Climate Change Adaptation

Maryland State Highway Administration

January 24, 2011

Maryland Climate Action Plan

- **Maryland Climate Action Plan**
  - **Required by Governor's Executive Order (January 2007) - Released August 2008**
  - **Eight Strategies related to Transportation & Land Use assigned to MDOT as lead agency, evaluated in multi-modal working groups**
  - **Requires SHA to develop a Climate Action Plan to address potential impacts to SHA assets**
  - **Annual progress reports are presented to Governor O'Malley every November**

Maryland Climate Change Commission

- Adaptation and Response Working Group
  - Department of Natural Resources
  - Department of Planning
- Greenhouse Gas & Carbon Mitigation Working Group
  - Department of the Environment
  - Department of Energy
- Scientific and Technical Working Group
  - Department of the Environment
  - Department of Natural Resources

SHA Climate Adaptation Team Goals

The Climate Adaptation Team (CAT) goals are to:

- **Adopt and implement a SHA-wide climate change adaptation program**
- **Utilize mitigation strategies in development of the CTP**

Preparing for Climate Change

- **Mitigation - measures to reduce greenhouse gas emissions**
  - **Highway System Efficiency**
  - **Reduced Fuel & Energy Use**

- **Adaptation - Natural or man-made adjustments or actions to accommodate or reduce the adverse consequences of climate change**
  - **Protect, Strengthen, Elevate or move critical infrastructure**
  - **Abandon & Disinvest**
  - **Enhance Redundancy**

MITIGATION

Highway System Efficiency

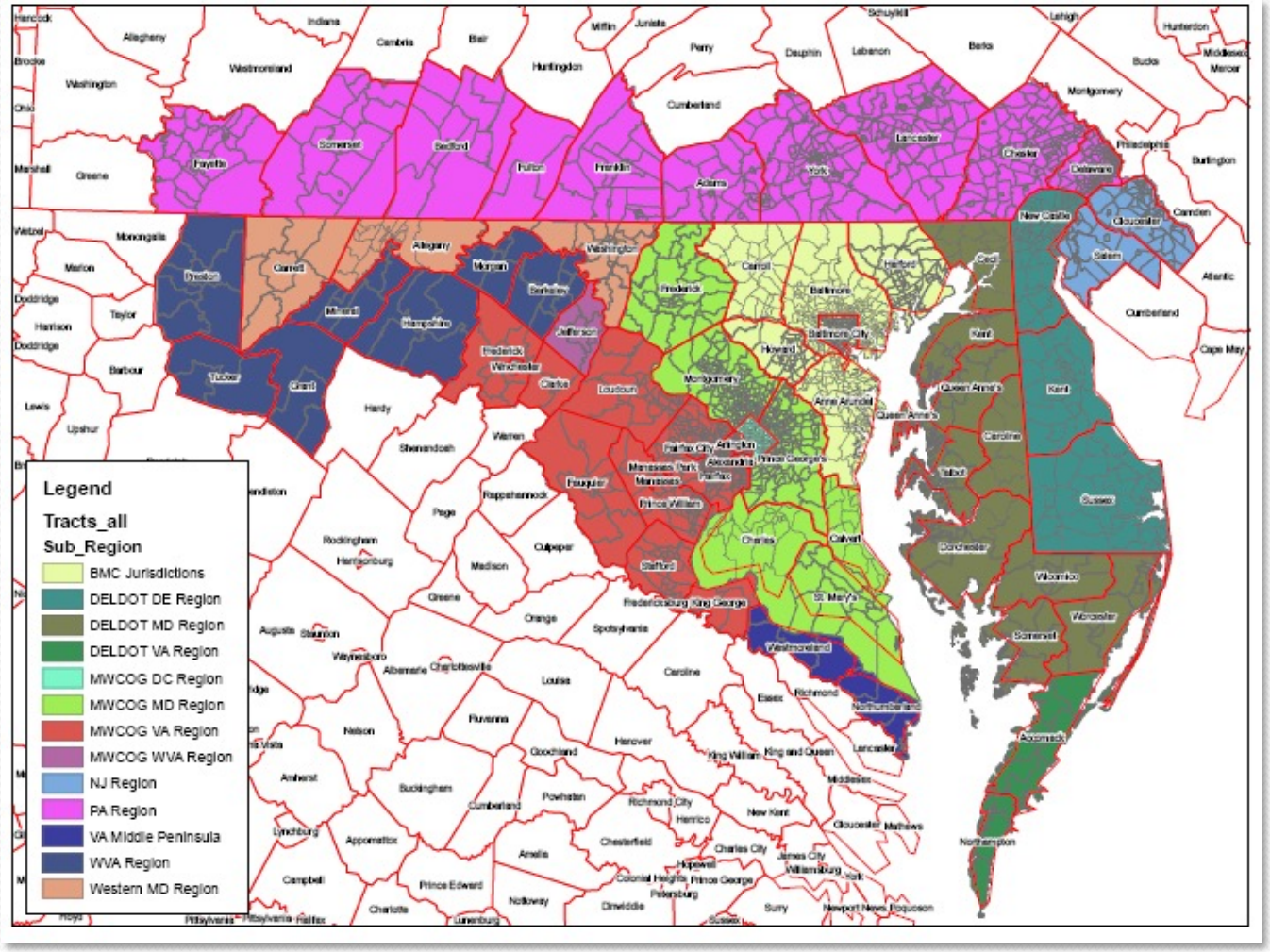
What does this really mean?

Better mobility equals better air quality

- **Focusing on keeping cars moving (TSM/TDM)**
- **ITS and managed lane strategies**
- **Moving people**
- **Mode shifts**
- **Restructuring capacity (lane widths)**
- **Recurring congestion vs. non-recurring**

Highway System Efficiency

MD Statewide Transportation Model (MSTM)

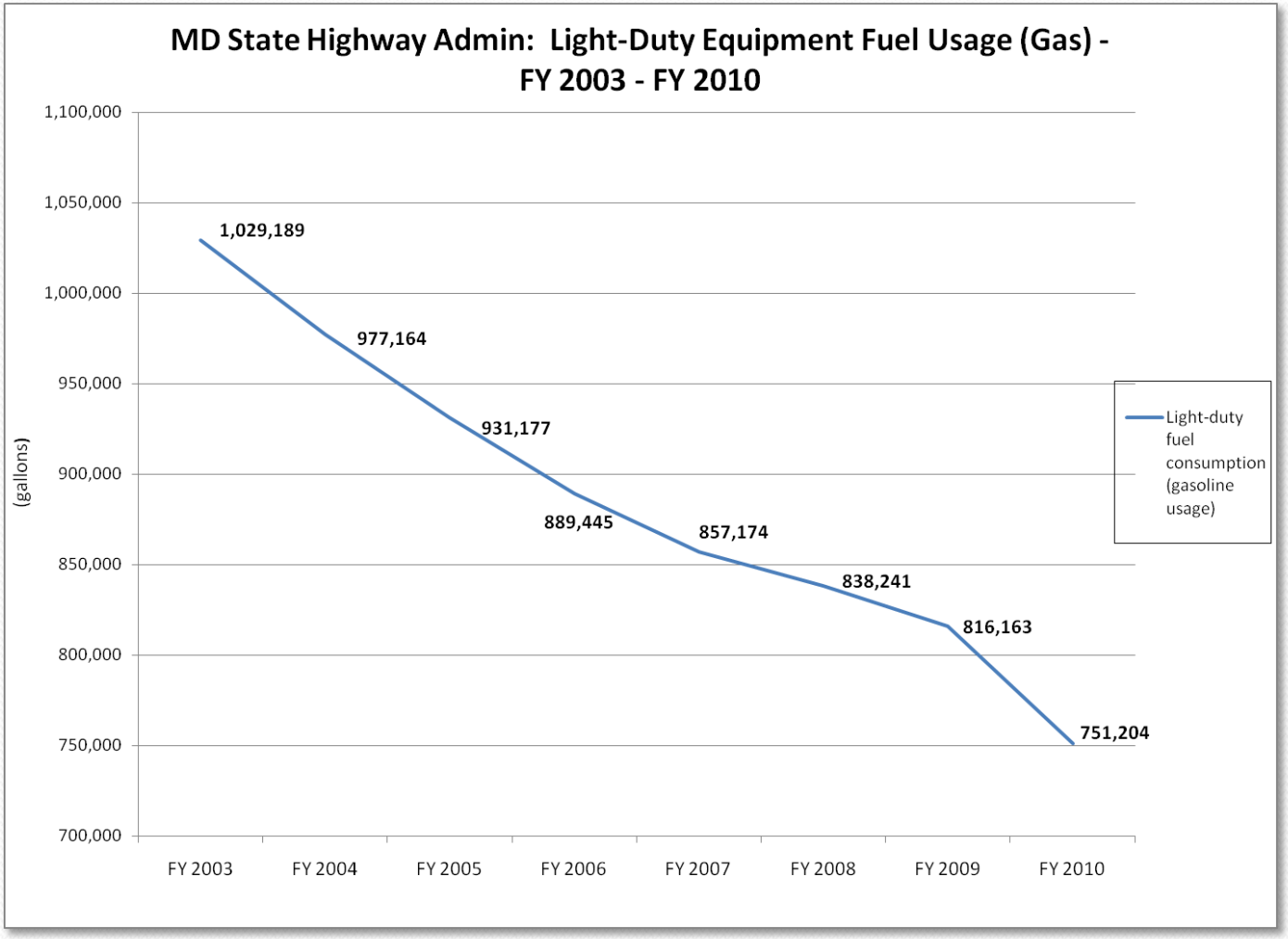


Highway System Efficiency

CHART Air Quality Data

Summary of CHART Benefits (2006-2009)					
Reduction due to CHART		**2006**	**2007**	**2008**	**2009**
Delay (Million Vehicle-hours)	Truck	2.456	2.66	2.09	1.68
	Car	35.09	33.32	29.57	30.75
Total Delay (Million Vehicle-hours)		37.54	35.98	31.66	32.43
Fuel Consumption (Million Gallons)		6.34	6.07	6.39	6.23
Emission (Tons)	HC	490.72	470.41	413.87	424.00
	CO	5,511.54	5,283.47	4,648.42	4,762.25
	NO	235.02	225.29	198.21	203.07
	CO_2	N/A	N/A	58,977.67	57,098.97

SHA Light-Duty Fuel Usage



SHA Heavy Equipment

Continue to:

- **Increase use of alternative fuels**
- **Improve alternative fuel distribution systems**
- **Make scheduled fleet replacements with higher efficiency vehicles**
- **Track carbon footprint data for fleet fuel use**

Develop calculation methods and implement tracking of carbon footprint data for heavy equipment

Improved Construction Performance

- **May 4, 2010 - SHA adopted Truck Staging and Idling Requirements**
- **Incorporate SHA idling policy into contract specifications**
- **Provide contractor incentives to increase use of alternative fuels**
- **Improve quality or type of turf installed to sequester maximum nitrogen and carbon**

ADAPTATION

Predicted Climate Changes

Change	Near Term (20 Years)	Mid-Century (40 Years)	End-of Century (90 Years)
Δ Annual Mean Temperature °F	2.5°F	3.8 - 4.8°F	5.4 - 9.0°F
Δ Number of Days with temperature = or> 100°F	1-4 days	4-9 days	9-14 days 14-28 days (under high emissions)
Δ Annual Total Precipitation	6.00%	8.0 -11.0%	11 -17%
Annual Amount of Precipitation (currently @ 41.84 inches)	45 inches	48.6 inches	50.85 inches
Δ Storm Intensity Increase in Average amount of rainfall per rainy day event	-	8-9%	12-15%
Δ Annual Frequency of 2 Year Rainfall Event 3.5 inches/24hours*	50%	54%	57%
Δ Annual Frequency of 10 Year Rainfall Event 4.5 - 5.5 inches/24 hours*	10%	11%	12%
Δ Frequency of 100 Year Coastal Flood Event	1 in 100	1 in 80 to 1 in 40	1 in 20 to 1 in 2
Δ Sea Level Increase**	2 - 5 inches	1 - 2 feet	3 - 6.5 feet
Likely Regionally Influenced Increases	-	2-3 inches	+5.9 - 8.3 inches
Δ Storm Surge Depth	-	+/- 20 inches	+ /- 40 inches

**Calculated using Δ Storm Intensity predictions for North Eastern United States.*
***Does not include Regional Influences*

Anticipated Changes

Highway Systems & Engineering must Adapt Assets for:

- Increased Temperature
- Increased Precipitation in Spring Months
- More days over 100 degrees F in Summer Months
- Variety of forms of precipitation
- Increased Storm Frequency & Intensity
- Stronger Hurricanes
- Storm surge
- Increased 100-Year Event Frequency
- Sea-level Rise

Consequences of Climate Change

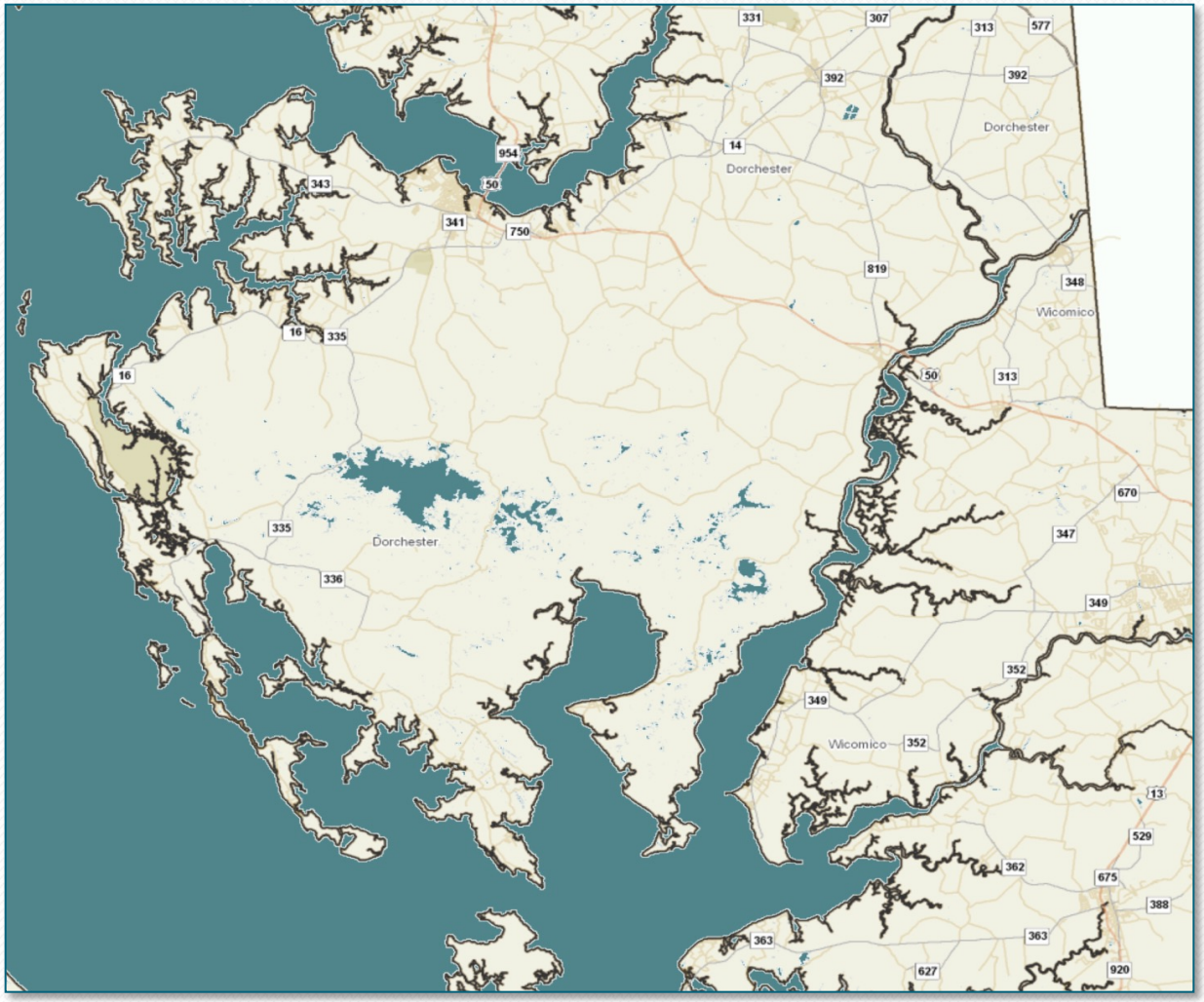
Highway Systems & Engineering must Adapt Assets for :

- Pavement rutting & buckling
- Increased precipitation (spring rain & winter snow)
- More frequent and costly evacuations
- Scouring of bridge foundations & failure of bridge decks
- Flooding, Increased 100-Year storm frequency (every 20 years), Power Loss, Traffic Disruptions
- Sea-level Rise Inundation of Coastal areas

SHA Risk Policy

- **Adaptation – Build into Project Development Process**
  - **Policy to cover not what to adapt to but when to adapt**
  - **Assess risk and prioritize activities by anticipated impact and whether near- or long-term consequences**
  - **Focus on near-term impacts with low variability of occurrence**

Vulnerable Land
Dorchester County Maryland



Vulnerable Land in Dorchester County Maryland

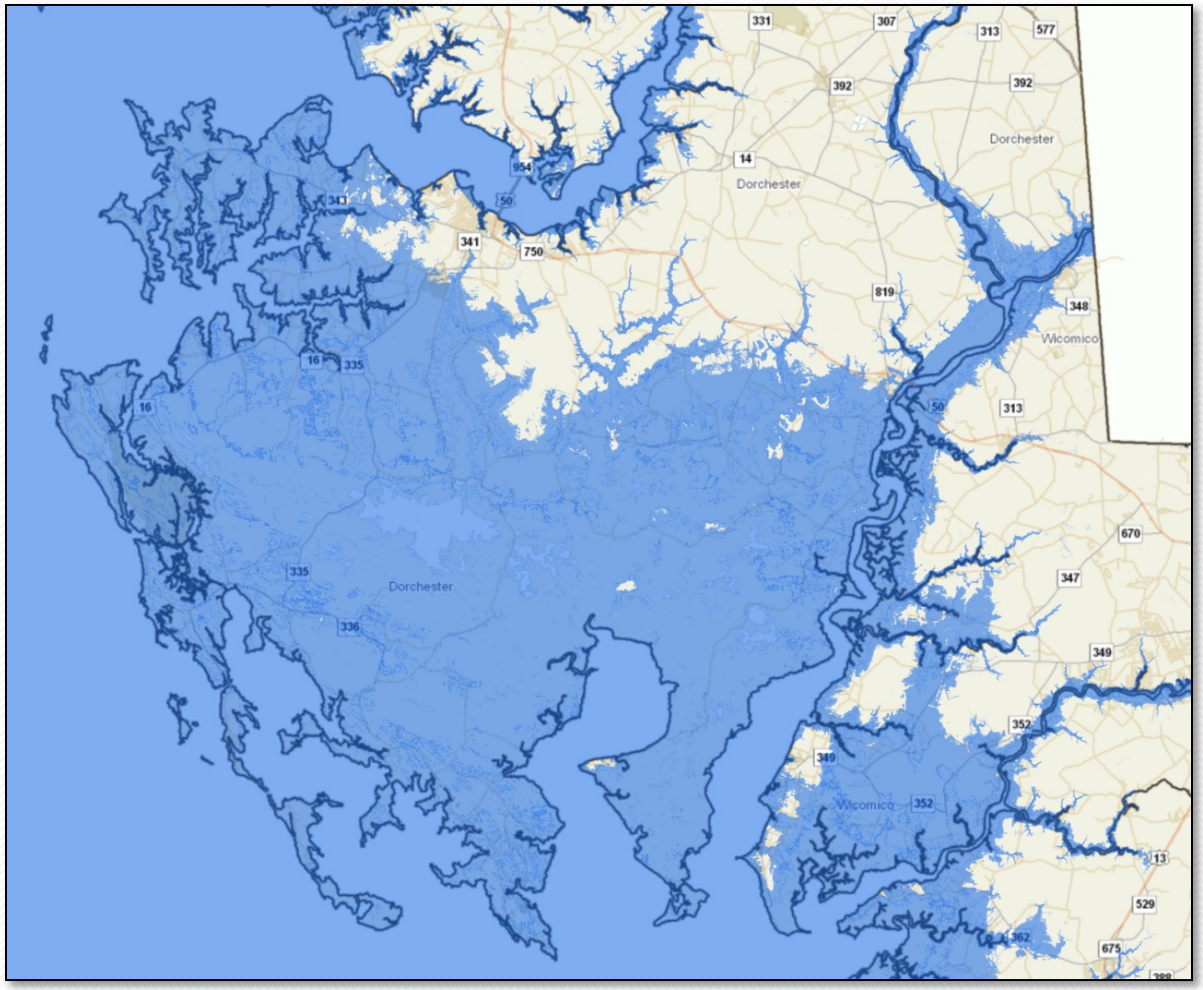
2 feet of Sea-Level Rise

Vulnerable Land in Dorchester County Maryland

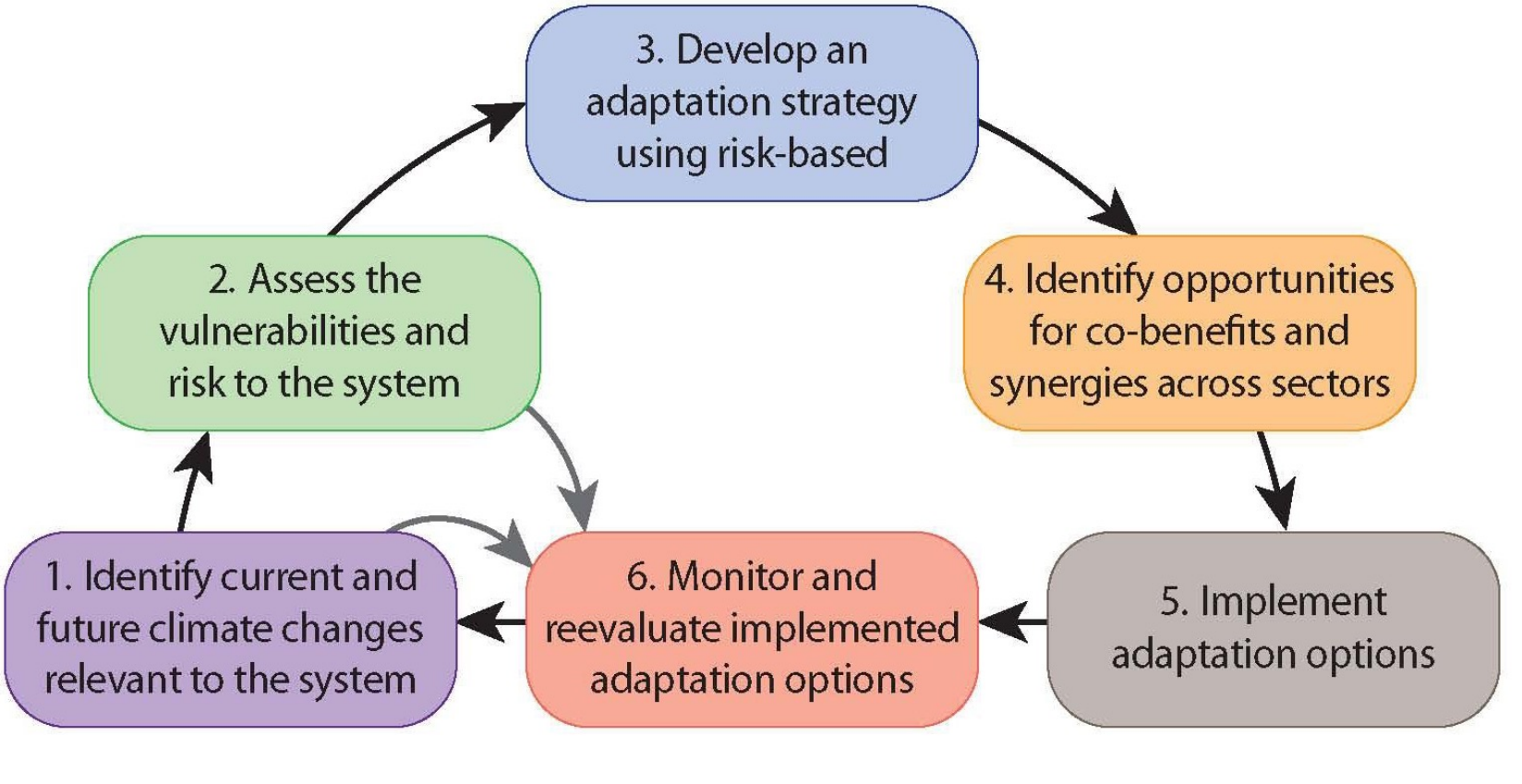
5 ft. feet of Sea-Level Rise

Vulnerable Land in Dorchester County Maryland

10 ft. feet of Sea-Level Rise

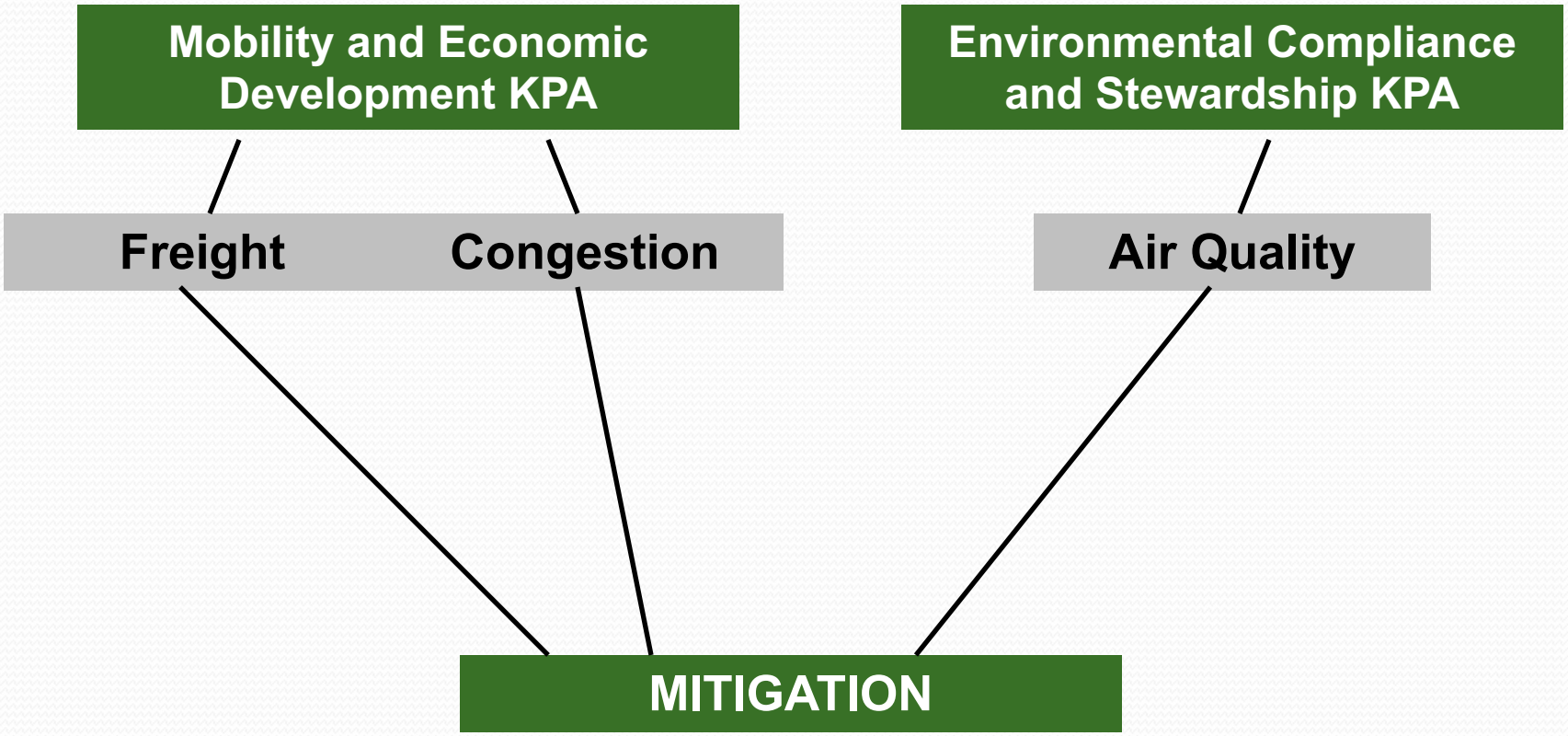


Adaptation Planning Process



http://onlinepubs.trb.org/onlinepubs/webinars/AmericasClimateChoicesAdaptationTransportation.pdf

Focus Areas in new Business Plan Development that need to have shared vision on direction strategies, and objectives



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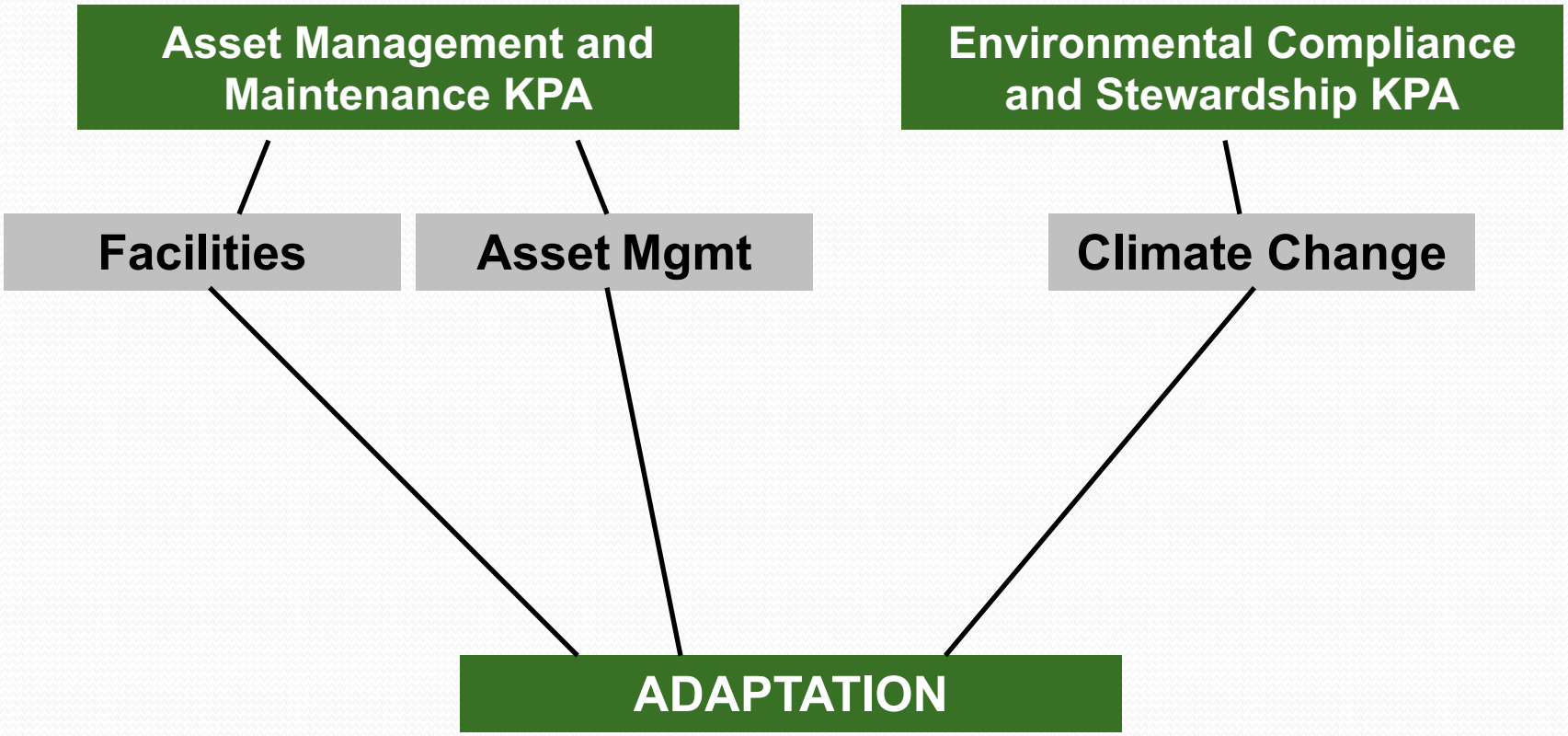

Asset Management

- **Incorporate Climate Change data collection in Transportation Asset Management Program (TAMP) to better analyze priority assets**
  - **Age**
  - **Elevation**
  - **Materials Used**
  - **Design Lifetime and stage of life**
  - **FEMA maps**
  - **Current & historical performance and conditions**
  - **Vegetation Survey**
  - **Soil type**
  - **ADT**
  - **Bridge SR**
  - **Scour criticality**
  - **Length/width of Bridge**

Highway System Vulnerability

- State Maintained Roads requiring further evaluation for impacts due to varying increases in sea-level
  - 2 ft. – 156 miles – 2%
  - 5 ft. – 371 miles – 4.5%
  - 10 ft. – 792 miles – 10%
- Prioritization of assets must consider emergency evacuation planning and system redundancy

SHA Structures Vulnerability

- Planning for Structures with more frequent & severe storms – must consider more than sea-level rise
  - FEMA 100-Year Floodplain indicates 28% of SHA Structures (bridges to culverts) need further impact evaluation
- State Maintained Roads requiring further evaluation for impacts due to varying increases in sea-level
  - 2 ft. – 93 structures – 3.5%
  - 5 ft. – 132 structures – 5%
  - 10 ft. – 196 structures – 7.5%
- Must research & consider new construction and design elements

QUESTIONS

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