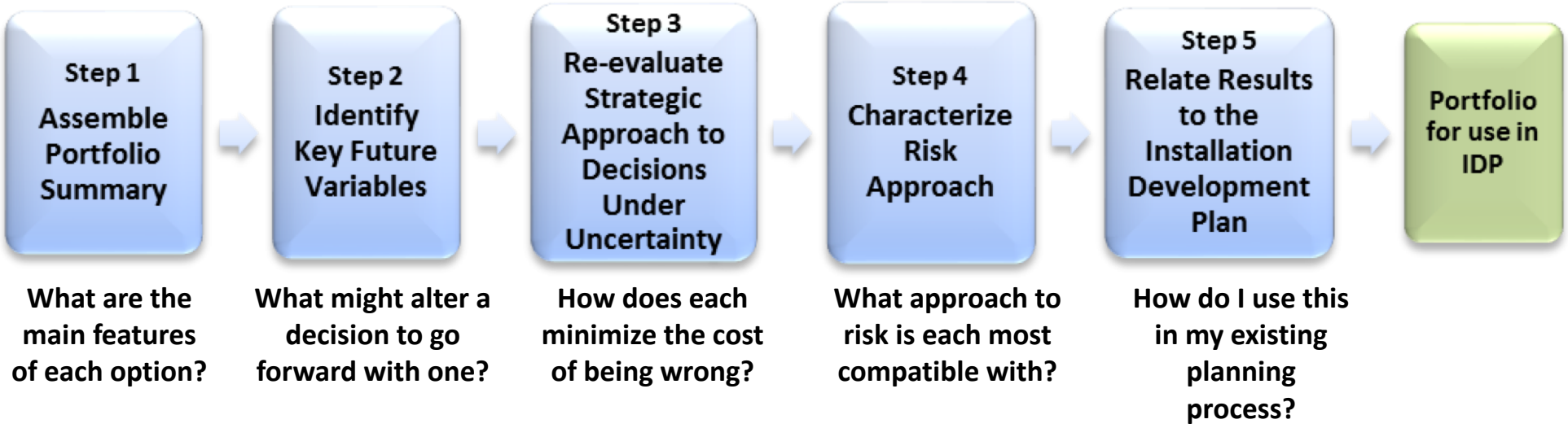
Stage III – Calculate Benefits & Costs of Action Alternatives

Step 3
Complete Impact Analysis Framing

- Identify the types of **benefits** for each action alternative
  - Avoided Damages (also known as "resilience benefits")
  - Economic Benefits
  - Installation/Community Benefits
  - Environmental/Ecosystem Benefits
  - Intangibles
- Frame the benefits in monetized terms

Year	Yr #	I. Resilience Benefit Values					II. Economic Revitalization Benefit Values	III. Installation / Community Benefit Values	IV. Environmental / Ecosystem Benefit Values	V. Other Benefits / Intangibles Values	VI. Total Benefits
		a. Avoided damages to structures.	*b. Avoided damages to building contents*	*c. Avoided damages to vehicles*	*d. Avoided damages to critical infrastructure*	*e. Other avoided damages*					
2016	*0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*
2017	*1*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*
2018	*2*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*
2019	*3*	***$270,825***	*$67,706*	*$20,625*	*$120,000*	*$0*	*$0*	*$0*	*$184,500*	*$0*	*$663,656*
2020	*4*	*$273,180*	*$68,295*	*$20,625*	*$120,000*	*$0*	*$0*	*$0*	*$184,500*	*$0*	*$666,600*
2021	*5*	*$275,535*	*$68,884*	*$20,625*	*$120,000*	*$0*	*$0*	*$0*	*$184,500*	*$0*	*$669,544*

Stage IV – Assemble Portfolio Summary

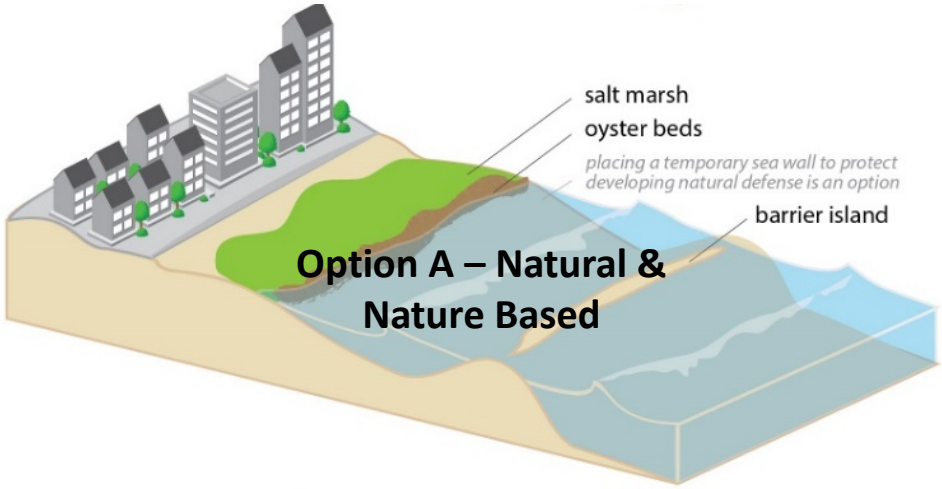


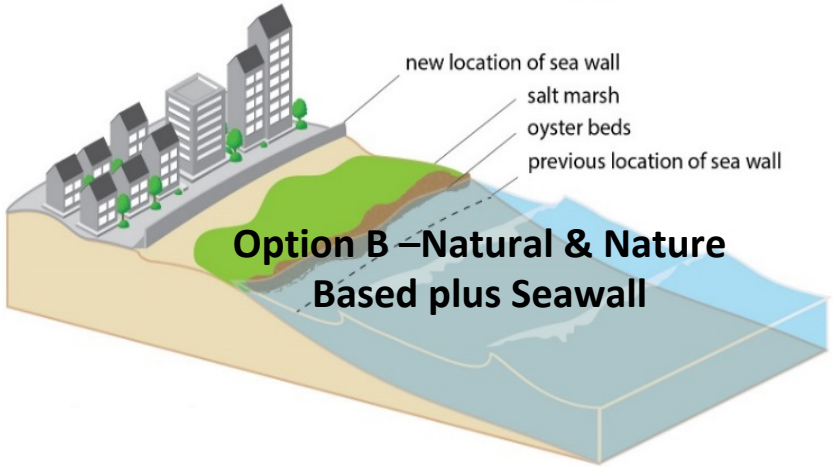
Apply different **filters** to assemble alternative Portfolios of Action Alternatives

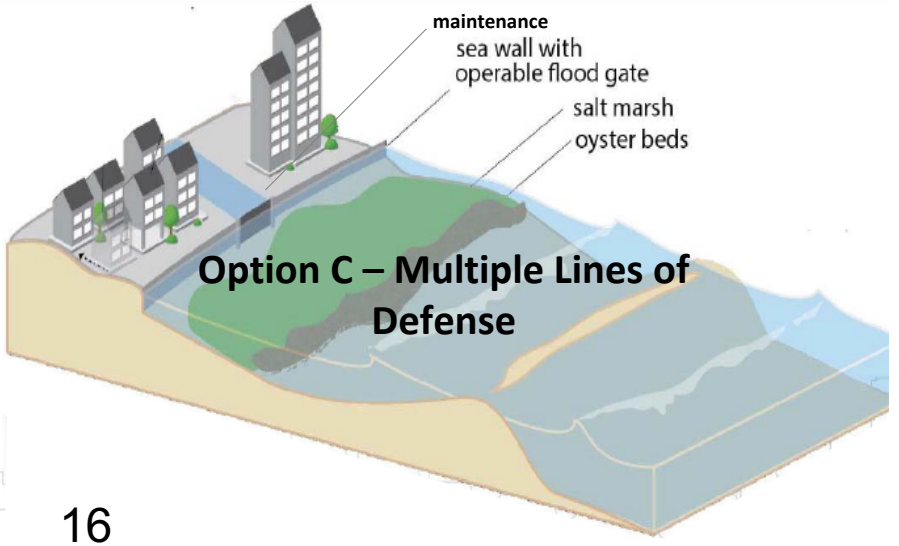
- Capture Synergies
- Investment Strategy
- Risk Management Strategy

Stage IV – Assemble Portfolio Summary

Package alternatives into portfolios to be considered during the Installation Development Planning (IDP) alternatives analysis process.







Integrate into the Installation Planning Process

Step 5
Relate Results to the Installation Development Plan